The Relationships at Play in Integrating Indigenous Knowledges-Sciences (IK-S) in Science Curriculum: A Case Study of Saskatchewan K-12 Science Curriculum

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A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Doctor of Philosophy (Education)

June 2018

Dedication

For my halmonees (grandmothers), Yang-Rye Park 박양례 and Yong-Soon Lee 이용순 and my umma (mother), Hwa Suk You 유화숙. For their love and living wisdom and for being role models and examples of fierce women who always persevered and strived to live fully each and every day.

Acknowledgements

I would like to begin by expressing my gratitude towards the people who helped me on this re/search journey. Without you, this dissertation would not be possible.

Dr. Steven Jordan, my PhD co-supervisor: for picking up the very first phone call I made to McGill and continuing to push me to be a better writer while giving me much freedom and intellectual space to explore many ideas and never losing his peculiar sense of humour with me. Yes.

Dr. Anila Asghar, my PhD co-supervisor: for being an example of how to stay true to one's self in academia, paving the way and candidly sharing experience and lessons as a first-generation immigrant, women of colour scholar in Education, advising me that "power does not come from a space. You can still sit in the toilet and write," and giving me many hugs when I needed.

Dr. Laara Fitznor, my PhD committee member: for sharing her wisdom, stories, laughs throughout my re/search journey, for pushing me to critically think every word I use as well as reflect on my cultural identities and for always opening her arms and heart to me when I am in a crisis, meeting up for soup, teas and food to listen to my stories.

Dr. Dawn Wiseman, my PhD internal examiner: for allowing me to share my re/search process and experience with her and her students, for sharing her experience as a researcher and for always opening her office door to listen to my on-going struggles being in the *inter esse*.

Dr. Christopher Stonebanks, my PhD external examiner: for agreeing to read this dissertation and (future) feedback that would make me critically reflect on my dissertation as well as my future academic endeavours.

Dr. Glen Aikenhead, for paving the field of Indigenous science education, for sharing his knowledge and experience with me, for showing me how to become a person and an academic that has both 'great mind' and 'great heart.'

My oral defense committee members- Dr. Mindy Carter, Dr. Jessica Ruglis and Dr. Marta Kobiela, Thank you for sharing your time and suggestions for this work.

All my sharers in Saskatchewan: Dr. Glen Aikenhead, Dr. Dean Elliott, Mr. Ted View, Ms. Tina Rioux, Mr. Rory Bergmann, Mr. Darryl Isbister for making headways in, and being examples of engaging with IK-S infused science education from the development of curricula, textbooks and teaching in schools, for sharing their stories, wisdom and time with me and for believing in me that I could do this work. Without you, this project would've never be possible. I can't thank you enough.

All my sharers elsewhere: Dr. Robyn Barnes, Mr. Ken Beardsall, Dr. Marc Higgins, Dr. Brian Lewthwaite, Dr. Micheal Michie, Mr. Tim O'loan and Ms. Michelene Reiniger for their work in reconciliation and making political and educational spaces more inclusive towards Indigenous peoples' way of coming to know, for sharing their time and wisdom with me and allowing me to expand my thinking and understanding around IK-S infused curriculum and the notion of reconciliation in diverse contexts.

Dr. James Sa'ke'j Henderson and Dr. Marie Battiste: for encouraging me to continue my work as an ally and sharing their kind words and wisdom, especially at the conference venues which makes the entire event a learning place for me – both as a human and an academic.

Dr. Jennifer Adams, Dr. Marissa Bellino, Ms. Atasi Das, Ms. Jennifer Stoops, Ms. LaToya Strong and Ms. Pieronna Pieronni a.k.a The Urban Education Coven members: for adopting 'a lost witch' into their coven and their continual support and pushing me to 'keep going.'

Colleagues and Friends from DISE: Dr. Sabrina Jafralie, Mr. Ehaab Abdou, Ms. Neerusha Baurhoo, Ms. Alice Chan, Dr. Alison Crump, Ms. Saba Din, Dr. Maria Ezcurra, Ms. Jennie Ferris, Ms. Sumanthra Govender, Ms. Apple Green, Ms. Sara Hashem, Ms. Elaine Huang, Dr. Limin Jao, Ms. Marcia Malcolm, Ms. Heather McPherson Dr. Stephen Peters, Mr. Costaritinus Yanniris and Ms. Jennifer Wallace: for sharing their friendships, kind words, support, advices, feedback on drafts and making time to meet up for stories, arts, coffee, lunch, dinner, beer (or any alcoholic drinks), and laughter .

Support team from DISE: Mr. Jim Harris, Mr. Micheal Lariviere and Mr. Norman Nadeau: for their support and patience (Thank you! Really!) and saving me from many technical/administrative struggles throughout my PhD journey.

Ms. Shaylene Petiquan for sharing her heart and stories with me throughout the year and for never giving up.

Mr. Philippe Cariter: for translating French abstract for this dissertation, delicious meals, awesome allongés and martinis, continual support and love and push me to make it to the finish line.

Ms. Linda Chen: for creating all the graphics for this dissertation and for our 16 years of friendship.

Dr. Gordon Robinson: for believing in me that I can pursue an academic career from the beginning of my graduate studies journey when no one else (other than my family) did, and for his continual support and kind words.

My family: Dr. Jaehong Kim (But I am the first female Dr. Kim of the house, Dad!), Hwasuk You, EunSun (Sarah) Kim and SungJin (Sean) Kim: for their love and continual support. Without you this will not be even started. Thank you.

I would also like to gratefully acknowledge the Social Sciences and Humanities Research Council (SSHRC) and the Faculty of Education, McGill University, for their financial support for this PhD project.

Abstract

With the final publication of the Truth and Reconciliation Commission (TRC) report in 2015, the landscape of Canadian education is changing to include local Indigenous peoples' knowledges and perspectives for *all* students' learning. Since the 2005 curriculum renewal, the Saskatchewan Ministry of Education has focused on creating Indigenous knowledges-science (IK-S)–infused K-12 science curricula (Aikenhead & Elliott, 2005). In this doctoral project, I explored the question: What are the relationships at play in integrating Indigenous perspectives and content in science curricula in Saskatchewan?

In conceptualizing curriculum as a text, I followed Fairclough's (1989) three-tiered model. As such, this project involved: 1) a *textual* level: analysis of K-12 official curriculum documents; 2) a *discursive* practice level: interviews with diverse stakeholders (e.g., Ministry of Education science education consultants, teachers, First Nations and Métis education coordinators, and university professors); and 3) a *historical* practice level: the exploration of the historical and political contexts of the development of IK-S–infused science curricula in Saskatchewan.

Situated as *re/search*, rather than the positivist notion of research, this project valued both the process and outcome of the project (Kovach, 2009; Wilson, 2008). As such, this dissertation focuses on showing the whole process and the product of the project: the personal and academic purposes of the project; the ways in which I engaged with theories and stories from Indigenous scholars and knowledge keepers and non-Indigenous scholars; the development of the conceptual framework (i.e., the Dancing Amoeba Model); and changes of the inquiry based on the relationships built (or lack thereof), the methodology, the analysis process, and the findings.

The findings from the study suggest that the integration of IK-S in science curricula is a multilevel process involving political pressure from federal and provincial governments, academia, classrooms teachers, as well as grassroots movements. The exploration of the historical and political contexts illustrate the ways Western modern knowledge-science (WMK-S) obtained its status as the universal and only kind of science to be included in curricula. The findings from the curriculum analysis show the diverse ways in which IK-S has been conceptualized for science teaching. The interviews with the stakeholders emphasize the importance of teachers' education and professional development that provide *true authentic* learning opportunities, wherein teachers can have opportunities to build relationships with Indigenous Elders and knowledge keepers. In turn, I argue that teachers should focus on creating a "sharing place" wherein teachers and students are engaged in building and strengthening relationships with each other, local Indigenous peoples, and the Land. I conclude that thinking, learning, and acting with IK-S–infused science curricula is a *lifelong learning process* and emphasize the importance of relationships that diminish the *colonial logic frontier* (Donald, 2009) and help us to move forward to our shared future.

Résumé

Suite au rapport final émis par la Commission de la Vérité et de la Réconciliation (TRC) publié en 2015, le paysage canadien de l'éducation change en cherchant maintenant à inclure le savoir et les perspectives des populations autochtones pour *tous* les étudiants en apprentissage. Depuis le renouvellement du programme en 2005, le Ministère de l'Éducation de la Saskatchewan a intégré les Sciences-Connaissances Autochtones (S-CA) à leur programme de science au niveau primaire et secondaire (Aikenhead & Elliott, 2005). Dans ce projet de doctorat, j'ai exploré la question des enjeux de l'intégration du contenu et des perspectives autochtones dans le programme des sciences en Saskatchewan.

Pour conceptualiser le programme en tant que texte, j'ai suivi le modèle à trois niveaux de Fairclough's (1989). Conséquemment, ce projet inclus: 1) un niveau *textuel*: une analyse des documents officiels des programmes du niveau primaire et secondaire ; 2) un niveau de pratique *discursive*: entrevues avec les divers intervenants (p. ex., les consultants en éducation scientifique du ministère de l'Éducation, les enseignants, les coordonnateurs de l'éducation des Premières Nations et des Métis ainsi que les professeurs d'université); 3) un niveau de pratique *historique*: l'exploration du contexte historique et politique du développement des S-CA en Saskatchewan.

En valorisant autant le processus que les résultats (Kovach, 2009; Wilson, 2008), ce projet se présente comme une *re/cherche* plutôt qu'une approche positiviste de la recherche. Dès lors, cette dissertation se concentre sur la présentation de l'ensemble du processus et du fruit de ce dernier: la vocation personnelle et académique du projet; les façons d'aborder les diverses histoires et théories des érudits et gardiens du savoir d'origine autochtone ou non; le développement et la conceptualisation du plan (i.e., le modèle de l'Amoeba Dansant); et les

changements de l'enquête au gré des relations établies (ou l'absence de), la méthodologie, le processus d'analyse et les résultats.

Les résultats de l'étude suggèrent que l'intégration des S-CA au programme de science actuel est un processus à paliers multiples qui requiert une implication politique du gouvernement fédéral et provincial, du milieu académique, du professorat ainsi que des mouvements populaires. L'exploration des contextes historiques et politiques illustrent les façons dont les Connaissances-Sciences Occidentales Modernes (C-SOM) ont obtenu le statut universel du seul type de science à être inclus au programme d'enseignement. Les découvertes faites lors de l'analyse curriculaire démontrent les diverses façons par lesquelles les S-CA ont été conceptualisées pour l'enseignement de la science. Les entrevues avec les différents acteurs mettent en relief l'importance de la formation des enseignants et du développement professionnel pour procurer une opportunité *d'apprentissage authentique* où les enseignants ont la chance de bâtir des liens avec les aînés autochtones et les gardiens du savoir. À mon tour, je soutiens que les enseignants devraient se concentrer sur la création d'un «lieu d'échange» où les enseignants et les élèves sont engagés dans la construction et le renforcement des relations entre eux, les peuples autochtones locaux et la Terre. Je conclus que penser, apprendre et agir selon le précepte de la science inspirée des S-CA est un *processus d'apprentissage continu* qui souligne l'importance des relations qui estompent la *frontière de la logique coloniale* (Donald, 2009) et qui nous aident à avancer ensemble vers l'avenir.

Table of Contents

List of Tables

List of Figures

Introduction

My Name is Eun-Ji Amy Kim. I was born in Seoul, Korea. I am part of the 71st generation of the Sam-hyun tribe (삼현파) of Kimhae (김해), Korea. When I was 16 years old, my family moved to Winnipeg, the territory of the Anishnaabeg, Cree, Oji-Cree, Dakota, and Dene peoples; this is also the homeland of the Métis and Treaty 1 territory (Treaty Relations Commission of Manitoba, 2017). I currently reside, do research, and teach in Montreal, the unceded territory of the Kanien'kehá:ka (Mohawk) people, known as Tiotia:ke in their language (Canadian Association of University Teachers, 2016).

This dissertation was written in a way that shows both the process and products of the research project. As such, as you are reading the dissertation, you will be walking through the research with me, witnessing and experiencing the process of this research project. In writing this dissertation, I particularly focused on how the notion of 'relationships' plays in each aspect of my research journey: from the purpose, selecting research sites and methodology as well as analytic framework. The connections between my own lived experiences, choices I made in methodology and the product of this dissertation- the whole journey of my PhD project- may not come together until later in the reading of this dissertation. Here, I would like to explain that the choice of such a relational writing style was made to reflect my commitment to show both the process and the products of this research project (Wilson, 2008). I go against the tradition and rules that dissertations should always be written in the past tense. I use both the past and present tense, depending on the context and flow of the process. The project—both the site and the inquiry—changed multiple times, based on the relationships I built (or lack thereof) as well as the lessons that came with my living inquiry *kemoochly*[1]. Developing from an understanding that process is as important as product (Kovach, 2009), the structure of the dissertation shows preparation, engagement, and reflection throughout the process.

In this dissertation, I explore the question: What relationships are at play in integrating IK-S in science curricula? In particular, I explore the current K-12 official science curriculum documents in Saskatchewan, which are examples of Indigenous knowledges-sciences (IK-S)–infused science curricula. Chapters 1 and 2 show the researcher and research preparation process. Chapter 1 illustrates my personal purpose for doing this project. I reflect on my personal encounters with Indigenous cultures and peoples as well as the internalized assumptions and biases before delving into the project. In Chapter 2, I describe the academic purpose of this project. In so doing, I show the process of the evolution of the inquiry and research site, as well as state my positionality and commitment. Readers will witness the process, products, and reflection illustrated in Chapters 3 through 8. Chapter 3 explores the literature in science education on Indigenous perspectives in school science. Also, reflecting on both literature and stories from Indigenous Elders and scholars, I introduce the conceptual framework for this project: the Dancing Amoeba Model. In Chapter 4, I explain the methodology—theory, practice, and ethics—and the way I engage with these components of the methodology throughout the process. Chapter 5 explores the historical and political contexts that influenced the current IK-S–infused science curriculum documents in Saskatchewan. As such, I illustrate the history of Eurocentric science, the history of Canadian science education, as well as the history of

[1] *Kemoochly* is a "Cree-English combined word" " word taught by Dr. Laara Fitznor. The word Kemooch is Cree for secret and adding the adverb 'ly' denotes the working 'under the radar', against the grain to ensure that Indigenous perspectives are present/engaged within the educational system and going ahead without asking for permission first - asking for forgiveness is easier. It means "in secret" and "working against" (personal communication, March 24, 2016). The concept of *Kemoochly* has been a guiding principle for my research process. Detailed explanation of the concept can be found in Chapter 2.

education in Saskatchewan. Chapter 6 presents the findings from the curriculum document analysis. Chapter 7 presents the stories from the sharers (i.e., diverse educational stakeholders) on their views and experience engaging with IK-S–infused science curricula. Finally, in Chapter 8, I reflect on all the previous chapters and share my lessons learned throughout the process of this project.

Chapter One: My Personal Purpose and Motivation in Pursuing This Work

"Feeling is connected to our intellect and we ignore, hide from, disguise, and suppress that feeling at our peril and at the peril of those around us.
Emotionless, passionless, abstract, intellectual, academic research is a goddamn lie, it does not exist. It is a lie to ourselves and a lie to other people."
(Eber Hampton, 1995, p. 52)

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A Cree scholar, Margaret Kovach (2008) stated that "knowing one's own purpose and motivation for research was [is] fundamental" (p. 114). Researchers should be clear on both their academic and personal purposes. Therefore, I start my dissertation with purpose statements. In reflecting on my purpose, I am inspired by Kovach's (2008) questions: "what is your purpose for this research? How is your motivation found in your story? Why and how does this research give back to community?" (p. 115). In this light, I delve into my *personal* purpose and motivation in this chapter; Chapter 2 will delve into my *academic* purpose for this project.

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I first start with a reflection of the learning moment from my PhD candidacy defense in 2013: "For my doctoral research project, I would like to investigate different approaches to integrating Indigenous perspectives into science curricula in settler countries like Canada and Australia. I hope to link the content found in curricula to other educational policy frameworks as well as historical policy frameworks with regards to Indigenous education. Thank you for your time." Clicking to show the final slide, which reads Thank you. Questions and Comments? I take a deep breath. My heart is pumping fast. I feel the adrenaline rushing through my body, becoming a bit dizzy as I look up and around room 233, the small conference space where my PhD candidacy defense is happening.

One of my committee members, Dr. Fitznor, asks me, "So Amy, what is your stance? What is your position in this work?" Without hesitation, I answer confidently, "My stance is that there is more than one form of science. Science education should especially consider teaching knowledges and sciences from Indigenous communities to all students, so that all students can learn their value, not construct negative stereotypes of Indigenous peoples, and appreciate their contributions." Silence from Dr. Fitznor. She then probes me further, "So what can you contribute with your work?"

Confused and feeling adrenaline rushing through my veins, I respond, "I am not too sure what you mean, Dr. Fitznor. Can you repeat your question, please?" Dr. Fitznor then responds, "Your stance as an ally can bring some insight to the field." "Your stance as an ally," she says again, pausing for few seconds. "I think it would be a good idea for you to write a chapter for your PhD thesis on how you came to choose your research topic. Relational writing. Trying to understand your positionality along with your research project would be good."

I feel my cheeks turn red with embarrassment. That brief moment of confidence—when I thought that I had finished framing my work and I just had to go out, collect the data and write the dissertation, and that I was the expert—is already out the window. I write down *Ally. Relational writing. How I came to my research topic. First chapter, starting again*. It wasn't almost over. It was just beginning.

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In the past when people have asked me why I was interested in working with Aboriginal peoples, I used to answer, "I actually don't know. I just know that I am an ally." My understanding of "ally" at that point was that if I was working for the benefit of Aboriginal peoples and promoting knowledge of the history of colonization, I would be an ally to Aboriginal peoples. I had been using the term *ally* without giving it much thought. Anne Bishop (2015) stated that an ally is not an identity but rather a process of becoming. In order to engage yourself in the process of "becoming an ally," you must engage in learning and understanding the oppressions, different forms of power, the roles of an oppressor, as well as the experiences of the oppressed, and the ways in which they interact. All of these reflections should take place on both individual and collective levels, thus working towards your own liberation. Here, liberation refers to what Bishop (2015) described as “the struggle to change exploitation to cooperation” (p. 143). I concur with Bishop’s notion of liberation. The process of liberation, however, is not a linear process but rather a circular ongoing one:

> It begins with breaking the silence, ending the shame and sharing our concerns and feelings. Storytelling leads to analysis where we figure out together what is happening to us and why, and who benefits. Analysis leads to strategy, when we decide what to do about it. Strategy leads to action, together, to change the injustices we suffer. Action leads to another round of reflection, analysis, strategy, action. (Bishop, 2015, p. 81)

In this chapter, I begin to explain my cycle of liberation, actively engaging in the process of becoming an ally by “breaking the silence” through self-reflection on my experience as both the oppressed and the oppressor. As a woman of colour and a first-generation immigrant to Canada, I am particularly interested in the ways in which White supremacy has influenced me as an individual. My understanding of White supremacy here is best described as “the idea that the established, European or Western way of doing things has both moral and intellectual superiority over those things non-Western . . . [and] viewed as natural and legitimate” (Brayboy, 2005, p. 432). I continue to reflect on my own experiences living in Korea as a child influenced by the educational and religious practices that were rooted in my own people’s acceptance to the effects of White supremacy, and how I, in turn as an adult living in Canada, have replicated this internalized oppression in my interactions with Aboriginal peoples.[2]

[2] To refer to Indigenous peoples in North America, I use the terms Native and Indigenous (terms Indigenous peoples used in the North American context), and Aboriginal (in a specifically Canadian context). I also use the plural term *peoples* to acknowledge their cultural diversity (e.g., Indigenous peoples, cultures, and knowledges).

Becoming an ally requires reflection and understanding the individual as well as the collective structural nature of oppression (Bishop, 2015). Moreover, as mentioned previously, as an ally, it is important to find out my personal motives for undertaking this PhD research project. To this, echoing Eber Hampton's (1995) work, "Memory comes before knowledge: research may improve if researchers remember their motives." Kovach (2008) suggested telling a story from memories to find out motives for research, as "they are usually found in story" (p. 115). Therefore, I chose autoethnography as the method to best reflect my experiences and stories as autoethnography makes the author reflect a phenomenon both at an individual and a cultural (collective) level and connect those two together (Elis & Bochner, 2000). As well, autoethnography allows for "the process of self-exploration and interrogation [which] aides individuals in locating themselves within their own history and culture allowing them to broaden their understanding their own values in relation to others" (Starr, 2010, p. 1). It is through autoethnography that I aim to explore my own experiences as stories to find out my personal purpose for the PhD project as well as my own beliefs.

Recognizing the diverse subgenres that exist within autoethnography, I am particularly drawn to the "layered account" described by Ronai (1992). Written in multiple layers of reflection, a layered account allows the author to play fast and loose with time and space, shifting their storytelling as they feel would give the best credence to their personal views and experience and how those experiences fit within the dominant cultural narrative. In this autoethnographical writing, therefore, my purpose is to offer different layers of narrative that explore my experiences with oppression (both as oppressed and oppressor) in connection with the oppression playing out on a larger cultural, collective level, as found in the literature. I will use an asterisk section break to denote a shift between narrative layers in this chapter.

The layered account provides "an impressionistic sketch . . . a continuous dialectic of experience, emerging from the multitude of reflexive voices that simultaneously produce and interpret a text" (Ronai, 1992, p. 396). As a method, autoethnography is both a process and product (Ellis, Adams, & Bochner, 2011). This chapter itself is the product of my lived experiences as both oppressed and oppressor. This chapter also is the process as it intends to engage and benefit readers, encouraging them to think about their lives and the roles they play in the process of becoming an ally. In this regard, I ask readers to "take a more active role as they are invited into the author's [my] world, evoked to a feeling level about the events being described and stimulated to use what they learn to reflect on, understand, and cope with their own lives" (Ellis & Bochner, 2000, pp. 741-742). In so doing, I ask my readers to reflect on their actions and thoughts and engage emotionally, aesthetically and intellectually (Ellis & Bochner, 2000).

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I was born in Seoul, Korea, and raised there until I was 16 years old. I always knew I was from Kimhae because, in Korea, last names are all based on the place where one's ancestors lived. My last name is Kim (김) of Kimhae (김해), a town near the Pacific Ocean. I am Eun-Ji Kim of Kimhae, the 71st generation of the Sam-hyun tribe (삼현파).

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Figure 1. My Halmonee (grandmother) and I

It was a beautiful day. The sun was spreading its rays everywhere, to the corners in the bus, and onto my legs and my halmonee's (grandmother) short, curly, dark black hair. It was my first trip alone with Halmonee to "the village" where my father grew up, located on the south end of the Korean peninsula. My aunt's family resided in the village, growing rice in the fields. In the village, a bus only goes by twice a day. In the village, I was able to see and smell the ocean nearby. In the village, I could see the sky without buildings in the way. This village was also where my grandfather was buried. I didn't know much about my grandfather. He had passed away when my dad was only eight years old.

It was a beautiful summer day with the sun shining. I felt very pretty. I was wearing a pink dress with huge bows around the chest and shiny white shoes, also with bows that my auntie had bought for me at a village market. Holding a black plastic bag in one hand and my hand in the other, Halmonee was leading the way wearing a long grey skirt and black rubber shoes. We walked between green bushes on a narrow unpaved road. The road led to a small mountain behind my aunt's place. We walked till there was no more road. "Come this way," said Halmonee, who was walking up to a steep little hill in front of me. I couldn't walk up the hill, so I climbed. My grandmother offered her hand from the top and pulled me up. From the top, I saw another field. Surrounded by trees, there it was. My halabujee's (grandfather) grave. There was no tombstone, no other graves around. Nothing. Just a little round bump covered with green, and some dried brown grass. Halmonee started to pick the old, dried, brown grass from the bump. I joined her. Once we finished, Halmonee told me to bow to the grave (as shown in Figure 1). "Say hello to your grandfather." I had never bowed to a grave in my life. I bowed and stood in front of it. "You have to bow twice," Halmonee said, standing by. I bowed again while trying to remember the steps of how to bow properly. Then Halmonee poured some soju (Korean rice wine) into a paper cup. She poured the soju on the grave as she walked around the little grassy bump. "Offer your grandfather some drinks too." Halmonee handed me the paper cup. As I held the cup in my two small hands, Halmonee poured the soju. I slowly walked around the grave. Afraid that I might spill it, I walked as slowly as I could, as Halmonee had. I said to my grandfather, "Halabujee, drink this please." As the leaves on the poplar trees blew, I thought I heard my halabujee greeting me, "Thank you, Aga."[3] This was the very first and last time I bowed down and offered drinks to my halabujee. This was the first and last time I connected with him.

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I was six years old when I attended my first vacation bible summer (VBS) camp at a church where my dad used to work as an intern-pastor. He was in charge of the young adults group. Everyone in the church knew me. I was the pastor's daughter. The intelligent one, as my Korean name denoted: Ji means intelligence. I used to recite bible verses pretty well. All the halmonees and elders from the church liked me. They used to give me treats or money and pat my head whenever they saw me.

[3] Aga means *baby* in Korean.

My favorite pastor led the VBS camp. She was like the princesses you see in movies. She must have been in her 20s, and she had long, pretty, curly hair. When she spoke, it was like sweet cotton candy speaking to you. One day during the VBS, the princess pastor asked us a question: “Has anyone here bowed down to graves or other sculptures?” Remembering the time I paid respect to my grandfather, I raised my hand high up. The pastor and other teachers looked at each other, confused. “Eun-Ji, you have bowed down in front of graves or sculptures like Buddha before? Are you sure?” The pastor’s voice was different from her usual soft one. “Yes I have! I bowed down to my grandfather’s grave in the village. Twice!” I answered with pride. I felt proud that I, the intelligent pastor’s daughter, had yet again experienced something that no other kid in the crowd had. I felt confident.

I remember the awkward silence that followed my answer. The pastor and the teachers looked at each other. The pastor looked at the other children and asked again, “how about others?” One kid from the crowd said, “My family does not bow down to graves. My mom says it is a bad thing. God doesn’t like that. Instead, we pray to God.” The pastor nodded her head. “Yes, you are right. As Christians, it is a sin to bow down to graves or sculptures.” I felt like I had done something wrong. I started doubting and blaming Halmonee. *Was Halmonee wrong? She doesn’t know how to read. Perhaps, Halmonee didn’t read the bible, so she didn’t know that it was a sin,* I thought to myself. I don’t know if it was from this moment exactly, but I started seeing my grandmother as an uneducated, illiterate villager and her wisdom as superstition. I loved my halmonee, but she just didn’t know any better.

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“Full of glowing Christian crosses” was the term that Aaron Tan, a director of a Hong Kong architectural firm used when he first saw the night view of Seoul (Kim, 2011). In the past few decades, Christianity, particularly Protestantism, has been widely accepted as the religion of the middle class, youths, intellectuals, urbanites, and modernizers, and has been central to South Korea's pursuit of modernity and their emulation of the United States after the end of World War II (Jang, 2004).

Christianity was first brought to Korea in the early 17th century. Scholars of "Silhak" (practical learning) were introduced to it by the Chinese and saw in it an egalitarian value that could end the birth-based class system[4] (Kim, 1983). With the acceptance and endorsement of these Silhak scholars, Christianity in Korea first began as an "Indigenous lay movement" rather than being imposed by foreign missionaries (Choi, 1984, p. 5). However, soon before and during the Japanese colonial period (1910-1945), Western missionaries began to settle in Korea. With Christianity, they brought Western knowledge, Western hospitals and schools based on the Western education system. During the Japanese colonial period, middle-class elites were educated in Protestant schools (which were seen as providing modern knowledge) instead of *Seodang* (i.e., traditional private schools) (Kyung, 2002). In this way, Christianity was often linked with modernity.

During the Japanese colonial period, Japan took an assimilation approach, forcing Koreans to worship and praise the Japanese emperor. Korean Christians refused to worship the Japanese emperor, in line with their belief that they should not worship any other Gods, persons, or objects other than the Christian God. Albeit for theological rather than political reasons, Korean people started to link Christianity with Korean nationalism and resistance against Japanese colonization (Latourette, 1945). Linked with modernity and nationalism, Christianity in Korea, especially Protestantism, has flourished since.

[4] Korean society used to have something similar to India's caste system, which started to deteriorate after liberation from the Japanese colonial period (1945).

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Under a blue grey sky fragmented by the tops of buildings in Seoul City, I only ever saw apartments or buildings that were covered with neon store signs, or windows where people put their laundry or flowers. Amongst those buildings, my kindergarten was different. It had a huge cross above its long church bell tower. You could actually see red bricks on the church building. It had a green roof. My earliest encounter with Indigenous cultures was in this kindergarten. Each classroom door had "Indian (인디언[5])" names. *Samanco* was the name of my class. I did not know what it meant and thought it was a word that originated from an "Indian" language. I later Googled the word and found out that Samanco is a name of a region in Peru, and of a fish-shaped Korean ice cream. My little sister was in the *Watanka*[6] class. In the summer, we wore white t-shirts with a chief with a big headdress on the front. Wearing these shirts, we used to attend what was then called "Indian summer camp" once a year. We took a tour bus and drove far away from Seoul. Indian summer camp was the only time I slept away from my home. It was the only time that I got to spend an entire day and night with my friends. It was also the only time that I got to explore forests or see the sky without seeing the tops of buildings.

As we got off the bus, our *sun-saeng-nim* (teacher), who wore a yellow cap, told us to breathe in. "Breathe in now! Breathe in the fresh air. It is so fresh! It will purify your body and mind! This fresh air, you can't get it in Seoul." I would breathe in. I was not sure what my teacher meant. I didn't taste or smell anything different, yet all the pretty colours and movement in nature made me happy.

[5] I use Korean characters to denote the culturally appropriated and misrepresented experiences of Indigenous peoples produced in Korea. The word "Indian 인디언" in Korea is used to refer to Indigenous peoples around the world. To refer to East Indian people, Koreans use "인도사람," which literally means, people from India.

[6] I also googled this word; *Watanka* means "sitting bull" in Sioux.

During the day, we did “nature” stuff. We went out to cornfields near the forest. Amid corn stems that were taller than us, we tried not to lose each other. I remember holding my partner Mi-rim’s hand tighter as we went further into the cornfields. Once we passed the tall stems, there it was. Our little forest. There was a huge white paper attached to some wooden board ready for us. On it was written “J.S. Shindo Kindergarten” (Figure 2).

Figure 2. Nature Activities at the Indian Camp

There were a few buckets of paints filled with different colours. The sun-saeng-nim said, “one by one, come up here and draw anything you like!” This was a phrase that I hadn’t heard from any teacher before. Normally it was “draw butterflies, draw flowers, draw your summer vacation with your family.” The freedom wasn’t there usually. As a result, I was not too sure what to draw so I just started striking the brush against the board. I saw the paint coming down like raindrops. “Look! The paint is coming down! It looks like rain!” I yelled. Then the sun-saeng-nim said: “Let’s move to our next location. Form two lines! Hold hands with your partner!” In lines, we marched through the forest, singing songs together that we had learned in class. “The tadpole by the pond, swimming, wiggling its tail, it becomes a frog!” By the time we finished singing the frog song, the sun-saeng-nim shouted, “We stop here! S-T-O-P! Everyone sit down where you are!” Still holding hands, Mirim and I sit down under the shade of a tree. “Look! There is a squirrel!" somebody shouted. Everyone in the group was trying to take a look at the squirrel. "Where? Where?" I, too, stood up trying to look for the squirrel. "Everyone! Sit down!" the sun-seang-nim yelled. I sat down on the ground. The sun-seang-nim then started handing out green plastic insect collecting boxes. She also gave us butterfly nets. "With your partner, go collect butterflies or bugs, or anything you like. But do not forget! You have to be with your partner at all times! And do not go further than the trees with the yellow ribbons!" Mirim and I started running, holding hands. As I was running, I felt the green grass and the wildflowers touching my legs. "Eun-Ji, Look!" Mirim was pointing at something—a red-pepper dragonfly (scarlet skimmer) sitting on the end of a forsythia branch. We held our breath and walked slowly towards it.

One step. Stop.

Two steps. Stop.

I was getting my index and middle fingers ready, making a peace sign to catch the dragonfly. I learned this from my cousin, Sang-Jun, when I was in the village with Halmonee. In the village, we didn't use nets to catch dragonflies. "You should always stand behind a dragonfly. Dragonflies do not see you when you approach them from behind. Then you should be really quiet. Hold your breath. Try to gently take the dragonfly's wings between your index and middle fingers," Sang-Jun's voice in my head instructed me. Holding my breath, I slowly slid the dragonfly's wings between my fingers. Nothing else existed in this moment. It was just me and the dragonfly.

"I got it!" I held the dragonfly in my fingers. "Mirim! Come and look and open the box!" Mirim, who was watching this whole act from three steps behind the forsythia, ran to me. "Wow! Dragonfly has weird eyes!" We started giggling as we put our dragonfly into the green collecting box. “Everyone! Now come back here! Under the tree!” Our sun-saeng-nim’s voice echoed in the forest, and Mirim and I ran toward the squad.

***

That night, we were getting ready for a special “Indian” ceremony. We made our own paper headdresses. Sunsaengnim said we could colour and put stickers on them as we liked, to make them pretty. Once the headdresses were ready, we put red stickers on our cheeks. We put on skirts made out of fabric around our hips, which were premade for us. We also made a banner for our class. Everyone in the class sat in a circle around the banner and drew something on it. Some drew a car, some drew a princess. Once everyone had a chance to add something. The sun-sang-nim wrote our classroom name, “Samanco,” on the banner. Headdresses and skirts on, we were ready for a special ceremony. The sun-saeng-nim asked us to form a line again. We marched again. There was a campfire waiting for us. We danced around the fire, chanting in a circle in what we understood to be an “Indian (인디언) way” (Figure 3).

Figure 3. Communal event at the Indian Camp

There was nothing but fire, us, and the stars in the sky. No city sounds, except cicadas singing. After dancing and games, sunsaengnim had us sit around the fire. Sitting on the ground, we closed our eyes. Sunsaengnim then spoke in a very low and soft voice, telling us to think of the times we had done something wrong to our parents, to think of the love and devotion our parents gave us. Thinking about my parents somehow made me feel sad. I heard others crying. Sometime after, we were told to open our eyes. I felt like I was something new. I felt like I was an Indian in the forest. I felt grown up. In the forest, with no city sounds, with nothing but us and the fire, as Haydon (1959) wrote, "the twentieth century slipped away in the darkness and all evidence of modern civilization were … somehow forgotten" (as cited in Wall, 2005, p. 528).

I looked at the fire. I looked at the little firebugs going up to sky. I saw a round, radiant full moon. The moon was familiar; I often saw it in Seoul. However, the moon in the forest felt different. The moon looked like it was expanding and shrinking as it gave off light to the earth. The moon was alive in the forest. In my Seoul City, I used to see four or five stars per night if I was lucky, but here in the forest, as I looked in the sky, I saw so many.

Sunsaegnim then asked, "Do you see the big dipper? It is right up there!" I followed her finger. There it was. The big dipper. "See—following the big dipper, you can see Polaris!" Sunsaegnim pointed again. But, I had a hard time following her. There were just too many stars. I just saw one star that sparkled the most to me. That must be Polaris, I thought. As I returned my eyes to the campfire, I saw the firebugs shooting up, all the way to *my* Polaris. This was the new, Indian Eun-Ji, discovering nature and her own star.

***

The "Indian Summer camp" dates back to 190l in North America when a well-known author, naturalist, and one of the founders of Boy Scouts of America named Ernest Thomson Seton created an organization called "the woodcraft Indians" for non-Aboriginal boys. Seton created summer camp programs where the boys from the organization were invited to live a life in a “make-believe tribe, the Sinaways.” This camp involved making Indian costumes and playing nature study games that emphasized the holistic experience of a natural environment by promoting the primitive, premodern, simpler life of Indians in nature (Figure 4) (Deloria, 1995, p. 96)

Figure 4: Earnest Thomson Seton’s original Sinaway Tribe at Standing Rock village, Wyndygoul, Connecticut, 1903 (Reproduced from Deloria, 1995, p. 9)

Indeed, the “back-to-nature” discourse stemmed from an antimodernist sentiment spawned in the 1930s as a reaction to urban and industrial culture, and it became a main vehicle of promotion for Indian camps in North America. Emerging from these antimodern concerns, the summer camps offered the “penchant of playing Indian . . . the perfect backdrop for the construction of alternate identities” (Wall, 2005, p. 520). Participating in communal events and imitating (portraying) the council ring, campers felt “emotionally stirred, personally connected, and perhaps even spiritually moved [meanwhile] Aboriginal people were far from mind and one’s own experience, the focal centerpiece” (Wall, 2005, p. 528). In fact, playing Indian “makes one self-conscious of the real ‘me’ underneath” (Deloria, 1998, p. 7). Thus, campers, including myself, created pseudo-Indian identities based on “a revised, more pleasing image of their own racial character” rather than a historically, culturally accurate version of the Indian (Deloria, 1995, p. 105). By playing Indian, campers could buy the cultures of Native peoples for pleasure without experiencing the full lived experiences or getting an accurate history of colonization. Native peoples' cultures came to be commodified without their control or participation in the creation of such camps. As consumers, non-Indigenous people dictate what they want, creating their own version of the racialized Indian to meet their antimodernist sentiments.

I have often wondered why my kindergarten decided to have us "play Indian" rather than "play traditional farmer." If it was only for the longing of "living a simple and creative life in nature," playing the traditional Korean farmer's or mountaineer's life could have done the job effectively. I argue that such similar White supremacy is in effect in Korea. Particularly, English has been "the most popular and important foreign language, at least in South [Korea]" (Shin, 2007, p. 77) ever since it was first brought to Korea with Christianity representing modernity and egalitarianism.

After the Korean War (1950-1953), the trend of celebrating White supremacy has been amplified due to the U.S. government playing a "hegemonic role in political, economic and cultural domains in Korea [which] has created an unequal relationship between the U.S. and Korea" (Shin, 2007, p. 77). Thus, language, culture, and education in the United States has achieved a high status in South Korea; Korean middle-class and upper-middle-class citizens legitimatized the Western (especially the U.S.) way of living and education system, positioning it as an elite system. White supremacy in the Korean education system can be seen in the establishment of "international schools" where Canadian or American curricula is used; all subjects are taught in English by native English speakers; and White native speakers are valued over English speakers of colour, including those with Korean heritage. The students attending these international schools are considered elite in society; there are even entrance examinations for those who wish to attend. This is an example of the dominant tendency to adopt a Western way of life in South Korea. Here, in defining *dominant*, I follow Wilson's (2009) description: "Dominant is used as an adjective to describe the culture of European-descended and Eurocentric, Christian, heterosexist, male-dominated Canada or Australia . . . some authors use the term 'Whitestream' as synonymous with dominant" (p. 35). I add that this notion of Whitestream dominance is also perpetuated in South Korea.

In this light, the "Indian summer camp" was not only organized to attract urban middle-class children who were longing for an escape from the city, but also to promote the adopted North American curricula, further ingraining notions of supremacy of the Western education system. As a child who participated in one such camp, I had accepted dominant White supremacy without question. I was also creating misrepresented, distorted images of Indigenous peoples as "primitive, premodern and exotic," while denying their lived experiences as I "seasonally put on Indian skins" (Wall, 2005, p. 539).

***

My family decided to move to Canada when I turned 16 years old. My family thought Canada had a better education system than Korea where we could learn English. When I came to Winnipeg, Canada, my family started attending a Korean church. This church used to go on a short-term mission trip to the Long Bears[7] native reserve near the city. I had arrived in Canada about a month before. I didn't speak much English. I didn't know anything about Canada. I didn't know anything about Native peoples or history. I decided to go with them on the mission trip simply because I didn't have anything else to do in the summer. I didn't have any friends. I

[7] Pseudonyms have been used for the names of all communities and people mentioned in this chapter.

was hoping to make some friends on the trip. Because I was new to the church and also new to the country, I was mainly an observer.

Once we arrived in Long Bears, we started putting our stuff in the cultural center. The cultural center was a big open space where sunlight came in from all directions. By the entrance, there was a sacred fireplace (I now think that it could've been for a council ring), secured by big white rocks. Arriving in Long Bears reminded me of the Indian summer camp I had attended. But it looked different than I'd imagined. The people didn't look like they were living in the forest. They were wearing T-shirts and pants. There were cars. There were modern houses. As we entered the cultural center, the youth group pastor instructed us on where to sleep and where to put our stuff. He said: "Youth groups members must now go hand out flyers and invite the people over here." The flyers had information about the services we were offering and about the Korean night. "Also if you see kids around, tell them to come to our VBS camp." We Koreans started to occupy the space. Not sure what to do, I made my way to the middle of the cultural center where the group of youth group members were congregating. "Do you want to come with us?" the youth group president asked me. I nodded. Youth groups were divided into groups of three or four; we got into three or so vans. The president was driving our group's van. Also present was a kid whose name and face I don't remember, and Joseph—a second-generation Korean-Canadian, whose Korean was barely strong enough for us to communicate. The president said, "I am going to drop off you guys by each house, you knock on their door and hand out the flyers." "I got this," Joseph said with confidence. The kid and I followed Joseph.

At the first house, I saw alcohol bottles, kids' toys, and some tires on the ground. As we were walking towards the door, we heard the sound of a dog barking. "There is a dog? I am scared of dogs," I said to Joseph. "It's alright. It's just a dog," he said. Then there they were. It wasn't just a dog. There were multiple dogs. Big, German-Shepard-looking dogs, growling, showing teeth, and running towards us. There was no hesitation. Joseph, the kid, and I started to run. "Run to the car!" we were all screaming. As we rushed into the car, the president asked, "Did you hand out the flyer?" "No way, there were dogs! Let's go to another house." We drove around the reserve, getting dropped off and walking up to each house and knocking on the door. There were fancy houses with trampolines where kids were playing and laughing. There were empty houses. They were houses hidden in the bushes we didn't even bother trying to get to because we heard dogs barking. Some people talked to us, some just grabbed flyers, some refused with a polite "no thank you."

After we finished handing out flyers, we went back to the cultural center. There were different sections. In one, there were medical teams consisting of doctors, dentists, and nurses, and they were examining people. On another corner, I saw hairdressers, giving free haircuts. In the kitchen, people were cooking for children attending VBS. I thought the team was actually helping people on the reserve. Medical help, free haircuts, educating young children. All free of cost. Just out of "love" for God and Christ. I admired the Korean-Christian elite who spoke English fluently, gave help to Indian people, and were good Christians. I wanted to be one of the elite.

The missionary team slept at the cultural center. In the small room, Joseph, the president, and other kids played cards and told scary stories with a flashlight on. I was bonding with a new social circle—the Korean church people. We were getting closer. I felt like I was attending the Indian Camp from my childhood. Not because I was experiencing the culture or building relationships with people from the reserve, but simply because I was on the reserve. I was in a place that was foreign yet I experienced a familiar "village in nature" feeling. I felt welcomed by my new elite Korean-Canadian Christian friends.

***

The next morning, some kids were playing around the sacred fireplace. They were walking and standing on the stones and several layers of them collapsed. The pastor told us not to go near it anymore. I don't remember if it was the pastor or the other adults, but someone complimented the kids for toppling the stones, as the sacred fireplace was for serving the devil. Serving anything other than God—ancestors, spirits, graves, sculptures—was sin; perhaps God had intended for us to break the council ring. I thought perhaps it was right to demolish the sacred fireplace. I wanted to learn English fast and become a part of this wonderful team, because being in a missionary team meant that you were a good Christian. If you were a good Christian, spoke English fluently, and got good marks in school, you were considered a good, elite student and got a good reputation in the Korean community. I wanted to be elite. I wanted people to like me. We returned to Winnipeg that day. The church never went back to Long Bears. Meanwhile I started school in Canada. Learning English, learning everything in English. The road to becoming elite had begun.

***

Malissa Phung (2011) explored what it means to be a settler in a Canadian context in her essay, "Are People of Colour Settlers too?" I have been grappling with the same question. Before delving into an answer, however, I feel that it is necessary to talk about what "settler privilege" refers to. Settler privilege generally refers to "the unearned benefits to live and work on Indigenous lands, and to the unequal benefits accrued through citizenship rights within the settler state" (Phung, 2011, p. 289). People of colours' settler privilege cannot be compared to that of

British or French descendant settlers as these settler privileges or social advantages are contingent on things like nationality, class, gender, and migration status. These are harder to accrue for some people of colour, especially for recent refugees (Jafri, 2012). Moreover, people of colour in Canada have long faced unequal benefits, exclusion, and discrimination, leading to a lacking sense of belonging in the dominant culture. However, people of colour are still "complicit in the ongoing land theft and colonial domination of Indigenous people" (Phung, 2011, p. 291). Though I may not have the same settler benefits as White settlers (Phung, 2011), I too, am benefiting from different treaties (Treaty 1: Winnipeg; Treaty 3: Montreal). I and other Korean Christians in the mission team had largely failed to learn that it was the suppression and suffering of the Cree and Blackfoot peoples that made it possible for us to settle in Winnipeg (Lawrence & Dua, 2005).

Moreover, Phung (2011) argued that people of colour place their political status above that of Indigenous peoples when they work towards achieving equality with Canadian settler subjects based on the notion of meritocracy and are thus complicit in the colonial domination of Indigenous peoples. For example, I thought that if I worked hard enough, I would succeed in Canada. It was all about my effort, but I was wrong. Though I have experienced racism in Canada, I never had to work to counter negative stereotypes that many Indigenous peoples in Canada face today (e.g., Natives get drunk for free. They are lazy. They should work harder). Asian-Canadians tend to carry positive stereotypes (constructed by Indigenized White settlers) of being a model minority group that are hard workers or good students (Phung, 2011). Because of this positive stereotype, Asian-Canadians may exaggerate their "physical and intellectual capacity" and can achieve upward class mobility faster while promoting "similar settler colonial labour narratives of hard work and enterprise in the face of Indigenous claims to autochthony," often forgetting that they have benefited from settler privilege as well (Phung, 2011, pp. 294-295). To this, Bishop (2015) stated that "power-over" breeds "power-over" (p. 84). Here, power-over refers to domination or force (Starhawk, 1987). Meanwhile, power can also take a different form in "power-with," which allows and encourages "one's own centeredness, one's grounding in one's own beliefs, wisdom, knowledge, skills, culture and community" (Starhawk, 1987, as cited in Bishop, 2015, p. 30). Being among the oppressed, people of colour who work towards achieving equality for themselves might subject power-over onto others, operating within settler colonial narratives similar to those used against them. I and other people of colour must recognize that the success and improvement of our status in Canada is not only a result of our own effort and labour but also the result of benefits from settler privilege. We must not repeat the same colonial settler narratives that breed "power-over."

***

I started attending another Korean church in Winnipeg. I was quite involved. I had a reputation for being an elite, good Christian and a good student who could speak English well. This church also sent out some people for a short mission trip to a Native reserve during summer. There were about fifteen people who volunteered to go on the trip, including me. I was put into a VBS camp team. There was an orientation session for the volunteers. The pastor handed out gospel cubes to us. As I folded and unfolded the cube, images of the stories of Jesus Christ popped up. "You can tell the kids about the gospel with this cube. The Aboriginal people are suffering from alcohol and drugs. Children are being neglected. With the grace of God, they can change. The Aboriginal people suffered a lot from White people. They do not trust White people, so we have to spread the gospel there. That is our job. That is our calling as non-White Christians. That's what God wants us to do."

***

The day had arrived. We were driving to Blue Rivers. There was a Korean missionary living on the reserve. We were to spend a few nights in Blue Rivers. We drove for several hours. After passing by mountains and rivers, there we were. Blue Rivers was not like Long Bears, which was on the plains, like Winnipeg. Blue Rivers was in the mountains. It was like the forest I went to as a child for Indian Summer Camp. I saw tall green trees, creeks, lakes, and mountains. I didn't see high-rise concrete buildings. I was surrounded by nature. As we were getting out of the car, I took a deep breath. This time, I smelled and tasted the cold yet crisp fresh air. The kind I couldn't get in the city.

***

The first thing we had to do was, of course, invite people. There were flyers similar to what I saw in Long Bears. Some of us dropped by the houses and handed them out. One lady in a pink house told us that there were ghosts in her house. She started telling us about where the ghost in her house was. We listened. Gave her a flyer. On to the next house. I saw a man making a drum outside his house. I went to speak to him, "Hello sir, how are you? We are from Winnipeg. There is a VBS camp for kids. If you want, you can send your kids to the church. That's where the camp is happening. Here is a flyer that has some information if you like." The man looked at me. His face told me that I was not welcome here. "No thank you," he said. While others moved to other houses, I decided to stay a bit and talk to him. "That's a beautiful drum you are making! Can I see it?" I asked. He lifted his head up. His face lightened up a little. "Sure. If you want you can touch it too." I sat down beside him and touched the drum. It was quite soft. I saw my group already walking far ahead of me. I thanked him as I stood up to join them.

***

The VBS camp was held in a church. There were singsongs, bible storytelling, craft making, lunch, snacks, and mini-Olympic activities. I don't remember much of the curriculum of VBS or what happened. However, at this camp, I met Ally and Arianne, both 11 years old who participated in the VBS camp. They were cousins, they said. Ally was living with her kokum (grandmother). Across from Ally's house, Arianne was living with her father and her baby sister. After VBS, volunteers were taking a rest either at the missionary's house or at the church (where some of the group members slept). Being with kids and running the summer camp was fun, yet physically exhausting. Ally and Arianne came to the missionary house where I was staying. They wanted to hang out with me. Despite the physical tiredness, I lifted my body and started putting on my shoes.

They took me to a lake. We decided to go for a swim. Ally ran and jumped in. I decided to do the same. The water was refreshing. Swimming in the lake surrounded by green mountains—it washed away all my tiredness. However, I forgot I had my glasses on. Ally and Arianne tried to look for my glasses at the bottom of the lake. My glasses are still somewhere in that lake to this day. Giving up on our search for the glasses, we sat down on the deck by the lake. I took out my cube. I told the stories of Jesus Christ to Ally and Arianne. Ally got up and left. Arianne was sitting still and listening to me. I invited Arianne to pray with me. We prayed together. "I accept Jesus Christ as my Saviour," she repeated after me quietly. I felt a sense of pride that I had succeeded in reaching out to Arianne and converting her.

After the swimming and the prayer, Ally and Arianne walked me back to the missionary's house. On the way back, we dropped by their grandfather's house. I asked Ally "Whose grandfather is he?" To this, Ally answered, "He is everyone's grandfather. You know, we are all related. This whole reserve, people are related. We are all cousins." That's when I knew that Ally and Arianne were not the same type of cousins that I knew of. They considered all community members family. The grandfather was sitting outside, with his plaid shirt and jeans and black cap on, resting one of his arms on the porch. “Hello!” Ally yelled. I told the grandfather that I came from Winnipeg, with the Korean church, and was staying at the Korean missionary house. He then said, “You know, White people, they came to our community and polluted the water. There are chemicals in the water now. We used to go fish and eat the fish. But we can’t do that anymore. There are chemicals in the water now.” He showed me his hand “Look at this. It is all because of the mercury.” I saw the bumps on his hand. As I was listening to him, I felt angry. “Why would White people come and interrupt people’s lives here? Why can’t they just leave them alone?” I thought to myself.

***

The discourse that said, “Natives do not trust White people because of the history. Native people trust us more because we are not White” is a common one amongst Koreans. Although Korean Christians acknowledge the differences marked by race, they still put themselves into the same categories with Whites in the Christian/Pagan binary. We (Korean Christian missionaries) had the same goal as White Christians: to convert Aboriginal people to Christianity so they could have a better life (and afterlife). We were writing the same colonial narratives that create negative stereotypes and assumptions about Aboriginal peoples: Aboriginal peoples need help, so they can get better. To this, Tatum (1992) stated that the cultural racism stemming from White supremacy is like smog in the air. We all are breathing it in and living in it every day. We all are influenced by White supremacy and colonization. Sometimes it is thick enough to be visible, and sometimes it is not apparent. This smog of cultural racism blinded our eyes to reflect our actions as I and other Korean Christians noticed and acknowledged the harm and colonial practices (e.g., residential schools, polluted waters) that White settlers had caused Native peoples while failing to recognize the less apparent or visible harms that actually came from the same ideology that we were bringing to the Native communities (e.g., imposing a religion on children; destroying sacred places). Jensen (2005) stated, "virtually all White people have to face the fact that racism lurks in our hearts and minds as a result of being raised in a White-supremacist society" (p. 26). Though I am not White, I too, grew up in a White supremacist society—both in Korea and Canada—and have thus internalized the values and ideologies that came from this society that puts dominant cultures (i.e., European-descended and Eurocentric, Christian, heterosexist, male-dominated) over others.

As well, Korean Christians here, including myself, considered ourselves experts, and did not think of taking a stance as learners. None of us knew the history of the treaty-settler relations. We didn't study the Ojibwa nation or the place itself. I learnt that we were in the Ojibwa nation because Ally and Arianne told me that they speak Ojibway and they are Anishinabek. As Korean Christians, we had good intentions of "helping them," but we weren't being critical about our own actions or opening up to learn more about the place and the people. We did not follow the established community protocols (nor did we consider finding out what they were). We did not consult with anybody from the communities in our planning of VBS. We had our goal and good intentions of "helping" them through an introduction to Christianity. Atkinson (2010) also problematized the practices in social work, as it is often the case that White social workers who enter the work "thinking or believing that they are 'experts' [or given some sort of special role to help people] . . . would not engage the community in the planning for children" (p. 95). White social workers too, had their goal of fulfilling their purpose of "helping" people. Atkinson (2010) responded:

> I have also witnessed a practice that is harmful to Aboriginal children, families and communities—not by people intent on doing harm but by well-intentioned social workers [educators or missionaries] who fail to understand how completely entrenched they are in Canadian racist ideology with respect to Aboriginal people. This failure blinds workers to the fact that it is not the intention that counts—it is the result that counts. (p. 5)

We, "well-intentioned" Korean missionary teams and White social workers were living in smog whether we realized it or not and bringing the smog into Native communities, "doing harm."

***

A year later, the church returned to Blue Rivers. Again, we started by handing out flyers. This time, Ally and Arianne joined me. Once again we encountered the dogs. "I am scared of dogs," I told the girls. So they chased them away. With Arianne and Ally walking with me, I felt safe, unlike the experience in Long Bears. The girls were protecting me.

That night, the missionary teams were gathering in the church for a service. It was intense. Everyone was praying with passion. Some were speaking in tongues, some were crying, "Please help these people. Please save these people from alcohol and drugs. Please help the kids to be better leaders for their community." I was also crying and praying for the girls. I really hoped that Ally and Arianne would grow up without sin, away from drugs and alcohol. After the service, I felt purified. The praying and crying cleansed me. I felt more connected to God. People were gathering. Playing games and talking. Connecting with each other.

Ally and Arianne came by the church late that night and asked me if we could drive around the reserve. Since I hadn't brought my car, I asked one of the Korean guys to drive us around. He had just arrived in Canada a few months ago. He didn't speak much English. As I had been in Long Bears, he too was an observer. He had come on the mission trip to make new friends. He didn't know much about the languages and histories in Canada. This observer guy agreed to drive us. Perhaps he wanted us to be his friends.

***

It was dark outside. We couldn't see even an inch away without lights. In the van, driving with the girls, I started to get to know the place better. "You know, there was a fire, a man died," Ally pointed out a half-burned house. I then remembered the woman who told me about the ghost she was seeing.

"Hey Ally, what happened to the woman? There was a woman who saw a ghost?"

"Oh! Is it the lady in the pink house?"

"Yeah!"

"She died last month."

"What happened?" I asked in shock.

"I don't know. I think she had some mental problems, I heard. She was just crazy. She died, anyways," Ally mumbled.

Ally then asked me "Amy, do you drink?" I was a bit hesitant to answer. Without giving her an answer, I asked her, "What do you mean, Ally? Do you drink?"

"Yeah. We all drink. We also smoke some weed too."

I didn't know how to respond to this. Arianne was not saying anything. I was in shock. They were only 11 years old! "Who sells you the weed and drinks?" "There is a guy down there. He sells," Ally said.

As we were driving, Ally pointed out a spot in the bushes right beside the road, "You know, my sister died there." "What do you mean? What happened?" I asked. Arianne replied, "Ally's sister died in a car crash here." Ally then told me, "Arianne and I promised to finish high school. Not be like our sisters. And be a role model for our baby sisters." I nodded. Staying silent. Then I finally opened my mouth. "I think that is a very good idea."

In the car, we were bonding. This was the first time that I was building a relationship with the girls. Not with God. Not with other Korean–Christians. For the first time, I felt gratitude and appreciation that the girls were sharing their stories with me. I recalled all the other stories I had heard from Blue Rivers—a guy with drums, a lady with ghost stories, a grandfather with mercury stories, and the girls with theirs. I recalled all the opportunities I had missed to build true relationships because I was blinded by the pursuit of my own goal as an oppressor: to convert them to Christianity.

As we dropped off Ally and Arianne, I looked up. I saw so many stars in the sky. They were like the stars I had seen at the Indian Camp when I was little. Somehow, seeing the stars did not make me feel calm anymore. There were all sorts of emotions mixed up, tangled in my heart. I no longer felt purified or cleansed. I felt confused. I felt sad. I looked at Polaris. Not my Polaris, but the Polaris that was guiding my ancestors, and Ally and Arianne's ancestors.

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Two years ago, I attended Indigenous Education Week at the University of Toronto. There I met a lady. In a conversation with her, I told her that I went on a mission trip to Blue Rivers and that that was one of the motivations and inspirations for the academic work that I was doing. She then told me, "You know . . . there is a divide in the Blue Rivers community now. Some of the community members who are Christians do not want to participate in any cultural activities anymore." I felt guilty. I remembered the moment where I asked Ally and Arianne to join me in prayer. Then I remembered my young self attending VBS, and having values imposed on me that conflicted with my grandmother's teachings. Would they now think that their kokums are "uneducated villagers"? I remembered being little Eun-Ji from the Korean VBS camp. I remembered the embarrassment and confusion I had felt as I started to undermine my halmonee's wisdom. The oppressed had become the oppressor. What had I done? I felt shame.

***

The Indian Act has been in place in Canada for 140 years now. First introduced in 1876, its goal was to eradicate Native cultures and assimilate them into Euro-Canadian society. The Indian Act "forbade First Nations from practicing their traditional religions; declared potlatch and other cultural ceremonies illegal" (Joseph, 2016, para. 8). The glocalized values of Korean Christianity also forbade Koreans from practicing traditional ritual practices. Some Christians in Blue Rivers also refuse to partake in their traditional ceremonies. I am by no means criticizing Native Christians or Korean Christians for refusing to practice their traditional rituals. However, I argue that we need to critically examine the different types of powers at play within both individual and collective society, as well as how these power relations work for or against us as oppressors and oppressed. As mentioned previously, power can take the form of "power-over" (domination or force) or it can be in a form of "power-with," which allows and encourages cooperation between people (Starhawk, 1987). However, as Bishop (2015) mentioned, when a culture practicing "power-with" meets a culture that practices "power-over," people from a cooperative, power-with culture tend to trust others and welcome them whereas people from power-over remain oppressive. In this light, I identify Korean missionary teams, myself included, as immigrant-settlers who bring "power-over" culture to reserves, with the belief that Christian doctrines are better than Native traditions. Meanwhile, people on the reserves were part of "power-with" culture—one that focuses on the relations among things and people, and that sees all things as connected, with less emphasis on a hierarchy amongst its members (Wilson, 2009).

People in Blue Rivers showed me this power-with culture. Though I was there as an oppressor, a man shared his drums with me, a grandfather shared his story with me, and the girls shared their hearts with me. Atkinson (2010) stated, “Aboriginal peoples have a tremendous capacity to forgive when a White person [or any settler] is willing to learn” (p. 95). When Atkinson (2010) turned down the plate of food offered to her by a Native community, nobody made her feel badly or shamed. “Instead, I [she] was provided a powerful and lasting lesson” (p. 95).

***

It is painful for me to write this chapter. It is painful for any individual to reflect on their mistakes and wrong-doing and look critically at the effects of their actions. I was scared to look at how my actions may have had any negative impact on the girls and other members of Indigenous communities I have relations with. Ellis and Bochner (2000) stated that “honest autoethnographic exploration generates a lot of fears and doubts—and emotional pain . . . there’s the vulnerability of revealing yourself, not being able to take back what you’ve written or having any control over how readers interpret it” (p. 738). However, Atkinson (2010) assured me that these feelings of blame, shame, and guilt I felt are actually significant and shape one’s experience of becoming an ally.

It is risky for me to share these stories in this dissertation. It is risky because of the Korean-Christian community I once was a part of. I still have contact with many of them, who also know my family. This paper is not only a reflection of my wrong-doing as an oppressor, but it is a reflection on the ongoing missionary practices in the Korean-Christian community across North America, and on their wrong-doing regardless of good intentions. I may hurt their feelings because I am calling them oppressors and/or I (and my family) may face negative judgements from them. However, as Atkinson (2010) said, “Simply believing that we do good practice with

Aboriginal peoples is not good enough" (p. 105). Breaking the silence through reflection, analysis, strategy, and finally action is needed in order to stop injustice (Bishop, 2015). I hope this thesis serves not only as my own reflection-log but also offers an opportunity to others who work in Aboriginal communities to reflect on their own roles as an oppressor and an oppressed person. Self-reflection, "involving the painful work of examining one's own complicity in oppressive culture" (Shultz, 2003, p. 29), is required for one's own liberation and in order to learn about oppression (Bishop, 2015).

While I reflected on my own experience as an oppressed person, my own settler privileges, and mistakes I've made as an oppressor, I am afraid that I will make mistakes again in the future due to the nature of my untangled internalized oppression that I still need to learn more about. Karen Max (2002) wrote, "being an ally means living with the ambiguity of not knowing and the fear of making mistakes" (p. 62). Further, the process of becoming an ally cannot simply be taught. On the contrary, "becoming an ally is learned through experience and critical self reflection" (Atkinson, 2010, p. 116). Thomas and Green (2007) used the Medicine Wheel in describing the learning process:

> once you have journeyed around the wheel, you have the opportunity to learn from your experiences and journey around the wheel again, this time learning from your mistakes . . . . if we remember what the challenges were in our previous journey, then our next journey can be different and more effective. (p. 92)

As I close my reflection, I write these words in my notebook:

> Self-reflection
>
> Learning from my own mistakes
>
> Listening and acting when working *with* Indigenous peoples, not helping

Ongoing learning

***

Ally and Arianne are 18 years old now. We kept in touch for many years. However, I lost touch with Ally about three years ago. The last time I spoke to her she was in care in town. I don't pray to God to help Ally and Arianne. Arianne will be working with her family at the lodge this summer. She is going to go back to school next year to finish her high school degree. I do not help her. She is going through her own life and she is making the best of it. She said she is going to be a role model to her baby sisters. I am here to listen to her stories and to share my stories with her and Arianne is also there to listen to my stories and share her stories with me. I celebrate our respectful and reciprocal relationship. Meanwhile, I am still on the journey of learning. It is never over. As Bishop (2015) wrote:

> an ally is not an identity, but an endlessly unfolding struggle for equity. Just as an alcoholic must accept that they will never not be an alcoholic, an ally never "arrives." One can not be an ally, but is always becoming one, part of a larger process. . . . No matter how much work you have done on that area of yourself, there is more to be done; the oppressive messages that surround us, unconsciously absorbed, constantly undo some of our efforts. . . . In fact, the minute I hear someone claim to be free of the attitudes and actions of a certain oppression (as in, "I'm not racist"), I know they have barely begun the process. Humility is the mark of someone who has gone a way down the road and has caught a glimpse of just how long the road is. (p. 94)

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Chapter Two: Locating Myself Within the Research: Purpose and Motivation

> *the methodologies and methods of research, the theories that inform them, the questions which they generate and the writing styles they employ, all become significant acts which need to be considered carefully and critically before being applied. In other words, they need to be "decolonized." (Smith, 1999, p. 41)*

Acknowledging the importance of knowing both my *academic* and *personal* purposes for research (Hampton, 1995; Kovach, 2009), I explored my *personal* purpose and motivation for studying and working with Indigenous peoples (particularly in Canada) in the previous chapter. In exploring my experience as the oppressed and the oppressor, and with different forms of power (i.e., power-over and power-with), I stated that my *personal* purpose and motivation for pursuing a PhD were to engage myself in the process of becoming an ally for Indigenous students, and to make the Canadian educational landscape more inclusive.

A Blackfoot Elder, Narcisse Blood, said, "the worst thing to do is nothing and just go with the same . . . eh . . . you know, status-quo" (as cited in Wiseman, 2016, p. 107). Following this advice, I attempted to avoid engaging in research practices that promote "the same Status-Quo," "the same old colonial song" (Cole & O'Riley, 2005, p. 22), or what Neale (2014) referred to as "waffle and lies" (p. 13)[8] but tried instead to delve into possibilities in research (Kovach, 2009). In this chapter, I reflect on my *academic* purpose and the choices that I made for this particular research project. In so doing, I seek to be clear about my "politics of truths"—knowing the limits and the capacities of me as a researcher (Graham Smith, as cited in Kovach, 2009, p. 90).

[8] Jonathan Neale (2014) has stated that "young scholars may start out by applying for that money with a deep cynicism. They fill the form with words they regard as *waffle and lies*. . . . But their monographs eventually come out and validate the existence of a new, funder-created field like 'social exclusion.' The required language of the forms leaks down through committees, introductions and reading lists. . . . Soon students are consuming as knowledge what everyone knew was *hypocrisy* ten years ago" (p. 13, emphasis added).

Locating the Project: Indigenous Inquiry? Decolonization?

No matter how a research project is positioned, Kovach (2009) has asserted, "a *decolonizing* agenda must be incorporated within contemporary exploration of *Indigenous inquiry* because of persisting colonial influence on Indigenous representation and voice in research" (p. 81, emphasis added). This statement raises two questions for me: What exactly constitutes Indigenous inquiry? I am not Indigenous, but my project deals with topics concerning Indigenous peoples. Does that make it an Indigenous inquiry? Or does Indigenous inquiry have to be inquiry by Indigenous peoples that stems from their ways of being, doing, and thinking?

I have positioned myself as a person in the process of becoming an ally to Indigenous peoples and my project as re/search that makes a commitment to avoiding the "same old colonial song." However, I am not quite convinced that the concepts *decolonizing* and *Indigenous inquiry* effectively reflect the nature of my PhD project, as I understand that no research project undertaken within a Western academic context by a settler like myself is free of being what Smith (1999) called an "innocent or distant academic exercise" or "an activity that has something at a stake and that occurs in a set of political and social conditions" (p. 5). In order to address these concerns, in the next section, I explore what it means to engage in Indigenous inquiry and discuss the decolonizing agenda for this project.

This Project is Not Indigenous Inquiry: The Use of the Term *Indigenous*

At the Canadian Society for the Studies in Education (CSSE) conference in 2016, I took a seat at the "kitchen table" set up by the Canadian Association of Studies of Indigenous Education (CASIE). The kitchen table was a place where people stopped by to rest, make beads, and have conversations with others in the midst of the business of the conference (Figure 5).

Figure 5. Kitchen Table

I was sitting alone, making a beaded necklace when James Sa'ke'j Youngblood Henderson, a scholar from the Chickasaw nation and the Cheyenne tribe sat beside me. I don't quite remember how the conversation started, but I spoke to him about my dilemma of being non-Indigenous and undertaking a project involving Indigenous people. I said, "as a non-Indigenous person, I find it difficult to position my work and to decide to what extent I can draw from Indigenous research frameworks, or use my voice to explore topics of Indigenous education." In response to this, Henderson told me, "You are indigenous. You are indigenous somewhere. Everyone is" (personal communication, May 30, 2016). These three sentences guided me to multiple lessons as I went on with living my life and further helped me in "being grounded" in my project.

My first lesson from Henderson concerned the use of the term *Indigenous*. Wilson (2008) defined the term *Indigenous* within a discussion about the difference between the terms *Indigenous* and *indigenous*. He explained that *Indigenous* [with a capital I] is "inclusive of all first peoples—unique in our own [Indigenous] cultures—in our experiences of colonialism and our understanding of the world" (p. 16). The term *Indigenous* (with a capital I) emphasizes the collective lived experiences of Indigenous peoples around the world in resistance to colonialism and European imperialism. Eve Tuck and Wayne Yang (2010) added that Indigenous peoples are those who have creation stories about "how they came to be in a particular place—indeed how they came to *be a place"* (p. 6, emphasis added). Thus, the relationship that these Indigenous, original inhabitants (i.e., first peoples) have with the land and with the ancestors who presided before and have returned to land, and with the future generation who will come to the land, is an important aspect in describing being Indigenous (Wilson, 2008).

The term *indigenous* (with a lowercase i), on the other hand, generally refers to "things that have developed 'home grown' in specific places" (Wilson, 2008, p. 15). In locating myself in this project, I use the term *indigenous* to remind myself that I am indigenous to Korea and not indigenous to North America. However, I do not use *Indigenous* with a capital I to refer to myself, do not locate myself as Indigenous, and do not identify my project as Indigenous inquiry.

The second lesson from Henderson came in regards to the important role *being grounded* (Kovach, 2009) and *having ground outside academia* plays within the process of becoming an ally. *Being grounded* is about maintaining a sense of cultural and personal integrity. As Henderson said, I am indigenous somewhere. The importance of knowing my own history and knowing that I am not Indigenous are insights I took away from a talk Linda Tuihuiwai Smith (2014) gave at the University of Toronto. When a person from the audience asked her what it meant to be a good ally, she mentioned that:

> A good ally is a person who acknowledges that they are not Indigenous and are comfortable with who they are; is educated in Aboriginal history; takes the risk and goes

on a journey with Indigenous people, not seeking to help Indigenous people. (Seminar, February 24 2014, University of Toronto)

Knowing that I am not Indigenous, but indigenous to Korea, and being comfortable with who I am and where I come from gives me as a re/searcher a grounding outside Western academics, because the academy often consumes the cultural and personal identity of non-Western researchers (Kovach, 2009).

Knowing my Politics of Truth: My Limits and Capabilities in Drawing from Indigenous Research Paradigms

Now that I have demonstrated why my PhD project is not an Indigenous inquiry and located myself as an academic-in-training and an individual in the process of becoming an ally to Indigenous peoples, my question becomes: To what extent can I draw from Indigenous research frameworks?

Indigenous scholars, including Wilson (2008) and Kovach (2009), have previously mentioned the need for non-Indigenous students and scholars to learn about Indigenous research frameworks. Graham Smith, a Maori scholar, has also expressed his concern about individuals who claim Indigenous theorizing, but are not concerned with the role that tribal language plays in Indigenous research epistemologies and frameworks (as cited in Kovach, 2009, p. 59). Because language is fundamental to maintaining worldviews, cultures, knowledges, and practices (McKinley, 2008), Kovach (2009) underscored the importance of tribal language, identifying it as the "central component of Indigenous epistemologies [that] must be considered within Indigenous research frameworks" (p. 61).

I recognize that Indigenous research frameworks come from tribal epistemologies (Kovach, 2009) that are deeply embedded in one's relations, language, and lived experience in a particular place/land. I do not have knowledge of, or a relationship with, any tribal epistemologies or languages from North America. Therefore, I acknowledge that I am not able to use Indigenous research epistemologies or frameworks in their entirety, though I may still draw upon these frameworks. To illustrate my process of working through this tension more clearly, I relate my correspondence with Dr. Laara Fitznor.

While working on my PhD candidacy paper, which explored the current status of Traditional Ecological Knowledge (TEK), I wanted to present my findings in the form of a Medicine Wheel. I had made the choice to focus on Indigenous scholars' literature and voices, rather than Western scholars, in my paper and, at the time, I thought that using a Medicine Wheel would be a respectful way to reflect an Indigenous research framework. I sent the following email to Dr. Laara Fitznor to elicit her perspective on this choice:

> I am using Nicholas Houdes' (2005) "Six faces of TEK as a framework (i.e., pentagon)" to synthesize my literature review (TEK in science education; how TEK has been utilized in teaching science). However, I was wondering, instead of using "pentagon" as Houdes used, if I could use the Medicine Wheel framework to present the current TEK conceptualization/pedagogical view. If I were to do so, would it become problematic?—As I am not Aboriginal myself, I could be engaged in act of appropriating the usage of medicinal wheel? If you could let me know, that would help me a lot! Thank you very much! (Personal correspondence, January 10, 2014)

Dr. Fitznor replied:

> Hi Amy, good to hear from you. If I were you, and drawing from the works—sentiments of Indigenous scholars I would not use the Medicine Wheel as your primary discussion although you could refer to aspects of it or suggest is as another framework that has been used in literature etc. (Personal correspondence, January 12, 2014)

Dr. Fitznor's advice taught me valuable lessons. As mentioned in the previous chapter, it is not the intention that counts (Atkinson, 2005). Often, well-intentioned research, publications, and practices that intend to respect and honour Indigenous ways of being, thinking, and doing can actually lead to their appropriation and misrepresentation (Haig-Brown, 2008). The Medicine Wheel has multiple meanings according to different tribes. Based on the landscape and the relationships one has with living things on particular land, the meanings and lessons generated by the Medicine Wheel are particular to individuals. I am not indigenous to any community where meanings and lessons are shared through the Medicine Wheel and, as such, I do not have personal relationships to the Medicine Wheel. Though I am familiar with the Medicine Wheel, I cannot use it to make my own interpretations because it would be an act of appropriating the relationships, knowledges, cultures, and worldviews that are embedded within it. In this regard, I may draw upon how the Medicine Wheel has been interpreted by other Indigenous scholars, but I should not use the Medicine Wheel for my own purposes or my own interpretations.

Moreover, I have learned that just because lenses or research frameworks are Eurocentric or used by Western scholars, I should not necessarily avoid using them. Indeed, in a conversation with Kovach (2009), Graham Smith said:

> I am not going to say Western theory is useless that it's white man's knowledge and shouldn't use it and all that stuff. That's a load of bull—we need to use all the very best available theoretical and methodological tools, and where necessary develop new approaches when these tools are inadequate. (p. 91)

Graham Smith's statement is in line with Linda Tuhiwai Smith's (1999) argument that decolonizing research does not necessarily mean avoiding using Western frameworks of research altogether. Rather, decolonizing research it is about centering Indigenous ways of coming to know place (both physical and metaphorical). As I understand it, to avoid the "same colonial song," I do not necessarily have to choose between an Indigenous research framework or a Western framework. Both can, in fact, work together to allow "for new ideas and ways of looking at things to be incorporated constantly, without the need to search constantly for new theories" (Smith, 1999, p. 40). However, I remain critical about making such choices in this work. I am critical not in the sense of passing judgment on other people's theories and ideas, but in the sense of choosing my own use of language, method, and theory in this work.

I am committed to making sense of both Indigenous and non-Indigenous research frameworks and stories on my own terms. In so doing, I wish to move beyond the binary notion of non-Indigenous | Indigenous when drawing on research frameworks for my PhD project. However, thinking beyond the binary is challenging because we live in a binary world (Kovach, 2009); some things in our world exist in inseparable binary relations (e.g., self/other; nature/culture; ethical possibility/impossibility) (Higgins, 2016).[9] To this, Wiseman (2016) spoke about being in "the place of in-between" (p. 93) called *inter esse.*

Sitting with Uncertainty in The Process: Remaining Open Throughout the Process

Inter esse is a place "where Western and Indigenous ways of knowing, being and doing circulate together; things/not things recognizable" (Wiseman, 2016, p. 47). Dawn Wiseman (2016) drew on Jardine's (1998) concept of inter esse from hermeneutics, "being in the middle of things" (1998, p. 7). For Dawn, being inter esse "is [being] deeply and fundamentally interested in life

[9] In his dissertation, Marc Higgins delved into the question of "How is Indigenous science to-come within the context of science education?" He attempted to deconstruct and reconfigure such binaries in science education. Along with Dawn, Marc is non-Indigenous, and one of the few people I know whose work involves Indigenous science education in Canada. I hope that my dissertation shows how *relationship* played a role in constructing my ideas around the topic of Indigenous science education. I also hope that my dissertation serves as a thread of conversation linking the ideas presented by diverse Canadian academics in this area, including Dawn and Marc.

and living—in how the puzzle might emerge and grow from the middle" (Wiseman, 2016, p.31), rejecting the reductionist linear way of doing research.

To my understanding, *inter esse* is a both/and place where I can engage with and embrace both non-Indigenous and Indigenous methodology and epistemology that come from multiple ways of coming-to-know processes. Within this place of the *inter esse*, instead of fitting the project within an already existing research framework, I let the methodology and framework emerge throughout the process of re/search. The notion of *inter esse* is also in line with pragmatism. Pragmatists do not commit to a particular system of philosophy or reality and as such their research involves multiple methods and worldviews, and different assumptions (Creswell, 2003).

However, such an approach (i.e., not following a reductionist linear research approach) is not always easy or comfortable. Wiseman (2016) elaborated on the tensions of being in the *inter esse*, referring to this state as "flux": "it asks things of me on an ongoing basis—I have discovered that it is a place where it is possible to sit with the difficulties, allow them to be, and learn how to become comfortable with the discomfort" (p. 95). She in turn stated that it was through the act of living within *inter esse* that learning emerged. Indeed, William Doll (2012) in his discussion of complexity theory concurred that there is value in being in what he called "orderly disorder" (p. 12). In an open, living system, disorder and chaos illuminate creativity and form new understanding. My choice to draw from both Indigenous and non-Indigenous epistemologies, research frameworks, and theories, and to not commit to one particular research paradigm, left me in disorder. However, this disorder has helped me create my own interpretation of theories, ideas, and understanding. In order for new ideas to emerge in the process of making meaning on my own terms, it is unavoidable—and in fact necessary—to grapple with the messiness, anxiety, and uncertainty that comes from engaging in the "flux" and "disorder" inherent in the process.

I've found that other scholars whose work shares a similar context to my project (i.e., non-Indigenous scholars exploring Indigenous science education) all seem to have to engaged in the "flux," or chaotic process, that results from being in the *inter esse*. For example, Marc Higgins (2016) referred to his PhD dissertation as "wandering pathways": each chapter becomes a journey and each journey is "iterative travelling through, against, and/or beyond a particular path, wherein the learning is enfolded and carried forward into the next trip" (p. 25). In this way, Marc has engaged in the process of "getting lost" in science education. He does not lose his way. He loses *the* way: "strategically straying off the beaten path or taking the path in an unintended way" (p. 18). Losing the way involves being open to new experiences and ideas during the process of research and writing. He called this process "pathways of chance" that invite unexpected in the research process wherein the researcher "would not know the end result" (p. 122).

These reflections on others' experiences led me to return to considering my position as a re/searcher, a learner, and an individual in the process of *becoming* an ally. This process involves having an "openness to experience" (Rogers, 1961, p. xx)—engaging in a circular and open process of learning that involves being in "disorder" (Doll, 2012) and "flux" (Wiseman, 2016) and accepting the "pathways of chance" (Higgins, 2016). This approach encourages respect, reflexivity, integrity, and relationships with others and helps create new forms of understanding. In the end, my notion of re/search is about experiencing and trusting the process despite its ambiguity and a fear that I might make mistakes. I have learned to become comfortable with these discomforts and tensions. As Tewa scholar Gregory Cajete (1994) remarked, remaining in the process of *becoming* and *getting lost* will lead to "creative acts of perception. A free play of thought and an opening of the field" (p. 19). In this light, I position my project as *re/search*. Re/search is a concept I have arrived to describe my project. Re/search is a term that refers to a way of coming to know one's individual interpretation and understanding of phenomena, taking a subjectivist stance, rather than positing the outcome as a single universal truth based on the positivist view.

Re/search: Focusing on the Process, and *My* Interpretation of Inquiry

In writing about research, Maori scholar Linda Tuhiwai Smith (1999) suggested that "the term 'research' is inextricably linked to European imperialism and colonialism. The word itself . . . is probably one of the dirtiest words in the Indigenous world's vocabulary" (p. 1). Wiseman (2016)[10] has spoken about the "significant tension" she felt towards the label "research," as well as towards her position as a researcher for her PhD project. In response to this tension, she decided to position herself as a "learner, or to phrase it more actively, someone who finds life and living in learning" (p. 90). I, too, do not feel comfortable labeling myself as a researcher, acknowledging the colonial history and imperialist values and ideas attached to the word. As Edward Said (1978) stated, research has been "a Western discourse about the Other" (p. 2). To this end, like Dawn, I position myself as a learner. My notion of "re/search" emphasizes the aspect of learning that comes from fully engaging myself in both the *process* and content (e.g., outcome) of this PhD project.

[10] Dawn Wiseman and I share many similarities in terms of inquiries/research questions for our PhD projects. We are both not indigenous to North America and both explore Indigenous and Western ways of knowing in the field of science education. Some of the questions she has explored in her PhD project are very similar to my questions. Acknowledging the nature of re/search as individual interpretation, our process and interpretations of concepts are both similar and divergent—something that is made clear throughout the thesis.

In conceptualizing re/search, I drew on Aoki's (1999) rhetorical device—the forward slash (/)—to dwell in the metonymic moments: "the [liminal] space between a tensioned space of ambiguity, ambivalence, and uncertainty, [which is] simultaneously a vibrant site" (p. 181). First, my notion of re/search rejects the notion of a single, universal (positivist view of) truth. By using the forward slash in re/search, I highlight my goal to reiterate the action of searching and seeking *my* understanding of the research inquiry. The forward slash reflects the "in-between" liminal space that Aoki (1999) referred to as "simultaneously a vibrant site." Dwelling in these liminal spaces "that are neither this nor that, but this and that" (Pinar as in Irwin & de Cosson, 2004, p. 9), I continuously reflect, learn, and build relationships with the peoples and ideas I have encountered during the process of doing research and writing. Therefore, re/search reflects a "constant state of flux . . . allowing for new directions/approaches/ideas to emerge" (Carter & Irwin, 2014, p. 4).

As such, my re/search here values the process as much as the outcome. As Cree scholar Shawn Wilson (2008) has remarked, "research is all about unanswered questions, but it also reveals our unquestioned answers" (p. 6) such that "the process is the product" (p. 103). Deleuze and Guattari's (1987) notion of *rhizomatic relations* can be used to further explain this idea of *process as the product*: rhizomes make different, connected entry points into a system, growing organically in multiple directions. In this light, as re/search, my work here allows for "an evolution of questions and meaning through making connections to different theories, processes, and products" (Kim, 2016, p. 321). Thus, I focus on and value the process of this project as much as its content (i.e., its findings and outcomes).

By engaging in re/search that focuses on the process, I provide readers with a map of the evolution of my project and the stories and rationales behind this evolution, which makes my *academic* purpose, mistakes, and lessons learned throughout the project explicit to readers. In fact, such a re/search design also provides "common ground for Indigenous and non-Indigenous researchers to understand each other" (Kovach, 2009, p. 25). As previously mentioned, in this thesis I am trying to avoid engaging in inquiry that promotes the "same colonial song," which only serves non-Indigenous people. In my commitment to focusing on and valuing both the process and the content of this project, I also hope to remain open; to continue to learn; and to accept the evolution of the questions, methods, and analysis of the work based on the people and ideas I encounter.

Re/search is also about exploring and finding *individual interpretations* of the world and promoting respect for others' ideas. According to Wilson (2008), in Indigenous paradigms, knowledge is seen as collective—a part of the cosmos of which researchers are also a part. This notion is contrary to most Western research paradigms wherein one individual assumes ownership over the knowledge generated by their research. Rejecting the notion of individual ownership of knowledge, Wilson (2008) stated that researchers are "only the interpreters of this [collectively shared] knowledge" (p. 38). In turn, he stated that research is "ceremony," and that the purpose of any ceremony is to build stronger relationships (p. 11). Because one cannot know all the relationships that went into how an idea was formed, the focus of re/search should be "not about judging others' ideas but to make new connections of ideas" (Wilson, 2008, p. 94). In this light, rather than treating the findings of a project as universal truth or fact, I view the outcome (i.e., content) of this study as *my* interpretation of the inquiry, and the process of studying as the "ceremony" through which I make stronger connections and relationships with other ideas and peoples. Throughout the whole process of re/search, I have been guided by a Cree word taught by Dr. Laara Fitznor, *Kemoochly.*

Kemoochly[11]: Integrity

One afternoon, over lunch at Altos in Winnipeg, I spoke to Dr. Fitznor about my questions and dilemma regarding to what extent I could draw from Indigenous and/or Western frameworks for this project. Instead of giving me a direct answer, she taught me a Cree word, *Kemoochly*. It means “in secret” and “working against.” She suggested that I should find my own “living set of parameters” and that “we can’t pretend that all cultures are beautiful” (personal communication, March 25, 2016). When Dr. Fitznor first introduced me to the concepts of *Kemoochly* and *finding my own living set of parameters*, I didn’t quite understand what she meant. It took another six months for the meaning of *Kemoochly* to come to me.

Life is a continual *coming to know* process and it is from my life of living inquiry that learning comes, “*Kemoochly*— in secret.” Through living inquiry, I have come to understand what my own interpretation of the world is (Wilson, 2008). Finding my own living set of parameters is important in this process of *Kemoochly*. For the question: To what extent can I draw from Indigenous and Western frameworks? I realize that the answer can be found within myself— it comes from my own living inquiry and my own integrity. Dr. Fitznor also advised, “whatever choices you make, you need to feel *comfortable* about them” (personal communication, March 26, 2016). In the end, the process of interpretation and framework selection are about the integrity of one’s own research. Kovach (2009) also spoke about the importance of doing research in a good way (*Miyŏ* in Cree), “so that no matter the outcome you can sleep at night because you did right by the process” (p. 52). In conversation with Shawn Wilson (2008), Cora Weber-Pillwax, a Métis scholar, said:

[11] I acknowledge that my understanding of Kemoochly is based on my personal relationship with Dr. Laara Fitznor and my interpretation through living inquiry. For readers who would like to better understand the word, I encourage them to learn the word directly from Cree speakers.

> It [research] must not destroy or in some way negatively implicate or compromise my own personal integrity as a person, as a human being. That is another important aspect of research . . . it demands integrity. Otherwise, without integrity, you are outside of the system. If you are outside of the system, you don't survive. You destroy yourself. (p. 102)

Drawing from these conversations, I understand that I strive to maintain integrity in research that I feel *comfortable* with, and to do research in *a good way* not with the primary purpose of being benevolent to Indigenous peoples, but instead to develop my own personal learning and to maintain good relationships with others.

I attempt to "work against (*Kemoochly*)" the dominant, internalized oppression that comes from the Western world in which I currently reside. As Kovach (2009) mentioned, "the most effective allies are those who are able to respect Indigenous research frameworks on their own terms. This involves a responsibility to know what that means" (p. 13). For me, this is about being grounded. *Being grounded* involves knowing my politics of truth (Kovach, 2009), knowing where I am indigenous to, and being aware of my position as a person who is becoming an ally, rather than an Indigenous person or an expert in Indigenous issues. It maintains my integrity within the project and demonstrates that I have made a commitment to learn through this process, and not to repeat the "same old colonial song" in my re/search practice. As such, I open my heart and life to learning from both Indigenous and Western ways of coming to know, thus engaging in my own interpretation and understanding to emerge from my living within *inter esse*. As well, focusing on my re/search that values process as much as the product, I am committed to being honest and upfront about whole process of project and writing, thus keeping my integrity throughout the process.

The Decolonizing Agenda in My Research

Kovach (2009) stated that a way for non-Indigenous academics to support Indigenous scholarship is to decolonize self and institution. Speaking from a Maori context, Smith (1999) stated that, "the Maori struggle for decolonization is multilayered and multidimensional, and has occurred across multiple sites simultaneously" (p. 200). Acknowledging the intensive labour, experiences, theorizing, and research done by Indigenous peoples that resonate in the term *decolonizing*, I cannot use it lightly. I also acknowledge that there are multiple definitions and stances on the term *decolonization*. Indeed, Eve Tuck and Wayne Yang (2012) cautioned that, "decolonization is not a metaphor" (p. 1). For them, the term has been "superficially adopted" into education and other social sciences, supplanting the languages used for social justice and critical methodologies (p. 2). They explain that decolonization is not the same as these anticolonial struggles—it is about "the repatriation of Indigenous land and life" and "is not a metonym for social justice" (p. 21). Indeed, one of Canada's continuing colonial practices is to perpetuate the perception that land is separate from people, failing to acknowledge the "rationality and connectivity that comes from living together in a place for a long time" (Donald, 2009, p. 6). To this, Kovach (2016) enunciated that, in the multifaceted, complex process of decolonization, it is the small steps that make things happen. She in turn suggested that all people start such a decolonizing process by acknowledging the traditional and unceded territory that they are in (McGill Graduate Students Seminar, September 22, 2016). This may be a small step, but it is an important contribution to decolonization.

Meanwhile, Smith (1999) explained that decolonization in research practices is "a process which engages with imperialism and colonialism at multiple levels" (p. 21). One of the goals of a decolonizing agenda within research starts from *self*: critically reflecting on oneself to resist the imperialism rooted in Western research practices (Smith, 1999). Acknowledging the diverse stances that exist within "what *decolonization* entails," I went to speak to Dr. Fitznor. I asked her what decolonization means, how non-Indigenous peoples can participate, and on what terms. To answer these questions, Dr. Fitznor advised me to start from a point of decolonizing the s*elf,* first:

> Decolonization means willingness to see and look back to history behind. Everyone needs to be decolonized. Not only Indigenous peoples. In engaging with decolonizing activity, asking questions such as "Where is power dynamics? What do *I* encourage through this activity?"—are important. Also, decolonizing activity involves supporting Indigenous sovereignty, including Indigenous feminist sovereignty. (Personal communication, March 26, 2016)

Indeed, because the "personal is political" (Kovach, 2009, p. 83), to participate in decolonization, I must begin with by acknowledging Canada's colonial history along with examining my own history, beliefs, and values about knowledge and how these in turn shape my re/search practice. Following this practice, I need to ask questions about the decolonization of institutions (social and political) and examine the power dynamics and Whiteness within the institutions.

Dr. Dwayne Donald (2009), a Papaschase Cree scholar, used the term *colonial frontier logics* to explain the "epistemological assumptions and presuppositions, derived from the colonial project of dividing the world according to racial and cultural categorizations" (p. 20). Colonial frontier logics are deeply embedded in the cultures of educational institutions and make it possible to perpetuate the status quo between Indigenous knowledge and Western knowledge (i.e., Western modern science). Donald (2009) also described the "exclusionary colonial practices [that] are still replicated and perpetuated" (p. 18) through colonial frontier logics, ensuring that Indigenous epistemologies and knowledges are underrepresented or ignored in every state and education system (Battiste & Henderson, 2008). Kovach (2009) suggested that a *decolonizing institution* agenda should be about examining Whiteness and the powers at play in institutions. In addition to these, non-Indigenous people should listen to Indigenous voices and make space for Indigenous voices in and outside of these institutions, rather than taking a stance as experts who speak on behalf of Indigenous peoples. Most importantly, as Wiseman (2016) mentioned, it should be about "making room for that we [both Indigenous and non-Indigenous] are learning together and in living together" (Personal communication, August 26, 2016)—a practice which can help to diminish the "divisiveness" between Indigenous and non-Indigenous people enforced by colonial frontier logics (Donald, 2009). Meanwhile, Dr. Glen Aikenhead, an internationally known non-Indigenous scholar in the field of Indigenous science education, described decolonization as a process:

> Decolonization is the other side of the coin of the postcolonial [where] the postcolonial means that you are not past being colonized. It means you recognize the ways in which neo-colonialism continues and you work at diminishing it, and even trying to eliminate it. And you are never going to get there. . . . It [decolonization]'s a process; it is not a product. (Personal communication, March 24, 2016)

Drawing from these conversations around decolonization, I conceptualize decolonization as multilayered process that involves self, institutions, nations, and the globe. The ultimate goal of decolonization would be the repatriation of land for Indigenous peoples. However, in order for us to get there, we *all* need to work together to ensure that Indigenous peoples' voices are heard and valued in different political and social venues. As *an individual in the process of becoming an* *ally*, my decolonizing agenda for this re/search is therefore to examine my biases and assumptions first, and then to investigate power dynamics and Whiteness in educational institutions. In this way, I contribute to making a space for Indigenous people to share their voices and a space for Indigenous and non-Indigenous people to share and learn together. In so doing, I have committed to actively listening to and respecting the stories of Indigenous peoples. I have also committed to engaging in an open-learning process where I am challenged to remain in the flux and disorder. I also acknowledge that decolonization is a *becoming*[12] process, involving continuous learning experiences and building relationships.

I still feel discomfort and tension around the term *decolonization*. Because of this discomfort, I considered avoiding using the term in writing this dissertation. However, because the term has come up in conversations with others and the literature I engage with, I cannot simply ignore it. Especially as an individual becoming an ally, I've learned that decolonizing outcomes (however defined: repatriation of land, examining Whiteness and power dynamics at the institutional level, investigating one's own beliefs about knowledge and practice, etc.) is a demand of Indigenous communities (Kovach, 2009). I thus have continued to use the term *decolonization*. Throughout this dissertation, I continue to grapple with the notion of decolonization in the context of this re/search. I acknowledge that my understanding of decolonization here may fall into the "settler moves to innocence" (Tuck & Yang, 2012, p. 9). However, as Kovach (2016) advised, "We [both Indigenous and non-Indigenous] all have responsibility to the land for the future generations. You start where you are at and take small steps first" (McGill Graduate Students seminar, September 22, 2016). I thus continue on with

[12] Here, I follow Carl Rogers's (1961) notion that becoming involves an "openness to experience" (p. xx).

this process of learning, engaged in flux and disorder and pondering theories, ideas, and conversations as they come into my living inquiry with the mindset of *Kemoochly.*

My Relationship with the Re/search: Evolution of the Project

In this doctoral project, I explored the question: What are the relationships at play in integrating Indigenous perspectives and content in science curricula? However, the research questions and the site changed multiple times throughout the process. With the intent of doing re/search that values both process and outcome, in this section, I demonstrate the process that I went through to form the final guiding paths of inquiry for this project. In particular, in what follows, I reflect on the encounters that I had with Indigenous knowledge in academic settings that influenced the formation of my re/search inquiries. I also lay down the moments that had a significant impact on this re/search site and the questions with a commitment to show the honest process of the re/search process.

Prior to the formation of "the" re/search project: encounters with Indigenous knowledges in academia.

My first encounter with Indigenous knowledges (IK) came when I was enrolled in the Biology undergraduate program at the University of Manitoba. During this degree, I took a third-year course entitled Boreal Ecology, which focused on the culture, environment, and traditions of Indigenous peoples in Canada. I remember sitting in the back of the classroom wondering why the Biology Department offered courses that focused on "cultural" content rather than "scientific" content, and if what I was learning—Indigenous knowledge and practices—was considered science. The instructor, Dr. Rick Riewe, was a non-Indigenous scholar who had been working with Indigenous peoples in Canada, particularly in regards to land claims. The course did not involve typical university science lectures.[13] Instead Rick would share stories. In fact, he *only* used stories to teach. Whether it was him speaking or Elders in the video recordings he showed us, the class was never a lecture but a sharing of stories and experiences. After hearing these stories, students would go on a four-day field trip to Lake Manitoba and build and sleep in igloos, eat beavers, and touch different caribou and buffalo furs. The field trip wasn't like the Indian summer camps I mentioned in the previous chapter, though one might say that it had some similarities to those camps in that we were "trying to live" the Northern way for those four days—it was a type of cultural immersion.

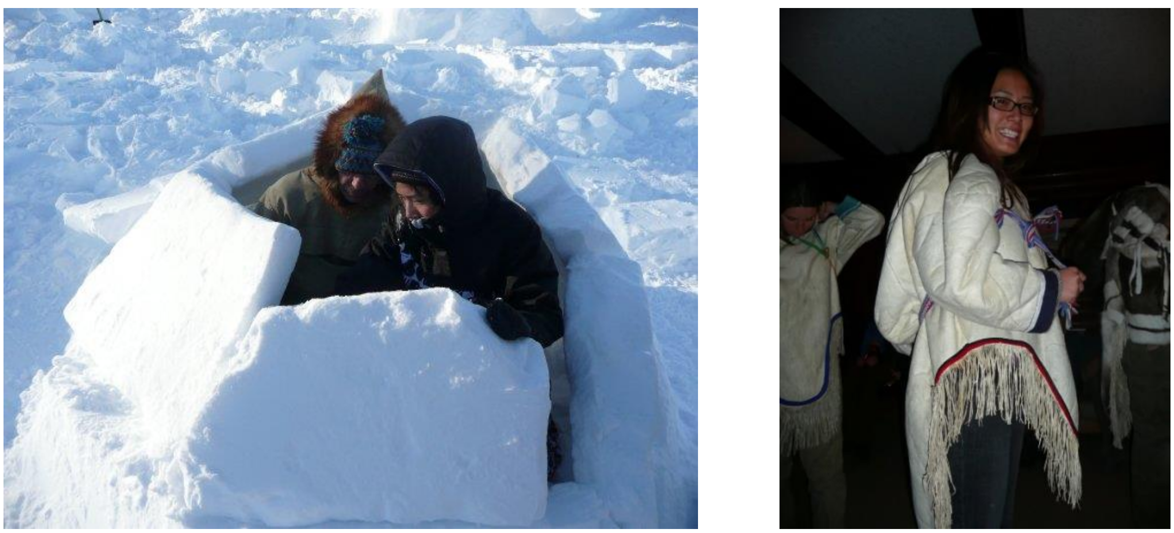

Figure 6. Boreal Ecology Field Trip

As I cut ice blocks for the igloos, I remembered the snow compositions that I learned from Rick's stories in class. While sharing beaver with others, I remembered the different ways that beavers make dams, and details about the life cycle of beavers and their relation to the

[13] Normally in university level science lectures, professors talk for about an hour at the front of the classroom and students listen (i.e., theatre style). This is a place where the relationship between professors and students does not really matter in learning. For example, my first-year biology courses were taught by professors through videos and Power Point slides.(i.e., 100 students go into a lecture hall and watch the professor on the screen giving classes; if you miss the "class," you simply go to the library and borrow one of the recordings to watch the professor on your own computer).

environment taught through the stories in the classroom. While touching and trying on *amauti* (a baby carrier parka) shared by an Inuk woman, I remembered learning about the social relations and systems of the community way of life I witnessed from the video recording in class.

Because of the field trip, I had the opportunity to relearn and link the stories and scientific concepts that I heard about in the classroom with real world experiences. I made relationships between ideas, stories, and peoples on my own terms. In this course, I explored non-European scientific knowledge and started to appreciate the value of Indigenous knowledges in science.

After finishing my B.Sc. in Manitoba, I moved to Ottawa, where I pursued a Bachelor of Education in science education. During the first professional seminar class, the professor asked us what we want to do after the B.Ed. degree, to which I answered, "I want to teach on Native reserves." In pursuing my goal of becoming a teacher on a reserve, I decided to take an elective course called Teaching in First Nations, Métis, and Inuit Communities taught by a Métis teacher named Helen Mertz.[14] Helen taught me the perspectives, cultures, and knowledge systems of different Aboriginal communities, and how to incorporate Indigenous knowledge (IK) into my teaching practice.

During the practicum of the B.Ed., I realized that although I loved teaching, I didn't see myself becoming a classroom teacher for the rest of my life.[15] However, I knew that I wanted to work in some way with Indigenous youth and children on reserves. I also wanted to understand the bigger picture of the Canadian education system and explore why the inequalities between

[14] In later years, I met Helen's grandson at McGill while volunteering as a tutor at Kahnawake schools. Her grandson made me more aware of the struggles with identity contemporary Native youth have, as he doesn't look Indigenous and has lost connection with his community. I also learned about the recursive nature of relationships: One relationship leads to another relationship and all relations become the circle of life.

[15] Though I did become one for a short period of time after finishing the B.Ed.

Indigenous and non-Indigenous education continue to be perpetuated. I decided to pursue a Master of Arts in Education.

Initially, I wasn't thinking of doing research within science education per se. I wanted to do an action research project working with Indigenous communities. However, one of the professors at the University of Ottawa advised, "Whatever you do, perhaps think of integrating with the topics in science education, since you are a science teacher." Following this advice, for my Master's thesis project, I explored the prevalence and representation of Traditional ecological knowledge (TEK)[16] in Canadian science curriculum documents for grades seven and eight (Kim & Dionne, 2014). In this work, I learned that Nunavut and Saskatchewan, in particular, have made some headway in integrating Indigenous knowledges into science curriculum documents because they try to avoid an essentialist, add-on approach to integrating IK and Indigenous Elders and scholars have been involved in the curriculum development processes.

The early formation of "the" re/search.

The inquiry for this doctoral project went through many iterations of change. When I first came to McGill, I wanted to expand my MA work. Initially, I wanted to conduct a comparative study examining how K-12 science curriculum documents of all jurisdictions in Canada convey Indigenous perspectives in science and build a national teaching framework for IK in science. However, my questions for this project changed over time. After the first year of my PhD, I switched focus, as I wanted to conduct a more classroom-based project: I intended to observe how integrated Indigenous-related content in Nunavut and Saskatchewan had influenced both Indigenous and non-Indigenous students' learning. Thus, I proposed questions related to

[16] My understanding and usage of TEK has changed since then. During my PhD I wrote a paper identifying TEK as a construct of the appropriation of Indigenous knowledges that should not be treated the same way as Indigenous knowledges (Kim, Asghar, & Jordan, 2017).

classroom practices such as: How is current IK-mandated curriculum content being taught in public schools? How are the current IK teaching approaches influencing both Aboriginal and non-Aboriginal students' perceptions of IK and attitudes towards learning science? In my SSHRC proposal (written in the second year of my PhD) I suggested: "I will focus specifically on students' *attitudes towards learning* science because these attitudes play a key role in future success and persistence in science, in addition to providing important information about the *efficacy* of current teaching approaches" (Smith, Walker, & Hamidova, 2012, emphasis added).

However, the more I delved into this inquiry, the more I felt discomfort and tension. I was not comfortable with the writing style that I was employing because it was very mechanical and made me feel like I did not have a relationship with my own writing. Moreover, when I looked at the possible conceptual frameworks and instruments used in other research on attitudes, they were mainly based on a Eurocentric perspective of how human psychology shapes learning efficacy. I found this problematic, as I did not want to repeat the "same old colonial song" by producing another research project wherein Indigenous peoples become only the subject of study, and the methods and instruments used in the project had no relation to myself as researcher or the people that I work with. Following many conversations with my co-supervisors about this dilemma, I decided to go back to my original inquiry: an analysis of K-12 Canadian science curriculum documents. However, after reading some literature on critical policy analyses (e.g., Ball, 1998; Fairclough, 1992; Rogers, 2011) as well as on Indigenous research methodologies (e.g., Kovach, 2009; Smith, 1999; Wilson, 2008), I decided to focus on the power dynamics in education systems, and the relationship between the different levels of the education system that integrate Indigenous perspectives or content in the science curriculum. I proposed a new study path that would investigate the representation of IK in science curriculum documents and the relationships the documents had to their historical colonial legacy as well as to educational stakeholders.[17]

"It is about place-based": Changing the context from national to states.

During my preliminary analysis of the documentation, I learned that the curriculum documents of different countries take different forms. For example, curriculum documents in Australia and Canada[18] include descriptive learning outcomes. However, Aotearoa New Zealand's national curriculum is summarized in five pages in which they only introduce broad scientific topics. This is because Aotearoa New Zealand employs a school-based approach in their education system: each school in the country adopts and further develops their own learning outcomes from the five-page curriculum document to meet local students' needs.[19] This local-based approach to education did not really fit into the scope of my project's inquiry (i.e., critical analysis of the official curriculum documents), so I decided to focus on Australia and Canada in this project.

However, in an email conversation, Dr. Marie Battiste, a Mi'kmaw scholar, advised:

> I note that the issue of "country" is quite vast and does not represent each of the unique jurisdictions of provincial and First Nations schools in Canada, and it is difficult to generalize science inclusion of Indigenous perspectives, knowledge and content to one country. Many jurisdictions are doing various initiatives to include content. (Personal communication, January 7, 2016)

Dr. Aikenhead (2016) echoed this point. When I asked him how advanced Canadians are in the process of decolonizing school curriculum, he replied:

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[17] I elaborate on my rationales and methods in Chapter 4.
[18] An official science curriculum is developed at the national level in Australia whereas Canadian science curricula are developed by jurisdictions (provincial/territorial).
[19] Also, Aotearoa New Zealand developed Pūtaiao, a science curriculum in Maori.

> My answer will be *place-based* and also I'd say *academic-based* . . . so there is no answer to your question because it is so variable and it is so place-based. . . . So everything is very idiosyncratic and there is no average. Well there's an average in the sense that if I have my feet—if I lie in the kitchen and have my feet in the oven and my head in the freezer, on the average I feel pretty good in terms of temperature. But the diversity of one extreme to the other just makes that average meaningless. So I think the answer to your question, it's a meaningless question and you'd have to talk in terms of degrees of what's been happening in various places. (Personal communication, March 24, 2016, emphasis added)

Considering these perspectives from Dr. Battiste and Dr. Aikenhead, I decided to focus on jurisdictions rather than countries: Nunavut in Canada and the Northern Territory of Australia. I chose these two jurisdictions based on the previous relationship I had with people in these two jurisdictions. These two jurisdictions also happened to be those with the largest Indigenous populations in each country. My previous work (Kim & Dionne, 2014) demonstrated that provincial/territorial Indigenous population size generally correlated with the prevalence and the representation of Indigenous-related content within science curricula. Thus, in conceptualizing this project, I also wanted to select a possible "model" jurisdiction in each country; in the jurisdiction with the highest Indigenous population, more innovative attempts might have been made to create culturally responsive curricula for local Indigenous students.

Relationships at play in the process.

Because I live, teach, and have been educated in Canada, I am familiar with the Canadian education system, and the cultures of each of its jurisdictions in terms of their stances on Indigenous perspectives within science education. For example, based on my previous work and the research of other Canadian scholars (e.g., Lewthwaite, 2010; Wiseman, 2016), and from conversations that I have had with other researchers, I know that Nunavut is one of the jurisdictions that has made some headway in integrating Indigenous perspectives in education.

To find a model jurisdiction in Australia that has made some headway, I had multiple conversations with academics in Australia. The scholars I spoke to there all voiced the concern that there really wasn't a model province in Australia because there had been little attempt to build science education in Australia that included Indigenous knowledges. I chose the Northern Territory (NT) based on the relationship I had with Dr. Michael Michie, who currently works there and also because NT has the highest Indigenous population in Australia (Australian Bureau of Statistics, 2011). Michael is internationally known for his work in Indigenous science education. He is an editor of *Indigenous Science Bulletin*, a venue through which global scholars can share current news about their work. Many Canadian academics in the field (e.g. Dr. Glen Aikenhead) suggested that he was "the person to go to" in Australia. Indeed, Michael helped me to connect with other Australians and build the necessary relationships for this project. As such, Michael became the starting thread for my conversations around Indigenous science education in Australia and allowed me to expand the circle of relationships I had there.

However, just as I was developing and changing as a re/searcher, the project itself was changing. At times, there were moments that I could not control. The project, in a way, has been guiding itself in its own courses and it was guiding me. For example, in both Nunavut and Northern Territory,[20] I could not gain access to speak to people in the department of education. As such, I had to change the scope of the project. Experiencing such flux of change, I've

[20] The Department of Education in Northern Territory rejected my ethics application because they did not see the benefit of my project to their communities. Although the ethics was granted from Nunavut Ethics Center, I was told that the Department of Education was going through major reorganization at the time and could not work with any researchers/PhD students.

realized, yet again, the need for more research and program development in the field of Indigenous science education. As there are limited numbers of people and resources for science education relating to Indigenous ways of knowing and being and doing, when one door closed, I had to change the entire project. In this sense, I've yet again learned the importance of building relationship prior to project work.

Wiseman (2016) has spoken about relationships, process, and place "as principles that have touched every aspect of the practice, as a means of engaging in and responding to the livingness and play of [her] inquiry" (p. 111). She suggested that it is the *place* within relationships and processes that are "immersed in and emergent from" (p. 77). As such, in her work, her relationships and processes are contextualized within a particular place where she was working and living. These three components; place, relationships, and processes—definitely played a role in the formation and evolution of my research project. However, of the three, relationship was a guiding component in my work because the *relationship* I had with people from diverse backgrounds and their ideas guided the *process* of this project and the *place* where this project took place. Dr. Aikenhead (2016) also underscored the importance of relationships in his work when he stated, "it's not theoretical, it's from personal experience [relationships built with Indigenous peoples] that that's the way I've developed all my research as we went along" (personal communication, March 26, 2016). Dawn Wiseman also enunciated that as a non-Indigenous academic doing research, "you have to *continually* build relationship" (personal communication, August 25, 2016, emphasis added). In this sense, research really is a ceremony because "the purpose of ceremony is to build stronger relationships, or bridge the distance between aspects of our cosmos and ourselves" (Wilson, 2008, p. 11). As illustrated in both the previous chapter and this chapter, the *relationships* I had with others (both Indigenous and non-

Indigenous) played a critical role in shaping this research project. It is the *relationships* I had with others that drove both the *personal and academic* purpose of this work. It is through *relationships* that I have learned multiple lessons and am constantly reminded that I am still in the process of learning and becoming an ally to Indigenous peoples in this project.

(The) Project.

After getting rejections from the Department of Education of Nunavut and Northern Territory, I decide to explore initiatives in Saskatchewan. As stated earlier, Saskatchewan was one of the provinces that made headway in including Indigenous perspectives in science education. Also I had someone who vouched for and introduced my work to others in Saskatchewan. Dr. Glen Aikenhead first referred me to several people (except for Indigenous Elders, as he was very cautious about asking Elders, since building trust and relationships with the communities requires significant time and work). Thereafter, people whom I spoke to referred me to others who I could further engage in the conversation. The details of building relationships and the context of the study will be elaborated in Chapter 4. For now, I would like to emphasize that it was relationship that drove the direction of this doctoral project.

Recognizing the important role relationship in re/search, the central question guiding this inquiry is: What are the relationships at play in integrating Indigenous perspectives and content in science curricula?

In order to further delve into this question, I focused on the following re/search aims:

1) Investigate the ways in which Indigenous perspectives and content are represented in the official K-12 science curriculum documents in Saskatchewan, Canada
2) Unpack the relationship these curriculum documents have to a larger historical colonial legacy

3) Analyze the different views of educational policy stakeholders (e.g., academics, curriculum consultants, and developers) on Indigenous perspectives and content within science education

The specific research questions explored in this project are:

1) What was the process through which the integration of Indigenous perspectives/content in the curricula became a part of the educational policy agenda in SK?
2) In what ways are Indigenous perspectives/content being represented within curriculum documents relative to other scientific learning concepts?
3) What are various educational stakeholders' views on current approaches to integration?
4) How do these educational stakeholders position themselves and how do their positions influence their work in the integration of Indigenous perspectives in science education?

As an individual on the journey of becoming an ally (Bishop, 2015), I recognize that it is my responsibility to work *with* Indigenous peoples to change the education system for Indigenous students in Canada. This may be a life-long, rather than an immediate, goal, however I see this PhD project as a starting point. Because my "ignorance is part of the oppression" (Bishop, 2015, p. 97), I start my journey of becoming an ally by exploring curriculum development processes and products within the science education system for Indigenous students and by identifying the significance of their greater historical colonial legacy. In the next chapter, I explore the literature on diverse voices around engaging with Indigenous knowledge in science education.

Chapter Three: (Re) conceptualization of Science: Focusing on Building Relationship

Prelude

When I introduced local Indigenous peoples' practices in my grade 10 science classroom, one of the students, Ken shouted out: "Miss, why do we have to learn this in science? This is History!" Ken raised a question central to this chapter: Should Indigenous knowledges-sciences[21] (IK-S) be included in science classrooms? If so, in what ways? The term *science* is elastic and loose: it has no universal definition. Depending on individuals' definitions of what science is (or entails), their views on what science education should include vary. The idea of incorporating Indigenous knowledges-sciences (IK-S) is no longer queried in the field of science education (Higgins, 2016; McKinley, 2008). However, there are various rationales for and approaches to integrating IK-S in school science based on different positions regarding what constitutes science. In this chapter, I attempt to problematize traditional science education practices that only validate Western modern science (WMS) as the universal, objective truth. In doing so, I consider different definitions of science and how they shape various approaches to science education, as well as the discourse surrounding the integration of IK-S in science education. Recognizing that the notion that we are all related (Cajete, 2000) is largely silent in these conversations, I provide another conceptualization of science and what braiding together existing science education literature with stories from Indigenous Elders means for science education.

[21] Here, I use the plural forms for knowledges and sciences to acknowledge the diversity of different knowledge and science produced from diverse cultures.

Conventional Science Education Today

As a discipline, science holds an elevated status in our society. This view of science could exist because success in the science classroom is tied to more career choices, a view that reflects an emerging global, capitalist notion of success in twenty-first century societies (Osborne, 2003). Moreover, with the spread of globalization, the economies of nation-states around the world are becoming increasingly interdependent and competitive. As this competition and interdependence impacts the emergence of scientific and technological advances, it has direct implications for science education. In this context, educational success in the field of science and technology is strongly linked to the economic wellbeing of a nation, as well as its national security. Contemporary science education is, therefore, geared towards meeting the educational demands of science, technology, engineering, and mathematics (STEM)-driven societies in the global market (Carter, 2006; DeBoer, 2000, 2011). For instance, the OECD has put out various league tables to evaluate and compare global education systems and students' learning outcomes in STEM such as PISA and TIMMS.

Commenting on this approach, Strong et al. (2016) suggested that current science education is highly susceptible to market-based neoliberal ideologies and these ideologies are sustained as a norm. Meritocracy is a key neoliberal ideology promoted in the education system, as can be seen in the current worldwide move to adopt standardized testing to promote individual educational and wealth attainment. As well, the content (i.e., knowledge and practice) studied to prepare for such standardized testing is introduced in science classrooms as objective knowledge, and as such is understood as universal and *the* truth. In this light, students must master the skills, knowledge, and ideologies promoted in their science classrooms in order to succeed in STEM-driven societies. For LaToya Strong and her colleagues (2016), this is a sign of the neoliberal enclosure in science education, which is practiced globally. Drawing from Vasudevan, McFarlene, and Jeffery's (2008) notion of enclosure as "the transformation of commodifiable lands into exclusively owned plots" (p. 22), Strong et al. (2016) suggested that conventional science education is based on "exclusively owned plots" of Western modern science (p. 22). Following this reasoning, the language, skills, and values of WMS become a commodity that students must obtain in order to succeed in society while non-Western knowledges are introduced as additional and/or inferior material. Students who are trained in WMS then become professionals who reproduce WMS and thus maintain WMS's status as *the* truth and the "commodity for success" in science education (Stewart, 2005).

Moreover, the economistic philosophy of neoliberalism as a tool for globalization has led Euro-American cultures to become overwhelmingly powerful in the contemporary global world, including in science education (McKinley, 2008). The reductionism and technocratic rationality stemming from WMS have become the main philosophical foundations of science education around the world. As such "the past [is] quarantined from the present" in today's science classroom (Said, 1994, p. 2).

Aiming to dismantle neoliberal enclosure practices in science education while advocating for the multiplication of knowledges within science, many scholars in the field of education, including Snively and Corsiglia (2001), have called for a reconceptualization of science and advocated for a place for Indigenous knowledges within science education. However, despite diverse voices (McKinley & Stewart, 2008) and educational mandates to include Indigenous perspectives in education in British-settler countries including Australia, Canada, and New Zealand, Tobin (2008) argued that, "little progress is evident in resolving the underlying theoretical questions surrounding IK and science" (p. 536). The lack of philosophical engagement in science education is thus recognized by both researchers and practitioners alike (Cobern & Loving, 2008; Seigal, 2008).

Now that the voices advocating to include Indigenous knowledge(s) within science education are louder than ever, a reflexive examination of the existing definition of science as well as a radical reconceptualization of science are essential (Adams, Luitel, Afonso, & Taylor, 2008). As such, in the next section, I explore the existing rationales for integrating Indigenous perspectives into school science based on a continuum of positions on science education. In addressing the IK-WMS divide, Green (2008) suggested that scholars should consider "carefully and critically how knowledge is produced" (p. 147). Therefore, by exploring diverse positions and rationales, I seek to (re)conceptualize what science entails and how it is related to the knowledge production process.

The Continuum Bar: Diverse Approaches to Science Education

Efforts to integrate Indigenous perspectives into conventional WMS-focused science education have fueled a fierce debate between universalists and multiculturalists (pluralists and cross-culturalists) in science education. The debate between universalists and multiculturalists in science education is part of a wider critique of science based on Thomas Kuhn's (1970) arguments about the structure of scientific revolutions and is also informed by the emergence of poststructuralist and postmodernist philosophies (McKinley, 2005). Universalists generally view science as the "culture-free canon of knowledge" (Adams et al., 2008, p. 1006), whereas multiculturalists view science as "embedded in the context of a cultural group" and think that "all systems [of knowledge about nature] are therefore, culture-laden" (Lewis & Aikenhead, 2000, p. 3). Currently, the universalist-multiculturalist debate is more or less "an agreement to disagree" (Higgins, 2016, p. 68). At its core, the debate revolves around the rationales for creating a place for non-WMS in science classroom, and there are diverse stances within each of the universalist and multiculturalist camps. The diversity of these understandings of science leads to a broad diversity of perspectives on what science education should entail. As such, the discourses around integrating Indigenous knowledges-sciences (IK-S) into science education are now moving beyond the two poles of universalism and multiculturalism. For instance, scholars including Lyn Carter (2006) have recognized that the current globalizing processes affecting the practice and theories of science have been largely unacknowledged in conversations focused around these two poles; in turn, they have argued for a postcolonialist view of science that delves into the issues of hybridity in education influenced by globalization.

Acknowledging these diverse views in the field of science education, I have created a continuum bar to describe the different stances in science education—universalist, multiculturalist, and postcolonialist—and the diversity of perspectives within each with regards to the rationales for integrating IK-S into science education (Figure 7).

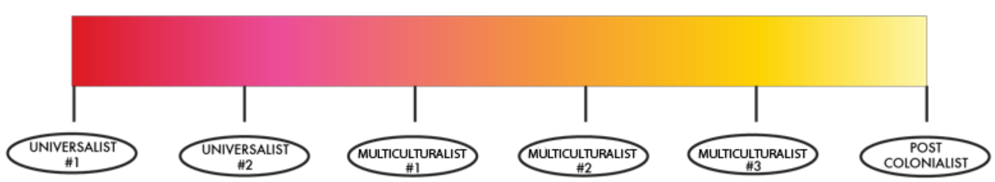

Figure 7. Continuum Bar of Different Stances in Science Education[22]

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[22] I recognize that there are other positions in terms of cultural diversity within science education (e.g., van Eijick & Roth's (2005) cultural and historical activity; Calabrese Barton's (2008) sociopolitical urban science education). However, I have chosen to focus on universalism and multiculturalism as the debate between the two explicitly links with the process of knowledge production based on cultures and its implication on what school science should teach.

Universalist approaches.

Universalist approach #1: "IK are not science".

The Universalist #1 approach might be the strongest universalist position represented within the field of science education. This position does not accept that cultures influence the construction of science and thus argues for "the truth claims of science" (Stanley & Brickhouse, 1994, p. 44). In this light, WMS is seen as objective and as the only valid science. Such a view of science is influenced by the foundationalists (e.g., pure proceduralists), who emphasize universal laws in the production of knowledge (Green, 2008).

This universalist position generally regards IK as "a body of cultural folklore, living practices, and thought that cannot be considered a rational and ordered system of theory and investigation comparable to anything found in Western science" (Cajete, 2000, p. 491). However, as Higgins (2016) mentioned, even these strong universalists do not oppose the integration of IK in science education. While validating WMS as the only kind of science, these universalists accept that the integration of IK offers students "a chance to see how the practice of science can benefit from the insights of another domain of knowledge. . . . It helps students see what is unique about science—what science can do that other domains of knowledge cannot do" (Cobern & Loving, 2001, p. 63). In this light, when they are introduced, IK should be regarded as nonscientific knowledge such as cultural content or seen as a separate subject like art, literature, or history that might help in advancing WMS (Higgins, 2016). To this end, IK in science curriculum can be legitimized in discourses related to fostering stewardship and ethics and values of respect towards the environment among students. As such, rather than being treated as science, IK are seen to accompany and compliment WMS content.

Universalist approach #2: "WMS is good science".

The Universalist #2 approach recognizes the cultural influences that shape science. Thus, this position sees IK as a form of science, but claims WMS to be the "truth claims of science" (Matthews, 1994, p. 182). Celebrating the objective study of nature as good science, this position establishes "criteria" for good science, which WMS aspires to embody. In this view, "good science" is:

> characterized in the forms of theories which are (a) testable, (b) genuinely predictive (especially of novelty), (c) revealing of underlying unobservable entities and the relations and casual mechanism . . . and is in their terms (d) genuinely and deeply explanatory. The production of such knowledge is the ultimate aim of *scientific* inquiry. (Siegel, 2002, p. 808, emphasis added)

These characteristics best describe WMS and, according to this approach, science education should replicate good WMS (Siegel, 2002, p. 686). Within the framework of WMS-based science education, IK can be integrated as a form of "boutique" multiculturalism celebrating "diversity in foods, practices, artefacts and lifestyles as spectacles of commodified cultural difference" (Carter, 2006, p. 681). In this light, WMS becomes a good, legitimate science and IK may represent alternative or primitive/traditional practices. For example, a curriculum based on this universalist position may ask about the effectiveness of Indigenous knowledges, thus emphasizing their inferiority against the dominant norm of WMS (Carter 2006; Kim 2015). Also, it may introduce the ancient scientific contributions of non-Europeans/Americans, but portray them as primitive and premodern in comparison to the contributions of WMS, which are seen as innovative and modern. Thus, rather than establishing common ground between WMS and non-Western sciences, this approach emphasizes their differences.

From universalism to multiculturalism.

Universalist positions have mainly been critiqued for their role in bringing Western epistemological hegemony and cultural imperialism into education (Snively & Corsiglia, 2001; Carter, 2006). Universalists create boundaries between science | nonscience (i.e., Universalist #1) and good science | bad (alternative) science (i.e., Universalist #2). Boundaries created by these universalist perspectives act as "a politic of exclusion" (Irzik, 2000, p. 71; Ryan, 2008) by establishing "good science criteria" based on the premises of WMS—objectivity, abstraction, weight and measuring, and generalization. However, these "good science" criteria, which originate from a Western orientation, have a limited capacity to measure the credibility of non-Western ways of knowing and being (Aikenhead & Michell, 2010). For example, while WMS aspires to generalize a pattern from observations, IK is a highly contextualized system embedded in a "circle of learning, living and relationships" that "moves far beyond the boundaries of objective measurement" (Cajete, 2008, p. 491). To universalists, these characteristics of IK may be seen as inadequate, inferior, or subordinate to WMS, or signal a position of deficit (Ryan, 2008; Semali & Kincheloe 1999; McKinley, 2008). Following this line of thinking, in science education, WMS becomes the only form of valid knowledge and non-WMS becomes cultural content, myths, superstitions, or inferior or alternative science (McKinley, 2008). In this way, WMS has become a norm within science education, and the findings of WMS are presented as universal and scientific, making the "White" aspect of WMS invisible (Semali & Kincheloe, 1999). To resist the imperialistic power that universalism gives to WMS in science education, some scholars argue for a multiculturalist approach in science education.

Multiculturalist approaches.

Carter (2006) described multiculturalism as "a complex discourse of cultural pluralism, inclusion and equity found within liberal/humanist ideologies of various types, as well as existing policy structure of Western settler nations like Australia and Canada" (p. 681). As such, multiculturalist perspectives reject the normalized discourse that WMS is the universal, literal truth and acknowledge that all forms of sciences are culture-laden (Ogawa, 1995). All multiculturalist perspectives include arguments about equity and accept that science curricula around the world are currently WMS-driven. They advocate for curriculum reform that includes diverse forms of sciences (McKinley & Stewart, 2012).

However, multiculturalists do not advocate for teaching based on relativism, which argues that any idea is acceptable (McKinley, 2007; Higgins, 2016). Multiculturalists advocate for teaching based on pluralism, which respects the equity of perspectives and argues for the inclusion of diverse *empirical* ways of knowing nature (Aikenhead & Michell, 2011; Higgins, 2016; McKinley 2007; McKinley & Stewart, 2012). In this light, science is viewed as "a rational, culturally based, empirically sound way of knowing that yields, in part, descriptions and explanations of nature" (Aikenhead & Michell, 2011, p. 30). While multiculturalists share these common values, they have divergent arguments and rationales for the integration of IK into science education, which I call: 1) the Parallel Approach 2) the Crossing Approach, and 3) the Merging (Hybrid) Approach.

Parallel approach: IKs complement WMS.

The Parallel Approach promotes the usefulness and benefits of IK for all students' learning. IK are seen as parallel to WMS: they offer something lacking in WMS yet complimentary but incommensurable to WMS (e.g., long-term observation data, the values and ethics for environmental education for sustainability) (McConney, Oliver, Woods-McConney, & Schibeci, 2011; Kimmerer, 2012; Snively & Corsiglia, 2001). In this light, IK inclusion takes the form of a selection of content that is parallel to WMS and does not conflict with already existing WMS-based curricula. Carter (2008) problematized such an approach as it marks and emphasizes the difference between IK and WMS, leading to the othering of IK discourse within the science classroom (i.e., differentiating between us [WMS] and them [Indigenous knowledges]). Moreover, following this approach, there is a danger of appropriating IK to meet other needs, such as addressing environmental problems in the classroom (Carter, 2008; Kim, 2015).

Crossing approach: IKs motivate Indigenous students' learning.

The Crossing Approach is particularly concerned with issues of inclusivity and equity for Indigenous students. Addressing multiple issues such as the lack of representation of Indigenous peoples in scientific careers, low education outcomes of Indigenous students (i.e., low test scores and postsecondary education enrolment), as well as social disadvantages for Indigenous students, this position aims to provide a science education that accommodates Indigenous students' learning (Aikenhead & Michell, 2010; Middleton, Dupius, & Tang, 2013; Stewart, 2005; McKinley, 2008). This position critiques conventional school science as highly Eurocentric and suggests that it does not harmonize with Indigenous students' prior conceptual understanding of nature. In turn, this position advocates culturally relevant curricula that integrate IK. Culturally relevant/responsive curriculum here refers to curriculum infused with rich connections to students' cultural and linguistic backgrounds within family and community contexts (Abrams, Taylor & Guo, 2013).

Glen Aikenhead's (1996) idea of cultural border crossing can be useful in elaborating on the importance of culturally relevant curricula for Indigenous students. For Aikenhead (1996), in order for students to learn the science concepts introduced in the classroom, effective crossing of borders between their everyday culture (i.e., their specific Indigenous culture) and the culture of school science has to occur. In order to successfully deliver such culturally responsive curricula, teachers need to be culturally competent and facilitate students' process of crossing the borders between their home cultures and the school culture of science (Aikenhead, 1996; Abrams, Taylor, & Guo, 2013; Brayboy & Castagno, 2008). In this light, the integration of Indigenous knowledge(s) into curriculum plays a role as a bridge that connects students' specific Indigenous culture and school science, and teachers act as culture brokers and/or border-crossing facilitators (Aikenhead, 2006; Michie, 2003).

However, the border crossing approach for IK integration may still be assimilatory, as the main structure and content (e.g., learning outcomes, educational philosophies) of the school curricula are still largely based on WMS. As such, it may lead to an add-on approach to IK, wherein the integrated IK content acts as a hook to engage students to learn WMS-based school science, rather than being introduced as scientific concepts to be mastered. Elizabeth McKinley (2008) critiqued such an approach, as it focuses on getting Indigenous students to become familiar and acculturated into the WMS-based school science culture; thus, it becomes another form of assimilation.

Merging/hybrid approach: promoting a more holistic way of studying nature. The Merging/Hybrid Approach focuses on appreciating the multiple conceptualizations of science and advocating for the place of non-Western knowledge within science education (Carter, 2004, Higgins, 2016, Snively & Corsglia, 2001). This position also acknowledges that all sciences are partial (Haraway, 1988) and advocates for IK integration so as to provide a more holistic approach to studying nature. In this approach, rather than providing rationales for IK usefulness and benefits, (i.e., IK for sustainability, IK for creating culturally relevant curricula), Indigenous knowledges are as accepted in the same way as Western modern science, without hierarchy (Brayboy & Castagno, 2008). Such a merging/hybrid approach results in integrative science, which requires two-eyed learning (Hatcher et al., 2009). Two-eyed learning 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). Embracing such diversity in sciences creates a place for students and teachers to explore diverse ways of knowing nature, allowing for new ideas to emerge (Yunkaporta, 2009). To Nakata (2007), this kind of exploring place is called a *cultural interface*. It is a place where students and teachers can explore "the dialogical *exchange* between Indigenous and non-Indigenous systems, as well as situating the life world of contemporary Indigenous people in the dynamic space . . . [which] carries a strong reconciling dynamic" (as cited in Yunkaporta, 2009, p. 58, emphasis added).

There are similarities between the Crossing Approach (i.e., border crossing) and the Merging/Hybrid Approach: they advocate for learning both Indigenous knowledges and WMS. However, as seen in Figure 8, the Crossing Approach focuses on students crossing the borders between the subculture of school science (i.e., WMS) and the culture of students' lives, and as such the borders between Indigenous knowledges and WMS remain.

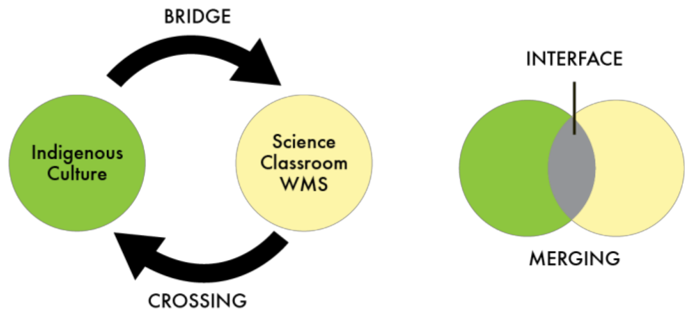

Figure 8: Crossing Approach vs. Merging Approach

In contrast, the Merging Approach focuses on education as a means to create a place for merging. In this place, individuals (teachers and students) are situated within a hybrid space (interface), which results in new interpretations and understanding based on diverse ways of knowing.

From multiculturalism to postcolonialism.

There are several critiques of multiculturalist points of view. First, while multiculturalists acknowledge the value of IK and their place within science education, many scholars, including Stewart (2010) and Carter (2006), have questioned how these multiculturalist approaches address the issues related to power/hegemony within science education and suggested that multiculturalist approaches perpetuate Eurocentric thinking. For example, McKinley (2008) claimed that the dominating discourses within multiculturalism are mainly based on theories from anthropology (i.e., worldview theory, border-crossing), a discipline which has “no way to deal with issues of power and economic privilege, and ha[s] a problematic history with indigenous peoples in the past” (p. 220).

Moreover, Carter (2006) and Mueller and Tippins (2008) suggested that multiculturalist positions continue to assert borders between Western and non-Western knowledges to distinguish one from another and thus compartmentalize them into static notions of culture. For Carter (2004), multiculturalist approaches do not address the role of the hybrid and diaspora cultures resulting from globalization. In this light, multiculturalist approaches continue to perpetuate the idea of the homogenous nature of national contexts and identities, although cultures are not bounded by nations (Green, 2008). In turn, Carter (2004) suggested a reconceptualization of science education under the postcolonial lens, which focuses on moving "beyond stable and unitary ideas about culture, tradition and identity" (p. 823).

Postcolonial approach.

Like other terms I've introduced, the term *postcolonial* is an "elastic and highly contested term" (Carter, 2008, p. 678). For example, as McKinley (2008) suggested, the *post* in postcolonialism may signal that the "European imperial project, and the appropriation of the 'Other' as a form of knowledge, has been assigned to an historical past" (p. 201). Meanwhile, according to Bhabha (1994), *post* can be used to mean beyond rather than after, which adds another dimension to the term.

Although *postcolonial* has different meanings across the disciplines, all these meanings share a common commitment: "to disrupt and resist any form of colonialism and imperialism . . . [and] to dislocate Eurocentrism in dominant ideas of Western culture, identity, education and science" (Zembylas & Avraamidou, 2008, p. 980). In the context of science education, postcolonialism can help teachers and researchers understand the contemporary knowledge and science production process, as well as to resist the hegemonic power of WMS by moving beyond a binary between WMS and IK-S and thus seeking redistributive justice (Carter 2008; Huggan, 2001). Postcolonialists in science education particularly advocate for science education that: 1) is against borders and 2) addresses the issues of hybridity due to globalization.

First, most postcolonialists are against the notion of boundaries and borders. They see borders as "the cultural, social and political boundaries that demarcate varying spaces of comfort, suffering, abuse and security that define an individual's or group's location and positionality" (Giroux, 1992, p. 17). As such, they see the concept of borders as a tool that further allows Western imperialism to perpetuate within the education system and society. The concept of borders is deeply implicated in Western thinking. It focuses on differences and these result in the discourse of Others and normalize the status-quo relationship between WMS and non-Western sciences (Carter, 2008). In this light, borders become a colonial project where WMS remains as the universal truth within science education and WMS values and criteria act as de facto gatekeepers for determining what should be included in school science. In contrast, rather than asserting borders between different knowledge systems, postcolonial science education seeks the multiplication of knowledge, mobile and provisional constructions of students' identities, and the unity of knowledge (Carter, 2008). Moving beyond thinking that emphasizes borders and boundaries, postcolonialists argue that transcultural and transdisciplinary approaches allow complex processes of reciprocity between diverse knowledges-sciences. These approaches allow for the study of hybrid cultures characteristic of the present modernity derived from globalization.

Second, postcolonialists in science education aim to address the hybridity resulting from globalization and/or (im)migration. Hybridity usually refers to the "creation of new transcultural forms of experiences" (Zembylas & Avraamidou, 2008, p. 981). In this regard, postcolonialists have much in common with the merging/hybrid multiculturalist approach discussed earlier. First of all, both groups embrace the in-between third spaces where cultural exchanges happen, which lead to the construction of hybrid identities (Bhabha, 1995). However, postcolonialists add one more layer of analysis, examining power-political forces at play in the third spaces. As well, the postcolonialist notion of hybridity particularly emphasizes the continuous process of becoming (Hall, 1996). From a postcolonialist perspective knowledges-sciences are seen as nonstatic and always evolving and must be put into a context. In this light, "thinking contextually"—continually examining the social, political historical factors influencing the process of knowledges-sciences production in particular sites—becomes important in postcolonialist science education (Zemblaya & Avriommou, 2008, p. 982).

Following the postcolonialist view of science education, Strong et al. (2016) introduced a critical transdisciplinary (crit-trans) heuristic for science education, which involves:

> (a) contextualizing and historicizing knowledge; (b) challenging assumptions of neutrality and objectivity through critical inquiry; (c) decentering hegemonic notions of knowledge production; (d) situating place and space; (e) privileging process over product; and (f) promoting participatory teaching, learning and research. (p. 227)

Through these parameters, the crit-trans approach focuses on an "interdisciplinary and transdisciplinary understanding of interconnectedness" of social, political and cultural factors shaping our education system and knowledges-sciences production (Strong et al., 2016, p. 227). With the aim of dismantling the conventional power structures that exist in the Eurocentric classroom, the crit-trans approach aspires to contextualize the content presented in the classroom, thus focusing on the lived experiences of students and educators rather than on preplanned scientific content promoted by Eurocentric science/education institutions. The crit-trans approach in science education does not rely on success on standardized exams or tests, but instead aims to "cultivate students as active agents in investigating and improving quality of life for themselves and their communities" (Strong et al., 2016, p. 227). The approach thus challenges the neoliberal enclosure practices in conventional science education.

Critiques of postcolonial science education.

The postcolonialist approach to science education has been critiqued for being theoretically preoccupied and ambiguous in application in school science (Carter 2006; Zembylas & Avraamidou, 2008). In particular, the postcolonialist discourse on third spaces and hybridity, as well as the idea of going "against/beyond borders" between cultures, have been critically examined by educators and scholars from other philosophical stances.

First of all, while there exists ample literature delving into the theoretical understanding and the usefulness of third spaces/hybridity in teaching and learning science (e.g., Carter, 2006), the potential drawbacks and challenges of the approach have rarely been discussed. Zembylas and Avraamidou (2008) argued that if they do not understand the challenges and possible drawbacks of the concept, researchers and educators may continue to use the term *third spaces* as part of "the self-righteous politics of the inclusivity/exclusivity binary" rather than delving into actual practices of postcolonialist approaches in teaching science (p. 991). In this light, limitations and possibilities of third spaces and hybridity should be further explored in the context of actual practices of teaching (Zembylas & Avraamidou, 2008).

Second, the notion of borders and boundaries has to be reconfigured. Currently, many postcolonialists argue that avoiding borders between multiple knowledges-sciences makes way for transdisciplinary, transcultural approaches in learning about the world we live in, which leads to redistributive justice for non-Western knowledges-sciences (Carter 2006). Thus, postcolonialists have often rejected the binary between IK and WMS (Mueller & Tippins, 2008). However, others have expressed concern about the notion of no boundaries and borders, stating that, for example, such no-boundaries thinking may lead to teaching science based on relativism. Haraway (1988) cautioned about the danger of relativism, as it is “a way of being nowhere while claiming to be everywhere equally” (p. 534). Lee Maracle, a member of the Sto:Loh nation, also cautioned about transcultural, transdisciplinary approaches, as “when trying to put two knowledge systems together, one of them will be diminished, which no longer represents the knowledge within its own context” (personal communication, November 2, 2014). She explained that Western and Indigenous knowledges should go together like a cup and coffee. They may complement one another and work together, but the cup is not the coffee and the coffee is not the cup, hence they should not be treated as one and the same. She further illustrated the relationship between different knowledge systems by comparing them to rivers. There are many rivers on the land. Some rivers merge; some go separate ways. However, if all rivers were to merge together, there would be a catastrophe and the world would die. IK and WMS are like streams of a river. They may come together at some points, but they are not the same. When trying to work within both systems, we must see the relationships between the systems and facilitate them working together, but we need to acknowledge their separateness as well.

Indeed, for Haraway (1988), one should come to understand the limitations of partial understandings of nature. Haraway (1998) thus advocated for building communities where diverse knowledges-sciences are “stitched together imperfectly and therefore able to join with another, to see *together without claiming to be another*” (p. 586, emphasis added). Haraway’s (1988) concept of situated and partial knowledges-sciences, as well as Maracle’s (2014) teaching on respecting the separateness and the relationship between diverse knowledges-sciences, bring us back to the important notion of relationship (“we are all related”) in knowledges-sciences production. Indeed, the notion of relationship has been largely overlooked in the current conversations among the positions presented in the Continuum Bar (Figure 7). As Shawn Wilson (2008) mentioned, "concepts or ideas are not as important as the relationships that went into forming them" (p. 74) and understanding that "we are all related"—i.e., the notions of relationship and relation thinking—is vital in understanding nature (Cajete, 2000).

The postcolonialist notions of hybridity and transculturalization that result from avoiding border thinking may address concerns around the neoliberal enclosure in science education that stems from universalism and Western hegemony. However, it is time that we shift our attention to relationships. This shift in focus is necessary as it is from the relationship one builds with nature and communities that productive third spaces can be built where meaningful exchanges of knowledges-sciences can occur. As such, in the next section, I seek to move beyond the perspectives presented in the continuum bar in an attempt to engage in (re)conceptualizing science with aims to emphasize the idea that we are all related.

A Cup of Water: Knowledges-Sciences as Inseparable

"What is the difference between Indigenous knowledges (IK) and Indigenous science (IS)? I am confused that you are using these two terms interchangeably." This question was asked by Dr. M, one of my master's thesis committee members, who wanted me to explore the difference between knowledge and science and the relationship between two. To address his request, I looked into the literature to figure out the difference between Indigenous knowledges and Indigenous science. Despite much effort, I couldn't find any. I went to talk to Dr. Marcelo Saavedra-Vargas, who taught Aboriginal Studies at the University of Ottawa. Marcelo is an Elder from the Auechua-Ayamara nation in Bolivia and he has also been acknowledged as an Anishinaabe Elder. When I shared with him my struggle about conceptualizing the nature of IK and IS and the difference between the two, Marcelo first said it is impossible to differentiate between them, because knowledges and sciences are "dynamically interdependent with each other as everything comes in a pair" (personal communication, January 20, 2012). In this light, I use the term *knowledges-sciences* to denote Marcelo's teaching. Marcelo then used the cup of water analogy to further illustrate the interdependent, inseparable relationship between knowledges and sciences (Figure 9).

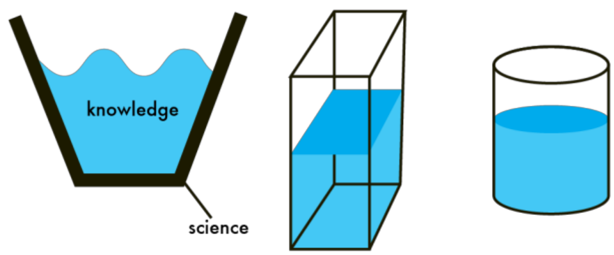

Figure 9: The cup of water analogy by Dr. Marcelo Saavedra-Vargas

Marcelo said cups can come in different shapes and that these different shapes result in different shapes of water inside the cups. Sciences can be seen as the cups and knowledges can be seen as the water inside the cups (Kim & Dionne, 2014). Water here may also represent nature and/or reality. I do not believe that there are multiple natures/realities. Water is simply water. However, water can be presented in a chemical formula as H_2O, or water as spirits or as alive through a story. Nature and reality can be perceived and presented in different ways based on knowledges-sciences stemming from different cultures. In further developing and thinking about these ideas, below, I continue to reflect on lessons stemming from the literature and stories by Indigenous scholars and others whose work is deeply rooted in working with Indigenous peoples.

Culture and science.

First, cups come in different shapes based on the cultures of communities. As Meyer (2001) stated, "science and culture are not separated" (p. 189); without culture, science cannot exist.

There are also many conceptualizations of culture. The majority of definitions focus on a community's understanding of nature (i.e., environment, land, place, nature). For example, Aikenhead (1996) stated that culture is: "an ordered system of meaning and symbols, in terms of which social interaction takes place" (p. 8). Michie (2014) also emphasized this "social interaction" in constructing a culture, as culture is "the social environment in which an individual is raised and lives and includes a range of concepts and beliefs that is accepted by individuals as defining their group identity" (p. 10). To Cajete (2000), the relationship one has with community and particular land builds a culture as, "in its most basic sense, culture is the way in which a group of people have come to relate to a place and its natural processes" (p. 86). However, because of the distinct relationship one community has to particular land, as well as the distinct languages spoken in the community, different communities come to different ways of relating to the local and natural processes of their local land.

I follow Cajete's (2000) definition of culture, which focuses on one's relation with community and a particular land. However, I wish to acknowledge that culture is not synonymous to nation[23] (Green, 2008). Rather, culture accentuates the relationship individuals have with land and community, and thus is "not dependent on selection of a particular line in one's genealogy to confer identity, but . . . allows for lifelong learning" (Green, 2008, p. 149). As such, I view culture as webs of relationships that allow for lifelong learning based on lived experience in a particular environment (i.e., land) and also on learned concepts, values, and beliefs from communities. Seen as webs of relationships, cultures are not static; they are continuously evolving as new relationships form within/outside communities. Considering this understanding of cultures as fluid, heterogeneous, and inseparable to sciences, we can

[23] Culture can exist in different communities such as race, gender, class, etc.

acknowledge that there may be multiple sciences derived from different cultures (Ogawa, 1995). Sciences are community practices of coming to know nature through rational and empirical ways of knowing nature and providing interpretations (i.e., descriptions and explanations) of nature (Aikenhead & Michell, 2011; Latour, 2004). In this light, culture and science are not separate (Meyer, 2001). There are many cultures in this world. If the cups (i.e., science) are shaped by these cultures, diverse shapes of cups must exist (Kim & Dionne, 2014).

Science and knowledges.

Different shapes of cup shape the water inside them (Figure 9). In order to elaborate on this idea, I adopt Ogawa's (1995) definition of sciences as "rational perceptions of reality" in which "perceiving means both *the action* of constructing reality and *the construct* of reality" (p. 588, emphasis added). Here, I interpret the "action of constructing reality" as the methods and the "construct of reality" as preexisting knowledge. Knowledge as a "construct of reality" here refers to a body of skills, practices, and understandings that community members possess, justify, and apply in practical ways (Goldblatt, 2000; Hunt, 2003). In other words, science includes both the methods and the already existing knowledge, which work together to arrive at a new representation of reality. In this light, one needs existing knowledge in order to inform the science used to arrive at new knowledge. Then, this new knowledge becomes a part of the science used to arrive at new understandings of nature. Because of the recursive/reciprocal relationship between sciences and knowledges, the two are interdependent and should be seen as a pair, that is, as knowledges-sciences.

Here, I wish to focus on the knowledges aspect of this pair. Knowledges are constantly moving-evolving (like the molecules of water inside a cup) and are shaped by the cultures of communities as well as by their interconnection with sciences. Green (2008) suggested that if we consider the continuous cultural influences on the knowledge production of communities as well as the communal nature of knowledge, the terms *knowledge practices* or *knowledge traditions* might be more suitable. Moreover, Aikenhead and Michell (2010) suggested that the term *knowledge* is based on the English noun-rich linguistic system and does not translate into most Indigenous languages systems, which tend to be verb-rich. Therefore, they suggested using terms such as "ways of living, being, of knowing in nature" instead. Both Green (2008) and Aikenhead and Michell (2010) rejected the notion of knowledge as static and decontextualized "truth"; in contrast, they emphasized the embodiment of individuals in nature and the relationship one has with community in knowledge production. I concur. However, rather than engage in the debate of whether the term *knowledge* is suitable to denote the skills, practices, and understandings of nature derived from communities' cultures, I deliberately choose to focus more on the characteristics of knowledge represented by the "water inside the cup." That is to say, I envision knowledges as fluid and constantly evolving and shaped by sciences. I represent the reciprocal relationship between knowledges and sciences with the inseparable pair knowledges-sciences, which are also inseparable from culture. And culture is also inseparable from nature. In essence, everything is related. We are all related (Cajete, 2000).

The Dancing Amoeba: Knowledges-Sciences-Nature

The cup of water analogy illustrates that "sciences, in all shapes and forms, are premised upon the ways in which Nature's enactments (i.e., ontology) are understood through and in relation to culture (i.e., epistemology)" (Higgins, 2016, p. 8). Meanwhile, I also seek to acknowledge the importance of the postcolonialist concerns regarding the effects of globalization as well as the role that third spaces play in creating hybridity between different knowledges-sciences. Drawing on from the lessons I learned from the cup of water analogy with the notions of third space and hybridity, I attempt to engage in the process of coming to understand relationships between Western and Indigenous ways of knowing, being, and doing within WMK-S and IK-S. My Dancing Amoeba Model (Figure 10), thus emphasizes the notion that we are all related (Cajete, 2000).

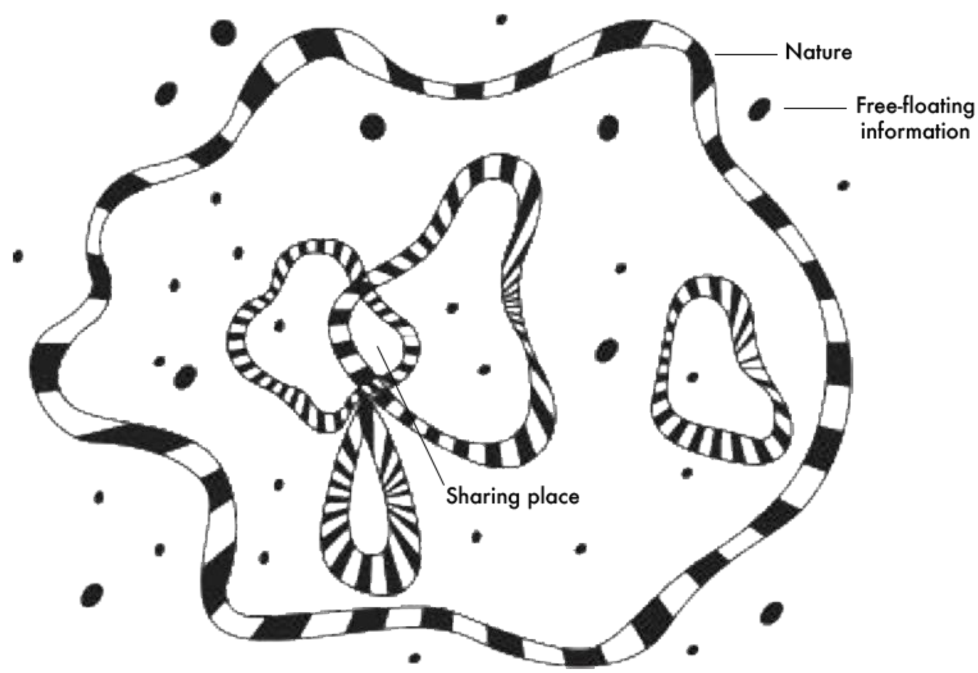

Figure 10: Dancing Amoeba Model

Nature: Mother Earth encompasses us all.

In this model, the whole dancing amoeba represents nature. Under the scope of Western values, nature is often perceived as "lifeless, a commodity to be bought or sold, an economic resource, an inert landscape to be shaped to the needs and will of those who own it" (Cajete, 2000, p. 304). The idea of Nature as amoeba defies such a static, commodity-based notion of nature. The amoeba is one of the simplest living organisms and does not have a fixed shape. The representation of Nature as amoeba focuses on its livingness, and thus views nature as an agent, rather than as a commodity. As Higgins (2016) put it, Nature "always makes itself intelligible and participates in the construction of knowledge about itself" (p. 5). Just like humans, nature itself reflects and engages in the circular process of learning. The notion of dancing delineates this dynamic nature of the amoeba, as it is constantly evolving based on its own learning and relationship.

Nature is an agent that is in a reciprocal relation with humans while also being a source for all human activities (Haraway, 1998). In this light, as shown in Figure 10, the largest dancing amoeba, Nature, encircles all things—cultures, knowledges-sciences, and all living and nonliving things. The smaller knowledges-sciences amoebas within the Nature amoeba thus represent the fact that all understandings of human life and community are inseparable from Nature (Cajete, 2000). We humans are part of creating Nature at the same time that Nature creates us. As Cajete (2006) put it, Nature is "a dynamic, ever- flowing river of creation inseparable from our own perceptions. Nature is the creative center from which we and everything else have come and to which we always return" (p. 250). We humans need to refocus the relationship that we have with Nature based on respect and reciprocity. As Higgins (2016) and Peat (2002) mentioned, coming to know is inseparable from coming to being; it is about entering into relationship. Thus, if the purpose of science is "coming to know Nature," then we must view humans and all their activities, including science, as part of Nature and we must view Nature as a living agent that we enter into relationship with.

Knowledges-sciences.

The smaller knowledges-sciences amoebas inside the Dancing Amoeba represent the situated and partial perspectives that are derived from different cultures (Haraway, 1988). Each K-S amoeba is shaped by the culture of its community, as illustrated earlier by the cup of water analogy. As mentioned previously, cultures as webs of relationships are not static. The knowledges-sciences produced in relation to one's culture are also dynamic and constantly evolving, like an amoeba.

As Haraway (1988) mentioned, all knowledges-sciences are situated and partial. As such, the K-S amoebas, each containing a partial representation of natural world, collide and interact together at different sites and different times. When they meet, they create "sharing places"[24] where dialogue and exchange of knowledges-sciences happen. In such sharing places, the focus should be on entering into a relationship and engaging in respectful dialogue. Sharing places can be found "by illuminating and unpacking the metaphors that science, scientists, and educators" use, which will lead us to think holistically about reality/science (Marker, 2016, p. 479).

Moreover, in these sharing places, the legitimacy of knowledges-sciences cannot be tied to any particular culture's criteria for establishing knowledge, as different webs of relationships have been built in each amoeba's construction of knowledges-sciences (Carter, 2006; Wilson, 2008).

In sharing places, some knowledges-sciences may merge as they find common grounds and/or find each other complementary. Some K-S amoebas may take bits and pieces of information from other amoebas and change their forms based on the new information. A birth of a new community and discipline may also arise from this sharing place.

[24] Sharing place here is the same notion as the cultural interface (Kanata, 2006), the meeting place (Wiseman, 2016), and interstitial transnational spaces (Gough, 2003; Carter, 2006).

Permeable/protective layers.

The amoebas circulate with permeable layers. The notion of permeable layers may address the issues of (re)conceptualizing the meanings of borders and boundaries (or finding shared meanings from existing conversations) that are taken up differently by multiculturalists and postcolonialists. Multiculturalists view borders and boundaries in more anthropological terms. This can be seen in some of the assumptions about culture that Chang (1999) laid out in order to conceptualize cultural borders. According to Chang (1999), a culture is a bounded system that can be separated and distinguished from others and each culture is homogenous. Furthermore, a culture is shared by members of a society and thus is viewed as a social unit. On the other hand, postcolonialists critique this anthropological notion of culture as bounded and homogenous (Carter, 2006).

Drawing from both multiculturalists and postcolonialists, I view borders as layers. First, because the production of knowledges-sciences is tied to a relationship with a particular geographical land and community, I follow the multiculturalist anthropological understanding of borders. However, instead of calling them *borders*, I call them *molding layers*; these molding layers of the knowledges-sciences amoebas fulfill the role of the cup (i.e., sciences) from the cup of water analogy. Basing itself on the distinctive cultures derived from relationships to the land, the layer changes its shape, and thus the knowledges' inside layer evolves according to the shape of the layer. Second, I follow the postcolonialist notion of knowledge sharing in a globalized world. In this light, the molding layers of knowledges-sciences amoebas should be seen as permeable rather than as rigid, closed boundaries or borders. A layer that is permeable allows the constant influx of new understandings of nature to come into the communities as they meet the current contemporary globalized world. Permeable layers allow for simultaneous and constant knowledges-sciences sharing at several different places and times. However, this “free floating” influx of new understanding and information through the permeable layer doesn’t necessarily require the building of a relationship, which is what differentiates this influx from the sharing places explained previously. Therefore, this permeable layer does not allow all the information from different knowledges-sciences amoebas to come in and out through it. In this light, the permeable layer can be also seen as a protective layer.

Battiste and Henderson (2000) illustrated this idea of a protective layer when they mentioned that within Indigenous communities not all knowledge gets shared with outsiders, especially with regards to relationships to ancestors and spirituality. In order for this information to be shared, trust and a relationship with the communities, land, and particular knowledge holders must be built. As such, the layer becomes a protective layer wherein, despite the forces of globalization and diaspora, not all knowledges-sciences are shared and some remain within a particular context. The notion of a permeable yet protective layer allows for the respect of the similarities and separateness of different knowledges-sciences (Maracle, 2014). My (re)conceptualization of the relationship between nature, culture, and knowledges-sciences as a dancing amoeba delineates the idea that we may offer situated and partial views of nature, but we are all related; therefore, the Dancing Amoeba Model promotes the multiplication of knowledges-sciences (Carter, 2006).

Coming Back to the Beginning of a Circle of Learning

The Dancing Amoeba Model provides a conceptualization of science that is complex. However, this complex conceptualization is a necessary aspect of the process of moving science education beyond the universalist and neoliberal enclosure of science education. Rather than emphasizing a universal truth of scientific knowledge, school science should allow a place for dialogue where multiplication of knowledges-sciences is encouraged. A complex conceptualization of science in relation to nature and culture should be discussed, instead of a simplification of knowledges-sciences that would bring us back to the universalism of WMS, and thus allow the status-quo relationship between WMS and non-WMS to perpetuate (Carter, 2006). Moreover, teaching about the natural world in school science should focus on relationship. The crit-trans heuristic approach (i.e., six parameters) discussed earlier in this chapter provides educators the pedagogical foundations for constructing their learning sites (whether formal or informal, inside/outside the classroom) as productive third spaces of continuous dialogue and exchange that focus on students' lived experiences. Learning sites constructed in this way can then become sharing places where teachers and students can explore together the history and political factors that influence their assumptions as well as the web of relationships embedded in their learning sites. The learning that starts from a "sense of place" is important as it encourages us to the specifics of the local environment and the impact that we have by global forces (Sutherland & Henning, 2009). Thus, with a crit-trans approach, students and teachers as a community can explore the idea that "science is negotiated not discovered" (Ryan, 2008, p. 674) and start thinking more holistic way about nature and science. Marker (2016) stated that such holistic thinking in science then can "soften and dissolve the concrete walls between categories that enforce dangerous binaries in our present world" (p. 479). Such an understanding and practice that appreciates multiplication of knowledges-sciences and focuses on building relationship to engage in dialogues will allow us to move forward to understand nature in a more holistic and respectful manner without perpetuating the status-quo relationship between different knowledges-sciences. This Dancing Amoeba Model will work as my conceptual framework to engage with my re/search project.

Chapter Four: Methodology—Thinking *Beyond*

> "Methodology" refers to the philosophic framework, the fundamental assumptions, and characteristics of a human science perspective. It includes the general orientation to life, the view of knowledge, and the sense of what it means to be human which is associated with or implied by a certain research method. (van Manen, 1997, p. 28)

Methodology consists of theory, practice, and ethics (Barad, 2007, 2010). I illustrated the ethical commitments for this project in Chapter 2 (i.e., academic purpose). To reiterate some points made in that chapter, I consider this project as re/search. The notion of re/search focuses on exploring *my* interpretation of the world, rather than finding the positivist notion of *the truth*. Re/search values the process as much as the product. During the process of the re/search, I located myself in the *inter esse* (Wiseman, 2016), wherein I invited multiple knowledges-sciences (Indigenous and Western) to come into play in the construction of my understanding. I am also committed to decolonizing myself and the institution of education, thus I continually work to ground myself (Kovach, 2008). I am continuously guided by the Cree word *Kemoochly* (in secret; working against; the idea that learning comes from within your living inquiry as well as working against the one's own internalized oppressions) as well as the understanding of self-in-relation, which recognizes that "we learn in *relationship* to others, knowing is a process of self-in-relation" (Graveline, 1998, p. 52, emphasis added). Therefore, I continue to focus on the relationship amongst things in this cosmos. In this chapter, I continue to delve into "the fabrication of methodology" by weaving theories and practices with the ethics of re/search mentioned above (Higgins, Madden, Berard, Kothe, & Norstorm, 2016, p. 1).

Higgins et al. (2016) critiqued studies where "methodology is often presented as an already or near finished garment that one simply gathers and garbs in order to carry out a research project" (p. 1). Meanwhile, St. Pierre (2013) critiqued the standardization of some qualitative inquiries based on the positivist ontology, according to which theories appear only in the literature review and are “abandoned during analysis” (p. 225). As an “emerging scholar of education engaging with/in qualitative research,” I understood the concerns raised by these scholars, as I had been struggling with finding the meaning and role of theories within my re/search process (Higgins et al., 2016, p. 1). To this, Higgins et al. (2016) suggested looking beyond the pursuit of the best-fit, pretailored methodology and engaging in a process of *de/sign* of one’s own garment of methodology.

Inspired by Jackson and Mazzei’s (2012) *Thinking with Theory*, which “works against normative trends by conceiving of and modeling data analysis as a complex location of theory-practice,” Higgins et al.’s (2016) de/sign of methodology offers a framework through which re/searchers can engage in braiding theories, practices, and ethics of research throughout a whole process—patchworking—through which they can continuously engage with theories as well as self-reflection (p. 2). Such *patchworking with theory* focuses on “displacing and disrupting methodology-as-usual” and “thinking beyond how you already think especially when you *need* to think beyond how you already think (e.g., if it is overcoded with norms of dominance)” (personal communication, February 13, 2017, emphasis in original).

As I made a commitment to thinking beyond the conventional positivist research tradition, as illustrated in Chapter 2, I *needed* to think beyond how I already think in order to continue to reflect on internalized oppressions that influence the process and the product of this re/search. This, in turn, helped me to participate in the decolonizing self process. Thus, in this chapter, I focus on the “self-in-relation” (Graveline, 1998); my relationship with theories, practices, and ethics of methodology; as well as the relationship amongst the three aspects of methodology. In this regard, Kovach (2008) advised that the “relational approach [which honours ‘self-in-relation’] should be found with process and content [or the research projects] and the reader must be able to identify both in the methodology" (p. 34). Thus, in writing my methodology, I am committed to showing the reader not only the final selected data and analytic frameworks, but also the process of the fabrication of methodology through which I built relationship with, and then braided, the theories, the data, as well as the analytic frameworks within the re/search.

Theoretical Lens for the Project: Building Relationship with Theories

Scholars in the fields of Indigenous science education and Indigenous research methodologies have demonstrated their practice of thinking beyond the methodology-as-usual and moving beyond the static notion of theories in methodologies as commodities or objects to consider theories as one of their relations. For example, Wiseman (2016) considered theory as a living entity that scholars need to form relationship with: "theory is not solely theoretical, it acts" (p. 106). As such, she experienced the forming of relationship with theories in the following way:

> Sometimes it is an uneasy relationship that I would rather forgo; at other times, it is a relationship in which I can lose myself, getting stuck in my head for hours, conversing with ideas and people who are not there. While the second type of relationship is more gratifying, I am uncertain that either is healthy. (p. 104)

I too have experienced this exhilarating process of building relationship with theories. Discovering theories has involved delving into questions such as: what is considered a theory and what is the role of theories in my re/search process? Given that methodology is "the philosophic framework, the fundamental assumptions, and characteristics of a human science perspective" (van Manen, 1997, p. 28), I had to get to know and build relationship with theories first in order to describe my methodology.

Building relationships requires time, patience, and respect. In the process of thinking about methodology, I learned how to respect theories. I used to see theories in mechanical terms. I saw theories only as tools for my project; hence I thought I could skip delving into thinking about/with theories if I didn't need such mechanisms for my project. However, as Cajete (2000) mentioned, we, including theories and theorists, are all related. Wilson (2008) also expanded the notion of *we* to include all things in the cosmos: "we can extend this thinking—of viewing objects as the relationships we share with them—on to how we see concepts and ideas. The concepts or ideas are not as important as the relationships [that] went into forming them" (p. 74). My relationships with theories thus drove other concepts and ideas that I encountered during the practice of the re/search process (e.g., data collection, analysis, and writing). Indeed, St. Pierre (2013) emphasized the role of theories, as "there are no data without theory that orders and gives classification to the things of the world" (p. 225). In essence, after three years, I finally understood why Dr. Fitznor asked me to delve into "relational writing" after my candidacy defence (as illustrated in Chapter 1). It is through this notion of "self-in-relation" (Graveline, 1998, p. 52) that I discovered the relationship between theories, data, ethics, and myself.

Moreover, just as the personal is political, so is methodology. As Russell and Kelly (2002) mentioned:

> By including political understandings as a natural and inevitable part of our research inquiry, we close the gap between the personal and the political, between the knower and the known, and between researchers and those whom we once thought of as subjects and now understand to be our co-creators. (p. 47)

Taking advice from Russell and Kelly (2002), I continued to grapple with the entangled politics of methodology; in order to do so, I first needed to figure out my relationship with theories, which I have continued to grapple with and reflect upon. Therefore, below, I lay out some of the theories with which I started building reflexive relationship throughout the re/search. As Higgins et al. (2016) suggested, rather than present the theoretical component as a stand-alone section in the dissertation, I continued to wrestle with, and build relationship with, these theories throughout the dissertation. Also, I was reminded by Kovach (2008) that "understanding is a layered endeavor" (p. 24). As such, in explaining my relations to the theories presented here, it is not to say that I understood the theories and theorists fully. At this point, I can say with confidence that I have begun "to ponder my own immediate process of understanding in relation to others" (Kovach, 2008, p. 24).

Neoliberalism: I am a part of the system.

Though I attempt to work against neoliberal capitalist values that are deeply rooted in contemporary Canadian society, I have to acknowledge that I too am part of the system and have been influenced by neoliberalism. To this end, Jordan and Wood (2015) cautioned researchers of the danger of falling for the "intellectual blind drift" by ignoring that we all are influenced by global neoliberalism, which "amounts to a reconfiguration of the very foundations of the public sphere and everyday life, with these relying increasingly on principles derived from the market and business" (p. 5). Neoliberalism, in short, is sneaky.

On the surface, neoliberalism advocates for reduced state and bureaucracy and claims to be an "autonomous, apolitical, and gender-neutral mechanism" promoting the self-interests of individuals; in the neoliberal model, the state plays the role of a "mediator of successful operation of the market" yet it retains control (Olssen et al., 2004, p. 137). As such, the neoliberal state creates a neoliberal mentalité (i.e., the neoliberal enclosure) where "the uses of markets to allocate health, education, public safety, national security, criminal justice, environmental protection, recreation, procreation, and other social goods are now taken for granted" (Sandel, 2012, p. 8, as cited in Jordan & Wood, 2015, p. 4). This neoliberal mentalité is produced by the "invisible hand" of the market, suggesting that the interests of individuals (researchers) are also actually highly crafted by the interests of the market-driven society, while creating "an individual [a researcher] that is an enterprising and competitive entrepreneur" (Olsson et al., 2004, p. 136). In such a neoliberal mentalité, education is seen as investment in the human capital of society. Shultz (1960b) presented education as "an investment in man and [suggests treating] its consequences as a form of capital. Since education becomes a part of the person receiving it, I shall refer to is as human capital. . . . It is a form of capital if it renders a productive service of value to the economy" (p. 571). In this light, education becomes for the economic growth of societies and "good" education then becomes the measurement of productivity for the labor market, which results in higher earnings for individuals and economic growth of the whole society (Olssen et al., 2004).

Related to this is the current emphasis placed on the STEM subjects in the curriculum globally. Under such a neoliberal mentalité, education becomes training to prepare competitive individuals for global competition and to produce educational research projects based on commercial values (Fairclough, 1992). Such trends lead to the promotion of neo-positivist "evidence-based" research projects in academia (Jordan & Wood, 2015). Neoliberalism not only affects the research practice in which researchers engage, but also their conceptualization of science education. As illustrated in Chapter 3, the neoliberal enclosure in science education promotes WMK-S as the exclusive plot and as the commodity to be mastered for STEM-driven societies (Strong et al., 2016). Though I resist the existence of such enclosures in the field of science education as well as in research practices, the neoliberal mentalité is deeply rooted and embedded in every aspect of my life, turning me into a "*manipulatable [wo]man* who is created by the state and who is continually encouraged to be 'perpetually responsive'" (Olsson et al., 2004, p. 137, emphasis in original). As a re/searcher, an educator, and a learner, I am deeply influenced by neoliberalism, as are the schools that I have been educated in and the policies that I am reading. In this light, I acknowledge the complicity of this project and myself in engaging with the neoliberal mentalité, albeit my attempts and struggles to work against it.

The neoliberal mentalité works against the aforementioned ethics to which I am committed. The neoliberal mentalité encourages me to focus on product rather than process. It urges me to compete rather than collaborate. It works to promote neo-positivist hegemony, thus leading to neoliberal closure within science education rather than encouraging the multiplication of knowledges-sciences, suggested by my Dancing Amoeba Model. It continues to create an educational environment wherein WMK-S is seen as superior and as a commodity (requirement) for success while subjugating Indigenous knowledges-sciences. However, Tatum (1992) also reminded us that individuals cannot be blamed for learning what they were taught but "as adults, we have a responsibility to try to identify and interrupt the cycle of oppression" (p. 4). The question then becomes: How can I change? To this, Blades (1997) stated, "change involves more than tinkering with an existing system, change is much, much more difficult; it is an effort to break from the system in which we are trapped" (p. 95). Thus, in an attempt to break from, and resist against, the neoliberal mentalité, I choose to *think beyond*, using poststructuralism. In opening up my continual learning process with poststructuralism, I hope to, first, deconstruct education that follows the *neoliberal mentalité.* Then, I envision other possibilities in education that create space for dialogues between Western modern science and local Indigenous knowledges and practices.

Poststructuralism: focusing on the possibility.

Poststructuralism "seeks to deconstruct productions of singular, powerful truths reproduced through oppressive metanarratives. It is antifoundationalist, antiessentialist, and committed to a critique of the 'common sense' assumptions that regulate and organize institutions" (Gebhard, 2015, p. 14). Poststructuralist thought has allowed me to identify how the neoliberal mentalité works within science education as well as to encourage the multiplication of knowledges-sciences. As Maclure (2003) suggested, in a poststructural view, "truths are always partial and knowledge is always 'situated'—that is, produced and for particular interests, in particular circumstances, at particular times" (p. 175). My earlier conceptualization of the dancing amoeba (Chapter 3) reflects my poststructural way of thinking, which recognizes "partial" and "situated" knowledges-sciences in relation with a particular culture and place. My relationship with poststructuralism has been good so far. We have more commonalities than differences.

I was given advice by Dr. James Sa'ke'j Youngblood Henderson that "knowledge doesn't give you certainty, but possibility" (personal communication, May 30, 2016). Wilson (2008) also mentioned that "research is all about unanswered questions, but it also reveals unquestioned answers" (p. 6). My earlier-mentioned commitment to remain open to possibility—to experience the "flux" (Wiseman, 2016) and "wandering pathway" (Higgins, 2016) during the re/search process—reflects this advice from Indigenous scholars and poststructuralists. Poststructuralists, including Gilles Deleuze (e.g., rhizomes, lines of flight, nomads) and William Doll (e.g., complexity theory), guided me to unpack this possibility of the re/search and knowledge production process, furthering my understanding and acceptance of the fluid nature of re/search process and leading me to appreciate the unexpected in the process.

However, I engaged in building a closer relationship with Michel Foucault (1980), a French poststructuralist, particularly for this project because of his notions of power as relations and power-knowledge resonated with my current view of the education structure and knowledge production. Thus, below, I describe some of Foucault's ideas in relation to my ideas about knowledge production and power relations. Honouring that I am in *inter esse*—I am committed to learn from and listen to both Western and Indigenous voices—below, I weave the ideas from Foucault with the lessons and stories I received from Indigenous scholars. In so doing, following Wilson's (2008) advice, I attempt to "develop his or her [my] own relationship with ideas therefore to form their [my] own conclusions [and] make new connections of ideas" (p. 94) rather than judge others' ideas or theories.

My relationship with Foucault.

Foucault has been one of the theorists I sought to build relationship with since the beginning of this re/search mainly because of his notion of power as relations. Foucault focused on the importance of relations. As such, Foucault's poststructuralism is not concerned with language but with politics (Olssen et al., 2004). Foucault (1980a) stated, "One's point of reference should not be [to] the great model of language and signs, but to that of war and battle [that went into the selection of language]" (p. 114). Signifiers alone do not produce meaning; rather meaning is produced by the exercised power. In other words, he considered discursive relations more important than preexisting meaning or signifiers. Here, discursive practice refers to a particular form of social practice that mediates between the text and the larger social practice (Fairclough, 1992). Foucault also claimed that, "concepts and ideas are not as important than the relationship that went into forming them" (Wilson, 2008, p. 74). He was interested in exploring the relationships among different stakeholders involved in institutions (i.e., power as exercised rather than possessed). Foucault (1978a), like many Indigenous scholars, defied linear causality-effect explanations of the social and historical process, but “render[ed] apparent the polymorphous cluster of correlation” (p. 13). Thus, in exploring social and historical processes, Foucault was keen to reveal the “play of dependencies,” which consists of three aspects:

> the *intradiscursive*, which concerns relations between objects, operations, and concepts within the discursive formations; secondly, the *interdiscursive*, which concerned relations between different discursive formation; and thirdly, the *extradiscursive*, concerning the relations between a discourse and the whole play of economic, political, and social practices. (As cited in Olssen et al., 2004, p. 19, emphasis added)

In exploring the integration of IK-S in Saskatchewan’s science curricula, I was also interested in exploring the play of dependencies, rather than looking for linear causes and effects. For example, in this project, I looked at:

1) the *intradiscursive*, which is the relationship between Indigenous knowledges-sciences (IK-S) and WMK-S, illustrated in the content of official science curriculum documents from K-12.
2) the *interdiscursive*, the educational stakeholders’ (e.g., teachers, education consultants, and academics) views on such IK-S infused science curricula. This involved two different discursive formations: the production of IK-S infused science curricula and the interpretation and views of these documents; and
3) the *extradiscursive,* the relation between IK-S-related content found within curriculum documents with larger political and social practices in Saskatchewan and Canada.

Exploring these relations from the play of dependencies, I aimed to explore the ways in which power was exercised in the representation of IK-S and WM-S content in different discursive formations: in curricula and their relations to the views from different actors involved in the curriculum production as well as other social and educational practices. Moreover, while exploring to uncover these relations, instead of asking, “What does power mean?” Foucault (1984b) suggested asking, “What does power do?” (Olssen et al., 2004, p. 99) and examining the ways in which power is exercised through different relations as power is exercised rather than possessed (Foucault 1984).

Foucault would not have been a universalist in science education, and nor am I. He did not engage the “quest for certainty” (Dewey, 1929). He did not believe that there is a true form of knowledge and science; rather he focused on the relationship between power and knowledge. To Foucault, knowledge and power are “always inextricably related and . . . there are always sociological implications to the production of knowledge” (Olssen et al., 2004, p. 21). However, Foucault did not situate all knowledges-sciences as a mere product or expression of power, rather he focused on the ‘discourse—the system of thoughts’ that legitimizes a particular form of knowledges-sciences (e.g., Western modern science). As such, Foucault’s view of power as relations respects Indigenous epistemology in a way that “[it] is all about ideas developing through the formation of relationships, an idea cannot be taken out of this relational context and still maintain its shape” (Wilson, 2008, p. 8). Foucault’s notion of power as relations and plays of dependencies thus served as a theoretical lens for this project. Foucault also guided me in ethical practices throughout the process of re/search.

Foucault, like Wilson (2008), respected the relationship that goes into forming ideas, thus he was not quick to dismiss others’ ideas. His notion of critique reflects this view. As Foucault (1988) put it:

> A critique is not a matter of saying that things are not right as they are. It is a matter of pointing out on what kinds of assumptions, what kinds of familiar, unchallenged, unconsidered modes of thoughts, the practices that we accept rest. (p. 154)

Foucault's critique resonates with my desire to uncover the relationship, including the assumptions, unchallenged modes of thoughts, and practices, that IK-S content in the curriculum documents has with other aspects of the education system (e.g., textbooks, teachers, and curriculum writers). Foucault (1988a) continued:

> Criticism is a matter of flushing out that thought and trying to change it: to show that things are not as self-evident as we believed, to see that what is accepted as self-evident will no longer be accepted as such. Practicing criticism is a matter of making facile gestures difficult. (p. 154)

Foucault's notion of critique/criticism also helped me to fulfill one of my ethical commitments—that of critical reflexivity—wherein I "purposefully give space for the political examination of location and privilege" (Herising, 2005, p. 136).

As such, in this re/search project, I have continued to reflect, examine, and *think beyond* the entangled politics influencing the re/search: the internalized practices and values stemming from a neoliberal mentalité from the institutions that I am working with/in for this project (i.e., the university setting wherein I produce this manuscript as well as my research sites) (Kovach, 2008). Meanwhile, Wilson (2008) reminded us that"research is ceremony. The purpose of any ceremony is to build stronger relationships or bridge the distance between aspects of our cosmos and ourselves" (p. 11). Therefore, in the following, I describe how these theories build relationship with my re/search practice of exploring the question: What relationships are at play in integrating Indigenous knowledges-sciences in science curricula?

Practice: Framework of the Project based on the Three-Tiered Model of Discourse

Foucault was "a poststructuralist whose central methodological approach [was] historical" and whose works were concerned mainly with "the social and political analysis of discursive practices as systems of rules" (Olssen et al., 2004, p. 49). Norman Fairclough,[25] a social linguist from Britain, agreed with these ideas of Foucault. However, Fairclough (1989) argued that the "textual analysis" component was largely missing in Foucault's work. To Fairclough (1989), to understand the ways in which power operates within education system, it is important to "analyz[e] the relationship between texts, processes, and their social conditions, both the immediate conditions of the situational context and the more remote conditions of institutional and social structures" (p. 26). In this light, Fairclough (1992) put forth a three-tiered model, which includes both text and social practice (Figure 11).

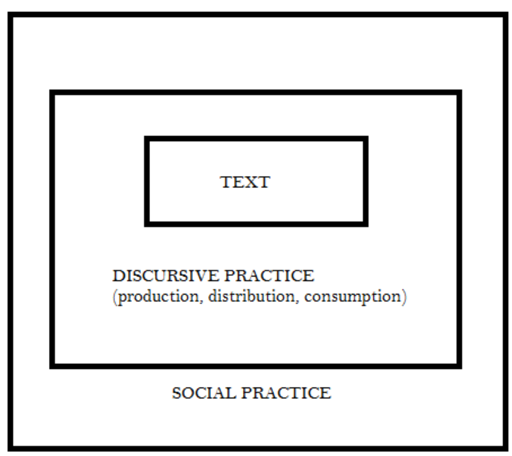

Figure 11. Three-tiered Conception of Discourse (reproduced from Fairclough, 1992, p. 73)

[25] Fairclough (1989, 1992) acknowledged Foucault's influence in his earlier works. However, he later sought to distance himself from Foucault as he was drawn more into "transcendental approach" of the critical realist (Curtis, 2014).

Building on Foucault (1978a)'s three aspects of the play of dependencies (i.e., the intradiscursive, interdiscursive, and extradiscursive), Fairclough (1992) specifically divided social practice into two different levels: discursive practice (microsociological practice) and social practice (macrosociological practice). Here, discursive practice is a particular form of social practice that mediates the text and larger social practice. In analyzing discursive practice, Fairclough (1992) specified the need to focus on the processes of text production, distribution, and consumption. These three processes, however, are "social and require reference to the particular economic, political, and institutional settings within which discourse [system of thoughts] is generated" (Fairclough, 1992, p. 71), which Fairclough explained in the same vein as Foucault's notion of the play of dependencies.

However, I am particularly drawn to Fairclough's three-tiered model as it gives a specific framework to conceptualize and analyze different discursive formations of the play of dependencies of IKS in science curricula that stems from the textual level (i.e., IKS content in science curricula). In other words, the model gave me a more tangible and clear framework to articulate the ways in which "text" (i.e., IKS-related content in the curriculum documents) enacts at the practice level, such as teachers' teaching practice, by adding an analytic layer of "discursive practice" (or what Foucault calls "intradiscursive"), which includes the production, distribution, and consumption of the interdiscursive relations that one sees in the textual level (i.e., contents in the curriculum document). The model also offers an opportunity to contextualize and link the textual and discursive practice analysis in larger social and historical contexts. Fairclough's three-tiered model has guided me throughout my re/search process, from an early phase of the project, (selecting what types of data I should invite into my re/search), to the analysis and writing process.

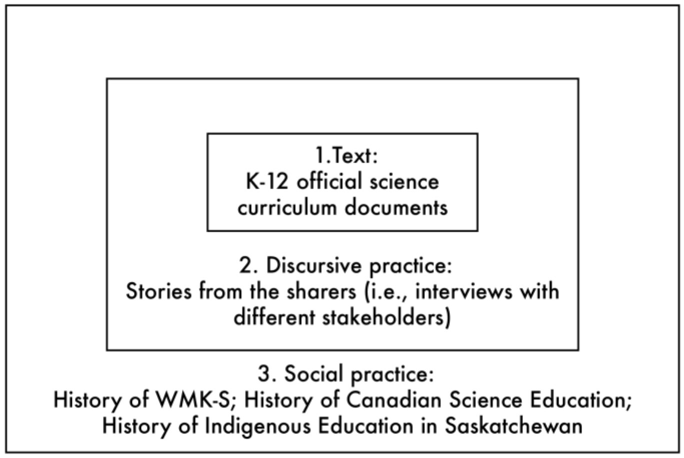

Figure 12. Data source for the Project

Following the understanding that we are all related (and that the notion of *we* encompasses both living and nonliving things) (Cajete, 2000; Higgins, 2016; Wiseman, 2016), I recognized that I needed to build relationship with all my data. Fairclough's three-tiered model assisted me in inviting and further building relationship with data, as shown in Figure 12. For my re/search, I invited curriculum documents for the *textual* level, stories from different educational stakeholders for the *discursive* level, and the history and policies related to Indigenous education and science education in SK for the *social* level. In the following, I introduce each data in detail.

Official curriculum documents: For the textual level, I invited official curriculum documents (K-12) into this project. Curriculum documents are the key political texts in the formal educational system, which is comprised of sites where power struggles of different knowledges-sciences exist. Published by the ministries of education, official curriculum documents provide guidelines for different stakeholders in the education system, including textbook publishers, teachers, and administrators (Posner, 2003). Endorsed by governments, official curricula play a significant role in transmitting knowledge, skills, and values of society to students, thereby conveying particular worldviews and political agendas. While entailing specific details as to the knowledge and teaching methods to be used in the classroom, these official curricula contribute to the production of a particular discourse for teachers in the classroom; further, they influence learners' perceptions of the content introduced in the classroom. Indeed, overseen by the state, official curriculum documents operate "to maintain relations of power throughout the society as a whole" (Olssen et al., 2004, p. 67). In this light, official curriculum documents are both instruments and objects of power (Fairclough, 1992). While recognizing this dual role, I focused on the relations that these curriculum documents have with other discursive practices. Curriculum documents are "political texts," resulting from "tension among a myriad of social, political, and economic forces and movements, which battle to decide what knowledge [knowledges-sciences] is of most worth" (Reis & Ng-A-Fook, 2012, p. 1015). The knowledges-sciences that win the "battle" of selection are then presented in the texts. In this way, curriculum documents are not merely artifacts that list learning outcomes and indicators, but also "specialized form of text[s]" that are "intentionally authorized and edited" to transmit a selective tradition of values, beliefs, and knowledges-sciences (Luke, 1989, p. 54). It is with this regard that I invited official curriculum documents into my re/search. The current K-12 curriculum documents in Saskatchewan[26] were renewed between 2010 and 2017.

Stories from Sharers: To explore discursive practices embedded in the integration of Indigenous knowledges-sciences (IK-S) within these curriculum documents, I invited stories from different educational stakeholders involved in Saskatchewan curriculum development. Orpwood and Souque (1985) emphasized that in curriculum analysis, one should also focus on "political forces" of curriculum (p. 11). Acknowledging these political forces working on curriculum, I

[26] The Saskatchewan science curriculum documents are available on
https://www.curriculum.gov.sk.ca/webapps/moe-curriculum-BBLEARN/Home?language=en

wanted to explore "what motivated and guided its developers" (Posner, 1992, p. 35) as well as how their views of IKS and WMS influenced the selection of content for curriculum documents. Therefore, I chose to speak with different educational stakeholders who were involved in the curriculum renewal. These include: a science education consultant (Saskatchewan Ministry of Education); teachers involved in curriculum writing; a researcher; and a First Nations and Métis Education coordinator at a school board in SK, who was also part of curriculum renewal process. I asked them about their views on science and current science curricula, general ideas about the integration of IK-S in curricula, and views on the role of ally. The sharers for this project are briefly introduced in Table 1. Appendix II presents the detailed introduction and relationship making process with each sharer.

Table 1. Sharers for this project

Name	Title/association	Date of the interviews
Glen Aikenhead	Emeritus Professor in Education (University of Saskatchewan)	March 24th, 2016 over skype (4 hours)
Rory Bergermann	High school Science Teacher (Prairie Spirit School Division)	December 12th, 2016 over phone (1hour 30 min)
Dean Elliott	Science Education Consultant (Ministry of Education of Saskatchewan)	November 2nd, 2016; December 19th 2016 over the phone (total of 4 hours)
Darryl Isbister	First Nations, Inuit and Metis Education Coordinator (Saskatoon Public Schools Division)	October 26th, 2016 over phone (1 hour 30 min)
Tina Rioux	High school Science Teacher (Saskatoon Public School Division)	January 3rd 2016 over the phone (2 hours)
Ted View	Former High school Teacher, Principal (Greater Saskatoon Catholic Schools Division)	November 10th, 2016; January 28th, 2017 over the phone (total 4 hours)

Here, I would like to be more detailed about the invitation process for the stakeholders, whom I now refer to as *sharers*[27] because this term makes explicit the importance of building relationships for the re/search process. The process of gathering these stories from these sharers initiated from my relationship with Dr. Glen Aikenhead.[28] The initial relationship that I had with Dr. Glen Aikenhead was primarily virtual and creative. Dr. Glen Aikenhead's works played a major role in guiding my understanding about places for Indigenous knowledges-sciences ever since I delved into my inquiry related to Indigenous ways of knowing, doing, and being in science education. In earlier years, my relationship with Dr. Aikenhead was more or less linear. I mainly drew on his ideas for my understanding. The relationship became more interactive and alive as I started to reach out to him to ask questions and share my dreams.

Dr. Glen Aikenhead has worked with various educational stakeholders in science education for decades. Recognizing the importance of establishing relationships before beginning research projects (Kovach, 2008) and after many changes in this project (as illustrated in Chapter 2), I reached out to Dr. Aikenhead to help me connect and bridge my relationship with other stakeholders in Saskatchewan. Given his established relationships and the trust that he had earned from others, I was able to develop relationships with different stakeholders for my re/search project, including Dr. Dean Elliot, a science education consultant in the Saskatchewan Ministry of Education; Mr. Darryl Isbister, the coordinator of First Nations, Inuit, and Métis education at the Saskatoon public school division; and Mr. Ted View, a principal in an elementary school and who

[27] I refer to interviews as sharing, thus interviewees become *sharers*. The introduction of these interviewees can be found in Appendix II. These introductions are in their own words. Rather than providing a brief biography of these sharers, I decided to present the stories/introduction in the form they were given to me. In this way, I am attempting to set a stage wherein readers may join the conversations between me and all the sharers.

[28] In the consent form, these sharers all indicated that they would like to be identified in this project.

had been collecting the stories from the Elders from different communities across Saskatchewan for the Saskatchewan-customized textbooks.

However, Dr. Glen Aikenhead was cautious about referring me to Elders who were involved in the curriculum development, as “the prerequisite to learning from Elders is to forge a relationship with them before requesting their help. Logically, that would be a challenge for you” (personal communication, October 5, 2016). These new forged relationships that I had built with Dean, Darryl, and Ted led me to other relationships. For example, Dean put me in touch with Ms. Tina Rioux and Mr. Rory Bergermann, two science teachers who had been part of the curriculum-writing process for the senior level. Then Tina referred me to Darryl. It is as if we are in a circle of relationships.

All the conversations with the six SK stakeholders happened either on the phone or Skype. The conversations were recorded and transcribed; the transcription was sent to each of them for their review. The sharers changed or edited the transcription if they felt it was necessary. Prior to speaking with these sharers, I prepared guiding questions (Appendix I). The more engaged I became in learning from the stories, the more I learned to listen without asking questions. Some interviews went on for four hours; sometimes we spoke over a period of a couple of days. It was this active listening that allowed my re/search to be open to “unquestioned answers” (Wilson, 2008, p. 6). As I am writing this chapter, the conversations continue through emails and sometimes in my dreams. These sharers not only allowed me to have access to their experience, stories, and time, they taught me how to become a better listener and a better human being. As a token of appreciation and a memorandum of our relationship and conversation, I shared with them Korean shell-decorated pencil cases that my father had brought back from South Korea.

Historical and political contexts: For the social practice level, I focused on the histories and other policies related to Indigenous and science education that influenced Saskatchewan's educational practices (e.g., pan-Canadian science education framework). Said (1994) mentioned, the "past [is] quarantined from the present" (p. 2). Jordan and Wood (2015) suggested that instead of treating "the past as something static," scholars need to understand history as "an ongoing process that connects the past and present (and prefigures the future)" (p. 8). I concur with them.

As such, for Fairclough's social practices level, I chose to focus on "the contextual historical charter of the categories that took root in, and develop in, the social and historical customs and practices of specific society" (Olssen at al., 2004, p. 40). Thus, I focused on the histories of three different sites: the first was the science education field. In exploring the literature on the history of science education, I focused on the ways in which Western modern knowledges-sciences have become the dominant form of knowledges-sciences appearing in curricula globally (Aikenhead, 2003; McKinley, 2005). Exploring the history of Eurocentric science is important because, as mentioned previously, the neoliberal enclosure of science education pushed current science education to see WMS as the only valid science, which in turn influenced their values and philosophy of science education of curriculum developers. These developers' values and philosophy then influence the discursive practice of curriculum production.

Second, I focused on the Canadian educational and social policies related to Indigenous education (e.g., the White Paper, 1969; the Report of the Royal Commission on Aboriginal Peoples; the First Nations, Métis, and Inuit Education Policy Framework), as well as current science education as reflected in the Common Framework of Science Learning Outcomes by Canadian Councils of Canada, Education. These policies have influenced the current science educational practices in Saskatchewan (Aikenhead, 1999). Thus, taking advice from Jordan and

Wood (2015), I treated these historical and political contexts as agents that play a role in power relations in the curriculum production process, rather than viewing them as a glimpse into the study's context. Third, I also drew from the "inside" stories told by sharers on the specific social context and process during the curriculum renewal in Saskatchewan. In so doing, I focused on the relationship the aforementioned policy documents have with the stories told by the sharers.

Data Analysis: Rebuilding Relationship with Data

Once I had all the data in front of me, I had to rebuild a relationship with the data. Before engaging in rebuilding a relationship with the data, I first sat down with all the stories and asked for my next steps. In this way, I engaged in the practice of "critical reflexivity" within the re/search process. I hoped to ensure that I did not miss, because of my assumptions and biases, any important aspects that would guide me in the analytic process. I also engaged in this process to follow the lesson I received from Tim O'Loan, a TRC advisor from the Dene Nation. In regards to my project and my life, Tim told me, "Don't rush yourself. Allow your natural cadence. Remember three things: your journey, your God, and your cadence" (personal communication, January 30, 2017). Tim also advised me to break barriers, not only the systemic barriers, but personal barriers. Thinking about what personal barriers may be affecting my re/search process encouraged me to slow down. Thus, instead of jumping into the next stage of the project, I paused for reflection and I decided to listen to the stories that were shared with me.

Indeed, reflecting with/from the stories shared by the sharers offered great advice in regards to my next steps in the re/search. Some stories guided me in my curriculum document analysis process by giving suggestions such as focusing on topics within science education: "it's really a matter of just sort of looking at what the topics are at each grade and then it's a chance to see from those topics which ones connect better and which ones don't" (Dean Elliot, personal communication, December 28, 2016). Some stories introduced me to other works in the field of Indigenous education, such as Lipka et al.'s (2005) notion of culturally based education, which I drew upon for my analytic process. Some stories offered wisdom and lessons about the protocol, which helped me strengthen other relationships in my life.

Once I engaged with stories from all my sharers in the first round, I moved to analyzing the K-12 curriculum documents for the first time to focus on the specific topics and ideas covered in each grade. Meanwhile, I explored the histories of science education and Indigenous education. After, I went back to analyzing the curriculum documents for the second time for an analysis focusing on Indigenous knowledges-sciences related content found within the documents. I revisited the stories from the sharers and historical and political contexts I explored earlier.

This analytic process required that I move back and forth between the data and the lessons emerging throughout the process. Throughout the process, I found that if the data collection process was about me inviting each data into the project and making relationships with each data separately, the analysis process for me was about having dinner with all the data together. Data and I were sitting in a sharing place. Sometimes data would speak to me or sometimes data would converse with each other. In this light, I found my project was, in a way, finding its own course, rather than me leading the project. As I was part of the relations of all the data and the process, there were times that I waited with the mindset of *kemoochly* for data to speak and build relationships with each other. Foucault (1981/2000) would have agreed, as he too experienced a similar analytic process involving self-in-relation in the re/search process. Foucault (1981/2000) said his work was always based on his personal experience, "because I thought I identified cracks, silent tremors, and dysfunctions in connection with processes I saw unfolding around me" (p. 458).

While these notions of self-in-relation (Graveline, 1998) and *Kemoochly* guided me through building relationships with data, Fairclough's three-tiered model offered me a tangible analytic and writing framework. Following Fairclough's model, this project has three different analytic categories: description, interpretation, and explanation (Figure 13). Using this three-tiered model, in the following, I lay out my analytic process and specific strategies used. In below, I provide details of each analytic phase.

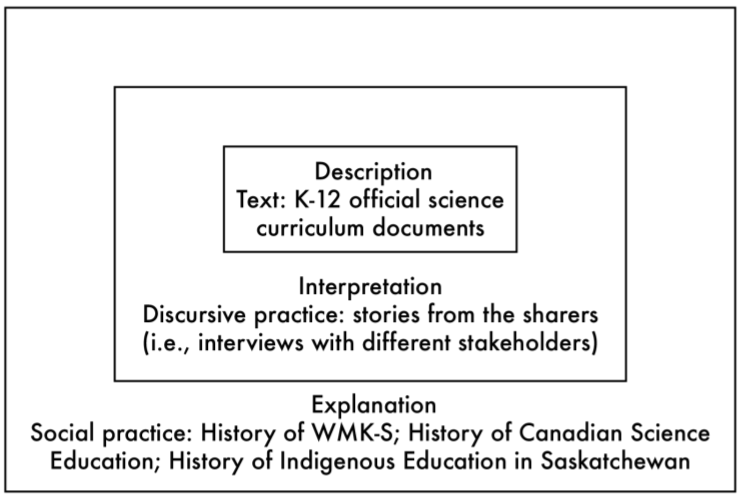

Figure 13. The three-tiered analytic framework for official curriculum (Reproduced from Fairclough, 1989)

Description: content analysis of official curricula.

In the description stage (Figure 13), I focused on exploring research question 1: In what ways is IK-S content being represented within curriculum documents relative to other science learning concepts? To respond to this question, I focused on the power relations between IK-S and WMK-S found within ***curriculum documents***. The description stage included content analyses of curriculum documents, which included an exploration of the relationship the content related to IK-

S has with the curriculum structure and other WMK-S–related content. To do so, I focused on the status of IK-S in curriculum documents and the ways in which IKS had been included in curriculum documents. Therefore, I first started the description stage by examining the structure of the curriculum documents and educational aims, goals, and visions of science education that are stated in the foundational pillars of science curriculum documents in SK.

Thereafter, I started identifying IK-S within the curriculum documents. I selected texts including words such as *First Nations*, *Indigenous*, *Métis*, *Cree*, *Inuit*, and *traditional* (as the Saskatchewan Ministry of Education suggested the word *traditional* was used for Indigenous knowledge). Once IK-S–related content[29] was identified, to further explore the relations between the IK-S content related to the content in other documents and the status of IK-S content in the curricula, four sets of frequency analyses were performed with a specific focus to:

(1) Number of appearance in K-12 by grades

(2) Priority scale

(3) The four learning contexts

(4) Three areas of integration

1.Number of appearance in K-12 by grades: The first stage of frequency analysis involved counting the number of occurrences of Indigenous-related topics within K-12 documents as well as of the three scientific disciplines (life science, physical science, earth and space science). This was to further investigate the relationship that IK-S content have with the WMK-S content and with the curriculum structure.

2.Priority Scale: After the first frequency analysis, the selected texts (those identified in the first stage) were analyzed according to a priority scale (Table 2), "which helps to categorize

[29] The IK-S content found within K-12 curriculum documents is listed in Appendix III.

data [IK-S related content] according to the weight each carries in the curriculum documents" (Kim & Dionne, 2014, p. 317). For example, if IK-S only appears as an example and add-on material, rather than outcome or indicators, while WMK-S only appears as outcomes and indicators, such curriculum can be assumed to be centralizing WMK-S and excluding or placing less value on non-WMK-S. As such, the learning priority of the content allows us to see the power relations between IK-S and WMK-S represented in science curricula.

The Saskatchewan priority scale was developed based on the description of outcomes and indicators provided in the curriculum documents. Outcomes "are statements of what students are expected to know and be able to do by the end of a grade in a particular area of study. The outcomes provide direction for assessment and evaluation, and for program, unit, and lesson planning" (Saskatchewan Ministry of Education, 2011, p. 2). Indicators "are representative of what students need to know and/or be able to do to achieve an outcome. Indicators represent the breadth and depth of learning related to a particular outcome" (Saskatchewan Ministry of Education, 2011, p. 2).

Table 2. Saskatchewan science curriculum content priority scale

Priority	Definitions
5	The content is mandated by the Ministry as an outcome. Students are expected to master the learning topic. The outcome "provides direction for assessment and evaluation, and for program, unit, and lesson planning" (Saskatchewan Ministry of Education, 2011, p. 2).
4	The content is mandated by the Ministry as an indicator. Indigenous-related content is reflected as a main integral topic of the indicator. Students are expected to master the learning topic. This content (skills/knowledge) will be tested.
3	The content is suggested by the Ministry as a part (i.e., "including") of an indicator. The term including "prescribes content, contexts, or strategies that student must experience in their learning, without excluding other possibilities [and] is mandatory" (Saskatchewan Ministry of Education, 2011, p. 2). …. like your idea of giving at 1-2 examples for each of these priority scales.

2	The content is suggested by the Ministry as a part (i.e., "such as") of an indicator. The term such as "provides examples of possible broad categories of content, contexts, or strategies that teachers or students may choose, without excluding other possibilities" (Saskatchewan Ministry of Education, 2011, p. 2).
1	The content is composed of additional materials for suggested activities. The term e.g., is used in the curriculum. E.g., "offers specific examples of what content, contexts, or strategies might look like" (Saskatchewan Ministry of Education, 2011, p. 3).

Once these frequency analyses were done, I started to explore the ways in which Indigenous-related content was integrated in the curricula. In so doing, I drew upon two frameworks: the four learning contexts provided by the Saskatchewan Ministry of Education and three areas of Indigenous knowledges integration by Lipka et al. (2005).

3.The four learning contexts: The learning contexts in Saskatchewan science education provide various/multiple "entry points into curriculum that engage students in inquiry-based learning to achieve scientific literacy" (Saskatchewan Ministry of Education, 2016a, p. 21). The goal of science education is stated throughout K-12 science curricula: to achieve scientific literacy through inquiry-based learning. Learning contexts represent the "how of curriculum" (p. 15). I use these learning contexts as the framework to explore the ways in which curriculum outcomes and indicators (i.e., the "what" of curriculum") are integrated in relation to the goal of Saskatchewan science education. The four learning contexts are listed below:

> The **scientific inquiry** leaning context reflects an emphasis on understanding the natural and constructed world using systematic empirical processes that lead to the formation of theories that explain observed events and that facilitate prediction.
>
> The **technological problem-solving** learning context reflects an emphasis on designing and building to solve practical human problems similar to the way an engineer would.
>
> The **STSE decision-making** learning context reflects the need to engage citizens in thinking about human and world issues through a scientific lens in order to inform and

empower decision making by individuals, communities, and society.

The **cultural perspectives** learning context reflects a humanistic perspective that views teaching and learning as cultural transmission and acquisition. (Aikenhead, 2006, as cited in Saskatchewan Ministry of Education, 2016a, p. 21)

One or more learning contexts can be incorporated into teaching approaches and taken all together, these contexts represent “philosophical rational for including science as a required area of study” (Saskatchewan Ministry of Education, 2016a, p. 21). The learning contexts of the identified curricula outcomes and indicators were counted for frequency analysis.

4.Three areas of Integration: In addition to these four learning contexts, in the fourth phase for the description (e.g., Analysis of curriculum documents), I also explored the curricula in relation to three different aspects of infusing Indigenous perspectives into curricula. These three aspects were initially discussed by Lipka, Hogan, Webster, Yanez, Adams, Clark and Lacy (2005) for their math in a cultural context (MCC) project in Alaska’s context. Developed with input from Yup’ik Elders and reform-oriented educators, the project focused on creating a math program focused on “math as problem-solving” that works against the “top-down authoritarian ways of teaching mathematics, in which there is one right answer and usually one way to find it” (Lipka et al., 2005, p. 3). Though the three aspects of MCC were for a different subject (mathematics), they give a good foundational understanding of the ways in which the school science/math classroom could integrate Indigenous perspectives/knowledges-sciences in teaching and learning and encourages the multiplication of knowledge-sciences in education suggested by my Dancing Amoeba Model.

While there had been other frameworks for the integration of Indigenous perspectives in curricula, MCC in particular was designed to create “classroom and community interaction [and] to include both Western reform-oriented instructional practices and local ways of learning and knowing" (Lipka et al., 2005, pp. 368-369). MCC therefore promotes holistic learning, including two-eyed seeing (Hatcher at al., 2009) and continuous relationship-building between classrooms and communities, which are important aspects in successful Indigenous science education (Sutherland & Henning, 2009). The three areas of integrations are:

> *Content knowledge* (informed by both Western knowledge and that of Yupi'ik [local Indigenous communities] Elders), *pedagogical knowledge* (informed by school-based practices and community-based ways of teaching, communicating, and learning), and *contextual knowledge* (ways of connecting schooling to students' prior knowledge and the everyday knowledge of the community. (Lipka et al., 2005, p. 368, emphasis added)

These three areas of integration helped me unpack the ways in which Indigenous related outcomes and indicators are introduced. It was my hope that data from the sets of frequency analyses would provide a scope indicating the status, the extent to which IKS content had been included or omitted, and its relations with WMKS content within curricula.

Interpretation: analysis of curriculum production and consumption.

The interpretation phase focused on exploring research question 2 (see figure 13): What are various educational stakeholders' views on current approaches to integration? How do these educational stakeholders position themselves and how does their position influence their work in the integration of IKS in science education?

As noted earlier, Fairclough (1992) posited that discursive practices include the process of production, distribution, and consumption. To explore the production process, I primarily considered the production of curriculum documents and the relationships between different stakeholders in the curriculum writing team. Thus, I explored the identity of curriculum developers and resources and other educational frameworks/policies (on Indigenous or science education) upon which producers rely. Also, I paid attention to the stories shared by the sharers (including curriculum consultants and developers) to gather their perspectives and experiences with teaching with IK-S content. In particular, I focused on exploring their general views on the integration of IKS in science education, their definition of science, their views on the current approaches to integrating IKS in science education and their role as an ally (if non-Indigenous and if they identify as an ally) or an Indigenous person. Once the stories were gathered, I then explored the relationships between their ideas and stories with the IKS content found within curricula.

To investigate the distribution process, I looked into the ways in which Indigenous knowledges-sciences were gathered and distributed to teachers as explained by the sharers. Sutherland and Henning (2009) suggested that "Elders, culture, language, and experiential learning [are] the most important elements in Indigenous science education programming" (p. 182). These four elements require building relationship with communities and the land and encourage lifelong learning and continual relationship-building. Therefore, I focused on the relationships that the Ministry had built with local Indigenous communities as well as the role Indigenous communities members and scholars played in the curriculum development process. In exploring such relations, I focused on whether the curriculum development process involved a "collaborative and consultative process" (Glen Aikenhead, as cited in Wiseman, 2016). Wiseman (2016) specified:

> The difference between the two processes lies in the willingness of provincial/territorial governments to enter into relationships where ministries "relinquish some genuine authority to Indigenous Elders [and other knowledge holders] to make contributions [to curricula] and take ownership of those contributions" (G. Aikenhead, May 13, 2013). Or, in other words, the difference between collaboration and consultation lies in the willingness

of provincial/territorial governments to let go of control and embrace the spirit of two-way integration. (p. 157)

As such, I focused on the processes through which local Indigenous Elders and community members got involved in curriculum development and the roles they played within the curriculum writing team. As well, I looked for the ways in which the Ministry has provided support for distributing IKS in classrooms (e.g., furthering relationships between classroom teachers and students to local Indigenous communities).

To explore the consumption process, I focused on the stories from the classroom teachers. Consumption in the context of my study refers to implemented aspects of curriculum, which describe how the learning objectives from intended curricula have been consumed by teachers. Therefore, I asked two classroom teachers about their own ways of integrating IKS and benefits and challenges of doing so.

All in all, the interpretation stage focused on examining the different discursive formations (i.e., interdiscursive of the play of dependencies) in the integration of IKS in the science education in Saskatchewan.

Explanation: looking in relation with and looking beyond.

The explanation stage focused on exploring research question 4 (see figure 13): What was the process through which the integration of IK-S in the curricula became a part of the educational policy agenda in Saskatchewan? This phase was divided into two sections. The first section of explanation (i.e., extradiscursive of the play of dependencies) focused on the historical and political contexts prior to and during the curriculum renewal/textbook development process in order to provide the historical/political context wherein curricula and textbooks were developed. As such, a brief history of science education and Indigenous education history and published police documents in Canada was analyzed in the first section of the explanation stage. Moreover, the first section of explanation part delved into the history of WMK-S and how it became the dominant form of knowledge-science within global science education as well as the way it became the dominant scaffolding mold mechanism for science education (e.g., science education based on learning outcomes and scientific topics divided and compartmentalized into different disciplines), coupled with neoliberalism. The explanation was to critique the normalized practices of the conventional structure of curricula that stemmed from the unchallenged neoliberal and capitalist values as well as the WMK-S supremacy in the field of education.

In this way, my critique of these curriculum development practices sought to challenge the normalized status quo relationship between Indigenous knowledges-sciences and Western modern knowledges-sciences and offer possibilities for how we can think beyond these "historically transitory constraints." Analyzing such "historical transitory constraints" resonates with Dr. Laara Fitznor's earlier mentioned notion of decolonization:

> Decolonization means willingness to see and look back to history behind. Everyone needs to be decolonized. Not only Indigenous peoples. In engaging with decolonizing activity, asking questions such as: Where is power dynamics? What do *I* encourage through this activity? (personal communication, March 24, 2015)

The second section focused on looking at the power dynamics between different discursive practices of curriculum documents and making relations/synthesizing meanings from all data across and exploring how all these data together represent the current status of the decolonization process of science education in Saskatchewan. I was guided by Afonso's (2012) five stages of integration of Indigenous knowledge systems (i.e., grounding framework) in science education: colonization, decolonization, neo-colonization, rebirth, and theorization (Table 3).

Table 3. Five Stages of the Integration of Indigenous Knowledge Systems.

1. Colonization	Indigenous Knowledges (IK) are not recognized as valued knowledge
2. Decolonization	Awareness of the value of IK starts to take place in debates on curriculum policies in education (i.e., a conduit for assimilation of IK into the Western paradigm)
3. Neo-colonization	Content integration: Process that undermines the cultural values of a society (e.g., integration that teaches Western science to Indigenous students and uses IK as a resource to clarify Western science)
4. Rebirth	Researchers and educators interrogate the lenses through which IK is communicated, argue for the inclusion of IK, and question the way in which it has been included/integrated
5. Theorizing	Researchers and educators are more concerned with justifying the claim for coexistence of different discourses in school curricula and seek to address ontological, axiological, and epistemological issues in including IK in school curricula (e.g., how do we teach IK?)

This framework provides a tool that analysts can use to "reflect on curriculum changes and on programs of research into the cultural contextualization of science education and/or of Indigenous Knowledge System inclusion in school curricula" (Afonso, 2012, p. 25). Recognizing that decolonization is an ongoing process, analyzing historical and political contexts involves not only *looking back* (Fitznor, 2015), but *looking in relation with* other discursive practices and texts as well as *looking beyond* the universals—a kind of "experimental one [practice]" (Foucault, 1984, p. 46). Foucault (1984) advised that this historical critical attitude is necessary for change to happen:

> I mean that this work done at the limits of ourselves must, on the one hand, open up a realm of historical inquiry and, on the other, put itself to the test of reality, of contemporary reality, both to grasp the points where change is possible and desirable, and to determine the precise from this change should take. (p. 46)

I reflected on the relations between data based on the Afonso's decolonization framework in order to find out what stage the science curriculum in Saskatchewan is at with regards to the integration of Indigenous knowledges-sciences and to see where “change is possible and desirable” (Foucault, 1984, p. 46). The second part of the explanation includes some recommendations for future directions for integrating IK-S in science education.

The first part of the explanation will be in next chapter, Chapter 5. The second part of this explanation will be embedded in the conclusion section (Chapter 8). The description (i.e., curriculum documents analysis) will be in Chapter 6 and the interpretation (i.e., stories from the sharers) will be in Chapter 7.

Conclusion of the Methodology: A Reflection

The methodology chapter was a candid account of the process of re/search and the ways in which I engaged in weaving theories, practices, and ethics—the three elements of methodology (van Manen, 1997). Drawing from Foucault (1980)’s play of dependencies and Fairclough (1989)’s three-tiered model, I conceptualized different discursive relations that are at play in integrating IKS in SK’s science curricula. The three-tiered model allowed me to select and collect data sources and analyze different discursive relations. Once the data was collected and analyzed, it was inevitable I would experience “flux” during the re/search in the *inter esse,* drawing from both Indigenous and non-Indigenous ideas and ways of coming to know (Wiseman, 2016). During yet another flux, I again had to build another relationship with new stories told by analyzed data. The analyzed data told stories that did not fit in the fixed three-tiered model. As such, in writing the findings sections, I was reminded by the notion of “self-in-relation” (Graveline, 1998) as well as Dr. Fitznor’s advice for decolonization, to think about ‘what do I encourage through this activity?’ It was me (the re/searcher) who moved back and forth between different discursive formations, finding different relations at play and making connections. Through the connections I made by moving back and forth between the different discursive formations, I found a way to present a story of integration of IK-S in Saskatchewan's science education.

Engaged in re/search practice that focused on both process and product as well as the relationship between data and different discursive practices, I was able to explore curriculum as both instrument and object of power (Foucault, 1997). As such, this project itself is in the circle of previous and future developments of curriculum-to-come. Indeed, curriculum theorist William Pinar (2011) mentioned that "we find the future not in the present, but in the past" (p. 49). Thomas and Green (2007) used the Medicine Wheel to describe the learning process: "once you have journeyed around the wheel, you have the opportunity to learn from your experiences and journey around the wheel again, this time learning from your mistakes. . . . If we remember what the challenges were in our previous journey, then our next journey can be different and more effective" (p. 92). Following the findings chapters is the journey of SK science curricula in integrating IKS, thus the process of working towards decolonizing curricula (Afonso, 2012). As Dr. Aikenhead mentioned, decolonization is "a process, it's not a product" and the Ministry of Education of Saskatchewan "established a good beginning on a decade project" (personal communication, March 26, 2016). I offer the following findings chapters in hopes that they will be useful for the next journey for the Saskatchewan Ministry of Education and the ministries of education of other provinces in their initiatives to create spaces for sharing IK-S in science education.

Chapter Five: Historical and Political Contexts Prior to the Current Science Curriculum Renewal in Saskatchewan

This chapter illustrates the *Explanation*: the historical and political contexts that influenced the discursive practices in the Saskatchewan Ministry of Education's initiative of integrating IK-S into the K-12 science curricula. I start my findings section with the findings from the explanation stage as this explanation (i.e., historical and political contexts) will provide the bigger picture of factors and contexts influencing the current Saskatchewan science education. Thereafter, I continue with the *Description* (Chapter 6) and the *Interpretation* (Chapter 7) providing more specific details about the process and product of the development of IK-S science curricula, all of which will be revisited in Chapter 8.

This explanation chapter is divided into two sections. The first illustrates the history of Eurocentric science (i.e., Western modern science) and the ways the values and practices derived from WMS have influenced modern Canadian science education history (i.e., post-Sputnik Era; 1957-present) (Murray, 2014). The second section explores the history of education in Saskatchewan with a focus on the political and historical key points that might have influenced the appearance of current Indigenous knowledges-sciences (IK-S)-inclusive curricula.

As Apple (1990) mentioned, curricula need to be subjectified as the curricula are not value free. Hence the historical-political context is important. Said also mentioned that the past is quarantined in the present. Thus, historical and political explanations will continue to reemerge in relation to other data from this project (e.g., curriculum documents and interviews with educational stakeholders) in following chapters.

History of Eurocentric Science: The Present and the Past of Western Modern Science

In Chapter 3, I elaborated that current conventional science education is based on the neoliberal enclosure of science education (Strong et al., 2016). This enclosure gives "the ability of WMS to present its findings as universal [and] gives it an imperialistic power dismissive of Indigenous knowledge as inadequate" (Semali & Kincheloe, 1999, p. 29). Science education has become a place where Western modern knowledge-science (WMK-S) is the only form of valid knowledge-science while non-WMK-S is treated as cultural content (McKinley, 2007; Ninnes, 2004). One of the conventional goals for science education is to teach students to think, behave, and believe like WMK-S–based scientists; the values and practices of WMK-S are the norm for school science (Akenhead & Elliot, 2010; Higgins, 2016). The values and norms of WMK-S are "emblematic of the masculine, Eurocentric and anthropocentric subject of Western modernity" (Higgins, 2016, p. 9). Thus, WMK-S is often referred to as "White male science" (Snively & Corsglia, 2001). Indeed, when Chambers (1983) asked students to draw a scientist at work, many drew White men and a chemistry lab. Such a racialized and gendered image of scientists has been perpetuated over decades (Samaras, Boniti, & Christidou, 2012). It is important to counteract the stereotypical image of scientists and the idea that WMK-S is the only kind of science that should be taught in school science to create a science classroom that appreciates the multiplication of knowledges-sciences, as discussed in Chapter 3. It is vital for students and teachers to understand that WMK-S is also a cultural form of science-knowledge, just like non-WMK-S, including Indigenous knowledges-sciences (Aikenhead 2006; Kuhn, 1970). Below, I describe the ways in which WMK-S and its value and underlying principles (e.g., empirical-positivism) are developed and perpetuated during its historical revolutions in an attempt to contest its universal status.

Baconian Inductivism in the 16th century[30].

Current global science education is largely based on observation, and the evidence-based scientific method developed in the 16th century by Sir Francis Bacon. Before the 16th century, it was mostly philosophical approaches in studying nature (rather than based on observation). For example, the ancient Greek, Egyptian, and Mesopotamian philosophers, including Aristotle and Plato, adopted a philosophical approach rather than the observational-evidence-based approach currently used in the field of science (Aikenhead, 2006). Islamic scholars brought these ancient Arabic and Greek philosophical approaches of studying nature to Europe in the 12th century. These philosophical approaches influenced the natural philosophers in Europe in the 16th century.

Galileo is known as "the father of science and/or the scientific method" and Bacon is famous for the Baconian view of science (i.e., Baconian inductivism) (Stewart, 2010). Bacon's inductive approach to investigating nature involves observation of nature first. Based on observation, patterns are generated and confirmed by comparison with other observations. After many comparisons, a scientific law is created based on the patterns observed. The Baconian inductive approach of studying nature thus advocates for evidence-based rational thinking. Indeed, the natural philosophers claimed that their study did not include any components of belief, such as spirituality, and was truly based on observed evidence (Green, 2008). The natural philosophers also attempted to resist any influences from the authority of the Church and monarchy in their scholarly works (Aikenhead, 2006; Aikenhead & Michell, 2010; Stewart, 2010).

[30] Recognizing that the origin of WMK-S goes back to the ancient Greek, Egyptian, and Mesopotamian philosophers, I start the history of WMK-S in the 16th century, wherein the values of WMK-S started to aid colonization for the "New World" (Stewart, 2010).

In the 1660s, the natural philosophers in Britain established The Royal Society, the first social organization for natural philosophers. Similar social organizations established in other regions in Europe included l'Academie des Sciences in France. The establishment of these institutions aided the values and knowledges practiced and promoted by natural philosophers to further spread across Europe and ultimately led to the scientific revolution in the 17th century (Stewart, 2010). Rene Descartes and Isaac Newton,[31] who were studying the physical universe, were influenced by these natural philosophers (Aikenhead, 2006). These scholars in the 17th century advocated objectivity in their works, wherein the subject (e.g., humans) is separated from the object of a study (e.g., nature). In other words, "the subject, as the thinking mind, knows the world as a series of objects extended in a space *external* to the subject" (Lamb, 2015, p. 17, emphasis added). These scholars thought that they were the "masters and possessors of nature, closely tied to the claims that knowledge is power and the knowledge of nature gives humans power over nature" (Lamb, 2015, p. 21). In turn, land and nature were viewed as resources and commodities to be exploited and over which humans should gain dominion and power (Fitzmaurice, 2014; Lamb, 2015). Thus, in studying nature, scholars pursued "a mechanistic and materialistic view of the world, according to which space is understood as matter in three-dimensional and volumetric form" (Lamb, 2015, p. 17). Ignoring the particular ties and relations that existed in places, natural philosophy and its imbued values and methods led to generalized and abstractive views of place through "the relative coordinates of a point within relational space, the result was the concealment of the concrete particularity of specific places," which led to "the imposition of normalizing and homogenizing processes of the

[31] Newton's scientific method (hypothetico-deductivism) starts from building a hypothesis, which differs from Baconian's scientific method, which starts from observation. Baconian scientific method does not apply to studying concepts that cannot be observed, such as the theory of gravity and atomic theory (Guest, 2005).

domination of places" (Lamb, 2015, p. 17). Such an understanding of a place through abstraction and measurability can be useful; however, coupled with the discourse and values of technological modernity and capitalism, it produced "violent relations of domination and destruction towards (mostly non-white) others and their environments" (Lamb, 2015, p. 157) and was an efficient tool for the dispossession of land (i.e., colonization of the New World).

During these scientific revolutions, European nations including Britain and France obtained printing press technology and started to embark on worldwide exploration and colonization of the New World. This led to the exportation of natural philosophy and its embedded values, including "objectivity and secularism," worldwide. According to Aikenhead (2006), the colonizers (e.g., Great Britain and France) used the "objectivity and secularism" embedded in Western Modern Science as forces of colonization (Aikenhead, 2006). For example, emphasizing the value of secularism, natural philosophy promoted "scientific racism" (Deloria, 1998) and "cognitive imperialism" (Battiste & Henderson, 2000): both promoted the idea that modern secular rational thinking was superior to the "primitive" spirituality imbedded in Indigenous knowledges-sciences (Aikenhead, 2006; Aikenhead & Michell, 2010; Deloria, 1997). Ideas stemming from scientific racism and cognitive imperialism became discourses for rationalizing and legitimatizing the education system that assimilated Indigenous students into Western ways of thinking (Battiste & Henderson, 2000).

Natural philosophy to "Science".

The rapid development of technology that followed led to the Industrial Revolution. Technology became a powerful social force. During the 18th century, some entrepreneurs in Britain found natural philosophy's concept of "dominion over nature and power" useful in increasing human productivity in industry and regarded natural philosophy as "the servant of technology"

(Aikenhead & Mitchell, 2011, p. 21). The natural philosophers did not want to be associated with the industrial technologists, and they certainly did not want their philosophy and work to be portrayed as the handmaiden or servant of technology. On the contrary, the natural philosophers wanted to develop a field of studying of nature into a distinct profession. These desires led to the establishment of the first professional institution, the British Association for the Advancement of Science (BAAS), in 1831.

Through BAAS the term *science* started to become associated with the knowledges and practices of Eurocentric "scientists," particularly natural philosophers. Before BAAS, *science*, derived from the Latin word *scientia*, which means "knowledge in the broadest possible sense" (Snively & Corsiglia, 2001, pp. 8-9), simply meant *knowledge* in archaic English. Members of BAAS deliberately chose the term *science* to replace *natural philosophy* for several reasons. First, they wanted to distinguish themselves from the natural philosophers of the old Royal Society and establish a modern professional organization rather than a social organization. Moreover, they attempted to differentiate themselves from the industrial technologists and develop a reputation as elitists who uphold the "pure abstract" and highly intellectual knowledge of nature (Aikenhead, 2006). They argued that research conducted by BAAS should not have any commercial benefit, in contrast to the industrial technologists who applied "pure" scientific knowledge produced by the scientists for commercial and industrial benefit. The "pure" notion of science reinforced the philosophy of *positivism*, which holds that scientific knowledge is the "only authentic kind of knowledge and all other purported forms of knowledge [are] in fact meaningless nonsense" (Charlesworth, 1982, p. 22). With a focus on positivism, BAAS furthered this notion of science as the discipline that provides the highest level of intellectual training;

BAAS also represented itself as a professional institution for modern science that had significantly evolved from earlier natural philosophy (DeBoer, 2000).

Education was an important venue for BAAS to establish the public image of scientists as those who hold elite knowledge and to continue the legacy of scientists. In 1867, BAAS assisted in developing the first-known English school science curriculum. They mainly ensured that the curriculum's ideology supported "an elite upper class of students; pre-professional screening for university science departments; [and] an emphasis on mental training and abstract knowledge over practical know-how" (Aikenhead & Michell, 2010, p. 22). Science officially became part of the school curriculum in the 19th century in Europe and the United States due to "the urgings of scientists themselves" rather than public demand (DeBoer, 2000, p. 583).

The influence of BAAS's early attention to the image of science and scientists as "pure-elitist" perpetuates to this day in the field of education to a large extent, as a result of which contemporary school science around the world is rooted in a 19th-century elitist Eurocentric philosophy of science (Aikenhead 2006; Stewart, 2010). For example, in the 20th century, the trend in education shifted from developing subject-specialists to developing well-rounded citizens, as promoted by Dewey (1916), who mentioned that "whatever natural science may be for the specialist, for educational purpose it is knowledge of conditions of human action" (p. 228). Relevance to contemporary life was encouraged for education. However, the goals of science education largely remained the same as the mission of BAAS in the early 19th century: to produce high-level intellectuals and specialists in the field of science. In the early 20th century, science as a discipline started to divide into physics, chemistry, biology, and geology. Specializing in these subdisciplines became a norm within the scientific community at large. For example, instead of looking at the broad relationship between living things and ideas across disciplines, a scientist will most likely specialize in a particular discipline. School science also adopted such a compartmentalized approach, maintaining the elite and specialist notion of scientists put forwarded by BAAS. Such a reductionist approach in Western modern science further contributed to an educational culture wherein students are directed to become specialists in specific disciplines of Western modern science, which are conflicting with the holistic nature of teaching and learning in many Indigenous cultures (Nakashima & Roue, 2002).

Under such a climate of education that encourages students to become both specialists in science as well as well-rounded citizens equipped with scientific knowledge, the mastery of WMS becomes important for students, not only to become specialists in WMS, but also to participate in decision-making processes in a modern democratic society. Indeed, Hatcher et al. (2009) stated that the scientists in the 20th and 21st centuries are trained at WMS-based universities, then work in industries, governments, and universities, further promoting WMS and its values and economistic philosophy; in the professional science communities, these scientists work within WMS-based culture, leading to further "disciplinary fragmentation (research silos)" (Stewart, 2010, p. 143).

Meanwhile, Calabrese Barton (2001) spoke about the close relation between WMK-S and capitalism as science education reforms globally are aligned with:

> the imperatives of the capitalist marketplace. . . . In other words, science education has become more about presenting students the science they need to fit into society rather than about educating students about how they might produce, use, and critique science to work with and transform society. (p. 848)

Capitalism, as an economic philosophy, became a tool for globalization, leading Euro-American culture to become "overwhelmingly powerful in the contemporary global situation"

(McKinley, 2008, p. 219). The domination of Euro-American culture has been enabled by the education system around the world, including science education. I will further elaborate on capitalism and neoliberal science education later in this chapter. The reductionism and technocratic rationality stemming from WMS has become the main philosophical foundation of science education around the world, continuing the Baconian paradigm from the 17th century promoted by BAAS and the first English science curriculum despite the development and evolution of diverse views of science and scientific methods.

The emergence of new ideas on scientific methods in the 20th century.

Scientists in the 20th century realized the discrepancy in the Baconian/Newtonian-empiricist-positivist account in science, as these traditional methods that were only based on observation, experimentation and following patterns did not accommodate scientists' creative and imaginative roles in constructing theories (Stewart, 2010; Guest, 2005). Karl Popper proposed science as a *creative* activity focusing more on theoretical superstructures rather than the observational bases of constructing knowledge, as the Baconian inductive approach suggests. Popper criticized the inductive approach, recognizing that the observation of nature is selective and subject to human choice and one cannot record everything observed (Guest, 2005). Popper argued that empirical science cannot be proven but can be falsified, as generalized patterns based on empirical evidence may not indicate scientifically proven truth. In turn, through the use of critical rationalism, Popper argued that scientific knowledge should be falsified (e.g., the falsification approach), rather than constructing it by seeking evidence that confirms scientists' propositions or hypotheses. However, Popper's view on studying nature did not really work in the field of science, as falsification hasn't been applied in the practice of science. While constructing scientific explanations, models, and theories, one should generalize the falsifiability of the observation at a certain point. Thus, one can't really falsify generalizations of empirical observation. Popper's views of science, however, opened a new perspective beyond the Baconian view of science (Charlesworth, 1982).

Thomas Kuhn (1970) introduced the term *paradigm* as a "disciplinary matrix" to explain the process behind the scientific revolution. Kuhn (1970) described science as a *social* activity as the disciplinary matrix includes beliefs, values, and the set of exemplars and applications that all members of a scientific community are to learn and teach. There is a shared value of what counts as scientific knowledge and what does not. This notion of science as a social activity drove multiculturalism/pluralism within science education, promoting that there are multiple science(s) based on different cultures (i.e., a matrix). This notion also influenced the field of science education, particular in two major reforms in last two decades: 1) science-technology-society (STS), which was the precedent form of the science-technology-society-environment (STSE) and 2) the history and philosophy of science. Both approaches suggest teaching science in relation to society—a more humanistic approach to teaching science than the traditional Baconian/positivist-empiricist approach (i.e., the academic rationalist approach). STS curriculum focuses on integrating two broad aspects of science as a social activity into school science: "(1) the interactions of science and scientists with social issues and institutions external to the scientific community, and (2) the social interactions of scientists and their communal, epistemic, and ontological values internal to the scientific community" (Aikenhead, 2005, p. 1). Kuhn's (1970) idea that what counts as science and scientific knowledge is in fact related to values stemming from the history and politics of different communities also influenced the educational movement to teach history and philosophy of science along with factual knowledge (Stewart, 2005).

However, despite these new ideas on scientific methods and science education developed in the early 20th century, current global science education has largely retained the legacy of scientific methods and values (such as objectivity) stemming from the natural philosophers from the 17th century and scientists from BAAS. Thus, the global science education system continues to resist to incorporate diverse approaches to knowing nature (e.g., Indigenous ways of knowing nature) derived from various cultures (Stewart, 2005). School science became a venue for the reductionism of the WMK-S to continue to uphold its legacy of "monolithic epistemological dominance" (Ninnes, 2004, p. 262). Haraway (1988) suggested that WMK-S has been

> about a search for translation, convertibility, mobility of meanings, and universality—which I call reductionism only when one language (guess whose?) must be forced as the standard for all the translations and conversions. What money does in the exchange orders of capitalism, reductionism does in the powerful mental orders of global sciences. (p. 580)

In the following sections, I describe neoliberal globalization and the ways it is instrumentalized by the dominant groups of the society, legitimizing WMS to be the only kind of science to be included in school science. Further, neoliberal globalization coupled with capitalism in the 21st century legitimized the universalization of science; global science education has been dominated by one language of science—WMS (Ball 2012; Strong et al., 2016).

The effects of neoliberal globalization in the 21st century.

Lingard (2009) described neoliberal globalization as "an ideology which promotes markets over the state and regulation and individual advancement/self-interest over the collective good and common well-being" (p. 18). Coupled with global capitalism, neoliberal globalization has become “both the guiding force and the ultimate destination in contemporary public pedagogy, in and outside of classroom” (Lamb, 2015, p. 55). In this current area of neoliberal globalization, school curriculum became a place for:

> public sector learning to confront its purported inadequacies, learning lessons from the methods and values of the private sector, and learning to reform itself. As well as in another sense learning the “hard lessons” taught by the disciplines of the market. All of this involves the instilling of new sensibilities and values, and new forms of social relations, into the practices of the public sector. The private sector is the model to be emulated, and the public sector is to be “enterprised” in its image. (Ball, 2012, p. 30)

In describing such global education trends driven by neoliberal globalization, scholars, including Ozga (2008) and Ball (2012), illustrated the role that *governing knowledge* plays within large-scale international outcome-based, evaluations systems. Governing knowledge is “a regime of numbers” (Ozga, 2008, p. 264) that becomes “a resource for comparison” (Ozga, 2008, p. 267). Once compared, it promotes the “improvements in quality and efficiency, by making nations, schools and students ‘legible’” (Ball, 2012, p. 33). Therefore, in evaluating the success of science education, the education systems around the world now tend to place more emphasis on the numerical scores achieved by students rather than learning process and relationships students have with teachers and peers. Governing knowledge derived by the methods and values of the market under the discourse of *international competitiveness* (Ball, 2012), the curriculum development gears towards meeting the outcomes of the standardized testing systems based on the criteria of those international large-scale assessments such as the Programme for International Student Assessment (PISA) administered by the Organization for Economic Co-operation Development (OECD).

OECD offers a variety of recommendations on educational policies based on PISA results and in turn makes its organization the "international authority in the field [of education]" (Bieber & Martens, 2011). For instance, *21st Century Skills and Competencies*, published by OECD (2009), is now a driver in the global education reform movement. The discussion regarding the relationships between (1) these 21st-century skills and competencies, and science education and (2) anticipated economic considerations and international rankings have started to surface in OECD member countries (Orpwood, Schmidt, & Jun, 2012; Murray, 2014). Indeed, the National Science Teachers Association (NSTA) published its position statement regarding the emphasis on developing students' 21st- century skills, "Quality Science Education and 21st Century Skills" in 2011, recommending "that the science education community support 21st-century skills consistent with best practices across a science education system, including curriculum, pedagogy, science teacher preparation, and teacher professional development" (para. 6).

The production of school science curriculum is driven by what Besley and Peters (2007) referred to as "neoliberal visions of pedagogy" (p. 170). Neoliberal visions of pedagogy focus on developing individuals who successfully participate in a nation's economic growth and development "based on science and technology, for which 'excellence,' 'technological literacy,' 'skills training,' 'performance,' and 'enterprise' are the key educational metrics" (Besley & Peters, 2007, p. 170). In turn, "states monitor, steer and reform their education system by the use of targets, benchmarks, and performance-triggered interventions" (Ball, 2012, p. 33). Schools act as *industrial factories*, creating a "*manipulatable* man [and woman] who is created by the state and who is continually encouraged to be 'perpetually responsive'" towards neoliberal mentalité (Olsson et al., 2004, p. 137, emphasis in original). Narrow standardized assessments that focus on meeting the outcomes of curricula, and the students' performances on the international testing such as PISA are the only a few symptoms of "capitalisms' revanchist ascension to public education" (McLaren as cited in Barton, 2001, p. 850).

In such neoliberal-capitalist schemes, students are encouraged to master the skills and knowledges promoted by the state, which are influenced by the market (Lingard, 2009; Ball, 2012). As in the factory, education systems under the neoliberal visions of pedagogy follow the top-down approach. Curricula are built and centralized by higher authorities (i.e., states, which are influenced by the market) and educators are expected to follow guidelines and report their progress, which in turn leads to standardized testing systems where students' learning is viewed as a product and outcome. Focusing on the standardized education driven by the market leads to "the establishment of universal schooling as a goal in [North] America" (Schwarts, 1991, p. 99). Under the neoliberal vision of pedagogy and the top-down approach, the selection of knowledge and skills for curriculum development is done in "the interests of dominant stakeholders [particularly the markets] who enjoy social, economic and political power in society" (Stewart, 2005, p. 56). Consequently, the influence of neoliberal globalization drives the continual neoliberal enclosure in science education (Strong et al., 2016).

Shizha (2011) critiqued the neoliberal pedagogy in science education vis-à-vis Indigenous knowledges, stating that "neoliberal globalization and Indigenous knowledges are in a state of contestation. Indigenous knowledges have become colonial captives within science education that ignores Indigenous philosophies as peripheral to contemporary society" (p. 15). Moreover, neoliberal visions of pedagogy in science education have disadvantaged many Indigenous students in learning, leading to neo-colonization within science education (Ryan, 2008); it enculturates all students including Indigenous students into WMS culture and values

(Aikenhead & Elliot, 2010; Stewart, 2005). Aikenhead (1997) called such Eurocentric science education the "hegemonic icon of cultural imperialism" (p. 15), while Semali and Kincheloe (1999) critiqued conventional science education as only "appreciate[ing] modernist scientific universalism excludes this 'White science' as a cultural knowledge" (p. 29). The history of WMK-S and its effect on global science education explored so far illustrates that:

1) the notion that "science is universal and objective" is a product of the social practices of natural philosophers and scientists from BAAS; even within the field of science, there are various stances and philosophies of what science is and multiple scientific methods have been put forward (Carter, 2006);
2) the global practice of universalization and the legitimization of WMK-S as the only kind of science in curricula is a product of the social practice from the scientific community and market;
3) science curricula are built through social practices and guided by agendas of communities (e.g., the scientific community, states and private markets, etc.), thus they include not only factual knowledge about nature but also values and attitudes prompted by the communities.

In order to better understand how these global neoliberal-capitalist pedagogies have influenced Canadian's science education, in the section below, I provide a brief history of Canadian science education and explore the ways in which these products of the history of WMK-S have influenced Canadian science education. I focus on the post-Sputnik Era (after 1957).

In his *Canadian Science 2030 Project*, John Murray (2014) explored modern Canadian Science education history and concluded that "Canadian science education can be characterized as a special case of the derivative curriculum that comes, not from ourselves and from within, but primarily from external influences over which we may have limited influence and control" (p.

15). He then listed three identifiable periods of science curriculum reform in Canada since the 1950s (what he refers to as "three trajectories"):

> (1) science in the *national interest* which developed in the post-WWII period and came to the international distinction during the post-Sputnik period, 1957-1970;
>
> (2) *humanistic science* education exemplified science-technology-society movement led by Canadian thinking of the 1970s and 1980s; and
>
> (3) the outcomes, standards, and *international accountability* thrust since the mid-1990s. (Murray, 2014, p. 7, emphasis added)

I aim to explore these three trajectories in relation to the history of WMS and global science education. Here, the trajectories refer to "the episodes constituting new paths, a progression, or new lines of developed argument. The term also implies a crossing of paths or passing by the older order of thinking which does not dispense with former ideas while entertaining new ideas" (Murray, 2014, p. 7).

The History of Canadian Science Education: Three Trajectories

In Canada, there was not much educational emphasis on science education prior to World War II (1939-1945); the structure of Canadian science curricula was "amorphous" (Murray, 2014, p. 37). However, along with rapid technological advancement and the postwar baby boom in the 1950s, the view on science education changed. Murray (2014) called this period the "opening of the modern era of science curriculum focus among Canadians and their geographical allies" (p. 67).

During the 1950s-1960s (Trajectory 1), there was a movement to make science a national interest. The Science Council of Canada (SCC) was formed in 1966 to advise the federal government on science and technology. SCC published a very important report on science education in the 1980s that played a major role in the Canadian science curriculum reform, as elaborated later in Trajectory 2.

In this era, the scholars and administrators in the field of science education focused on determining the structure and the functions of science as a discipline; they also put much effort into establishing centralized curriculum and resource development. For instance, in the 1950s, the reconstruction of a disciplined-centered and subject-specific curriculum started to take place within educational systems in the United States and Canada (Tomkins, 2008; Murray, 2014). The publication of the infamous *The Process of Education* by Jerome Bruner in 1961 acted as a "manifesto for academic rationalism, [and] the structure of the disciplines" and led to a massive development of classroom-based materials in science education (Murray, 2014, p. 45). Canada mainly adopted classroom-based science teaching materials and curricula developed in the United States (e.g., Harvard Project Physics, Biological Sciences Curriculum Study, etc.). During this period, the North American science curriculum shifted its prior attention to "industrial application and a quaint examination of the biosphere to making science education more "sophisticated, abstract and intellectually challenging" (Murray, 2014, p. 63). This shift is reminiscent of the practices of scientists from BAAS in the 19th century, involving the public interests in science, and the image of scientists.

To establish science as a discipline and gain its elitist position, BAAS portrayed science as "abstract and intellectual" knowledge, separate from its association with old natural philosophers and technologists. With similar goals (e.g., establishing the structure of science as a discipline and establishing centralized curriculum and resource development), Canadian science education followed BAAS's approach. In this light, the Canadian education system first promoted the intellectually elevated status of science over other knowledge by emphasizing the abstraction of knowledge. It also sought to disassociate "pure scientific knowledge" from the industrial application. Second, BAAS focused on creating school science curriculum to promote science as a profession. Similarly, Canadian science education also focused on creating more centralized and classroom-based materials to gain its importance in society, thus making science in the national interest.

The following years, the 1970s-1980s (Trajectory 2), were focused on finding the Canadian identity within science education as well as creating more humanistic science curricula. In the early 1970s, teachers were discontented with the implemented curriculum materials in schools from the 1960s (mainly adopted from U.S. resources) (Murray, 2014). Moreover in 1975, Symons's *Report of the Commission of Canadian Studies*, titled "To Know Ourselves," identified the lack of Canadian perspective in science education and technology. This report influenced the publication of Page's report in 1979, *A Canadian Context for Science Education.* Page was a historian and was commissioned by the Science Council of Canada (SCC) to respond to issues and challenges identified in Symons' report. The report listed five major issues on the content of Canadian science education:

> (1) the lack of attention to Canadian dimensions and problems in science teaching and research; (2) the failure of Canadians to recognize that science and technology are integral parts of our society's culture; (3) the need for increased public awareness of the roles played by science and technology in Canada; (4) the attitudes of young people toward science and technology, and (5) a particular criticism of the neglect of the history of science in Canada as a discipline of academic quality and one holding interest among Canadian universities and federal granting agencies. (Page, 1981, as cited in Murray, 2014, pp. 13- 14)

Acknowledging these challenges in Canadian science education, SCC embarked on its national investigation on the status of science education in 1980 and released its major findings in *Science for Every Student* (SCC, 1984). In its report, SCC offered key recommendations for Canadian science education around three particular areas: 1) science education for all; 2) redirecting science education; and 3) monitoring science education (SCC 1984).

S*cience for Every Student* (1984) played a significant role in making the Canadian science curriculum more humanistic and distinct from the academic rationalist approach. The report first endorsed "science for all" and emphasized the importance of "scientific literacy" for students to become informed citizens: "Science education must be the basis for informed participation in a technological society, a part of a continuing process of education, a preparation of the world of work, and a means for students' personal development" (SCC, 1984, p. 18). Moreover, some of the recommendations from the SCC study provided a rationale for the science-technology-society (STS) curriculum in science education:

> • Science education must include the study of how science, technology, and society interact;
>
> • Technology-oriented courses must be included in the secondary school curriculum;
>
> • Students must be taught how Canadians have contributed to science and how science has affected Canadian society; and
>
> • Science education must provide a more accurate view of the practice, uses and limitations of science. (SCC, 1984, p. 1)

By the late 1980s, STS in science education had gained its population within the scholarly world, and its theoretical importance had been emphasized internally (Solomon & Aikenhead, 1994). STS movement also had been coupled with the emergence of the focus on "scientific literacy" (Murray, 2014). STS types of science programs had been often seen as vehicles for improving scientific literacy and the participation of marginalized students in school science (Aikenhead, 2005, p. 385). Developing scientifically literate citizens, regardless of their gender, socioeconomic-status, and race, has become a goal in the Canadian science education. The Canadian government's commitment to this goal can be seen in the Councils of Ministers Education Canada (CMEC) administration of the *School Achievement Indicators Program (SAIP) Science I* in 1996 to examine students' understanding of science in real-life situations and to better assess students' scientific literacy (CMEC, 1996).

Efforts to create science education that has Canadian perspectives and to promote scientific literacy in the Trajectory 2 period led to the creation of the first national framework for science education, *The Common Framework of Learning Outcomes: Pan-Canadian Protocol for Collaboration on School Curriculum* (i.e., Pan-Canadian Common Framework) (Council of Ministers of Education Canada [CMEC], 1997; Murray, 2014). The common framework inevitably focused on developing scientific literacy among students and provided four foundations of scientific literacy as its education goals. STS became one of the foundations of scientific literacy, with equal status to the other traditionally focused areas of science education (e.g., nature of science, science skills and process, and scientific knowledge) (Murray, 2014).

Trajectory 3 (2000-present) of Canadian science education is "the point of departure to a new pathway for Canadian science education—that of international collaboration and globalization" (Murray, 2014, p. 58). Trajectory 3 has two distinctive features: 1) private sector interests in science education and their globalizing economic agenda and 2) the effects of large-scale international assessments, such as PISA. These features of trajectory 3 are the effects of neoliberal globalization. Curricula are becoming more outcome-specific and standardized based on the capitalist economistic philosophy driven by the private market. International competitiveness is promoted through large-scale international assessments, while international collaboration on educational resource development was being promoted by organizations such as OECD and UNESCO on the other hand (Amgen, 2012; UNESCO, 2008; Murray, 2014). Meanwhile, the *Pan-Canadian Common Framework* has been critiqued for its antiquity, lack of consultation with Canadian educators and experts in the development process, and generalized and ambiguous definition of scientific literacy (Aikenhead, 1999; Weinrib & Jones, 2013). Aikenhead (1999) also critiqued the framework's lack of Aboriginal perspectives.

With the publication of final *Truth and Reconciliation Commission* (2015) report and *The Accords of Indigenous Education* (2010), the Canadian education learning landscape is moving towards including more and more Indigenous knowledges in curricula and teacher preparation courses. While the majority of provinces have mandated the integration of Indigenous perspectives in K-12 science curricula, Saskatchewan has made particular headway in the inclusion of Indigenous perspectives in their science education (Aikenhead & Elliot, 2010; Kim & Dionne, 2014; Wiseman, 2016). Thus, as illustrated in Chapters 2 and 4, this study focuses on Saskatchewan's case in the development of IK-S infused science curricula. The Saskatchewan Ministry of Education commenced the renewal of curricula in 2005; a focus for the renewal was "the integration of First Nations, Métis and Inuit content, perspectives, and ways of knowing into all curricula to encourage the engagement and success of Indigenous students, and at the same time, to enhance the quality of school science for non-Indigenous students" (Aikenhead & Elliot, 2010, p. 329). The Saskatchewan Ministry of Education also has collaborated with Pearson Canada to develop its own customized science textbooks to include local Indigenous knowledges-sciences within the textbooks. There are historical factors that are unique to

Saskatchewan and some that are common to other jurisdictions that have influenced the creation of IK-S–integrated science curricula in Saskatchewan (Noonan, Hallman, & Scharf, 2006).

The section below explores the contextual and historical variation of the history of WMK-S as well as the Canadian science education history in Saskatchewan (Ball, 2012, p. 5). I aim to focus on "how the present situation arose. In particular, how did [integration of IK-S] come to be a central concern of science education in [Saskatchewan]?" (Ninnes, 2004, p. 262). In so doing, I explore the history of education in Saskatchewan with special focus on Indigenous education.

Different Trajectories in Saskatchewan Education: History of Saskatchewan Education

As Murray (2014) described, I see that, in the context of the history of education in Saskatchewan, the past historical episodes are interwoven with the current practices and events in Saskatchewan. The ways in which various trajectories are interwoven and influence the current science curricula in Saskatchewan, offering "a crossing of paths" and "new lines of developed argument" (Murray, 2014, p. 7), will be elaborated in the next chapters. By exploring these historical trajectories, I identify key events that act as cultural and social forces that have had an impact on education in Saskatchewan, particularly in the current initiatives to create IK-S–infused science curricula. I present five trajectories in Saskatchewan education:

1) schooling as missionary work (1820s-1905);
2) establishing formal/centralized education and vocational training (1905-1944);
3) changes with the Co-operative Commonwealth Federation (1944-1970);
4) laying the groundwork for Indigenous education (1970-2005);
5) actualization towards a shared future (2005-current).

Trajectory 1: Schooling as missionary work (1820s-1905).

In this era in Saskatchewan, schooling was a means to educate children and youth to be good Christians and British citizens. For Indigenous peoples, schooling was used to assimilate them into British civilization (Battiste, 2008). Before 1812, British settlers in Western Canadian regions were not concerned with assimilating (or "civilizing") Indigenous peoples. Rather, they saw the value in the knowledge and skills of Indigenous peoples and focused on maintaining "partnerships" with Indigenous peoples, as they saw Indigenous peoples as "military allies and as essential partners in the fur trade" (White & Peter, 2013, p. 15). However, after the War of 1812, British settlers were struggling with the hostile living environment and the fur trade was on the decline. They started to see the Indigenous population as "an impediment to European settlement" (White & Peter, 2013, p. 15). The British no longer treated Indigenous peoples as equal partners but sought to assimilate them into "the civilized" culture—the British way of life.

The Church of England started to send missionaries to achieve European civilizations in the New World (Littlejohn, 2006). Priests accompanied the Northwest Company (NWC) to venture out to the Saskatchewan region. Schooling was introduced in Saskatchewan through these missionaries and the fur trade (Chalmers, 1972; Littlejohn, 2006). After the amalgamation of NWC with the Hudson's Bay Company (HBC), the HBC formulated the first official schooling policy in the region of Saskatchewan for their license for fur trade rather than as a genuine interest in education. At that time, one of the criteria to license exclusive trade in Canada by the British Parliament was HBC's commitment to work for "the welfare of the native inhabitant by submitting regulation for promoting their moral and religious improvement" (Littlejohn, 2006, p. 63). Therefore, in order to maintain their exclusive license for the fur trade, HBC funded Catholic and Protestant missionaries as a way to build schools for the "Native inhabitants" in the Saskatchewan region. The HBC had initiated boarding schools in 1835, mainly for Aboriginal students. From 1840 to 1870, fledging mission schools for Aboriginal children and youth established along the rivers. These "Indian schools" were the first school system in the region and they started by assimilating Aboriginal children into British culture and religious values (Littlejohn, 2003).

Prior to the 1867 Constitution Act, there was no formal education system in Saskatchewan for the Native population or non-Aboriginals. The Act stated that the provinces are responsible for education. With the sale of Rupert's land to the Government of Canada in 1869, the HBC was no longer responsible for the schooling of "Native inhabitants" in Saskatchewan. The Government of Canada started to sign treaties with the First Nations in these regions: #2 (1871); #4 (1874); #5 (1875-1876); #6 (1876); #8 (1899-1900); #10 (1906-1907) (Office of the Treaty Commissioner, 2017). The Government of Canada only focused on providing schooling for nations that signed the treaties, which resulted in almost no formal education provided by the state for Métis children until 1938. Meanwhile, for the First Nations, the government started using schooling as an agent for British civilization, particularly focusing on assimilating children into the "ways of [the] industrial and agrarian world, and the skills of citizenship in the style of the British Canadian" (Littlejohn, 2006, p. 66). These educational goals were not much different from those of earlier missionaries with the HBC and the latter was cheaper. Hence, the federal government kept the missionaries as the main agents for education. The Canadian government saw the benefit to the nation's economy of the American model of "industrial schools" in transforming First Nations youth into farmers. However, often the industrial schools were built far from the reserves and did not have many students enrolled. In increasing student enrolment, the Department of Indian Affair officials started to move towards building boarding (residential) school systems for First Nations. As a result, between 1890 and 1910, the number of industrial schools decreased with the incline of residential schools (Little John, 2006; TRC, 2015). With the 1875 North-West Territories Act and the North-West Territories School Ordinance in 1884 and 1885, these schools established in the region either had to be a Catholic or Protestant. The North-West Territories Act allowed schools to be established voluntarily without any formal regulations.

However, in 1901 things started to shift with three initiatives. First, with the establishment of the Department of Education, "the basic model of centralization of authority over educational matters and decentralization for authority over administrative matters had been clearly established by 1901 and in most respects, applies to today's educational system in Saskatchewan" (Scharf, 2006, p. 5). Second, with the *Qu'Appelle Agreement* in the same year, English became the sole language of instruction in Saskatchewan. Third, with the *Ordinance 1901*, religious minority schools were ordered to form separate schools and the curriculum remained nondenominationally Christian. These early ordinances established the legal framework for modern-day Saskatchewan's education (Scharf, 2006).

Trajectory 2: Establishing a formal/centralized education system for education and vocational training (1905-1944).

In 1905, Saskatchewan officially became a province. The province focused on schooling in its early development. The first premier, Walter Scott, was also the minister of education for a decade (1905-1915) (Noonan, Hallman & Scharf, 2006). During Trajectory 2, the Saskatchewan government focused on the centralization of school systems along with universal access to elementary education and the promotion of high schools.

High school was first introduced in 1907 and consisted only of traditional academic subjects (i.e., reading, writing, and numeracy). By the early 20th century, secondary schools in urban areas started to adopt practical courses (i.e., vocational training), following the lead of the American curriculum (Owen, 2006). With the Depression of 1930, Saskatchewan had to increase the number of students entering secondary schools with no intention of pursuing postsecondary education. With the funding provided by the federal government in the 1942 *Vocational Training Act*, the provincial government focused on extending the availability of vocational programs for secondary school students. There was also a focus on vocational training for First Nations youth in the 1930s. However, the training did not provide the same employment opportunities as those afforded to non-Aboriginal students. The assimilation approach towards First Nations children through schooling continued.

The Saskatchewan Act of 1905 mirrored the *1867 British North America Act* (i.e., the *Constitution Act* of 1867) and established constitutional provisions for education in the province. (Noonan, Hallman, & Scharf, 2006). However, education for First Nations students had been a responsibility of the federal government based on the treaties and the Constitution Act. In 1910, a new contract for administration of "Indian" schooling was drawn up between the churches and the federal government with the aim of improving the educational environment for First Nations children (Vallery, 1942; Littlejohn, 2006,). The contract included changes for academic aspects (e.g., employment of qualified teachers rather than individuals associated with the Church; contracting inspectors to examine school systems and progress of the students; etc.). In 1915, Indian schools in Saskatchewan began using the provincial curriculum to align education for First Nations with the provincial education for non-Aboriginals (Littlejohn, 2006). However, as Littlejohn (2006) critiqued, this new approach still had the intention of maintaining the status quo between Indigenous and non-Indigenous peoples as “the new ‘educated’ Indian was never expected to become part of the non-Indian society. He/she was expected to return to the reserve among his/her people” (p. 68). Graduates from these Indian schools did not have the same employment opportunities as non-Indigenous students; the skills and knowledge obtained in the schools did not match with the lifestyle in the communities. Observing the schooling systems for First Nations in this era, Vallery (1942) reported:

> The government and churches have abandoned, to a large extent, previous policies, which attempted to “Canadianize” the Indians. Through a process of vocational and to a smaller extent academic training, they are not attempting to make good Indians, rather than poor mixtures of Indians and whites. While the ideal is still Christian Citizenship, the Government now hopes to move towards this end by continuing to segregate the Indian population, in large measure from the White race (44). (As cited in Littlejohn, 2006, p. 69)

Meanwhile, the federal government did not offer education for the Métis of Saskatchewan and other nations that did not sign treaties and “subsequently were not defined as ‘Indian’ under the Indian Act” (Littlejohn, 2006, p. 72). A large number of Métis and non-status “Indian” children therefore remained uneducated. The Saskatchewan government did not believe that the education for Métis and non-status Indian children was their responsibility. In 1938, the pressure from the Métis community drew attention to the problematic status of Métis education. The Saskatchewan government provided temporary grants to school boards to accommodate small numbers of Métis children. However, this was not very successful (Littlejohn, 2006).

Trajectory 3: Reorganization of Education (1944-1970). A lot of new changes were implemented in the Saskatchewan educational system in this era through the Cooperative Commonwealth Federation (CCF). Elected in 1944, CCF was the first socialist government in North America. Many teachers in the province were members of CCF; CCF pledged for changes in the educational system and other social services. After experiencing the war and the Depression, citizens wanted a change. CCF mainly focused on two aspects in terms of education: (1) implementing the organization of larger school units and (2) providing equal education for First Nations and Métis children and youth.

In implementing the organization of larger school units, CCF first passed the *Larger School Units Act* of 1944, which amalgamated over 5000 small local districts into 60 larger school units. This was the first and only major reorganization of educational structure in the province (Noonan, Hallman, & Scharf, 2006; Scharf, 2006). Owen (2006) called the act "a clear victory for teachers" (p. 55). The larger school units' act first had increased teachers' salaries and solved the continual financial problems encountered by small educational districts. Second, CCF listened to teachers. At that time, teachers were discontented with the "rigid system of testing and the lack of public and professional input into decisions about what should be taught" (Owen, 2006, p. 53).

Moreover, the CCF took responsibility for schooling all children in Saskatchewan. The Department of Education under CCF aimed to eliminate the inequalities in education, thus promoted a philosophy of equal education. They attempted to provide the same educational opportunities for First Nations and Métis students. In the 1940s, the climate of the global society was changing with postwar idealism as well as public interests in human rights and the rights of minorities; while in the United States the focus was on Black minorities, in Canada the focus was on Indigenous peoples (Littlejohn, 2006). In the 1940s, the federal government showed interest in Indian affairs due to the activism of Indigenous soldiers returning from the war. The Special Joint Committee of the Senate and the House of Commons was formed in 1946. The committee advocated for equal educational opportunities for Aboriginal students and promoted an integrated schooling system. The federal government negotiated with provincial governments and offered funding to provincial governments to integrate Aboriginal students in provincial schools. The first joint school agreement in Canada was signed in Saskatchewan in 1952 and the same year, under the *Federal-Provincial Co-operative Agreement*, the first joint school in Saskatchewan was constructed (Littlejohn, 2006). Meanwhile, the federal government continued to support the policy of integration by providing financial support to provincial governments to integrate Indigenous students into provincial schools. By 1960, the number of Aboriginal students attending schools outside of their communities was increasing. The goal of joint schools was for all students to enjoy equal education opportunities and for Indigenous and non-Indigenous parents to collaborate. However, as Littlejohn (2006) critiqued, "the effort did not allow Indian people to determine their own educational future. . . . The joint agreement remained a paternalistic document dictating inter-socialization" (p. 71). At the federal level, the *Joint Committee of the Senate and House Common* was reconvened in 1960 to examine the success of Indian schooling; a major study was undertaken in Saskatchewan. The result suggested that every Indigenous education initiative thus far was not successful (e.g., low retention rate, high teacher turn-over rate, etc.).

Trajectory 4: Laying the groundwork for Indigenous education (1970-2005). Aboriginal peoples and organizations began to mobilize politically in the early 1970s (Michell, Vizina, Augustus, & Sawyer, 2008). One of most important events that happened in this trajectory is the publication of *Indian Control of Indian Education* by the National Indian Brotherhood (NIB) in 1972. In its report, NIB suggested a “culture-based approach” of education Indigenous students in Canada. In the same year, the federal government started to close residential schools. At the provincial level, many Indigenous educational institutions were established. For example, the Saskatchewan Indian Cultural College was established in 1972 with the aim to support First Nations to deliver educational programs in their communities. Several Native teacher education programs were established across the province (e.g., the Northern Teacher Education Program (NORTEP); the Saskatchewan Urban Native Teachers Education Program (SUNTEP)) from 1972-1980 (Michell et al., 2008).

Many changes happened in Saskatchewan in the 1980s. The province was going through a big change in terms of its population. There was a significant decline in school enrolment in post-baby boom generations and rural areas. Moreover, the election of the Conservative government in Canada brought changes in priorities in economic and social policies, which led to changes in the K-12 curriculum (Scharf, 2006). Due to the influence of the international movement for increased accountability in education, the Saskatchewan curriculum reform in the 1980s focused on creating more school-based accountability and on classroom teaching materials (Scharf, 2006).

In 1981, the *Curriculum and Instruction Review Committee* reviewed the K-12 education system in Saskatchewan, which led to the publication of *Directions* (Saskatchewan Education, 1984), a document that paved the way for the development of the *Core Curriculum* (Saskatchewan Education, 2000b). *Core Curriculum* is the foundation of Saskatchewan’s curricula. They are the “components and initiatives of Saskatchewan’s education system that are designed to support all students in their achievement of the goals of education. *Core Curriculum* represents a model of teaching and learning in which curriculum, instruction, and assessment are integrated" (Saskatchewan Education, 1999, p.2). In *Core Curriculum* (Saskatchewan Education, 2000), the SK Ministry of Education mandated the inclusion of Indigenous perspectives in curricula, stating:

> The inclusion of First Nations, Métis, and Inuit content, perspectives and ways of knowing benefits all students. Culturally relevant curriculum and resources foster meaningful learning experiences for all students, promote an appreciation of Canada's cultural mosaic, and support universal human rights. (p. 5)

The Native Curriculum Review Committee formed in 1982 and played a major role in the acknowledgement of the inclusion of Indigenous perspectives that appeared in the core curriculum. First, the Committee developed the *Five-Year Action Plan for Native Curriculum Development* (1984), which laid out a series of recommendations for Aboriginal education. This document also suggested the inclusion of Aboriginal content and perspectives. Since 1982, the Government of Saskatchewan was guided by different advisory committees including the Indian and Métis Education Advisory Committee (IMEAC) and currently the Aboriginal Education Provincial Advisory Committee (AEPAC) (Michell et al., 2008). These advisory committees continued advocating for the inclusion of Indigenous perspectives in all curricula.

In the 1990s, the Canadian educational system underwent many restructuring processes (Owen, 2006). In 1996, the *Royal Commission on Aboriginal Peoples* suggested "on-going collaboration between federal, provincial, territorial and Aboriginal governments" (p. 19). The report also recommended changes in curriculum that would include Aboriginal perspectives, which echoed the recommendation from 1972 NIB report.

The educational landscapes started to shift towards to the inclusion of Indigenous perspectives in education systems. From the late 1990s, multiple provinces and territories in Canada began their educational mandates on including First Nations, Metis and Inuit perspectives in their curricula. For example, the Ministry of Education in British Columbia published 'Shared Learning', with the Aboriginal Education Initiative in 1998, advocating Indigenous perspective integration in education. In Nunavut as well, the Department of Education published the Inuit Qaujimajatuqangit Education Framework for Curriculum in 2007.

Indeed, the educational landscape in Saskatchewan was also changing in the 1990s. The *Saskatchewan Métis Act* was enacted in 2001. Unlike in the 1930s, when the province "did not believe that schooling of Métis and non-Indian children was its responsibility" (Littlejohn, 2006, p. 73), with the *Métis Act*, the province of Saskatchewan committed to working with Métis peoples and recognizing "the leadership role of Métis institutions in providing educational, social and health services to Métis people" (Part II, section 2, p. 4).

Along with the *Métis Act*, a lot of fruitful educational and political groundwork for the current Ministry of Education's initiative to create curricula that integrated First Nations and Métis perspectives was accomplished between the 1990s and the 2000s. First, the *Indian and Métis Education Policy from Kindergarten to Grade 12* was published in 1995, outlining the three major curriculum objectives:

1) The inclusion of Indian and Métis content in all core curricula for all students in the province;
2) The development and implementation of programs for and about Indian and Métis students, for example: Native Studies and Indian Languages and Program;

3) The development, identification and coordinated distribution of instructional resources and locally produced materials for core and other curricula (p. 4). (As cited in Michell et al., 2008, p. 23)

As AEPAC stated in their *Action Plan, 2000-2005*,

> Now that the groundwork and the structure are in place, we would like to shift our attention to actualization of Aboriginal content and perspectives in Saskatchewan schools—all schools, and not only those that have a significant population of Aboriginal students. (Saskatchewan Education, 2000a, p. 2, emphasis added)

The inclusion of Aboriginal perspectives was advocated for all students in Saskatchewan to learn history; the province started to focus on building partnerships with Indigenous stakeholders. Indeed, Saskatchewan Learning published a policy framework called *Building Partnerships: First Nations and Métis peoples and the Provincial Education System* in 2003. The policy framework provides a "historical and legal context for partnerships":

> The Constitution of Canada recognizes and affirms the existing Aboriginal and Treaty rights of the Aboriginal peoples of Canada. First Nations peoples have an historical relationship with Canada that is reflected in Treaty Numbers 4, 5, 6, 8 and 10 in the territory that is now Saskatchewan and in the Indian Act. The contribution of the Métis people in Saskatchewan are recognized in the Métis Act. This policy framework is advanced with full respect of rights and authorities established through this historical and legal context. (Saskatchewan Education, 2003, p. i)

In this policy framework, the province showed that the policy framework was not developed with "benevolence" or to "help" Indigenous peoples. Dr. Eber Hampton stated, "the question is not whether or not to become partners, we are partners. We are in this together. The question is; what is the quality of the partnership?" (as cited in Saskatchewan Education, 2003, p. 4). The policy document further laid out its goal, vision, and principles in building partnerships with First Nations and Métis people "towards shared future," which required "co-governance in the provincial education system" (Saskatchewan Education, 2003, p. 4). Thus, the importance of creating curricula that integrated Indigenous perspectives for all students and involvement of First Nations and Métis stakeholders in policy discussion was emphasized (Saskatchewan Education, 2003, p. 4).

When AEPAC published its interim report for the Action Plan 2000-2005 (i.e., *Learning Community in Aboriginal Education 2004-2007: Priorities Report*) (Saskatchewan Education, 2005), the principles of building partnerships and creating curricula that integrated Indigenous perspectives for all students were reaffirmed (Michell et al., 2008). The Ministry of Education embarked on its curriculum renewal process in 2005. One of the five foundations for renewal was the integration of the First Nations, Métis, and Inuit content, perspectives, and ways of knowing into all curricula to increase the engagement and success of Indigenous students and enhance the quality of school science for non-Indigenous students (Aikenhead & Eliott, 2010).

Trajectory 5: actualization towards a shared future (2005-present). The province of Saskatchewan defined *actualization* as "effective implementation and ongoing renewal" (Saskatchewan Education, 2000a, p. 2). Indeed, the province has been working towards the actualization of core curriculum, with one of its aims being to include First Nations, Métis, and Inuit content, perspectives, and ways of knowing in all curricula (Saskatchewan Education, 2000a; Ministry of Education, 2011). Based on the political and educational groundwork that had been done in previous trajectories, in this current era, many policies and documents focus on renewing the relationship with Indigenous peoples and recognize the importance of Indigenous peoples' knowledges and partnerships in creating a better future for all. For instance, the Indian residential school settlement agreement was implemented on September 19, 2007. In the same year, the speech from the throne recognized the importance of educating all students with treaty education:

> Treaty education is an important part of forging new ties. There must be an appreciation in the minds of the general public that Treaties are living, breathing documents that continue to bind us to promises made generations ago. This is why my government is committed to making mandatory instruction in history and content of the Treaties in the K-12 curriculum. (Speech from the Throne, 2007)

Reflecting on these events, in 2008, Prime Minister Stephen Harper offered a full official apology on Indian Residential school systems and reiterated the important role the Indian Residential Schools Truth and Reconciliation Commission plays in building relationships with Indigenous peoples. Prime Minister Harper stated that:

> This Commission presents a unique opportunity to educate all Canadians on the Indian Residential Schools system. It will be a positive step in forging a *new relationship* between Aboriginal peoples and other Canadians, a relationship based on the knowledge of our shared history, a respect for each other and a desire to move forward together with a renewed understanding that strong families, strong communities and vibrant cultures and traditions will contribute to *a stronger Canada for all of us*. (Statement of apology, 2008, emphasis added)

The federal government started to use discourses such as 'collaborative approach' with Indigenous peoples, emphasizing the 'new relationship' and 'a stronger Canada for all of us' in the statement of apology.

In the field of education as well, scholars and educational policy makers started to avoid using a binary (Aboriginal/non-Aboriginal), instead using discourses such as "two-eyed learning" (Hatcher el al., 2009) to describe Indigenous education approaches. Canadian Council of Learning (CCL) (2007a) suggested that:

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

In 2011, CCL created the holistic lifelong learning model for First Nations, Métis, and Inuit peoples which reflected the importance of educating Indigenous students in both Western and Indigenous knowledges. The models were endorsed by "national Aboriginal organizations such as the Assembly of First Nations, the Métis National Council and the Inuit Tapiirit Kanatami" (Michell et al., 2008, p. 16).

The United Nations published its *Declaration on the Rights of Indigenous Peoples* in 2008. The *Declaration* stated that

> states shall, in conjunction with indigenous peoples, take effective measures, in order for indigenous individuals, particularly children, including those living outside their communities, to have access, when possible, to an education in their own culture and provided in their own language. (Article 14. 3. p. 7)

and that Indigenous peoples shall "establish and control their educational systems and institutions providing education in their own languages, in a manner appropriate to their cultural methods of teaching and learning" (Article 14. 1, p. 7). The *Declaration* also stated that "the dignity and diversity of their cultures, traditions, histories and aspirations which shall be appropriately reflected in education and public information" (Article 15.1, p. 7). All of these political documents have led to the birth of new driver documents in education in Canada, including *The Accord on Indigenous Education* published by the Association of Canadian Deans of Education (2010) and the publication of the final report of the Truth and Reconciliation Commission (2015).

The *Accord* (2010) stated a vision "that Indigenous identities, cultures, languages, values and ways of knowing, and knowledge system will flourish in all Canadian learning settings" (p. 4) and it encouraged "respectful, collaborative and consultative process with Indigenous and non-Indigenous knowledge holders" and "multiple partnership among educational and Indigenous communities" to value "the diversity of Indigenous knowledge and ways of knowing and learning" (p. 5). The *Accord* committed to promoting "comprehensive teacher candidate and faculty programs that create meaningful opportunities for learning about practicing Indigenous pedagogies and ways of knowing" (p. 6).

The TRC final report (2015) suggested *calls to action* and specifically emphasized the role of education in reconciliation, stating:

> We call upon the Council of Ministers of Education, Canada to maintain an annual commitment to Aboriginal issues, including:
>
> i. Developing and implementing Kindergarten to Grade twelve curriculum and learning resources on Aboriginal peoples in Canadian history, and the history and legacy of residential schools.
>
> ii. Sharing information and best practise on teaching curriculum related to residential schools and Aboriginal history.

iii. Building student capacity for intercultural understanding, empathy, and mutual respect.

iv. Identifying teacher-training needs related to above. (Action # 63)

Recognizing the importance of building partnerships to create an education system benefitting *all* students with the focus on educating about the history, cultures, and practices of Indigenous peoples in Saskatchewan, the province implemented a few policy frameworks recently. In 2009, *Inspiring Success: Building Towards Student Achievement*, *First Nations and Métis Education Policy Framework* was published. The policy stated their vision of "inspiring success" as "a provincial education system that foundationally places First Nations and Métis ways of knowing in the learning program to create a culturally responsive education system that benefits all learners" (Saskatchewan Ministry of Education, 2009, p. 11). In reaching such success, the province emphasized the role of the involvement of Indigenous peoples as "engaging First Nations and Métis peoples in educational planning and decision making will increase the learner's potential to experience both Indigenous and Western methodologies within the educational setting" (Saskatchewan Ministry of Education, 2009, p. 11). In turn, the province published the *Elders Engagement Policy* in 2017. In the policy, they reiterated the importance of the collaboration with Elders in decision-making processes and offered "a guide" and "protocols . . . to participate in meetings and events in a manner that respects and honours cultural traditions and protocols" (Saskatchewan Ministry of Education, 2017, p. 1). Moreover, in 2013, the province mandated the *K-12 Continuum Treaty Education*. The document stressed the importance of treaty education to be "understood when considered as parts of a whole" (Saskatchewan Ministry of Education, 2013, p. 3) and it was suggested that treaty education be included in all K-12 and across curricula.

As explored above, there have been many education policies created to acknowledge that "provincially and nationally, educators have an obligation to strengthen students' Aboriginal identities" (Michell et al., 2008, p. 7). In this current time, with all of these policies in place, creating an education system that respects Indigenous ways of knowing, for all students became a mission for Saskatchewan Ministry of Education.

Darryl Isbister, a Métis educator and the First Nation, Inuit, and Métis Education coordinator at Saskatoon Public School Board, spoke of the four imperatives of integrating Indigenous ways of knowing, being, and doing in curricula:

> There's an *economic* imperative. Our Indigenous students, and then ultimately adults, don't enjoy the same economic benefits that non-Indigenous students do. There's a *demographic* imperative. Our population is shifting. And right now, our Indigenous population is the fastest growing segment of the province, and so our schools are going to continue to start to look different. There's a *moral* imperative. We know that right now, our Indigenous students don't experience the same education, and so we're morally obligated to ensure that they experience the same education as all our other students. And then just personally, [I mean] it's part of everything else, but the *historical* imperative that, you know, if we were ever to lose any aspect of this history, it's gone forever. And I say that as Métis person, my ancestral history is here, and I can never go anywhere else to find it. You know, there is no Métis land that I can travel to, to find out the history of my ancestors. It's here, and if we ever to lose that, then there is no other place. And right now, the history is told by the dominant culture of this land.… Indigenous history in our province right now is optional. It's not mandatory, and so many of our students can go through their whole educational career without actually learning about the original

inhabitants of this land, and we just need to change that. (Personal communication, October 26, 2016, emphasis added)

He later added that the integration of Indigenous ways of being and doing in curriculum will affirm "that Indigenous ways of knowing, being, and doing are valid and our Indigenous students can see themselves in curriculum and reduce some of the systemic barriers that are currently in place" (personal communication, April 27, 2017).

The inclusion of Indigenous perspectives in curricula is now being advocated as an agent to prepare our future generation for a "shared future." In the context of science education, there is both educational and political value of Indigenous knowledge being put forward by different stakeholders that drive the initiatives of integrating IK-S in science curricula (Aikenhead & Elliot, 2010; Ryan, 2008). Such integration of IK-S in curricula can help us to resist the "tyranny of globalizing discourses" (Foucault, 1980, p. 83) that assert the monolithic epistemological Western modern science and move forward in creating educational spaces that appreciate the multiplication of knowledges-sciences to be shared in classrooms. The science curriculum in Saskatchewan started its renewal process in 2005.

Reflection on the Historical and Political Context

This chapter explored the historical and political context that played a role in the development of Saskatchewan's current IK-S–infused science curricula. First, the history of WMK-S illustrated that science is social and political, not universal and objective as argued by the Universalists. As well, coupled with neoliberalism and capitalism, WMK-S in today's society became the "only kind of science"—"tyranny of globalizing discourses" in science education (Foucault, 1980, p. 83). Second, the history of Canadian science education illustrated that the science that has been taught in Canadian science education is, in fact, closely tied to the BAAS, and the tradition, values, and history of British scientists has been a root of Canada's and Saskatchewan's science education. The history of Saskatchewan education, with a specific focus on Indigenous education, illustrated some major policies and historical events that played a role in changing the political contexts for Indigenous education. The historical and political contexts explored in this chapter helped us to understand that the development of Saskatchewan's current IK-S–infused science curricula was influenced by multiple policies, history, and traditions. Particularly, the current curricula renewal and an educational focus on IK-S infused curricula are not the product of the generosity by the federal or provincial government. Current initiatives in such mandates to include Indigenous perspectives in curricula are the results of long term struggle for recognition and work by Indigenous peoples in multiple venues. Meanwhile, I am reminded of Said's (1994) notion of travelling theory that "the past [is] quarantined from the present" and it may take different format based on the new interpretation and next contexts of the society (p. 2). In the next chapter, I explore Saskatchewan's current K-12 official science curriculum documents. In so doing, I aim to focus on how the past—political and historical contexts from science and Indigenous education—possibly influenced the present—representations of IK-S in the curriculum documents.

Chapter Six: Findings from the Curriculum Document Analysis

In this chapter, I describe the findings from *description*: the curriculum document (textual level) analysis (Figure 13). The purpose of this textual analysis was to examine the relationship between WMK-S and IK-S as portrayed and prescribed for K-12 science education. The main guiding questions for the curriculum document analysis were: (1) In what ways have Indigenous knowledges-sciences (IK-S) been conceptualized and by whom? (2) In what ways is IK-S content being represented within curriculum documents relative to other science learning concepts?

The chapter is divided into two sections. The first section explores the ways in which the Saskatchewan Ministry of Education has defined and conceptualized "science" and how IK-S has appeared in the Ministry's goals and aims of science education. The second section then explores the ways in which IK-S content is incorporated in school science curriculum.

The General Goal of Science Education in Saskatchewan: Interconnectedness and Living in Harmony

In aiming for science education that appreciates the multiplication of knowledges-sciences (K-S) rather than the universalist perspective on science, the Dancing Amoeba Model (introduced in Chapter 3) advocates curricula and pedagogies that stem from:

- the understanding that all knowledge(s) about nature offer partial perspectives (Haraway, 1988), and that science has a fluid nature and thus is constantly changing;
- an understanding that teaching science that incorporates IK-S emphasizes the importance of teachers and students entering into a sharing space—a "third space" (Bhaba, 1997)—with respect to each other and to the land and recognizes that new ideas emerge through diverse "coming to know nature" processes (Peat, 2002); and

- an understanding of the importance of relational thinking and relationships that honour an understanding of "sacred ecology" (Cajete, 2000): the perspective that we are all related.

In this model, nature is viewed as a living agent (e.g., land-as-teacher) with which we can and should build relationships, rather than an object, commodity, or resource for exploitation. In its K-12 science curriculum documents, the Ministry recognized both WMK-S and IK-S as valid sources of knowledge about nature. The philosophy of science education found in the K-12 Saskatchewan curricula resonates to a certain extent with the three aspects of the Dancing Amoeba Model mentioned above. For example, in K-12 science curriculum documents, and emphasized the harmony and interconnectedness of various ways of knowing, as well as the interconnectedness of individuals, communities, place, and nature. These values are reflected in the aims and other learning philosophies mentioned in the curriculum documents.

For instance, curricula in Saskatchewan emphasized the focus of *three broad areas of learning*: "lifelong learners; sense of self, community, and place; and engaged citizens" (Saskatchewan Ministry of Education, 2011, p. 6). These broad areas of learning reinforce the idea of "self-in-relation" (Graveline, 1998; Kovach, 2009) and the interconnectedness between self and others, including nature. The *lifelong learners* area of learning advocated for science education that "provides the motivation to discover and explore their [learners'] learning experiences with others . . . [and to] develop skills that support them as lifelong learners" (Saskatchewan Ministry of Education, 2016a, p. 6). The *sense of self, community, and place* area of learning focused on the development of students':

> personal identity as they explore connections between their own understanding of the natural and constructed world and perspectives of others, including scientific and Indigenous perspective[s] [and] interact experientially with place-based local knowledge

to deepen their connection to and relationship with nature. (Saskatchewan Ministry of Education, 2016a, p. 6)

The *engaged citizen* area of learning emphasized the need for students to “reflect and act on their personal responsibility to understand and respect their place in the natural and constructed world, and make personal decisions that contribute to living in harmony with others and the natural world” (Saskatchewan Ministry of Education, 2016a, p. 6). All in all, these statements show the Ministry’s commitment to education that advocates “living in harmony with others and the natural world” (Saskatchewan Ministry of Education, 2016a, p. 6) through interacting with land and communities, driven by multiple understandings—including Indigenous knowledges—of nature. As shown in Figure 14, the Ministry focuses on the connection of all subjects taught in school, rather than promoting scientism (the idea that scientific knowledge has a higher status than other types of knowledge).

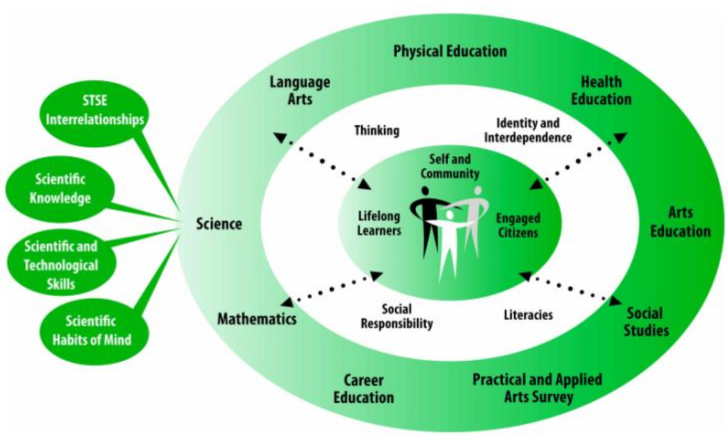

Figure 14: Saskatchewan Education Aims and Goals (Reproduced from Saskatchewan Ministry of Education, 2016a, p. 9)

Focusing on interconnectedness as well as “living in harmony” (Saskatchewan Ministry of Education, 2016a, p. 10), Saskatchewan’s K-12 science curricula stated that “First Nations and Métis ways of knowing nature [that] are within the broader category of Indigenous knowledge” (Saskatchewan Ministry of Education, 2016, p. 10), and that they, along with Euro-Canadian science, are knowledge domains for the curriculum.

Parallel yet distinct natures of Indigenous Knowledges and Western Modern Science.

The Saskatchewan Ministry of Education (2016) recognized that “modern science is not the only form of empirical knowledge about nature” (p. 17) and “a strong science program . . . aims to broaden student understanding of traditional and local knowledge systems” (p. 17). Particularly, the Ministry stated that their science education appreciates the “extensive history” of collaborative knowledge production processes involved in “the dialogue between scientists and traditional knowledge holders” in understanding the natural world (Saskatchewan Ministry of Education, 2016, p. 16). While recognizing the multiple perspectives of knowing nature, the Ministry emphasized “the parallels and distinctions” between the two knowledges-sciences (K-S) domains by providing the following definitions of each. In conceptualizing Indigenous knowledge, the Ministry employed the definition provided by the International Council of Science (2002):

> Traditional [Indigenous] knowledge is a cumulative body of knowledge, know-how, practices and representations maintained and developed by *peoples* with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource use practices,

> ritual, *spirituality* and worldview. (p. 3, as cited in the Saskatchewan Ministry of Education, 2016, p. 16, emphasis added)

Scientific knowledge is considered “similar to Indigenous knowledge” and defined as:

> a cumulative body of knowledge, know-how, practices and representations maintained and developed by people (*scientists*) with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part and parcel of cultural complexes that encompass language, naming and classification systems, resource use practices, ritual and worldview. (Saskatchewan Ministry of Education, 2016, p. 16, emphasis added)

In these definitions, while focusing on the similarities between the two knowledge domains, the Ministry clearly made a distinction between “scientific knowledge”—which is developed by “scientists”—and “traditional [Indigenous] knowledge”—which includes “spirituality.” This distinction was also reflected in the statement: “A Euro-Canadian way of knowing about the natural and constructed world is called *science,* while First Nations and Métis ways of knowing nature [that] are within the broader category of *Indigenous knowledge*” (Saskatchewan Ministry of Education, 2016, p. 10, emphasis added). As shown by the continuum bar (Chapter 3), the approach one takes with IK-S–infused curricula varies depending on one’s views and definition of science. The Saskatchewan Ministry of Education is most closely related to the multiculturalists’ positions (Chapter 3).

In defining what constitutes “science,” the Saskatchewan Ministry of Education explicitly recognized the cultural and social context wherein scientific knowledge is produced:

> Science is a social and cultural activity anchored in *a particular* intellectual tradition. It is *one* way of knowing nature, based on curiosity, intuition, exploration, observation,

replication, interpretation of evidence and consensus making over this evidence and its interpretation. More than most other ways of knowing nature, science excels at predicting what will happen next, based on its descriptions of natural and technological phenomena. (Saskatchewan Ministry of Education, 2016, p. 15, emphasis added)

The Ministry further suggested that science is "a particular intellectual tradition" (p. 10) that is a "Euro-Canadian way of knowing natural and constructed world" (p. 10). However, the Ministry sees science as *one* way of knowing nature and rejects the universal notion of scientific knowledge as *the* truth and the only legitimate way of knowing nature, an ideology that continues to percolate through neoliberal enclosure in science education today (Strong et al., 2016). These definitions of science show the Ministry's position as multiculturalists in science education, as identified by the continuum bar (explained in the Chapter 3).

Multiculturalists view science as "embedded in the context of a cultural group" and think that "all systems [of knowledge about nature] are therefore, culture-laden" (Lewis & Aikenhead, 2000, p. 3). Though they make a clear, separate distinction between science (i.e., WMK-S) and Indigenous knowledge (i.e., IK-S), they do not regard Indigenous knowledge as "a body of cultural folklore, living practices, and thought that cannot be considered a rational and ordered system of theory and investigation comparable to anything found in Western science" (Cajete, 2008, p. 491), which is the position of universalists. Because of the distinction (that is, the clearly stated boundaries between science and Indigenous knowledge), the Saskatchewan Ministry of Education does not fall into the postcolonialist position in science education, which advocates for nonboundary conceptualizations of diverse knowledges-sciences (see Chapter 3).

As explained by the continuum bar (Chapter 3), even within multiculturalist positions, there are diverse stances and approaches in the integration of IK-S. Based on the definitions of

Indigenous knowledge (IK) and science provided in the curricula, the Saskatchewan Ministry of Education is closest to the merging/hybrid approach. This position acknowledges that all cultural knowledge offers a partial view of nature (Haraway, 1988) and advocates for IK-S integration to provide a more holistic approach to studying nature. In this approach, rather than providing rationales for the usefulness and benefits of IK-S (i.e., IK-S for sustainability, IK-S for creating culturally relevant curricula), Indigenous knowledges are accepted in the same way as Western modern science, without a hierarchical perception of WMK-S as the universal system of ways of knowing nature and as superior to Indigenous ways of knowing nature (Brayboy & Castagno, 2008).

Moreover, as mentioned in Chapter 3, while the multiculturalist position acknowledges the multiple approaches to knowing nature, this perspective avoids teaching based on cultural relativism—which accepts any idea without any specific criteria for inclusion (McKinley, 2007; Higgins, 2016). Multiculturalists advocate for teaching based on pluralism, which respects the equity of perspectives and argues for the inclusion of diverse *empirical* ways of knowing nature (Aikenhead & Michell, 2011; Higgins, 2016; McKinley 2007; McKinley & Stewart, 2012). In this light, science is viewed as "a rational, culturally based, empirically sound way of knowing that yields, in part, descriptions and explanations of nature" (Aikenhead & Michell, 2011, p. 30) (see Chapter 3 for a detailed explanation of a multiculturalist position). The focus on including "empirical and rational" ways of knowing nature thus becomes the criteria for the curricula for these multiculturalist positions. Indeed, the Saskatchewan Ministry of Education acknowledges both IK-S and WMK-S to be "empirical and rational" ways of knowing nature, as shown in the aim of K-12 science education "to enable all Saskatchewan students to develop scientific literacy" through an inquiry learning approach (Saskatchewan Ministry of Education, 2016, p. 6).

Infusing diverse empirical *and* rational ways of knowing nature.

In conceptualizing scientific literacy, the Saskatchewan Ministry of Education (2016) acknowledged that there are multiple "sources of *empirical* knowledge about nature" (p. 16, emphasis added), thus contemporary scientific literacy embraces both Euro-Canadian and Indigenous "*empirical and rational* knowledge of nature" (p. 6, emphasis added). As mentioned in the previous chapter, the term *science* was chosen by the natural philosophers when establishing the institution BAAS for very political reasons (Aikenhead, 2006). They sought to distinguish themselves from technologists and to portray themselves publicly as the upholders of the highest intellectual and abstract knowledge. Because of Canada's colonial legacy with Britain (as discussed in Chapter 5), it is inevitable that there is evidence of BAAS's value and tradition rooted in the Saskatchewan Ministry of Education conceptualization of science.

As explored in Chapter 5, the cosmology of Eurocentric science stems from the values and the practices of natural philosophy, which involved both a philosophical approach and a Baconian inductive approach to studying science and further rejected the component of spirituality in pursuit of objective observation-based evidence. Although there is diversity within Indigenous K-S, the common core cosmology and values of Indigenous K-S are grounded in an understanding of Creation (Cajete, 2000). McGregor (2006) highlighted the importance of knowing Indigenous peoples' understandings of the world in the form of Creation stories or those conceptual frameworks that provide an Indigenous understanding of relationships with all of Creation. McGregor (2006) pointed out that these Creation stories highlight interconnectedness and that "knowledge comes from the Creator and from Creation itself" (p. 388). IK-S and WMK-S stem from different epistemologies (Kim, Asghar, & Jordan, 2017). Aikenhead and Elliott (2010) stated:

> Although Indigenous and scientific knowledge systems share some fundamental features (e.g., both are culture based, empirical, experimental, rational, communal, and dynamic), and although both embrace common values (e.g., honesty, perseverance, open-mindedness, curiosity, aesthetic beauty, repeatability, and precision), their worldviews tend to be ontologically, epistemologically, and axiologically incommensurate (Aikenhead & Michell, 2011). Metaphorically, scientists *see* the world, whereas Indigenous Elders *inhabit* the world. (p. 326, emphasis original)

Teachers who use these curriculum documents in their teaching are expected to integrate IK-S and WMK-S—which stem from two worldviews—into their teaching. However, this infusing of knowledges-sciences is extremely difficult when the cosmology of these knowledges-sciences (K-S) systems differs—a fact that should not be taken lightly. As mentioned in Chapter 3, Maracle (2014) cautioned that such infusing can be dangerous, as she said, "if all rivers merge, the world would die" (personal communication, November 2, 2014). However, as the Indigenous scientist Price (2011) mentioned, "combining the best of Western science and Indigenous knowledge of place is a superior combination from just one or the other and. . . such science curriculum would better enable students to tackle the challenges of this millennia" (as cited in Blades and McIvor, 2017, p. 470).

Infusing the multiple knowledges-sciences that are embedded in multiple values and extensive history is indeed a difficult task. The Saskatchewan Ministry of Education's effort to infuse different knowledges-sciences creates an opportunity for a *sharing place* (i.e., third space, as discussed in Chapter 3) within school settings, which requires constant reflection, relationship-building, as well as dialogue. By working to create science education that strives for "living in harmony with others and the natural world" (Saskatchewan Ministry of Education, 2016, p. 7) and infusing diverse empirical and rational ways of knowing nature, the Saskatchewan Ministry of Education showed evidence of an attempt at re/conceptualizing school science.

However, as Carter (2006, 2008) critiqued, the multiculturalists' positions, which the Saskatchewan Ministry of Education is mostly in line with, still do not deal with the hegemony of WMK-S; rather science programs following these multiculturalist positions try to work with the existing system laden with the values and practices of scientists that are deeply steeped in the hegemony of WMK-S. As Said (1983) mentioned, "the past is quarantined in the present" (p. 2); Afonso (2012) cautioned that many educational reforms do not consider the colonial legacy and hegemony of WMK-S that is covert and always present like smog in the air (Tatum, 1992).

Thus, while trying to make a change and reconceptualize the educational program, one must consider the influence of the history in which the program is embedded. In this light, I continue to question and explore how these commitments and statements of the Ministry, in regards to creating curricula that reinforce the harmony between diverse ways of knowing nature, are reflected in their curricular learning outcomes and indicators in relation to the historical and political contexts of science education and Saskatchewan's education discussed in Chapter 5. Below, I share the findings from the analyses of learning outcomes and indicators—the "what" of curriculum in relation to the "how" of curriculum— (1) number of occurrences, (2) priority (e.g., weight given to the IK-S related content), (3) the four science learning contexts as explained in the Saskatchewan curriculum (i.e., scientific inquiry, technological problem-solving, STSE decision-making learning, cultural perspectives) and (4) the three aspects of the integration of Indigenous perspectives (i.e., content knowledge, pedagogical knowledge, contextual knowledge) suggested by Lipka et al. (2005). As described in Chapter 4, Lipka et al.'s

(2005) *three aspects of integration* give a good foundational understanding of the ways in which the school science and math classroom could integrate IK-S in teaching and learning. These three areas of integration are:

> *Content knowledge* (informed by both Western knowledge and that of Yupi'ik [local Indigenous communities] Elders), *pedagogical knowledge* (informed by school-based practices and community-based ways of teaching, communicating, and learning), and *contextual knowledge* (ways of connecting schooling to students' prior knowledge and the everyday knowledge of the community. (Lipka et al., 2005, p. 368, emphasis added)

For example, if an outcome or indicator focuses on specific knowledge and content, then I categorized the outcome or indicator as content. Pedagogical knowledge was in relation to the outcome or indicator focused on the modes of transferring and representing their knowledge and coming to know process (e.g., art, story-telling, etc.). Finally, if the outcome and indicator contained an aspect about building relationships to local Indigenous community members, and/or if local Indigenous peoples were invited as a source of knowledge for students to interact with, then I considered the outcome and indicator to be contextual knowledge. The following example (Table 4) shows my analytic process.

In Biology 30, there is an outcome, "Explore how the dynamic nature of biological classification reflects advances in scientific understanding of relationships among organisms" (Saskatchewan Ministry of Education, 2016, p. 36). As mentioned in Chapter 4, outcomes are the ones that, "students are expected to attain by the end of a particular course" (Saskatchewan Ministry of Education, 2015, p. 2). Under this specificoutcome, there are a total 9 indicators associated with this outcome. Here, indicators are "a representative list of what students should know or be able to do if they have attained the outcome" (Saskatchewan Ministry of Education, 2015, p. 2).

Table 4. Analysis Example

Outcome	Total number of indicators	Number of the IK-S related indicator	Examples of IK-S related indicator
BI30-OL3 Explore how the dynamic nature of biological classification reflects advances in scientific understanding of relationships among organisms. [SI, CP]	9	1	b. Research how First Nations, Métis and Inuit peoples represent their understandings of relationships among living things. (p. 36) 4 Content/pedagogical

Out of 9 indicators, there was one Indigenous-related indicator: "Research how First Nations, Métis, Inuit peoples represent their understandings of relationships among living things" (Saskatchewan Ministry of Education, 2016, p. 36). This indicator falls under category 4, based on the priority scale (Table 2), that IK-S related content is a main aspect of the indicator. Based on four learning contexts, the Ministry puts all indicators under this outcome to be related to Scientific Inquiry (SI) and Cultural Perspective (CP). Based on three areas of integration, this indicator contains both a *content* (e.g, "understanding of relationships among living things") and a *pedagogical* (e.g., "how First Nations, Métis and Inuit peoples represent") aspect. All Indigenous-related content found in K-12 curricula I this project are listed in Appendix III.

The Appearance of Indigenous-Related Content in the "What" of Curricula: Frequency and the Priority of Indigenous-Related Outcomes and Indicators

The Ministry has attempted to include Indigenous-related indicators throughout K-12 science curriculum documents, as shown in Table 4. Indigenous-related content appeared the most in Health Science 20 (11%), Science 6 (7.7%), and Science 3 (6.6 %). No Indigenous-related content was found in Physics 30 and Computer Science 20/30[32] (Table 5).

Table 5. The Occurrence of Indigenous-Related content (Indicators)

	Number of Indigenous-related indicators	Total number of indicators	Approximate coverage of Indigenous-related content (%)
Kindergarten	2	34	5.9
Grade 1	3	87	3.4
Grade 2	5	88	5.7
Grade 3	6	91	6.6
Grade 4	5	135	3.7
Grade 5	7	142	4.9
Grade 6	9	117	7.7
Grade 7	4	122	3.3
Grade 8	4	132	3.0
Grade 9	7	130	5.4
Science 10	6	127	4.7
Health Science 20	11	100	11
Physical Science 20	2	103	1.94
Environmental Science 20	7	121	5.8
Biology 30	3	84	3.6
Earth Science 30	2	115	1.73
Chemistry 30	4	101	4.0
Total	87	1829	4.8

Blades and McIvor (2017) mentioned that after Grade 4 the pedagogy for school science shifts from more hands-on and inquiry-based learning to content knowledge and memorization. Such a shift in pedagogy in turn influences science curricula to bear "no resemblance to the ancestral knowledge of Indigenous peoples" (Blades & McIvor, 2017, p. 470). This applies to the

[32] These courses were not included in the table as no IK-S related content was founded.

case of Saskatchewan to a certain extent. No Indigenous-related indicators were found in Physics 30 and Computer Science 20/30, and secondary courses including Earth Science 30 (1.73%) and Physical Science 20 (1.94%) had the lowest coverage of Indigenous-related content. However, the highest coverage was also found in higher grades (Health Science 20 and Grade 6). Therefore, there is no correlation between the grade level and the coverage of Indigenous-related content in Saskatchewan science curricula.

As Table 6 shows, the Indigenous related outcomes and indicators appeared in all levels of priority scales during this analysis. For example, in Science 10, under the topic of Climate and Ecosystems Dynamics, one of the outcomes was to "assess the implications of human actions on the local and global climate and the sustainability ecosystems" as shown in Appendix III (SCI10-CD1). There are 12 indicators for this outcome, one of which is to "examine the positions of First Nations and government agencies responsible for the stewardship and management of resources, including the duty to consult" (Saskatchewan Ministry of Education, 2015, p. 33). IK-S–related content is a main aspect of this indicator. Hence, according to the priority scale, it would be level 4 (Table 6).

Table 6: The Occurrence of IK-S based on Priority Scale

	5 (outcome)	4 (main aspect of the indicator)	3 (a part of indicator- "including"): prescribed content; context; or strategies	2 (a part of indicator- "such as"); examples of possible broad categories of content; contexts strategies	1 (a part of indicator- "e.g.,"); composed of additional materials for suggested activities	Total
Science Kindergarten		1	1	1	1	4
Science 1		1	1		1	3
Science 2		3			1	4
Science 3		2	1	1	2	6
Science 4		3	2			5
Science 5		5	2			7
Science 6		6	2		1	9
Science 7	1	4				5
Science 8		4				4
Science 9	1	5	2			8
Science 10		4	2			6
Environmental Science 20		8				8
Health Science 20	1	7		2	1	11
Physical Science 20		2				2
Biology 30		3				3
Chemistry 30		4				4
Physics 30	N/A					
Earth Science 30		2				2
Total	3 (3.30%)	64 (70.33%)	13 (14.29%)	4 (4.40%)	7 (7.70%)	91 (100.02%)

However, when Indigenous related content was introduced in science curricula for all grade levels, it was mainly at level 4 (70.33%), and included as a main aspect of the learning indicator. For example, in Grade 4, one of the learning indicators related "to investigat[ing] the characteristics and physical properties of materials in solid, liquid and gaseous states of matter" (Outcome MC 5.1) required that students "discuss the importance of water, in all states of matter, as a *sacred* substance within First Nations and Métis cultures" (Saskatchewan Ministry of Education, 2016, p. 30, emphasis added). In this way, sacredness, a component of spirituality that had been largely unrecognized in the history of science education, has been integrated as one of the main aspects of the learning outcome (see Appendix III for more examples).

All in all, the integrated Indigenous-related content appeared throughout all of the levels. However, the high number of appearances in level 4 in the priority scale suggests that, when integrated, Indigenous-related content was considered as important as the WMK-S content, rather than considered as add-on curricula. Indeed, during the curriculum renewal in 2008, the Ministry worked towards avoiding the add-on approach in Saskatchewan's curricula. As Aikenhead and Elliot (2010) mentioned, in Saskatchewan science curricula, IK-S is "not addressed as a stand-alone unit of study or an add-on to a unit of study, but is integral to each of the four units of study at each grade in an attempt to avoid tokenism" (p. 14).

Brayboy and Castagno (2008) stated that "simply inserting" Indigenous knowledge and science as add-on content "does little to change the status accorded to various ways of knowing" (p. 740). Including IK-S alongside WMK-S as a main aspect of the learning indicators in Saskatchewan's curricula is a step towards creating a science program that focuses on coexistence and promotes the function of "both systems side by side," rather than proliferating the hegemony of WMK-S in school science (McGregor, 2000, p. 54, as cited in Sutherland &

Henning, 2009). Creating a science education curriculum that promotes the coexistence of both systems (McGregor, 2000) or the multiplication of knowledges-sciences, which the Dancing Amoeba Model (Chapter 3) promotes, requires challenging the assumptions that come from the long history of influence of the hegemony of WMK-S in science education (Garroutte, 1999).

Meanwhile, I am mindful that school curriculum represents a selection of knowledges-sciences from a dominant culture (Apple, 2000; Reis & Ng-A-Fook, 2002) and as Taylor and Cobern (1998) put it, "one of the self-sustaining (and disempowering) characteristics of a culture is its invisibility to its participants" (p. 205). In order to better understand this invisible process of cultural selection of curricula, I looked into the ways in which Indigenous-related content found within K-12 Saskatchewan curricula has been represented, particularly in relation to learning contexts as explained in Chapter 4 and the three areas of the integration of IK-S suggested by Lipka et al. (2005). In so doing, I kept in mind Linda Smith's (1999) advice that any textual products (including the ones written with and by Indigenous peoples) "may reinforce and maintain a style of discourse which is never innocent. . . . By building on previous texts written about indigenous people [and Indigenous knowledge], we continue to legitimize views about ourselves [Indigenous peoples] which are hostile to us [Indigenous peoples]" (p. 36). In this light, I continue to challenge the existing discourses on integrating IK-S, which might focus on culturalism (Ninnes, 2002) rather than knowledges-sciences production and harmony between diverse ways of knowing.

The "How" of Curriculum: Learning Contexts and the Three Areas of Integration

As mentioned in Chapter 4, the four learning contexts serve two important roles in science curricula. First, they provide "entry points into the curriculum" to achieve scientific literacy, the goal of Saskatchewan's science education (Saskatchewan Ministry of Education, 2016, p. 21).

Second, they reflect a “philosophical rationale for including science as a required area of study” (Saskatchewan Ministry of Education, 2016, p. 21). As explained in Chapter 4, Learning Contexts represent the “how of curriculum” (Saskatchewan Ministry of Education, 2016, p. 14). I use these learning contexts as a framework to explore the ways in which Indigenous related outcomes and indicators (i.e., the “what” of curriculum) are integrated in relation to the goal of Saskatchewan science education, especially with regards to different pedagogical approaches. The four learning contexts are listed below (as illustrated in Chapter 4):

> The **scientific inquiry (SI)** learning context reflects an emphasis on understanding the natural and constructed world using systematic empirical processes that lead to the formation of theories that explain observed events and that facilitate prediction.
>
> The **technological problem-solving learning (TPS)** context reflects an emphasis on designing and building to solve practical human problems similar to the way an engineer would.
>
> The **STSE decision-making (DM)** learning context reflects the need to engage citizens in thinking about human and world issues through a scientific lens in order to inform and empower decision making by individuals, communities and society.
>
> The **cultural perspectives (CP)** learning context reflects a humanistic perspective that views teaching and learning as cultural transmission and acquisition (Aikenhead, 2006, as cited in Saskatchewan Ministry of Education, 2016, p. 21).

One or more learning contexts have been incorporated into teaching approaches identified in the curriculum and taken together, these contexts represent “philosophical rational for including science as a required area of study” (Saskatchewan Ministry of Education, 2016, p. 21). The learning contexts of the identified curricular outcomes and indicators were counted for frequency analysis (see Appendix III for details). Table 7 shows the learning contexts wherein the identified Indigenous-related contents were found.

Table 7. IK-S Outcomes and Indicators Based on the Four Learning Contexts

	Scientific inquiry [SI]	Technological Problem Solving [TPS]	STSE Decision-Making [DM]	Cultural Perspective [CP]
Kindergarten	1			1
Grade 1	3			3
Grade 2	1		2	3
Grade 3	1	1	2	3
Grade 4	2	1	2	3
Grade 5	4		4	3
Grade 6	6		2	6
Science Grade 7			2	3
Science Grade 8	3		2	1
Science Grade 9	3	2	2	2
Science 10	4		3	3
Environmental Science 20	5		6	5
Health Science 20	7	1	3	6
Physical Science 20	2		1	1
Biology 30	2		1	2
Chemistry 30	3	1		2
Earth Science 30* (did not have the LC organized)	2			1
Total	49	6	32	48

Out of the four learning contexts, the Technological Problem Solving (TPS) learning context introduced the lowest number of Indigenous-related indicators. The main aspect of TPS is "technological design," which "address[es] human and social needs and is typically addressed through an interactive design-action process" (Saskatchewan Ministry of Education, 2016, p. 23). TPS learning contexts presented the following steps as a linear process: identifying a problem, constraints and sources of support, and a possible solution; planning and building a prototype or a plan; testing; and finally evaluating the prototype or the plan. Indigenous-related content found in TPS contexts is closely linked with the step: *identifying constraints and sources of support* and were mostly introduced as a source of information for technological problem-solving that students are asked to research as it offers information about nature. For example, in Grade 3 Earth and Space Science, an outcome in the TPS context asked students "to analyze how weathering, erosion, and fossils provide evidence to support human understanding of the formation of land forms on earth" (RM 4.3, p. 37). To achieve this outcome, one of the indicators that suggested/asked students to "construct a visual representation of the diversity of landscapes and landforms throughout Saskatchewan, including those that have significance for First Nations and Métis people" (Saskatchewan Ministry of Education, 2016, p. 37). An example from an indicator in Chemistry 30 suggested that students "explore how First Nations and Métis people used their understanding of material properties to determine their use (e.g., different species of wood used for burning, smoking and creating structures for housing and transportation)" (Saskatchewan Ministry of Education, 2016, p. 35). Both indicator examples portrayed Indigenous-related content as *a source of information* (Chemistry 30 example) or *a perspective to be considered* (Grade 3 example) for technological problem-solving that is useful in developing “capacities to analyze and resolve authentic problems in the natural and constructed world” (Saskatchewan Ministry of Education, 2016, p. 23). Considering IK-S content as a possible solution and information in addressing contemporary technological and environmental problem helps avoid what Fabian (1983) called a “denial of coevolves,” which trivialize IK-S as “primitive” and locked in the past (p. 31). It is also the case with the STSE decision-making (DM) context.

This STSE learning context focuses on developing students’ critical thinking. STSE decision-making also involves steps similar to the technological problem-solving (TPS) context: “clarifying issues, evaluating available research and different points of view, generation possible courses of actions, evaluation pros and cons, making a thoughtful decision, examining the impact of the decision and reflecting back on the process of decision making” (Saskatchewan Ministry of Education, 2016, p. 23). In STSE learning contexts, IK-S–related content is introduced as a form of information to be researched by students. For example, in Grade 4 Earth and Space Science, for an outcome that asked students to “analyze the interdependence between soil and living things, including the importance of soil for individuals, society, and all components of the environment” (p. 34), one of the indicators asked students to “suggest ways in which individuals and communities value and use soil, including the importance of Mother Earth for First Nations and Métis peoples” (p. 34). Moreover, in making a decision for communities, the “importance of Mother Earth for First Nations and Métis peoples” is included to “evaluat[e] . . . different viewpoints on the issues” (p. 23). Similar to the TPS context, within the STSE and DM context, IK-S are included as the information or perspective that students need to consider in making a decision in contemporary society. Such inclusion of IK-S is an attempt to avoid a “denial of coevolves” and to make IK-S relevant to current discourse of the contemporary STSE understanding.

However, Afonso (2012) cautioned about the danger of a neo-colonial integration of IK-S in science education “that name[s] the subject IK-S within the Western Science framework” (p. 28). She observed that “it is an irony that it was with the justification to contextualize science education that IKS was decontextualized and exploited” (p. 27). The lessons and meaning from IK-S from many communities is contextual in terms of time, space, place, and the subjects who interpret the knowledge in relation to the teachers (i.e., Elders, knowledge keepers, grandmothers, grandfathers, etc.) (Afonso, 2012; Wilson, 2008). To contextualize IK-S in science education, one must remember the importance of relationship. As Palmer (1983) stated, “to know something is to have a living relationship with it” (p. xv). In a similar vein, Wilson (2008) stated, “concepts or ideas are not as important as the relationships that went into forming them” (p. 74). Therefore, the integration of IK-S must involve what Lipka et al. (2005) referred to as the contextual aspect of integration and should also promote building relationships with local Indigenous communities. The notion of contextuality will be further elaborated on in a later section of this chapter.

As explained previously, the Saskatchewan Ministry of Education (2016) is committed to creating science education that involves two foundational knowledge sources: “First Nations and Métis cultures (Indigenous knowledge) and Euro-Canadian cultures (science)” (p. 23). Combining these two knowledge sources, curricular indicators may both involve approaches promoting learning from empirical observations of nature following the traditions of Western modern scientists and local community members. The Ministry’s commitment to include both ways of knowing is most evident in the scientific inquiry (SI) and cultural perspective (CP) learning contexts.

The scientific inquiry learning context reflects “an emphasis on . . . using systematic empirical processes that lead to the formation of theories that explain observed events”(Saskatchewan Ministry of Education, 2016, p. 21). The cultural perspective learning context involves “a humanistic perspective that views teaching and learning as cultural transmission and acquisition” (Saskatchewan Ministry of Education, 2016, p. 21). As shown in Table 7, these two learning contexts feature in the highest number of Indigenous-related indicators and they are often coupled in learning outcomes involving both WMK-S and IK-S (Appendix III). For example, one of the learning outcomes for Kindergarten life science is: “to examine observable characteristics of plants, animals, and people in their local environment” (Saskatchewan Ministry of Education, 2010, p. 59), which involves indicators from “CP” and “SI” to direct teaching that involves both IK-S and WMK-S.

One of the indicators for this outcome asks students to “explore portrayal of plants, animals, and people through stories and artwork from various cultures, including First Nations and Métis” (Saskatchewan Ministry of Education, 2010, p. 60), reflecting the CP learning context. By asking students to explore stories and artwork from various cultures, the Saskatchewan Ministry has continued to include “a humanistic perspective that views teaching and learning as cultural transmission and acquisition” in their science education (Saskatchewan Ministry of Education, 2016, p. 21). Through exploring stories and artwork, the curricula open the door for diverse learning and coming-to-know nature methods in school science, beyond the legacy of the empirical observation-based Baconian inductive scientific method. The cultural perspective learning context also creates a sharing place wherein students and teachers have the opportunity to discuss “how commonly-used patterns taught in science often originate from particular cultural perspective” (Blades & McInvor, 2017, p. 469). Allowing diverse methods and a space for conversation, this indicator in CP encourages a multiplication of knowledge-sciences, rather than a universalization of scientific knowledge stemming from the hegemony of WMK-S.

Another indicator, "seek out information about the observable characteristics of plants, animals, and people from *a variety of sources*, such as family members, friends, Elders, knowledge keepers and scientists" (Saskatchewan Ministry of Education, 2010, p. 59, emphasis added), reflects the SI context. Acknowledging a diversity of sources of knowledges-sciences (i.e., "a variety of sources") can be seen as a step towards a multiplication of knowledges-sciences that resists the "tyranny of globalizing discourses" (Foucault, 1980, p. 83) in science education and results from the universalization of knowledges-sciences stemming from the hegemony of WMK-S following a positivist-reductionist philosophy.

While acknowledging and integrating multiple ways of knowing in science education is important, it is crucial to challenge the assumptions coming from the evidence-based Baconian approach and the invisible colonial legacy within which the educational curriculum and program has been developed (Afonso, 2012). As mentioned previously, the hegemony and legacy of WMK-S is deeply rooted in global science education. If not challenged, the new initiatives may become "the 'panel beatings' of the old system or a substitution of one type of Western system of education for another" (Jegede, 1998, p. 168).

As discussed in Chapter 5, the legacy of 18th-century BAAS and its predecessor, natural philosophy, are still significant drivers in global science education. Saskatchewan is no exception. As discussed earlier, the Saskatchewan Ministry (2016) used terms such as *science* and *scientific knowledge* to refer to "a Euro-Canadian way of knowing about the natural and constructed world" (p. 9) that is "maintained and developed by scientists" (p. 17), which emphasizes its historical relation to BAAS. Indeed, the Ministry further elaborated the culture and language of science as “the principles and theories of science [that] have been established through repeated experimentations and observation and have been referred through peer review before general acceptance by the scientific community” (Saskatchewan Ministry of Education, 2016, p. 24). In the context wherein science is associated with the culture and tradition of scientists, which first originated from BAAS, scientific inquiry is defined as “diverse ways in which [Eurocentric] scientists study the natural world and propose explanations based on the evidence derived from their work,” therefore continuing the association with and legacy of BAAS (Saskatchewan Ministry of Education, 2016, p. 22). As explored in Chapter 5, natural philosophy and BAAS, the predecessors of modern scientists, promoted objectivity and reductionism. In turn, WMK-S is devoid of a spiritual component (McGregor, 2004). In this light, I continued to ask the following questions: How does the Saskatchewan Ministry reconcile the difference between the core values of different knowledges-sciences, such as objectivity from WMK-S and spirituality from IK-S, in regards to teaching science in schools? To what extent do these indicators found in Saskatchewan science curricula convey the knowledges-sciences from local Indigenous community members and Elders? As illustrated in the analysis of the technological problem-solving and STSE decision-making contexts mentioned above, in what ways do K-12 science curricula promote a contextual integration of IK-S? With these questions in mind, I further continued to explore the ways in which IK-S is introduced in curricula in relation to three areas of integration:

> *Content knowledge* (informed by both Western knowledge and that of Yupi’ik [local Indigenous communities] Elders), *pedagogical knowledge* (informed by school-based practices and community-based ways of teaching, communicating, and learning), and

> *contextual knowledge* (ways of connecting schooling to students' prior knowledge and the everyday knowledge of the community. (Lipka et al., 2005, p. 368, emphasis added)

These three areas of integration—content, pedagogical, and contextual—helped me unpack the diverse ways in which IK-S has been represented and promoted in Saskatchewan K-12 documents in a manner that allowed me to explore how "the various representations and discourses operate to regulate relations of power between various knowledge and ways of knowing" (Ninnes, 2001, p. 558). In the next section, I describe the various representations of IK-S in Saskatchewan science curricula in relation to these three areas of IK-S integration.

Three Areas of Indigenous Knowledges-Sciences Integration

Similar to learning contexts, some indicators involve more than one aspect of integration. In counting the coverage of each of the areas, some indicators were counted multiple times as they involved more than one aspect of integration. Nonetheless, IK-S included in Saskatchewan curricula mostly appeared in relation to content knowledge integration (Table 8). Numbers of indicators for each area were divided by the total number of indicators found in all documents. As shown in Table 6, there are a total number of 87 indicators.

Table 8: IK-S in relation to the Three Areas of Integration (Lipka's Framework)

	Number of Indicators	Percentage (%)	Examples
Content	83	91.2%	AN. 2.2.d. Recognize the cyclic nature of Mother Earth expressed by the Medicine Wheel, including life cycles and seasonal behaviours of animals (p. 27) HC 4.3. g. Investigate how both scientists' and traditional knowledge keepers' knowledge of plant growth and development has led to the development of agricultural methods and techniques (e.g., tillage, hydroponics, nutrient management, pest control, crop rotation, companion plants, and plant breeding) that affect habitats and communities (p. 29) ES20-ES10.c. Analyze how different worldviews (e.g., anthropocentric, biocentric and ecocentric) are expressed through various environmental action plans or environmental policies developed by individuals, industry, government and non-governmental organizations and First Nations, Métis and Inuit groups (p. 33) CH30-MS3.i. Research how First Nations and Métis people used organic compounds as medicines and to make soap and cleaning products. (p. 34) PS 20-PW1. B. Examine First Nations and Métis perspectives on waves, including wave as a carrier of energy (p. 38)
Pedagogical	15	16.5%	LTK. 1. f: Explore the portrayal of plants, animals and people through stories and artwork from various cultures, including First Nations and Métis (p. 60) LI. 4.1.c. Examine the significance of light in First Nations and Métis stories, legends, and spirituality including the role of fire, lightning, aurorae, and Thunderbird.(p. 30)
Contextual	7	7.7%	LTK1. C. Seek out information about the observable characteristics of plants, animals, and people from a variety of sources, such as family members, friends, Elders, knowledge keepers, and scientists (p. 59) HC 4.3.g. Recognize and discuss the role of traditional knowledge in learning about, valuing and caring for plants and animals within local habitats and communities (p. 29)
Total number of IK-S indicators	91*	115.4%	

*Note: Total number of indicators with IK-S related content is 91 (Table 5). Percentage adds up to > 100% as some indicators were counted for in more than one area.

Once the indicators were categorized based on the three aspects of IK-S integration (Lipka et al., 2005), I conducted a thematic analysis for each aspect. Below, I describe the themes that emerged from the analysis, which are presented in regards to content, pedagogical, and contextual aspects of IK-S.

Content knowledge.

Firstly, as content knowledge, IK-S in Saskatchewan's science curricula has been included mainly in four different and yet inter-related themes:

1) Sacred ecology: we are all related
2) Specific views and practices of local Indigenous communities in relation to WMK-S concepts
3) As an example of various cultural views
4) In comparison with contemporary and Western science

In including Indigenous peoples' values and worldviews, the curricula largely introduced the aspect of sacred ecology with a focus on "we are all related" and "all things are sacred" (Cajete, 2000). Cajete (2006) described nature as "a dynamic, ever-flowing river of creation inseparable from our own [human] perceptions. Nature is the creative center from which we and everything else have come and to which we always return" (p. 250). In this light, within science education that strives to respect and honour sacred ecology, science curricula should offer students an opportunity to learn or at least acknowledge various ways of "the subtle, but all important, language of relationship" with nature (Cajete, 2000, p.178). Such subtle language of a relationship with nature may come through sacred stories, symbolism, and metaphoric thinking (Cajete 1994). The goal of scientific literacy of respecting the sacred ecology then expands from "a task of knowing about nature" to "rather knowing-in-being with nature as an inseparable and co-constitutive part of the ecologies of relationships in order to learn" (Higgins, 2016, p. 189). In this light, this theme focuses on an idea that the Dancing Amoeba Model (Chapter 3) promotes: nature as a living agent one should build relationship with rather than as a commodity to be objectified. In this way, the Ministry employed the term *Mother Earth* to refer to nature. For example, an indicator from the Grade 1 program asked students to "recognize the cyclical nature of Mother Earth expressed by the Medicine Wheel, including life cycles and seasonal behaviors of animals" (Saskatchewan Ministry of Education, 2016, p. 27)

Saskatchewan's curricula further included practices and worldviews of IK-S that explore the interconnectedness of all relations and respect towards all living things and each other. Integrating indicators to "examine the importance of *sacredness* of animals" (Saskatchewan Ministry of Education, 2011a, p. 28, emphasis added) or to "examine the significance to some First nations and Métis people of offering tobacco during harvesting" (Saskatchewan Ministry of Education, 2011b, p. 28), or to "examine First Nations and Métis perspectives on the *interdependence and connectedness* of human body systems and the sacredness of life" (Saskatchewan Ministry of Education, 2009b, p. 31, emphasis added). Inclusion of the values of IK-S, including interconnectedness, holism, and the sacredness of ecological relationship and practices communities practice in order to live in such ethics, can be seen as a step away from the reductionist-technological view of nature that has been dominant in the field of science and science education since the 18th-century technological revolution.

However, despite the link made with sacred ecology, no explicit link to Creation or Creation stories, which provide an ontological and epistemological base for IK-S, are mentioned in the curriculum documents (Battiste & Henderson, 2000; McGregor, 2004, 2006). The closest link to the Creation stories was shown in an indicator from Grade 9 in Earth and Space Science:

“First Nations and Métis perspectives on the origin of the solar system and the universe” (p. 40). McGregor (2004) highlighted the importance of knowing Indigenous peoples’ understandings of the world in the form of Creation stories or those conceptual frameworks that provide an Indigenous understanding of relationships with all of Creation. As McGregor (2004) later pointed out, these Creation stories highlight interconnectedness and “knowledge comes from the Creator and from Creation itself” (p. 388). However, this relationship with Creation stories and Creator, which provides the cosmological grounding of IK-S, is not present in current Saskatchewan curricular documents.

Moreover, the reductionist philosophy-driven compartmentalization of subjects and knowledges-sciences was more evident in higher grade levels. At the higher grades, rather than presenting IK-S in a more holistic matter, the selection of IK-S content becomes more specific in relation to WMS concepts. Also, instead of involving multiple areas of integration, most of the areas only involved the *content* knowledge aspect, which Nakashima and Roué (2002) referred to as *science-concrete*. The selection of the science-concrete aspect of IK-S included the views and positions of Indigenous community members on a particular topic (e.g., First Nations peoples’ views on treaties or Indigenous land rights) or practices in line with WMS concepts (e.g., Chemistry 30: “Identify examples of acid-base reactions in . . . First Nations and Métis practices such as tanning hides” (Saskatchewan Ministry of Education, 2016, p. 39)). Keane (2008) argued that selecting bits of IK-S that fit with WMK-S learning outcomes leads to a decontexualization of IK-S from their epistemological and ontological basis, which no longer represents IK-S. Battiste and Henderson (2000) also critiqued the fragmentation of knowledge as being based on objectivism stemming from Western modern scientific thought and being used as a method of education transmission whereby knowledges-sciences is broken down into grade levels and disciplines.

Blades and Newbury (2014) pointed to the "technical-rational process" of curriculum development consisting of "defin[ing] sustainability, identify[ing] a goal and establish[ing] best practices aimed at achieving that goal" as a starting point for a change (p. 196). In a similar vein, Aoki (1991) also suggested that a focus on "empirical-analytic knowledge" in curriculum development proliferated human interest in control, thus leading to the rigid structure of "curriculum-as-plan" (p. 159). Blades (1997) observed that such technical-rational processes are "more likely to entrench existing practices than they are to change them" as they continue to keep practicing the compartmentalization of knowledges-sciences (K-S), which results in the decontexualization of IK-S in pursuit of "empirical-analytical" knowledge within curriculum (p. 196). In focusing on the sustainability of a program as well as the mastery of specific learning topics in a reductionist manner, curriculum-as-plan allows little opportunity for teachers and students to engage in a sharing place wherein the diverse lived experiences and ideas are encouraged, as suggested by the Dancing Amoeba Model (Chapter 3).

Blades and Newbury (2014) further suggested that we must consistently ask "different kinds of questions . . . questions [that] shift from begin technical in nature, to being ontological" (p. 196). Indeed, the challenge in integrating IK-S in curricula is "always how to avoid epistemological dependency, viewing IKS as dependent on the lens of Western science" (Afonso, 2012, p. 29). Creating a sharing place for IK-S and WMK-S in school science then must start from asking ontological questions. The questions should not only be about the technicality of how IK-S should be integrated and what of IK-S should be integrated in school science curricula. Instead, the questions should start from challenging the assumptions that school science and science classrooms have, as they were mainly structured based on WMK-S objectives where non-WMK-S—including IK-S—are either appropriated or placed in the periphery. One must thus ask, as Foucault (1980) did, what does the power do?—to continue to question and challenge the power relations between multiple ways of knowing nature (e.g., in this case, IK-S and WMK-S)—followed closely by the political question: "How else could it *be*?" (Blades, 1997, p. 107). In this light, the questions become ontological rather than technical (Blades & Newbury, 2014, p. 196). In asking such ontological questions, teachers and students together can explore the diverse social, political, and historical contexts of their local learning sites that influence their teaching and learning process (Garroutte, 1999; MacIvor, 1995; Strong et al., 2016). To this, Pinar (2011) also suggested that curriculum is "a complicated conversation" which according to Pinar means :

> "a conversation in which interlocutors are speaking not only among themselves but to those not present, not only to historical figure sand unnamed peoples and places they may be studying, but to politicians and parents dead and alive, not to mention to the selves they have been, are in the process of becoming, someday may become" (p. 43)

In a similar vein, Ryan (2008) reminded us of the importance of dialogue in integrating IK-S in science curriculum: "Dialogue becomes important in this quest because knowledge and ideas are both socially contextualized and contested" (p. 681). Therefore, attempts to integrate IK-S in school science must consider a learning site as a sharing place where teachers and learners together ask ontological questions and continue to have dialogues.

Meanwhile, some indicators illustrate IK-S as an example of various cultural perspectives on phenomenon (i.e., "various cultures *including* First Nations and Métis"; level 3 in priority scale). As illustrated in the priority scale table (Table 6), 14.29% of indicators were introduced in this manner. As briefly explored in the learning context section, this integration of IK-S as a part of “various cultures” may help curricula to “prescribe possible interpretations” (Luke, 1989, p. 76) by avoiding “the use of universalistic and objective language,” which continues to encourage the monolithic epistemological dominance of WMK-S in science education (Ninnes, 2001, p. 84). However, Carter (2006) cautioned that by focusing too much on culture, curricula may only involve ‘weak and boutique multiculturalism of science education’ wherein artefacts and celebration of cultural events become the focus of integration of IK-S, rather than the promoting multiple ways of knowing nature. Ninnes (2001) also cautioned against “cultural binaries that exaggerate difference between groups” (p. 263). Such boutique multiculturalism and cultural binaries are dangerous as they can become the tools for “the very process of labelling a discourse ‘scientific’ subjugates and diminished other non-scientific discourses because of the power that has been attributed and reserved for science since medieval times” (as cited in Nimnes, 2001, p. 82).

In Saskatchewan’s curricula, some indicators have been used to compare IK-S with WMK-S. In so doing, the Ministry used the terms “traditional and contemporary” and “Western and Indigenous” (e.g., “Investigate how both scientists’ and traditional knowledge keepers’ knowledge of plant growth and development has led to the development of agricultural methods and techniques” found in Grade 4, p. 29; “Engage in personal, scientific, and Indigenous ways of organizing understanding of living things” found in Grade 1, p. 27). As illustrated earlier, the Ministry’s usage of the term *traditional knowledge* refers to Indigenous knowledges (Saskatchewan Ministry of Education, 2016, p. 17). Such indicators and outcomes comparing “Western, Indigenous, traditional, contemporary and alternative approaches” further contributed to students drawing upon IK-S and WMK-S to understand nature, leading to “two-eyed seeing” (Hatcher et al., 2009) or a “co-existence model” (McGregor, 2000). However, the concerns around the possibility of creating cultural binaries resulting from employing these terms (e.g., *traditional*, *contemporary*, *Indigenous*, and *Western*) remain. Fortunately, Saskatchewan's curriculum documents have shown evidence of an attempt to go beyond cultural binaries and focus on the synergy of multiple ways of knowing. For example, one learning outcome in the Health 20 program (Grade 10) asked students to "analyze how *Western, Indigenous, traditional, contemporary* and *alternative* approaches to health care can contribute to a holistic (e.g., mental, emotional, physical, and spiritual perspective of health) perspective of health" (Saskatchewan Ministry of Education, 2016b, p. 33, emphasis added). Indicators associated with this learning outcome acknowledged the challenges of using these terms and created an opportunity for students to reflect on the terms and possible outcomes when employing such terms: "discuss the importance and difficulties in defining terms such as Western, Indigenous, traditional, contemporary and alternative approaches to health care within a global context" (Saskatchewan Ministry of Education, 2016b, p. 33).

However, in order to better avoid possible cultural binaries or boutique multiculturalism, which continues to create monolithic epistemological dominance of WMK-S in science education and continue the status quo between IK-S and WMK-S, the curricula can focus more on the collaborative process and products between IK-S and WMK-S and other ways of knowing nature. This can happen through including examples and cases in society to showcase the ways in which WMK-S and IK-S can work together to bring more a synergetic understanding of natural phenomenon, rather than focusing on gathering information in a separate, reductionist manner (which only highlights the differences of these two systems rather than the potentials of working with multiple knowledges-sciences (K-S)).

Pedagogical knowledge.

The pedagogical knowledge aspect focuses on community-based ways of teaching, communicating, and learning (Lipka et al., 2005, p. 368). As such, to find the pedagogical knowledge aspect of integration, I particularly focused on the ways Saskatchewan's curricula bring in local communities' tools and practices of teaching, communicating, and learning. For example, 16.5 % of Indigenous-related indicators found within K-12 Saskatchewan science curricula involved the pedagogical area of integration (Table 6). Stories and artworks were the main pedagogical knowledge aspects introduced in Saskatchewan's curricula. For example, an indicator found in Grade 1 Earth and Space Science asked students "to examine ways in which various cultures, including First Nations and Métis, represent daily and seasonal changes *through oral traditions and artistic work*" (Saskatchewan Ministry of Education, 2010, p. 33, emphasis added). Another example was found in Grade 4 Physical Science: "Examine the significance of light in First Nations and Métis stories, legends, and spirituality including the role of fire, lightening, aurorae, and Thunderbird" (Saskatchewan Ministry of Education, 2011, p. 30). Many Indigenous communities use symbolism and metaphors in the transmission of knowledge. Thus, the artwork from Indigenous communities are closely in line with legends and stories (Cajete, 2000). Many First Nations communities' knowledges-sciences have been transmitted orally; storytelling and stories have been the "primary teaching aid of many First Nations people . . . for every event, natural feature or animal, there was a story" (Indian and Northern Affairs of Canada, 2010, p. 3). Indeed, the oral tradition of Aboriginal peoples contributes to the "uniqueness of Aboriginal perspectives and behavior" (Manitoba Education and Youth, 2003, p. 8).

In order to receive the stories from Elders and community members, learners "must first acquire the language of their family, community, or nation to fully understand the direction being given" (Manitoba Education and Youth, 2003, p. 8). Alongside Elders, culture, and experiential learning, language is considered one of the most important elements in Indigenous science education (Sutherland & Henning, 2009). It is within the language of community that lessons have been passed down across generations (Battiste, 2013). In this sense, Indigenous languages hold the key to an Indigenous worldview and philosophy (Battiste & Henderson, 2000). However, no terms in any of the languages of First Nations communities in Saskatchewan were introduced in the curriculum documents nor there were any curricula indicators explicitly asking students to learn the terms in local languages of Indigenous communities when exploring stories and artworks.

Moreover, in teaching and learning IK-S, the concept of *coming-to-know* is important and ceremony is an important pedagogical tool for the coming-to-know process (Battiste & Henderson, 2000; View, 2016). *Coming-to-know* is a term used to describe "the process of developing understanding in Indigenous Science" (Sutherland & Henning, 2009, p. 176). Coming-to-know is about "entering into relationship with the spirits of knowledge, with plants and animal, with beings that animate dreams and visions and with the spirit of the people" (Peat, 1994, p. 65). Thinking in relationship with all relations (Wilson, 2008) and understanding the spiritual connection to the Creator are an important, integral part of every aspect of Indigenous peoples (Manitoba Education and Youth, 2003). Indeed, in the guide *Aboriginal Perspectives into the Teaching and Learning Science Education: Beginning the Conversations in Southern Saskatchewan*, Sammel (2005) emphasized the educational goal "to live in balance with Creation" (p. 38) and further suggested that spiritual activities, such as prayer and ceremony in pursuit of “constructive and respectful relations with the Creator,” should be included in integrating IK-S (p. 38). In participating in ceremony, one had to build trustworthy relationships with communities and be invited into the ceremony.

As language and ceremony play vital roles in understanding IK-S, the long-term *established relationship*, built with 3R (respect, reciprocity, and responsibility) prior to engaging in the act of integrating IK-S into science education, is therefore extremely important to avoid unintended decontexualization of IK-S, which leads to neo-colonization in science education (Alfonso, 2012; Ryan, 2008). As Kovach (2009) put it, “understanding is a layered endeavor” (p. 24) and the coming-to-know process and understanding IK-S require much more work than the mastery of content, as coming-to-know IK-S is “inseparable from coming-to-being” (Higgins, 2016, p. 12). As mentioned earlier, the integration of IK-S should go beyond the integration of science concrete and it should be contextual. Moreover, it should involve having a sharing place wherein building relationship to community members, land, and Creator as well as discussion happens around these topics.

Meanwhile, IK-S pedagogy goes beyond stories and artwork. Kovach (2009) mentioned that “meaning-making with Indigenous inquiry involved observation, sensory experience, contextual knowledge and recognition of patterns” (p. 140). There are diverse ways of coming-to-know, based on land, language, and individuals’ interpretations of lessons provided by Elders and knowledge keepers. As such, continual relationship-building and reflexivity should be the core foundation one must consider in including pedagogical aspect of IK-S.

Contextual knowledge.

Contextual knowledge refers to “ways of connecting schooling to students’ prior knowledge and the everyday knowledge of the community” (Lipka et al., 2005, p. 368). The benefits of integrating contextual knowledge of IK-S that is “a land-based, experiential learning approach (where students incorporate science as a living, learning process as a part of their everyday lives) is not only positive for Indigenous learners but for all learners” (Sutherland & Henning, 2009, p. 187).

The contextual knowledge of IK-S had the least percentage (7.7%) of association with Saskatchewan’s science curricula, as shown in Table 7. When included, the contextual knowledge of IK-S found within curricula included local Indigenous Elders and knowledge keepers as one of the “variety of sources.” For example, an indicator from Science 1 Life Science asked students to “use a variety of sources of information and ideas (e.g., picture books including non-fiction texts, Elders, naturalist, videos, Internet sites, and personal observation) to learn about observable characteristics of living things” (Saskatchewan Ministry of Education, 2011, p. 27).

Including Elders as a legitimate source of knowledge for science education may help challenge the positivist notion of WMK-S. It is “imperative to reach out to the Elders, the experts” of IK-S in developing an understanding for IK-S (Samuel, 2011, p. 6). However, Sutherland and Henning (2009) described that Elders’ involvement in science education should be “for more reasons than their knowledge; Elders ‘ground’ the learning and provide a context and purpose of coming to know in affirming the responsibility of knowledge within Indigenous worldviews” (p. 187). Thus, Elders’ involvement is crucial in diminishing the danger of decontexualization and compartmentalization of IK-S in school science (Alfonso, 2013; Battiste, 2013). Indeed, in Aikenhead and Elliot’s (2010) description of the Saskatchewan science curricula, they emphasized the importance of teachers’ building a relationship with an Elder:

> A teacher will develop a relationship with an Elder or other knowledge keepers in the community, show them the Indigenous knowledge in the science curriculum, and enlist their help in determining what local knowledge should be taught instead, and how it should be taught. For instance, if Plains Cree information about the physical elements of Mother Earth (earth, water, wind, and fire) appears in the curriculum, and if a science teacher has Dene students, then the teacher will need to collaborate with a Dene Elder or knowledge keeper to determine what equivalent Dene content might be added to the curriculum's Plains Cree content. (p. 17)

With the acknowledged importance of Elders' involvement in teaching IK-S and grounding IK-S throughout the sharing process in school science, understanding protocol becomes important in building relationships with Elders (View, 2016). The integration of IK-S in school science therefore needs a lot of grounding work that involves learning local community's protocol and local natural land, as well as building relationships with Elders and other community members.

In fact, without such groundwork, Alfonso (2013) cautioned that the school curricula will do harm, leading to neo-colonization in science education, albeit unintended. The integration of IK-S in curricula requires an iterative process of building relationship, understanding multiple ways of understanding and knowing nature, and reflection. In this light, the integration becomes a circular learning process. Thomas and Green (2007) used the Medicine Wheel in describing the circular learning process:

> Once you have journeyed around the wheel, you have the opportunity to learn from your experiences and journey around the wheel again, this time learning from your

mistakes. . . . if we remember what the challenges were in our previous journey, then our next journey can be different and more effective. (p. 92)

In this light, as Wiseman (2016) mentioned, the integration of IK-S in school science curricula may not be really about integration. It is about building relationship with nature, communities, and all living things based on respect and an iterative learning-reflective process.

Reflection from the Curriculum Documents Analysis

The Saskatchewan Ministry of Education acknowledged IK-S as a source of valid knowledge foundation along with WMK-S and emphasized the importance of diverse ways of knowing nature to provide a strong science program. However, the Ministry never challenged the hegemony of WMK-S. As such, according to the continuum bar of integrating IK-S (Chapter 3), the Saskatchewan Ministry of Education took a "multiculturalist position": acknowledging the diverse ways of knowing nature and creating a space for dialogues, however never questioning the hegemony of WMK-S. In order to create science curricula and programs that authentically appreciate IK-S and promote harmony among multiple ways of knowing nature, "the existing cultural interpretative monopoly of European knowledge, assumptions, and methodologies" has to be explored by all educational stakeholders involved—curriculum writers, teachers, and students (Battiste, 2013, p. 103). The legitimacy of WMK-S was never been questioned or challenged and many renderings from BAAS and earlier natural philosophers remained in Saskatchewan curricula. For example, their usage of the term *science* was only in association with WMK-S and their descriptions and usages of the term of *scientific inquiry* were mainly associated with Baconian inductive scientific methods. Curricula encouraging the creation of a sharing place to continue to ask ontological questions about IK-S and WMK-S, respecting sacred ecology and a continual relationship-building and reflecting with Elders and knowledge keepers are considered as the most important factors in integrating IK-S. In the next chapter, I further explore the stories from the sharers (i.e., educational stakeholders) about the production and consumption of these curricula materials in relation to the factors listed above.

Chapter Seven: Stories From the Sharers

Prelude: "The Process is the Product" (Wilson, 2009, p. 103)

In this chapter, I describe findings from the *interpretation* stage as mentioned in Chapter 4 (Figure 13). I share the lessons and ideas that emerged from the sharers' (i.e., the different educational stakeholders') stories in relation to their views and experiences with the IK-S–infused science curriculum in Saskatchewan. As illustrated by Fairclough's (1989) three nested model, official K-12 science curriculum documents as texts have a dual function: they are the products of different social and discursive practices, yet they act as drivers of further enactment of discursive and social practices. Thus, in exploring the dissertation question (what relationships are at play in integrating IK-S in science curricula?), stories from the sharers were important sources for me to explore the ways in which curricula as a text influenced the product and the driver of different discursive practices. Here, I reintroduce the three types of discursive practices involved in the *Interpretation*, first described in Chapter 4: production, distribution, and consumption (Fairclough, 1989).

Table. 8: A summary of Discursive Practices Analysis

Stage	Description
Production	- General views on integration of IK-S: - Sharers' conceptualization of science - Their views on the current approach in integration IK-S in science education - Their role as an ally (if non-Indigenous and if they identify as an ally) and/or Indigenous community member
Distribution	- The ways in which Indigenous knowledges-sciences (IK-S) were gathered and distributed to teachers - The forged relationship between the Ministry of Education and local Indigenous communities - Collaborative or consultative approach: role of Indigenous scholars, Elders, knowledge keepers in the development and delivery of teaching (Wiseman, 2016)
Consumption	- Stories from teachers: o Their own experiences/ways of integrating IK-S in their teaching o Benefits and challenges of teaching with IK-S infused science curricula

It was my intention to interpret the stories based on these three categories and perform a thematic analysis. However, as I was analyzing (rereading) the stories shared with me, many ideas and lessons emerged. In the flux of diverse ideas, I attempted to organize these stories and lessons into themes based on the production, distribution, and consumption of the curriculum documents, with a focus on finding the cause and effect of the IK-S–infused science curricula in Saskatchewan. Then, I realized that I had yet again fallen into a trap of my internalized habit of doing research in a linear and reductionist way instead of looking at the relations between stories and allowing lessons and new ideas to emerge. I was reminded of Shawn Wilson's (2008) suggestion that "the process is the product" (p. 103). Thus, I yet again focused on showing the readers about the process in which I engaged with the stories from the sharers.

In stating the academic purposes of this project in Chapter 2, I have shown my commitment *not* to follow, and to resist, a reductionist linear approach of doing research and to remain open to learning throughout the re/search process. In this light, as a re/searcher I am—and my re/search project is—situated within the *Inter esse* (Wiseman, 2016) wherein I reflect on both Indigenous and non-Indigenous ways of thinking and doing the re/search. In so doing, I have been guided by the notion of *Kemoochly*, which communicates that the lessons and ideas would come to me "quietly" through my living inquiry (Fitznor, 2016). Therefore, I decided to take a breath in, and "sit with the difficulties, allow them to be, and learn how to become comfortable with the discomfort" (Wiseman, 2016, p. 95). While doing so, I was reminded of wisdom that was shared with me by Dr. Sa'ke'j James Henderson. Below, I illustrate and reflect on the context and the wisdom shared by Dr. Sa'ke'j Henderson.

Reflections on the wisdom shared with me.

I was attending the CSSE conference in May 2017. I was excited to see many familiar faces at the conference. The thought of having new learning opportunities excited me a lot. Before attending any sessions, I saw Sa'ke'j Henderson (SH). I had had a conversation with Dr. Henderson during CSSE the year before (the kitchen table encounters illustrated in Chapter 2). I approached to him slowly, uncertain that he would remember me.

Hello! How are you? Do you remember me?

SH: Of course, I remember you.

Really?

In his calm voice, he answered.

SH: Yes, we had conversation at the kitchen table.

Oh, you do remember me! How are you?

SH: Are you excited?

Yes, I am! Are you not?

SH: . . . (shakes his head)

Instead of giving me any verbal answers, he just shook his head. I thought I saw a bit of disappointment and sadness appear on his face. I answered awkwardly, "Oh. Ok."

We said bye and I went on to attend a session. However, the question he asked me—"are you excited?"—lingered in my mind throughout the conference: Why wasn't he excited? Or was I just overly excited?

After a few days of attending the conference, I found myself feeling sad and disappointed. I'd been struggling with my identity within academia and had been thinking that perhaps I did not belong "here." The CSSE community that I had been part of since the beginning of my master's studies felt very foreign to me. I felt very alienated by everything. The learning that was happening felt so far from what I believed in. I felt like the conference confirmed that I did not belong here. On the morning of the third day of attending the conference, as I was walking to Ryerson University (the conference venue), I wondered if I should talk to Sa'ke'j about my tensions with the academia. But I doubted that he would read emails during the conference and also I did not want to waste his precious time on my identity crisis. As I was heading to another session, I ran into Sa'ke'j again, standing by the door of the room I was going to walk into. When he saw me, he greeted me with a smile and then asked, "What kind of adventures have you been on?"

That simple question touched the core of my heart. Out of nowhere, I felt something warm coming up from my stomach, and next thing I knew, I was crying in front of him in the corner of the corridor. I shared with him the tensions I have been feeling in academia and how the neoliberal culture and the politics in academia were changing who I was. On the corridor with natural sun shining through the window, which from time to time was hidden by the grey rain clouds, we stood for over an hour and he shared some of his wisdom with me (obviously, I did not make it to the session). While I was listening to him, there were so many stories and lessons that emerged and I was afraid that I would not remember anything. He said to me, "Do not worry—whatever was meant to stick to you will stick." He also said, "Knowledge does not give you certainty but possibility. . . . Knowledge that doesn't get shared isn't knowledge," and gave me permission to share his wisdom with others. It is in this sense that I share the lessons from him in this dissertation to show how his wisdom has guided my re/search process. By sharing his wisdom—or rather, my interpretations of his wisdom—in this dissertation, I hope that "whatever that was meant to stick to you will stick" and this will offer an opportunity for new interpretations and lessons to emerge for the readers (you).

Sa'ke'j told me that the path between the mind and heart is very tangled and complex. It requires a lot of work to connect the mind and heart. I told him that I have experienced a lot of great minds in academia, but not as much the ones with "good hearts." To this, he said to me "Yes. There are lots of narcissistic and arrogant knowledge keepers especially in the conference. But stay true to yourself. Do not change. Let your mind relax." Sa'ke'j also told me of the importance of "relaxing the mind" through meditation and ceremony and that ceremony is a good place for the mind to relax. Once your mind is relaxed, then you can experience the opening of spiritual space. He then talked about cognitive space:

> You know. . . . It is different from spiritual space. It is not only the physical space that is confined and we are being assimilated into. It is also cognitive space. You know about entropy? When the entropy is high, you reach the maximum chaos moment. You are in that state. However, do not worry, after this, you will reach to the stabilization moment, spiritually and emotionally. . . . I look at the trees in the city of Toronto. They are struggling but they are still here.

He then told me about the Creator—that the Creator created me and I have a purpose "here." The Creator does not intervene but he made sure that I am "here" for a reason (personal communications, May 31, 2017).

While I was sitting with the stories with the sharers, I experienced the state of being in high entropy—the state of chaos—yet again. So many ideas, which seemed beyond my ability to make connections and make meaning out of, were pouring in. Yet, I was reminded by the commitment I made in Chapter 2: to be grounded (Kovach, 2009). I needed to reflect on the reasons I am "here"—in the "entropy chaos" with the data as well as trusting the process that "whatever may stick to me will stick." These reminders came to me *Kemoochly* and encouraged me to reflect on my personal and academic purposes for this project, as illustrated in Chapters 1 and 2: to engage in building better relationships with all relations and to participate in decolonization (both at the self and institution level), which involves identifying and resisting what comes easy to me because of my internalized biases (i.e., linear, reductionist way of engaging with the stories), and to continue to reflect on the process. In speaking about the nature of research, Dr. Eber Hampton (1990) said, "the cut-and-dried, rigid, cold, hard, precise facts are dead. What is alive is messy and growing, and flexible, and soft, and warm, and often fuzzy. I preferred life to death [in research]" (p. 49). I too, prefer life. Albeit it seemed and felt messy, I remained open to learn and let the lessons, ideas, and relations between stories emerge, rather than focusing on the cause and effects in IK-S–infused science curricula. In this light, I have experienced what Dawn Wiseman referred to as something "*inarticulable*, just a feeling, the sense that there is something to track, perhaps a way to find a sense of pattern, or find a way back to pattern. . . . But who says a story needs a beginning, middle, and end?" (Wiseman, 2016, p. 313, emphasis added). Trusting the process with the notion of *Kemoochly* (Fitznor, 2016), and accepting that I am in a state of high entropy (Henderson, 2017) and that something *inarticulable* is present in my re/search (Wiseman, 2016), I was able to reach my stabilization point where I was able to make sense of the relations between the stories told by the sharers and, as mentioned in Chapter 4, sometimes, I felt that the stories were speaking to each other, asking and answering each other's questions.

I also acknowledge that I had to make some selection of parts of stories for this dissertation and there was a negotiation process of the selection of stories for this dissertation. Such a process confirmed my notion of re/search (explained in Chapter 2) that re/search is about finding my own individual interpretation rather than finding the answer or the truth, thus emphasizing the role of subjectivity played in the process.

Meanwhile, Dr. Laara Fitznor advised me "to think and write with metaphors from my [Korean] culture" (personal communication, October 8, 2017). Dr. Fitznor's advice has led me to move beyond finding the cause, influences, and effects—a linear way of thinking and reading the stories from the sharers—and engage in diverse ways of thinking, such as stories, metaphors, and dreams. Indeed, it was through this process of allowing myself to be open to learning and reflecting and resisting my internalized values of linear, reductionist ways of doing and presenting re/search process and product that I was able to find ways to engage with the stories from the sharers and find the connections and relations between these stories.

The stories that focused on production, consumption, or distribution of curricula documents allowed me to rethink and, in turn, the following question and metaphor that became the organizing theme for the stories shared by the sharers: "Why cross the island in the first place?" and "Pouring water into a bottomless vase: head, heart and hand." Below, followed by the description of the each organizing principles, I share the findings from stories from the sharers, which focus on the process and product of Saskatchewan's IK-S–infused curricula as well as the reminders and suggestions for future initiatives. The first section, "Why cross the island, in the first place?" focuses on illustrating "why" IK-S–infused curricula was created in Saskatchewan based on the sharer's views. Also, the sharer's understandings and views of WMK-S and IK-S are reflected in this section. The second part, "Pouring water into a bottom less vase," describes the experience and lessons that sharers gained throughout the curriculum production, consumption, and distribution process, mainly emphasizing the importance of relationship.

Stories from the Sharers Part 1: “Why” from Multiple Levels

When teaching preservice teachers, in at least one class I opened up the discussion and dialogue about the relationship between WMK-S and IK-S. I dreamt about one of these classes, where we were talking about how to integrate IK-S in science education. However, in my dream, there were no chairs or desks in the classroom. My students and I were sitting on the floor in circle, listening to Dr. Glen Aikenhead speak:

> Through an inquiry approach, we can integrate Indigenous perspective in a non-tokenistic way. How? You need to build a relationship with community members and land and integrate story in your teaching. The story doesn’t really have to be a perfect match with Western-based outcomes. It can be situation or stories like “my mom has this symptom and so does my grandmother. Is this genetic? In our culture we explain such situations as this this this. . . .” Thus, it is about bringing different perspectives and lenses to explore the same phenomenon. But it may provide different explanations.

Then Dr. Aikenhead showed us a picture of an island, one that looks like the Moa in the hat from *The Little Prince* (Figure 15). He then asked us, “How do we cross the island?”

Figure 15. Moa Island in the Dream

Students provided different creative answers. Some said they would build a "banana boat" that would actually peel off its skin while crossing island, and some would build a boat that would go around the island like a bird. After students shared their answers, Dr. Aikenhead said, "People may have different answers. But also, the question itself can be interpreted in different ways. So, even if we look at the same thing, it might result in different interpretations and approach." After he said this response, I woke up.

After waking up, I decided to send Dr. Aikenhead an email, asking him what he thought of the wisdom that he shared in my dream. He replied to my email:

> My reaction to my voice in your dream is that it expresses a cross-cultural understanding of student-centered inquiry in science at its best. The island metaphor is interesting. I suppose that in consciousness, one might also ask, "*Why* would we want to cross the island *in the first place*?" That could open the cross-cultural science/engineering inquiry conversation even more broadly. (Personal communication, January 14, 2017, emphasis added).

This response from Dr. Aikenhead encouraged me to shift my focus of re/search from how to why. Indeed, Tanaka (2016) also emphasized the importance of "understanding the *why* of another culture” in actual enactment and practice of educators to incorporate multiple cultural perspectives into their pedagogy (p. 197). As such, instead of looking at how the curriculum has been produced, distributed, and consumed by diverse stakeholders, this shift allowed me to reflect on the “why . . . in the first place?” in regards to the stories of Saskatchewan’s current IK-S–infused curricula. Meanwhile, by reflecting and rereading the stories shared, I understood that creating IK-S–infused science curricula involved a multilevel process, which resulted in many different rationales and pressures from diverse arenas. Styres (2017) mentioned that to reduce “hegemonic ideologies that serve to perpetuate dominant Western practices within education,” changes need to happen on multiple levels including “administration and infrastructure; networks and relations of power; the ways knowledge is constructed and legitimized within the dominating epistemology; policies, pedagogies, and classroom practices; and the complex issues regarding language, literacies and evaluative strategies” (p. 26). As well, such a multilevel process of IK-S–infused curricula does not necessarily involve a chronologically linear process; it may happen spontaneously at the same time in different places. In the Saskatchewan context, Dr. Glen Aikenhead mentioned that “it was pressure from a lot of different places that happened to come together simultaneously, besides the Conservative government” that made the curriculum renewal possible (personal communication, March 26, 2016).

Indeed, other sharers, including Dean Elliot (Ministry Science Education Consultant), Tina Rioux (Teacher), and Ted View (Teacher), also mentioned the following political pressures coming from multiple levels that influenced the development of Saskatchewan’s IK-S–infused science curricula:

(1) Federal government level: the prime minister’s apology in 2008 and the publication of the final report of Truth and Reconciliation Commission (TRC) in 2015 and the existence of treaty;

(2) Provincial government level: reports and policies produced in First Nations and Métis organizations in Saskatchewan as illustrated in Chapter 5 including the *Five-Year Action Plan for Native Curriculum Development* (1984); *Core Curriculum* (2000); *Building Partnerships: First Nations and Métis Peoples and the provincial Education System* (2003);

(3) Academia: an article critiquing the pan-Canadian science education framework as well as Saskatchewan's grade 10 science curriculum for being euro-centric, and their lack of Aboriginal perspectives as outlined in *Towards Decolonizing Pan-Canadian Science Framework* (Aikenhead, 2006) and;

(4) Other grassroots movements, including the Idle No More movement.

While this political pressure from diverse spaces led to changes in the educational political climate that resulted in more openness towards local Indigenous ways of knowing and practices coming into the classroom, many of these initiatives largely focused on critiquing the current Eurocentric systemic structure of failing to accommodate local Indigenous students and emphasizing the four imperatives of creating IK-S–infused curricula. For example, as Darryl Isbister mentioned:

> There's four imperatives as to why we do this. There's an *economic imperative*. Our Indigenous students, and then ultimately adults, don't enjoy the same economic benefits that non-Indigenous students do. There's a *demographic imperative*. Our population is shifting and right now, our Indigenous population is the fastest growing segment of the province and our schools are going to continue to start to look different. There's a *moral imperative.* We know that right now, our Indigenous students don't experience the same education, and so we're morally obligated to ensure that they experience the same education as all our other students. And then just personally, I mean it's part of

> everything else, but the *historical imperative* that, you know, if we were ever to lose any aspect of this history, it's gone forever. And I say that as Métis person, my ancestral history is here, and I can never go anywhere else to find it. You know, there is no Métis land that I can travel to, to find out the history of my ancestors. It's here and if we ever to lose that, then there is no other place. And right now, the history is told by the dominant culture of this land. . . . Indigenous history in our province right now is optional. It's not mandatory, and so many of our students can go through their whole educational career without actually learning about the original inhabitants of this land, and we just need to change that. (Personal communication, October 26, 2016, emphasis added)

As explored in Chapter 5, the first school established in Saskatchewan education was the missionary school for Indigenous students, which had a goal of assimilating them into a "civilized" British way of life in the 1820s; many scholars and educators (e.g., Battiste & Henderson, 2006) and other reports published by First Nations and Métis groups in Saskatchewan have critiqued the assimilation approach of schooling for Indigenous students and instead suggested education that honours and respects Indigenous ways of knowing. In this light, the rationale for creating IK-S–infused curricula was to better accommodate Indigenous students by creating culturally relevant/responsive curricula. However, *Core Curriculum*, published by the Saskatchewan Ministry of Education (2000b) emphasized that such "culturally relevant curriculum and resources foster meaningful learning experiences for *all* students, promote an appreciation of Canadas cultural mosaic, and support universal human rights" (p. 5, emphasis added). All of the sharers—including classroom teachers, ministry consultant, university professors, and First Nations and Métis education coordinators—I have spoken to agreed with the statement that the inclusion of IK-S in science is for *all* students, not only for Indigenous students. Some sharers including Ted, particularly emphasized the importance of a place-based education approach that honors the relationship with land and its original inhabitants, while challenging the hegemonic monopoly of WMK-S and its universal and its objective status in education:

> I think it's the culture of the people that are here that's really significant. So it's acknowledging the original people that lived here. That would be no different than going to China studying science, western science there too, but also knowing and understanding the history of Chinese ways of knowing there and how they related and understand the world. So how do you maintain rice paddies for example? And how did the Yangtze provide so much nutrient for the farmers around there? How do they keep land going without all of the luxuries of technology, like advanced technology like we have in terms of chemical fertilizers and whatnot and how does that impact the land over there? So that understanding of the land over there is equally valid for a culture that has existed for thousands of years. So why wouldn't the ways of knowing for a culture here that's existed here for thousands for years be equally valid. So I think that's a change that we have to understand it. The difference is the dominant culture there is Chinese whereas here First Nations and Métis ways of knowing cultures here are not the dominant cultures so that's why we have that distinction, right? But I suggest that because we live in Saskatchewan we really have to know and understand the ways of knowing of the people that live here originally. . . . You can't teach them that science is completely empirical and objective. It's not objective. There's always a motive and agenda to push certain aspects of the dominant culture. (Ted View, personal communication, November 10, 2016)

Similar to Ted, Rory also acknowledged the hegemonic aspects of Eurocentric science education as it comes with “a belief that is the true way of looking at the universe, the true way of looking at our natural surroundings” (personal communication, December 12, 2016). Meanwhile, all sharers acknowledged that IK-S–infused science curricula is about the balance and harmony of multiple ways of knowing for our “shared future.” In this light, IK-S–infused curriculum is about what Dawn mentioned: “making a room so that we both learn together” (personal communication, August 25, 2016), which Darryl explained as “walking and living together” (personal communication, October 26, 2016). Indeed, Tanaka (2016) spoke about the importance and the need of providing opportunities for teachers and students, where “Indigenous and non-Indigenous can walk alongside each other and learn together” (p. 196). In so doing, it should be about a “deep act of *visiting with*, rather than merely *touring past*, another culture” (p. 196, emphasis original). In the act of “visiting with” or “walk[ing] and liv[ing] together,” I am reminded of the lesson I received from Lee Maracle from Sto:Loh Nation, as illustrated in Chapter 4. She emphasized the relationship between different knowledge systems by comparing them to rivers. There are many rivers on the land. Some rivers merge; some go separate ways. However, if all rivers were to merge together, there would be a catastrophe and the world would die. IK-S and WMK-S are like streams of a river. They may come together at some points, but they are not the same. When trying to work with both systems, we must see the relationships between the systems and facilitate them to work together, but we need to acknowledge their separateness as well. Such a view of looking at IK-S and WMK-S resonates with McGregor’s (2000) co-existence model, which “promotes functioning of both systems side by side . . . the model of co-existence encourages equality, mutual respect, support, and cooperation” (p. 454). Garroutte (1999) also suggested that such “explicit recognition of different ways of knowing” nature allows teachers and students to embrace diverse sources of knowledge to understand nature (p. 104). In this light, "engaging with," "infusing," "integrating" (whatever the term may be) is ultimately about creating a space that allows educators and all students to "visit with" and learn and grow together "side by side" thus educators and students alike may "walk in two [or multiple] worlds" (Stryre, 2017). Thus, the notion of WMK-S vis-à-vis IK-S (Kim, 2014, 2015) is accentuated and the effects of hierarchy, status-quo, and the competitive notion of WMK-S versus IK-S diminishes.

All the sharers agreed that Saskatchewan has taken some steps towards "walking along" and "visiting with" local IK-S in their science curricula. However, the province is "very much at the start of something here in its infancy" (Rory Bergermann, December 12, 2016, personal communication), or "just an opening of the door [albeit] hav[ing] made more steps than most other provinces . . . and hopefully that opens the door to more steps in the future" (Dean Elliot, December 19, 2016, personal communication). Glen Aikenhead used a nuclear metaphor to further illustrate what needs to happen in Saskatchewan, to move forward:

> We've now established a good beginning on a decade project and it's always a matter of having, and I'm going to use the nuclear metaphor, having that critical mass. Not that the teaching is going to explode, but it does take a critical mass. Probably if, 20% are—this is just off the top of my head is what the critical mass might be—I think if we had 20% of the science teachers doing this that would be irreversible. But it still would take another ten years to reach sort of 60% to 80% and you're never going to get higher than that and that's something about curriculum development. Remember the self-identity of teachers are very important and their value systems. And when you ask yourself where those are forged, they're mostly forged in the science departments at the university. And to change

> the curriculum so it's more open to an Indigenous point of view is as easy as relocating a cemetery some place, it just doesn't happen. And all the universities in Canada have been thrust into that because of the TRC report coming out and they don't know what to do.… But changing a curriculum—like in the sciences the Elders are adamant, that they're saying, "we don't want science professors and chemistry, biology, physics, geology to include Indigenous knowledge in their curriculum" because they said their curriculum is already too full. Because their job is to produce scientists, you know the pipeline arrangement. They want the environment, the intellectual environment to be conducive to what I would call—well people call it third space dialogue. That's one of the terminology. I really like the camping spots of dialogue, because sort of sitting at a camping site is more amenable to what these are. (Personal communication, March 24, 2016, emphasis added)

This story from Glen Aikenhead resonates with some of the lessons I received from Indigenous scholars and Elders. The first lesson is about knowing the *politics of truths* (Kovach, 2006): this is about knowing their benefits (and abilities) as well as their limits. One of the benefits (abilities) of creating and teaching IK-S–infused science curricula is providing opportunities for teachers and *all* students to learn to "walk in the two worlds." However, it is also important to know the limit of walking in two worlds. This could be about what Lee Maracle illustrated, acknowledging that the relationships of IK-S and WMK-S as "two streams of the rivers" thus acknowledging their separateness and recognizing that not all topics can be explained in both IK-S and WMK-S ways of understanding nature. Tina mentioned that:

> It's hard to do it all the time, like it's just impossible, because the [WMK-S] topics don't match Indigenous knowledge. Some areas don't have any parallel to what was important

> to Indigenous knowledge keepers. Trying to make connections where they don't fit, it's ridiculous—it's kind of forced. But the bigger picture is—or my goal is—just to get kids thinking that it's okay to have a different viewpoint. My goal is to make them more empathetic to all cultures, but specifically Saskatchewan First Nations' cultures, because it is prevalent in our province. (Personal communication, January 3, 2016)

Indeed, as the Elders Dr. Aikenhead met told him, what is more important than content-based integration in every content of WMK-S (i.e., biology, chemistry, physics, etc.) is creating a place for dialogue, a place where multiple ways of knowing nature can interact.

In a similar vein, Dawn mentioned, "if we really want to get a deep lasting change, that goes to *changing relationships* because in some ways it's not really about science, it's fundamentally about changing relationships between Indigenous and non-Indigenous peoples in Canada" (personal communication, August 25, 2016, emphasis added). After all, IK-S–infused science curricula is really about creating a "sharing place," as suggested by the Dancing Amoeba Model (Chapter 4) where mutual respect and relationships are forged and strengthened and where there is no hierarchy among different knowledge systems. Thus the hegemony of WMK-S and its tradition is challenged, and new ideas and interpretations are encouraged while the separateness of the different knowledge systems are also acknowledged and appreciated.

Most importantly, we need to recognize the role that teachers play in engaging with and creating sharing place in classroom. Dr. Brian Lewthwaite mentioned that "it [IK-S and WMKS-infused curricula] has to be a multi-system process of change. . . . There might be changes at a level . . . but until you get in the heads of teachers, there's not going to be a radical change" (personal communication, May 1, 2016). As depicted earlier by Dr. Glen Aikenhead's story, teachers are the "critical nuclear mass": important game changers, drivers, and agents of making deep, lasting, fundamental changes in education. Many of the sharers pointed out that in order for Saskatchewan's current IK-S–infused science curricula to be improved, the next step is to focus on the professional development and education for teachers. Tina mentioned:

> So one of the mandates for us [teachers] is that everyone, regardless of their subject, should be including Indigenous knowledge into their courses. It came down from the government, right from the Ministry. Many people were up in arms. Initially when this word came out, people were all, "well, this is ridiculous, why should I have to do this?" and so through different PDs that we've been doing through school and through the division, I feel like it's given teachers the *understanding of why* this work is important. (Personal communication, January 3, 2016, emphasis added)

Ted also mentioned:

> I believe that there's been a lot of work [in Saskatchewan], but there's a lot more to go. I think the downfall of the inclusion of First Nation Métis ways of knowing is that not enough work has been done with teachers in order to know how to do [it] well…. *True learning* would require building relationships with elders and learning that over time, experiencing culture and nature … it's really not something you learn from a textbook, and I think that's one of the biggest downfalls of trying to indigenize curriculum when we haven't something to support that sort of learning for non-First Nations people…. So I think the first thing to really change the curriculum is if you're able to offer experience for teachers to experience First Nation Métis ways of knowing and to build relationships with people in their community who are First Nation, who are knowledge keepers, who have experience that can help them reach the two worlds. (Personal communication, January 28, 2017, emphasis added)

Rory (ministry science education consultant) pointed out that providing opportunities for teachers to build relationship with local Indigenous Elders and knowledge keepers is key:

> It's going to be improved, number one by teachers. We're going to have to take teachers, who, let's face it, are the people that are closest to kind, making this connection, but we have to find a way to get teachers comfortable with using our resources that we have locally. And that is *building relationships* between teachers and local First Nations elders and knowledge keepers so that we can start to build that sense of community and trust and we could start and everyone starts in the path towards learning their knowledge, their tradition, and infusing it into our science curriculum. Not just as an add-on, but as sort of a central feed that we use throughout. (Personal communication, December 12, 2016, emphasis added)

Indeed, many other sharers emphasized the need for more "true learning experiences" and "building relationship" opportunities for teachers, "where Indigenous and non-Indigenous can *walk alongside* each other and learn together" (Tanaka, 2016, p. 196, emphasis in original). Thus, they suggested that more funding and planning should focus on supporting classroom teachers, teachers' professional development, and education in providing learning experiences from local Indigenous peoples. As Tina (teacher) said:

> It's mostly to do with, you've got to kind of put your money where your mouth is. So if you're going to say that . . . everyone has to teach First Nations content, then you have to actually train people to do so, and you have to bring in people that can help teachers become comfortable with that content, whether it be develop more resources that are going to support teachers. (Personal communication, January 3, 2016)

Glen agreed with the point that what Saskatchewan needs is "human resources. . . . More money for more personnel to get out in the schools to help teachers. . . . The resources are there now, they really are. The paper and pencil resources, the resources on the internet, they're there now. And so it's the human resources" (personal communication, March 24, 2016). In order to expand the *true learning* opportunities for both teachers and students, what needs to happen, in relation to teacher education and professional development, is to cultivate and promote education for the "teacher-leaders" (Dean), "culture brokers" (Ted), and what Darryl called "cultural catalyst teachers":

> We would train up to one person for each school right now, to become a *catalyst* for their school, to support people within the school with understanding—with having that cultural background—cultural competent background to support people in the schools. And you know, that doesn't necessarily have to be Indigenous people, we're always searching for allies, and people who want to support Indigenous education in the same way that we do. (Darryl Isbister, personal communication, October 26, 2016, emphasis added)

Darryl's response resonates with the goals of *Building Partnerships: First Nations and Métis Peoples and the Provincial Education System*, a policy framework developed by Saskatchewan Learning (2003) that emphasized that both Indigenous and non-Indigenous peoples need to build partnerships "towards shared future." It is not only Indigenous peoples' duty, nor non-Indigenous people's benevolence or the attitude of "helping" Indigenous students. It is for all—so that we can "live together in dignity, peace, and prosperity on these lands we now share" (TRC, 2015, p. 8). We are now in an era, where we have moved beyond dwelling on rationalizing and legitimating about the whys of IK-S in science education. As illustrated in the previous chapters, particularly by the continuum bar (Chapter 3), the diverse rationales for IK-S in science education have been put forward by different scholars and educators. The focus now should be about "changing the relationships between Indigenous and non-Indigenous people . . . and providing [a] clear and consistent message on a long-term basis" (Dawn Wiseman, personal communication, August 25, 2015). Thus, providing more opportunities to increase the number of "critical nuclear mass" teachers to understand the "why" engaging IK-S–infused science curricula is important and necessary for our shared future. Dr. Eber Hampton reminded us that "we are in this together. The question [now] is, what is the quality of the partnership?" (as cited in Saskatchewan Education, 2003, p. 4).

Stories from the Sharers Part 2: "Pouring Water into a Bottomless Vase"

In Korean culture, we have a metaphor: "pouring water into a bottomless vase." It means that it doesn't matter how many efforts and resources you put in the vase to fill up, if the base of the vase is not built strongly, all the efforts and resources are useless. In a way, this is similar to what Atkinson (2010) said about White social workers working in Aboriginal communities: "It is not the intention that counts—it is the result that counts" (p. 5). Sometimes, without a strong base, not only the efforts and resources become useless, the efforts and resources can do harm—it may break the vase. In this section, I explore the foundations, the "base" of *distribution* (Figure 13) of IK-S infused curricula: Building relationships with Indigenous communities.

As Glen mentioned, there are many "pens and pencils" resources for teachers provided by the Ministry of Education. Mainly, as elaborated in the previous chapter, the official K-12 science curricula documents acknowledge IK-S as one of the main knowledge foundations for science education and provide some examples in which WMK-S and IK-S can coexist and be co-taught and learned in a classroom. In addition to the curriculum, the Ministry offered:

- *Saskatchewan Customized Textbooks* (Pearson): Textbooks integrating First Nations and Métis ways of knowing and stories from local Indigenous Elders.
- *Bridging Culture* (Aikenhead & Michell, 2011): A book written for teachers to understand the importance and the "why" of IK-S–infused science curricula;
- *Enhancing School Science with Indigenous Knowledge* (Aikenhead et al., 2014): A resource book for teachers to reflect on experience and stories from teachers and researchers.
- *Elders Engagement Policy* (Saskatchewan Ministry of Education, 2017): A quick resource that briefly introduces the process of protocol and provide the references other policy documents.

In addition to these, Dean Elliot mentioned that more resources and materials have been developed by outreach organizations in collaboration with the Ministry of Education. With all of these resources and aforementioned political pressures from multiple levels,

> we [Saskatchewan] have got the message out there that . . . if you grab 100 secondary science teachers out of the province and talk to them about First Nations way of knowing in curriculum, you'd probably be surprised how many are comfortable with it and understand that's just part of what we [Saskatchewan education] do, but maybe don't have the same comfort level with how to do it. That tends to still be the challenge. (Dean Elliot, personal communication, December 19, 2016)

To this, Dawn suggested that the notion of *a learning process* needs to be understood by the teachers and other stakeholders involved in engaging with IK-S–infused curricula:

> With every single Indigenous person that I've met over my lifetime, there is an understanding that it is a *learning process*. It's not that you need to enter into it complete

> and with the entirety of the practice. My friend who doesn't call herself a medicine woman still uses those plants and still teaches about those plants, right, to the best of her capability. But she knows she's not a medicine woman so she doesn't call herself that. So there's always this understanding of work in process and learning. And it's a really deep understanding of *lifelong learning*. And everybody's involved in that, it just doesn't last K to 12, it lasts your entire life. And it isn't focused on knowing things. It's focused on becoming a more complete human being and sort of moving towards wisdom as opposed to some kind of static knowledge, right? So this understanding that people have to learn how to go, how to do, this is embedded in that process too. That maybe hasn't been communicated well and I think some of the things if you look at some of the literature around integration, they will identify there's a need for connection to, a better need for connection to community and access to elders and those sort of things. And in some places that exists and in some places it doesn't. But that understanding that it's a *learning process that has to start somewhere*, right, is absolutely part of it. (Personal communication, August 25, 2016, emphasis added)

In order to build a strong and good base for their vase, or what Dr. Eber Hampton referred to as "the quality of the partnership," (Saskatchewan Education, 2003, p. 4) teachers first need to acknowledge their status as "lifelong learners" and that learning is "organic yet focused on process embedded in the practical usefulness of getting to know how things work within a *relational* context" (Tanaka, 2016, p. 48, emphasis added). Engaging with IK-S–infused science curricula and teaching in a relational context include both understanding and honoring the importance of *relationality*: sacred ecology (that "we are all related" (Cajete, 2000) and "self-in-relation" (Graveline, 1989)) as well as building relationships with Elders and knowledge keepers that lead to the "true learning" (Ted) and "authentic ways" (Darryl). Without the understanding of the relational context, "walk[ing] along with each other" (Tanaka, 2016) and "walk[ing] in two worlds" (Styres, 2017; CCL, 2011) would not be possible. In offering some of the possible ways in which teachers could better engage with IK-S–infused science curricula in such relational context, here, I revisit my Dancing Amoeba Model (Figure 10).

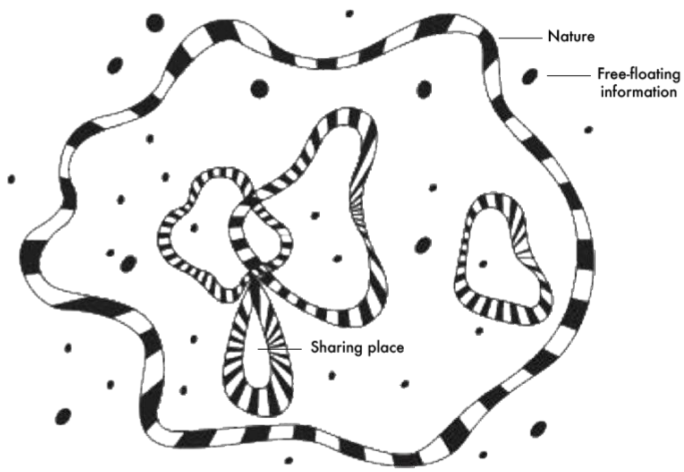

Figure 10. Dancing Amoeba Model (as introduced in Chapter 3)

As illustrated in Chapter 3, the Dancing Amoeba Model promotes the understanding of the importance of creating a space for dialogue and openness to learn and allow new ideas to emerge. The model illustrates that different cultures have their own knowledges-sciences, that the K-S production is never universal and static, and each K-S is always partially situated (Haraway, 1988). In creating science education that focuses on building mutual respect and relationships and challenging the hegemony of WMK-S and neoliberal enclosure of science education (Strong et al., 2016), the model particularly emphasizes the role of: 1) sacred ecology;

2) the permeable and protective layer of K-S, and 3) sharing place (i.e., third space). Meanwhile, as Tanaka (2016) stated, learning is:

> up to the learner to find his or her own path through the learning process, to recognize possible learning opportunities, and to decide what matched personal learning needs. This type of process happened at different rates for different learners and was unpredictable. (p. 73)

This notion of learning is similar to what Sa'ke'j Henderson told me, "whatever may stick will stick to you," in the sense that learning occurs through each individual living inquiry and it is each individual's own process and responsibility. Thus, "knowledge does not give you certainty, but possibility" as Sa'ke'j Henderson said (personal communication, May 27, 2017). It is in this regard that I share what follows: the lessons and suggestions to expand the path of possibility of "walking two worlds," "walking along each other," and reconciliation between peoples and with nature towards the shared future.

Tanaka (2016) suggested that "Indigenous teaching focuses as much as on 'learning with the heart' as it does on 'learning with the mind'" (p. xii). She also mentioned that "using 'good hands' by having a clear mind and healthy intent are deepened through a focus on physicality and doing" (Tanaka, 2016, pp. 22-23). I concur. Learning with the mind, learning with the heart, and using hands resonate with many of the teachings and stories I have been given by the sharers throughout this re/search process. Therefore, I share the lessons and suggestions for IK-S–infused science curricula, with a special focus on these three facets of learning in the Indigenous view: preparation for the head (mind), heart, and hands in relation to the Dancing Amoeba Model.

Educating the head (mind): multiple ways to come to know nature.

Firstly, the Dancing Amoeba suggests that nature should be looked as "an agent that we should build relationships with" rather than resources that are to be exploited. Therefore, I suggest that the goal of science education should move beyond the notion of "studying" nature in an objective manner to "coming to know and building relationship" with nature. Peat (1994) described coming to know as "entering into relationship with the spirits of knowledge, with plants and animals, with beings that animate dreams and visions and with the spirit of people" (p. 65). In so doing, the sacred ecology—"we are all related" (Cajete, 2000)—should be the guiding principle in coming to know process.

As elaborated in Chapter 5, the current WMK-S–based science education globally focuses on the pursuit of the goal of objectivity in studying nature, which stems from the traditions from the natural philosophy and the Baconian inductive approach (Stewart, 2010). Objectivity encourages the attitudes and thinking that separates human from nature: "the subject, as the thinking mind, knows the world as a series of objects extended in a space *external* to the subject" (Lamb, 2015, p. 17, emphasis added). Through the lens of objectivity, WMK-S becomes a tool for humans to gain control of nature, and thus place themselves as superior to any other living things with the idea that the laws and ideas of WMK-S are universal and thus can be applied anywhere, regardless of culture and context. Teachers need to recognize and challenge this "tyranny of globalizing discourses" (Foucault, 1980, p. 83) in science education, which pursues the universal, literal truth understanding of WMK-S and states that science is "objective, unitary, self- regulating . . . [and a tool of] finding the disputable truth about nature" (Ninnes, 2002, p. 558). Instead, one should remain open to multiple ways of coming to know nature and also acknowledge that they are a part of nature—that "we are all related" (Cajete, 2003). In this light, teachers can employ trans-disciplinary ways and diverse methods and knowledge sources to come to know the nature in their teaching. Styres (2017) spoke about the notion of Land (capital L), "Iethi'nihsténha Ohwentsia'kékha": "Land as an Indigenous philosophical construct is both space (abstract) and place/land (concrete); it is also conceptual, experiential, relational and embodied. Land is an expression of holism that embodies the four aspects of being: spiritual, emotive, cognitive and physical" (p. 49). As such, in coming to know nature (rather than "investigating" and "studying" nature as a commodity), one can draw upon their experience and knowledges-sciences on these four aspects of being, from diverse knowledge-sciences sources.

Here, I wish to acknowledge that my intention is not to demonize WMK-S nor demean the importance and the value of WMK-S. However, it is to advocate for opening of the minds of all students and teachers to diverse ways of coming to know nature and recognizing the possibilities of co-existence and the interconnectedness of ideas and "all our relations" on the Land, thus following a more holistic view on Nature. However, such a holistic view can be obtained through balancing different ways of coming to know nature. Indeed, Graveline (1998) stated that "wholeness or holism is equated with balance" (p. 76).

Elder Charlie Patton from Kahnawake gave a prayer and shared a creation story before the Sauvé lecture at McGill. In his prayer, he emphasized the notion of balance and harmony of WMK-S and IK-S: "If we have understanding about each other, then it brings harmony, then the harmony brings the balance, balance then brings us to be in tune with cycle of life" (Sauvé Lecture, McGill University, March 12, 2017). The Baconian inductive approach, which involves finding generalized patterns based on observations, can be *one* way. Story, metaphor, myth, ritual, mediation, art, and dreams are also ways to coming to know nature (Graveline, 1998). The key is to bring the harmony of these diverse methods and multiple ways of coming to know and creating space where multiple ways and ideas are welcomed, not judged by WMK-S's criteria. Here, I am reminded by Sa'ke'j Henderson's wisdom that it is not only the physical space that is restrained and assimilated into. It is also the cognitive space. "Let your mind relax," he said (Personal communication, May 29, 2017). Graveline (1998) also suggested that one can find their "own personal meaning from any educational experience" when they allow for a "quieting [of] the rational mind, relaxing and moving into another state of consciousness" (p. 77). For me, it was "dreaming" that allowed me to be open to new possibilities of coming to know nature and strengthened my ideas and my relationships with others. The Dancing Amoeba Model is an example. When I was pondering about sacred ecology and its relation to knowledge and science production, at certain point, I was quite frustrated as I felt that my thinking was blocked. I tried to make outlines. I tried reading more literature. I tried talking to people. However, I could not make the connection between my thoughts. One day, in my dream, the Dancing Amoeba Model appeared. The amoeba was dancing in front of me, dancing, as though it was suggesting that everything in life is forever evolving, never static, including my relations to Nature, peoples, and ideas. I got up in the morning before dawn and started to draw what I saw in my dream:

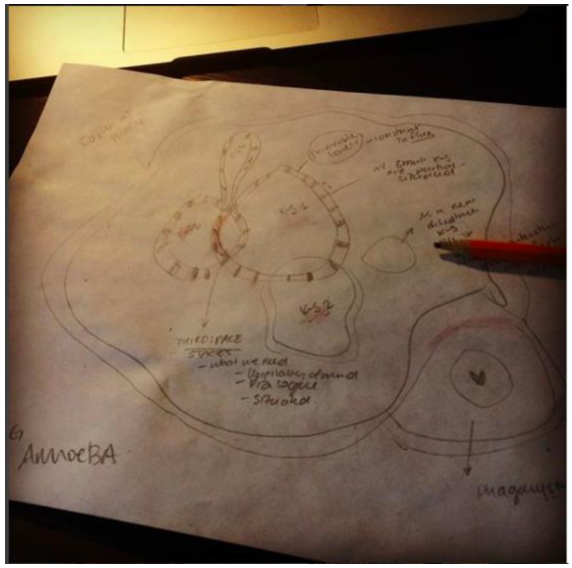

Figure 16: Drawing of earlier version of Dancing Amoeba Model after my dream

It was through this dream that I started to unpack my understanding and interpretation of coming to know sacred ecology and knowledge and the science production process, which became the Dancing Amoeba Model, a main conceptual framework of this re/search. Another example of dreams as way of coming to know was my conversation with Dr. Aikenhead in a dream, as explained earlier, which allowed me to engage further with him in real life. Dream has been a way for me to expand my cognitive space and to relax my rational mind. In my dreams, thoughts and lessons came to me in the manner of *Kemoochly*, freely yet quietly, wherein my internalized biases and WMK-S–based reductionist mode of thoughts became a less limiting factor in creatively musing with different ideas and theories and thinking and seeing the bigger picture of the relations of the concepts.

Ted also recognized non-WMK-S–based methods of coming to know nature such as ceremony. Ted mentioned ceremony as:

> the way that teaching is done. I find that with ceremony, when I first was invited to ceremony, one explained what a ceremony was. Like the very first smudge that I ever

did, I just watched the other teachers do it and I learned the teaching as we went. I found the ceremonies—the smudges—particularly when we did it every day at ten o'clock, was a fantastic way to slow our day down, to be meditative. And then after we did the smudge and we said a prayer, we passed a talking stone around, so everybody had the stone, and when you had the stone you could talk. And you talked from your heart, and it was a really good way for young people to share their heart, what was on their mind. (Personal communication, November 16, 2016)

Ted's story illustrates how ceremony can allow us to "relax our mind," which then leads us to new opportunities to better come to know nature and all our relations. Indeed, John Mohawk, an Elder of Seneca nation and a deeply rooted Haudenosaunee (Iroquois) traditionalist, explained:

> We need to understand the context of human beings and its relationship to all of life, really just animate life or even plant life. Really, all that things that support life. And that was the things that I understand why we have ceremonies. The ceremonies are the ones who keep us mindful of what it is that our role is in the world. We are not the above plants, we are not above the animals, we are not above anything. We are participants and we are nurturers. We nurture them and they nurture us. (Spirit Matters Gatherings, May 13, 2004)

Thus, teachers who wish to engage with IK-S–infused curricula first need to recognize and challenge the assimilative forces that encourage linear, reductionist, "objective" ways of studying nature, which restrict students from opening cognitive spaces and inviting multiple ways of coming to know nature. In so doing, Tanaka (2016) suggested that teachers should work to have "an integrity that is non-hierarchical and non-judgmental" in their minds, which will lead them to "the practice of mindfulness, a state of active, open awareness of what it is" (p. 201).

Ultimately, opening up to understand diverse ways of coming to know and being mindful that IK-S and WMK-S can co-exist will enable us “to be in tune with cycle of life,” as Elder Patton said (Sauvé Lecture, McGill University, March 12, 2017). Science education with a focus on *coming to know nature* with open minds to invite diverse ways of knowing, rather than studying the nature *objectively* based on the universal notion of WMK-S, can be a venue for teachers and students to engage in an act of “remembering the how to be with Mother Earth, how to be with plants, how to *be with* all our relations” (Dr. Laara Fitznor, Spirit Matters Gatherings, April 20, 2007).

Educating the heart: building relationships and honouring the protocol.

Even when teachers are committed to opening up their cognitive space and allowing multiple ways of coming to know nature in their teaching, without building relationship with Indigenous peoples, the base of their vase might not be strong. Understanding sacred ecology, and the role of opening up the cognitive space only fulfills the preparation of their head (i.e., the mind). While the preparation of their head (the mind) is important, Dr. Glen Aikenhead said that the preparation of the heart, which starts from a cultural immersion, should be a main focus in future teachers’ education:

> So in terms of professional development for teachers, I wouldn’t have anything to do with any project unless it began with a cultural immersion because we know from lots of wonderful work in Hawaii, in their projects in both mathematics and in science, that it’s the cultural immersion that makes things happen. It’s as if the *brain gets turned off until the heart gets pumping away* and the cultural immersion influences the emotions of the heart. Which is not an intellectual way of looking at teacher education, but that’s the evidence. If you want evidence-based practice, that’s the evidence…. And I’ve become a

> better person because of my understanding and my relationships with Indigenous people. So I think that's the parallel question given what we know about implementing this [IK-S–infused science curricula], that it's not just an intellectual, it's having to do with the heart and that turns out to be very important for me and for . . . I can see that happening for some students. (Personal communication, March 24, 2016, emphasis added)

Along with Glen, all the sharers that I spoke to, emphasized the importance of building relationships with local Indigenous Elders, knowledge keepers, and community members, having opportunities for "cultural immersion" (Glen Aikenhead, March 24, 2016, Personal communication), "true learning" (Ted View, November 10, 2016, Personal communication), and "visiting with and walking along" (Tanaka, 2016) with Indigenous peoples, Tina also mentioned that it was direct contact with "traditional knowledge keepers" that helped her to learn the way to teach IK-S–infused curricula—drawing from both the *head* and *heart*. In regards to what helped her the most in terms of your teaching practice, Tina explained:

> The direct contact with traditional knowledge keepers, and a variety of them. . . . it [Elders and knowledge keepers speaking] was striking the right chord with me. . . . Different chiefs and traditional knowledge keepers around Saskatchewan that I've been able to listen to and speak to have had an impact. They've really driven it home that we have to do this kind of work and specifically we need to be more cognisant of anything we do, coming from the *right mindset* or *right place in your heart*, I guess is how they put it; it's going to be beneficial for the kids, do you know what I mean? Those kinds of things keep it in perspective and takes away that fear, because you get more permission to try things because you're not as scared to screw up, so to speak. (Personal communication, January 3, 2016, emphasis added)

Indeed, as Tanaka (2016) described, it is "going directly to the [knowledge] source . . . [who] experienced life with their entire bodies, with all their senses including language and thought, to find the answers to questions to aid in their understandings of themselves and their world" that the true learning happens (p. 60). As mentioned earlier, there are already many "pens and pencils" types of resources available for teachers in Saskatchewan. These resources do not necessarily require building relationships with knowledge keepers and Elders. According to the Dancing Amoeba Model, each K-S has a permeable yet protective layer. Because of globalization and advancement of technology, free-floating information and ideas (the resources) can be exchanged freely across different cultures. However, "true learning opportunities," "authentic" learning from Indigenous communities, would not happen through these free-floating information and resources.

Styres (2017) explained that "*authentic* refers to how traditional knowledges are transmitted in ways that are emotionally and relationally appropriate, significantly relevant, purposefully, and mindfully respectful, as well as ethically responsible" (p. 84). In this light, my use of "authentic learning" here refers to learning that "pumps the heart," as Glen said, and involves emotional engagement and the commitment to ethics and responsibility that comes with the knowledge and learning. Such authentic learning only happens when one builds consensus relationships based on the trust. Unless such relationships are built, true authentic learning would not happen across the permeable, yet protective layer of IK-S. As Wilson (2008) stated, one must remember that "concepts or ideas are not as important as the relationships that went into forming them" (p. 74). This is shown in Dean's story:

> When we start working with the First Nations communities its, until you've built that relationship and offered tobacco and start to talk to people, they're just not going to tell

> you much of anything. And so, what I've really discovered is, it's just incredibly slow process and, you know, I think, in my ministry job we often fall into the, here's a project, here's your budget, go get something done. And if I just need to bring six teachers in to do something for two days, I know how to organize that, I know how to make it happen. Same thing, just some emails and I can get people to come to a meeting. But if it's going to be Elders, it's like, oh, okay, well I am going to have to go talk to people first and see if they're even interested and start to build a bit of a relationship. So, ultimately, it's probably a much better process, right, but then it slows it down in the short term. Because if you try to skip those steps, then you just may not get the Elders to say very much or they may decide to talk about something totally different than what you wanted, because they might feel that you haven't respected them appropriately. . . . And if you don't respect that, you don't get the answers you need and it's very frustrating, so it's just you have to build that relationship. (Personal communication, November 2, 2016)

Indeed, Glen Aikenhead and Dawn Wiseman also underscored the importance of relationships in their research and teaching practices engaging with IK-S. For Aikenhead, "It's not theoretical; it's from personal experience [of relationships built with Indigenous peoples] that that's the way I've developed all my research as we went along" (personal communication, March 26, 2016). Wiseman also enunciated that as a non-Indigenous academic doing research, "you have to continually build relationship" (personal communication, August 25, 2016). In this sense, teaching and research practices focusing on building relationship should be seen as a ceremony because "the purpose of ceremony is to build stronger relationships, or bridge the distance between aspects of our cosmos and ourselves" (Wilson, 2008, p. 11). In this light, it is always better to start from building relationship before planning anything, when engaging with IK-S–

infused science curricula—when doing so, educators need to take stances as learners rather than experts (Kim, 2015) and listen carefully with open hearts (Bishop, 2015; View, 2016). Focusing on learning rather than planning can help all educators move beyond the notion of collaboration to meet policy mandates, to build relationships that are based on mutual respect, trust, and honesty—and honouring Indigenous communities' protocol that one should learn and respect when building relationship with Indigenous Elders and knowledge keepers.

When I asked Ted about the most important advice that he could give to educators who wish to enter to relationship with Indigenous peoples and wish to learn about Indigenous ways of knowing, Ted told me about the role of the protocol in learning from Indigenous peoples:

> I think the most important things that teachers need to realize is that [offering] tobacco is really significant in the Indigenous pedagogy. If you don't understand tobacco teachings, you don't understand how it forms a relationship, how it creates a relationship of *tepway*; *tepway* is a *Nehiyaw* word for truth and trust, honesty. So it forms this relationship of honesty between people, and the Elder, when they accept your tobacco [or gifts depending on the traditions], what they're really saying is, "I've agreed to teach what I know from my heart." That's really significant. So this protocol is really significant anytime we approach an Elder, and I think that's the first thing that a teacher (and an academic) must learn. (Personal communication, November 10, 2016)

Herman Michell (2009), a Woodlands Cree scholar, also advised that accessing Indigenous ways of knowing involves respecting Elders and community and following protocol. Protocol involves "practices by which knowledge is handled" (Ermine, Sinclair, & Browne, 2005, p. 18). Ted explained, "The first thing I really strongly tell teachers is that the protocol isn't something perfunctory that we do. Protocol is establishing a really sacred trust and it's a way of handling sacred knowledge, a way of sharing sacred knowledge. It's a really significant relationship that you're establishing with them" (personal communication, November 10, 2016). In this light, protocol is more than a checklist of what to do and not do. It is about showing that you have prepared your heart to truly learn. Protocol is about building relationships with the knowledge holders and Elders—relationships that are built from trust, respect, and honesty (View, 2016). Meanwhile, in engaging in building relationships, one needs to commit to a life-long learning process. As Cree professor Priscilla Settee (2017) mentioned in an interview with CBC news, it is "a worldview and it takes a long time to learn how to do it [integrating Indigenous perspectives] respectfully, even for those of us that are Indigenous" (para. 2). As Styres (2017) said, "while it is true that adhering to protocols and building relationships can and often does take time—it is a necessary and critical part of *doing* the *real* work. It is far better to take time necessary to build relationship and attempt to respect and follow protocols—and risk possibility making some mistakes along the journey—than to do nothing and risk offence by replicating dehumanizing and de-relationalizing research and education" (p. 169, emphasis original).

IK-S–infused science curricula can *do real* work when teachers are committed to life-long learning journey, both engaged in their head (cognitive space) as well as their heart. Also, one must remember that it is through honoring the protocol and continuously striving to build sustaining relationships with Indigenous peoples that opens up and "pumps up" the heart of teachers for this life-long journey of learning to "walk together" towards a shared future. Indeed, all sharers I spoke with emphasized the importance of building relationships with Indigenous peoples because you cannot work with the curricular documents unless you learn and work with Indigenous peoples first.

Educating hands: examples from the classroom.

Tanaka (2016) suggested that the "notion of reciprocity, 'Giveaway,' and using 'good hands' by having a clear mind and healthy intent are deepened through a focus on physicality and doing" (pp. 22-23). Kevin Lamoureux (2016) explained that an Elder taught him that "knowledge comes with responsibility" (panel discussion, SSHRC Congress 2016). Similarly, Celia Haig-Brown (2008) shared what she learned from Mary Thomas, a Secwepemc Elder: "a learner has a responsibility to share what s/he has learnt otherwise the knowledge becomes dormant" (p. 10). Indeed, I was given a lesson by James Sa'ke'j Henderson that "if knowledge is not shared with others, then it is not knowledge" (personal communication, May 29, 2017). Therefore, teachers who have been gifted with wisdom from Elders and knowledge keepers have the responsibility to share knowledge with their students through *doing*, using their "good hands" (Tanaka, 2016, p. 22). Thus, it is important for teachers to engage in teaching IK-S–infused science curricula in their teaching by using their hands and put what they have learned into practice. In so doing, teachers can be mindful about: *preparing head, hearts, and hands* for their own teaching process as well.

In preparing the heads (minds) of a classroom as a community, reflection is key. When engaging in delivering and teaching IK-S–infused curricula, Brayboy and Castagno (2009) cautioned teachers to avoid "simply inserting" IK-S as this would not offer students the *authentic* learning opportunities (p. 270). Indeed, Ninnes (2004) described many examples of "simply appropriating others' knowledge with the unintended effect of maintaining the dominance of scientific [WMK-S] epistemology" (p. 83). In turn, Brayboy and Castagno (2009) suggested that "teachers and students must be clear about the assumptions that are often made about valid scientific knowledge and that there are other ways of thinking about and engaging in science" (p.

270). In the same vein, Ryan (2008) also mentioned that, in the classroom, it should be explicitly mentioned that "science is negotiated, not discovered" (p. 679). When engaging with IK-S–infused science curricula in teaching, teachers must acknowledge and challenge students' (as well as their own) assumptions and understandings of what counts as science.

As mentioned earlier, the effects of the "neoliberal enclosure of science education" (Strong et al., 2016) wherein WMK-S becomes the true, universal, and only legitimate form of sciences continue. If not reflected on it and resisted, WMK-S acts like a "vampire amoeba" that potentially may harm students' process of coming to know nature through multiple K-S.

Figure 17. Picture of Vampire Amoebas. (Retrieved from http://www.bbc.com/earth/story/20141031-the-tiniest-vampires-in-the-world)

In order to counter the ongoing influences of the neoliberal enclosure (and avoid vampire amoebas in science education), teachers can start contextualizing their learning space (Ryan, 2008; Strong et al., 2016). First, they can acknowledge and honour the traditional territory and its original inhabitants. In so doing, teachers and students can both start the conversation about the Land (both as place as well as worldview) and the history of colonization and discuss why it is important to learn about the geographic place and understanding of nature by the local

Indigenous community. As Darryl pointed out, “so many of our [SK] students go through their whole educational career without actually learning about the original inhabitants of this land, and we just need to change that. . . . It [Elder’s stories] speaks to the Indigenous science that needs to happen, and needs to be appreciated by students” (personal communication, October 26, 2016). Indeed, contextualizing their local space by acknowledging the traditional territory and its original inhabitants and continuous reflection on their assumptions on the hegemony of WMK-S together as a class will prepare the heads (minds) of students for diverse ways of coming to know nature. In this way, the classroom as a community may engage in what Battiste (2013) called a “two-prong process” of decolonizing education, which entails “*deconstruction* of (neo-)colonial structure and strategies and *reconstruction* that centres and takes seriously Indigenous, diasporic, and other post-colonial ways of knowing and ways of being towards reshaping the place-based process and priorities of education” (Higgins, 2016, p. 13, emphasis original). In other words, class as a community can “re-wire and [then] come together in a different way” (Tanaka, 2016, p. 23)

Second, teachers need to acknowledge that teaching with IK-S–infused science curricula is about creating “sharing place” (see the Dancing Amoeba Model, Figure 10) where multiple ways of coming to know are encouraged and new interpretations and ideas may come out as a result of dialogue. As such, teaching should be student-centered, inviting students’ lived experiences and ideas to be part of the sources of knowledge. Moreover, just as cultural immersion and “true authentic” learning were important for the preparation of their hearts, teachers should strive to provide the same opportunities for their students as well. This could happen in diverse ways. One can invite knowledge keepers and Elders in their classroom (or vice versa) or teachers can share what they have learned from knowledge keepers and Elders with students with permission from the knowledge sources (Kim & Dionne, 2014). Meanwhile, the wisdom keepers that Tanaka (2016) worked with believed that "once learners knew the basic skills, they could then come up with their own interpretations and ways of creating" (p. 78). Teachers often have the fear of making mistakes in engaging with IK-S–infused curricula (citation). As Darryl mentioned:

> I remember one conversation with a close colleague of mine, and you know, there's a belief that if you're not Indigenous out here, that you can't teach anything Indigenous. And I said, "You know, you can always teach history, you know? No one would ever ask you to teach a ceremony, or anything like that." I said, "But you can always teach history from an Indigenous perspective." And he said to me, "Well no I can't, I'm not Indigenous." And I looked at him, and I said tongue in cheek, I said, "Well, you're not Greek either, but you teach their history every year." And he paused for a minute and had no come back to what I had just told him.… One of the biggest pieces about learning from an Indigenous perspective, is that, you know, a mistake is just your first try, and that many of Elders we work with—I am so appreciative of them, because we all make mistakes, we're human beings, and I just remember making mistakes sometimes, and they're just so gentle in how they let you know that you've made a mistake, and then guide you in the direction that you need to be guided. (Personal communication, October 26, 2016)

Indeed, as Tina's earlier story mentioned, the direct relationships with knowledge keepers and elders and their encouragement helped her "keep it [teaching with IK-S–infused curricula] in perspective and takes away that fear, because you get more permission to try things because you're not as scared to screw up, so to speak" (personal communication, January 3, 2016). As such, teachers should be mindful that engaging with IK-S–infused science curricula is a life-long learning process, and they may make mistakes. However, as Thomas and Green (2008) mentioned, through mistakes, one should reflect and learn and take another journey to "take risk and try things," as Darryl explained (personal communication, October 26, 2016).

When inviting Elders and knowledge keepers, teachers should follow the protocols, as mentioned previously, and always remember the importance of offering tobacco (or other gifts, depending on the nation), building trust, and the process of the preparation of the head and hearts. Also by inviting Elders and knowledge keepers to a class, teachers are engaging in extending and strengthening relationships, not just fulfilling educational mandates and objectives. Ted also cautioned against inviting Elders and knowledge keepers with a perspective of: "Okay, I've fulfilled the objective about First Nations Métis ways of knowing, check. I think if you go about it that way, then you've gone about it with the wrong spirit" (personal communication, January 28, 2017). With such an attitude, one cannot build a strong base of the vase, as the earlier Korean metaphor depicted. In fact, such an attitude may contribute to breaking the vase. Therefore, one must be mindful that creating a sharing place in a classroom is about providing authentic learning opportunities for students to engage in building relationships with knowledge keepers and Elders. In this light, teachers play a sacred role of extending and facilitating the relationship-building process in their teaching and creating a sharing space. As such teachers should be vigilant about preparing their own head and heart beforehand.

Stories from Teachers Engaging with IK-S–Infused Science Curriculum in Their Classroom.

In this section, I share three stories from the three teachers (Ted, Rory, and Tina) regarding their ways of engaging with the IK-S–infused science curriculum and of creating a *sharing space* for their students. These stories show the consumption (Fairclough, 1989) aspect of interpretation from the Fairclough's model (Figure. 13). As such, the stories illustrate the ways in which these teachers engaged with IK-S infused science curricula in their science classrooms.

It is my intention to bring in as much context regarding each teacher's relationships with Indigenous peoples and their own students. In so doing, I, myself, as a re/searcher engage in the creation of sharing space within this dissertation, thus facilitate the conversations between these teachers and the readers. Moreover, in sharing their stories I hope to offer some examples and also illustrate that there is no universal way of teaching IK-S–infused curricula; the pedagogy depends on teachers' relationships with knowledge keepers and Elders and their "own path through the learning process" results in diverse ways of engaging with IK-S in their teaching (Tanaka, 2016, p. 73).

Rory's story: "I just found it was complementary".

"I was part of the vetting process [for curriculum development process] with First Nations Elders and knowledge keepers so I got to meet a variety of different people from around the province and I had two days with the 20 level sciences and I had another day where I spent some time vetting for the physics 30, chemistry 30 curriculums with another group of First Nations Elders and knowledge keepers. Some of those people were the same people that I had worked with the year previous on the 20 levels for vetting, as I did on the 30 levels for vetting.

So you get an opportunity then to spend a full day or full two days or three days with these people and really get to know them and they get to know you and you start to build that trust. So I had an advantage that way. So some of those people were very willing to come and come to your school and you know, we acknowledged right off the start that it was going to be more challenging for physical science 20 or for Physics 30 or Chemistry 30—let's say, very more challenging to be inclusive in having them come in and try to talk about their way of understanding that perspective that we would do in science for those particular subject areas. But we just said, you know what? We have [things] in common, we have the four elements. The four elements are, you know, a natural place of origin that the Medicine Wheel that is an integral part of all Indigenous perspectives, and four elements, that is the historical Greek perspective of science. It was the four elements. And if you look at a Chinese Buddhist sacred circle, also refers to the four elements. So the four elements is a very common way of looking at things.

So, I invited them, one of the Elders to come into the school and have a talk and you know, we were able to do this with not just my science class but then our Native Studies class and we could have the Social Studies group all tie into this person coming into our community for the day. But for me, just my perspective for science, we tried to relate—so at that time it would have been Physical Science 20 that I was doing, how can I relate foundations of chemistry. So we talked about, okay so you have chemistry of solids, and you have chemistry of gasses. You have chemistry of liquids, so how does that related to the Earth, the air and the water, right? So we look at those three parts of the Medicine Wheel. And then, of course, all chemical reactions are exothermic or endothermic, so heat is released, so that would relate to fire on the Medicine Wheel. When we looked at heat, so it was chemistry, so we looked at heat perspective, the sun is obviously fire and then of course the sun heats the Earth, the sun heats the air, the sun heats the water. So we can talk about all four elements being present in heat again, and as well as warming the Earth and then warming the air and of course water being the most common element here on Earth, we can talk about solids, liquids, gasses, phase change and all that sort of stuff. But from the perspective of the Medicine Wheel.

And then when it came to waves, we said there are waves in the Earth. We've got earthquakes. There's waves in water. We have waves at the beach. There are waves in the air.

We have atmospheric high and low pressures. The air is always moving, there's weather systems come and go, and all of that is driven by the – you know, heat received from the sun and the tilt of the Earth, and that sort of stuff. So again we tried to related the concept of waves to the four elements of the Medicine Wheel.

So really it's just let's look at it from a First Nations perspective, the four elements, and then how does the Eurocentric model that we are teaching in school foundations chemistry, heat and properties of waves, how is that really same thing from a Medicine Wheel or four elements perspective, and the two actually went- they really complemented each other I found. It wasn't as abstract as you would think. They actually have a lot of commonality there."

Amy: Thank you. And how would the students react to it when they were learning about this?

"I mean I can only talk from my perspective again, but the students were very respectful. They were very accepting. They were very engaged in, you know, the stories that were being told and how, you know, you could talk about the four elements and how they related, their interconnectedness form their perspective, and then we can talk about it—or I guess, I am more comfortable obviously talking about it from a science perspective. But just an appreciation how we're looking at the same thing. When we look at the ocean, we're looking at the same thing. We're just looking at it—the same coin, two different sides. But it's still the same coin, right? And the kids are very engaged. They understand it totally. They're very receptive to looking at it from different perspectives. And again, I just found it was complementary. There wasn't anything about it that would have been contradictory. And to me again, it helps with adding diversity and inclusion in science education. This is not just something that we do, you know, in a lab wearing white coats and safety glasses. This is something that happens all around you. In the world around us and we're just trying to understand it holistically. Not reductionist perspective."

Ted's story: "I see ways that we can benefit from both systems, if nothing but to teach kids a deeper appreciation of the land, the earth and everything around us".

"The way school worked at that time is that we team-taught. So they would pair up two teachers at the same time and we taught about thirty students, and I was paired up with Delvin for the first semester. His background is in First Nations Métis ways of knowing. He's got a Bachelor and a Masters of Education as well, but his specialty is Cree language—First Nations languages. And so we were assigned to teach a science class together, and so I would lead teaching the science content, and then he included all the Indigenous ways of knowing. So we did a very unique, very awesome hybrid blend. So he would add all the Cree words, I would talk about the science and Western science terminology, and then he gave the *Nehiyaw* world view, and then he would incorporate all of the teachings that he gave. And that's how we did, I believe, a very genuine integration of Indigenous ways of knowing in science. And so that's what made me realize that it's possible that these two worldviews, as disparate as it may seem, to have very complementary elements from which both people can learn from each other. Part of that is having the openness as a teacher, because I remember, there was one class where I taught and Delvin wasn't there—this was a science 10 class, I believe—and we were embarking on a concept of biotic and abiotic. So I gave the scientific explanation of it, and I looked around the room for examples of abiotic, and I picked up a stone—and I don't know what possessed me to do this—I picked up the stone and I said, 'Is this biotic or abiotic?' And no one replied. And I said, 'Well, you know, from a science perspective, this rock is abiotic,' and one young man, he raised his hand and he said, 'In our culture that's wrong; it's not right in our culture.' And I said 'Well, what do you mean?' And he said, 'In our culture, the rock has a spirit. All different things, all created things have a spirit.'

So at that point I had a choice as a teacher: I could say 'Well, you're wrong—your ideas, your cultural ideas have no value in a science class.' Or I can open my heart and my ears and listen, and that's what I chose to do. And I said, 'Tell me more.' And then he said, 'Well, in our culture the rock is considered animate. That means that it gives life.'

Think about it. And when you kind of delve down, it makes sense. We have calcium in our bones that comes from the earth that's rock, and we have phosphorous, all of these elements that we need. You know, electrons don't fire without the elements of sodium and chlorine. The ion pumps in our nerves in our nerves don't fire without those elements, and sodium is from the earth. And when you put it in that perspective, yes, rock gives life. And from their view, the earth is sacred, the rock is sacred, so obviously teachings from Elders regarding the rock as a grandfather one of the *akday yukanak*—*akday yukanak* means the grandfather sprit, and so like the air, fire… So I see ways that we can benefit from both systems, if nothing but to teach kids a deeper appreciation of the land, the earth and everything around us."

Tina's story: "I learned a lot from the kids".

Amy: You talked about the powerful sweat ceremony. Can you tell me little bit more about that? How did it actually all start? Was it suggested by the members of Indigenous community, or was it actually suggested by some of the students, or was it just conversation emerged from you and knowledge keepers?

Tina: "Yea, so actually that's really funny, because that came out when you have opportunities to learn. Our school division offers, I believe, two seasonal sweats—one per semester—and so when they were starting to offer these, I decided to try it, because I'd never been in a sweat.

And so I went with my colleague, who—we started that [problem-based learning program for grade 11]—together and so we decided well, let's try it, because we were curious about it. And we were wanting to really include that Indigenous voice in our work with students.

It was a completely different course, it was problem-based learning and students were not taught by us at all, but—that sounds kind of bad, but we actually created opportunities for them to work through their case studies, and we worked in collaboration with the College of Agriculture, who helped us find different businesses and people—I guess speakers—and we had farmers and we had people come from the *Western Producer*, which is a newspaper out here that most farmers subscribe to. And so we had all these different contacts throughout the agricultural community that came in and were part of our voices, because these kids got case studies to work on to help them through the objectives of the courses we were giving them credit for.

So what would happen is, we would organize with these people to come in and speak to them at various times and these kids were working in groups of eight and they would we'd give them the introduction to the case and they would have to learn about that on their own, so they got time to research.

"Then we would facilitate by bringing in these experts and they would have to use the information they gleaned from these experts to help them with each selection of each case. And at the end of cases, they had to present to these professionals and superintendents, or whoever we could get to come and watch their presentations, and then they got evaluated and assessed by their solutions to the cases.

"So to me, that's true education. I loved every second of those classes, but the problem was that a lot of the work that we did was place-based.… That's kind of a background of that class, because it was very different, so we were given a lot of freedom and it was very successful. But the reason why that Indigenous piece came in, was because it was built into the idea of these cases, and that this was going to be how it was going to be threaded through every case. The kids knew that they had to have an Indigenous perspective in every case, so we had to rack our brains on how to make sure that they were given enough to that opportunity, so that's why we had to learn more.

"As teachers, we decided to go to that sweat, and then from there I spoke to Donnie, and he's sort of one of our main cultural guys for First Nations Indigenous work in our division. He helped us organize a sweat for our class. He's the one who got me to sort of organize it with my students. He came in and explained what it was about and he spent a whole hour and a half explaining to them and answering their questions, and the kids thought about it. I said to them, 'it's up to you totally; you are not going to be punished if you don't go, and if it's the moon time for the girls, then they're not allowed to go. So if you elect not to go, that's fine.' I had only two students that didn't do it, out of thirty two, and the rest of them—and the only reason they didn't was, again one was on her moon time and the other one, he's a big summer hockey player and he had a big tournament coming up and it would have just completely depleted him, so he couldn't participate. That was kind of how that came about. It just sort of evolved because you're kind of trekking down that track, and then the right people fall into place and it's good time to try something. . . . [Indigenous perspective] played a really strong role [for the course]. I feel like the kids, I think the students really gained an understanding of the Indigenous role in and why Indigenous people have such a strong affiliation for protecting the environment. The students were much more in tune with Indigenous knowledge and much more empathetic to the Indigenous situation in our country because they had to consider it from various perspectives based upon the various case studies they studied.

“Because they were allowed to—we tried to set up experiences like the sweats and bringing in our traditional knowledge keepers, but on their own, in their work time, they were allowed to kind of pursue whatever direction they wanted.… It was amazing. I learned a lot from the kids doing their presentation, because every piece of their cases had to include that Indigenous piece. Because it was ingrained in them, they became very fluent in that understanding, and just accepted it, you know what I mean? Like kids are so good at that … when I think of the quality of the learning, it’s just so much better and so much more rich in that other environment, because it’s them [students] controlling it and they can expand it to make it something that makes sense to them.”

Reflection on the Lessons Learned from the Sharers

The examples shared by Rory, Tina, and Ted show that there is no universal way to engage with IK-S–infused science curricula in teaching. In collaborating with an Indigenous Elder, Rory tried to showcase the commonalities and complementary between IK-S and WMK-S for students to understand nature holistically. For Ted, it was a daily experience of co-teaching with an Indigenous teacher, whereby students were continually encouraged to look at all phenomena introduced in class in a “two-eyed seeing” manner (Hatcher et al., 2009). When tension and conflict of ideas between WMK-S and IK-S arose, Ted allowed students’ lived experiences, ideas, and stories to come into the learning space and created opportunities for students to engage in dialogue. In such a way, he was able to shift his WMK-S–based understanding of science (e.g., rock as abiotic to living things) to an IK-S–grounded understanding of nature as a living agent. Tina focused on creating true learning opportunities for students. She offered opportunities for students to participate in a sweat. She allowed students to self-direct their ways of getting to know IK-S. In turn, Tina learned from the students, thus creating a *sharing space* wherein students and teachers co-constructed knowledges together in the classroom (Strong et al., 2016). However, all of these teachers, before using their hands, went through a preparation of their heads and hearts by building relationship with Indigenous Elders and knowledge keepers. Also, in their teaching, they allowed students to create a sharing place wherein diverse ways of coming to know natures are invited.

In this chapter, I advocated that teachers should contextualize their learning space in relation to the original inhabitants of the land (e.g., acknowledge the traditional territory) as well as provide authentic learning opportunities for students wherein students are invited to further build relationships with Elders and knowledge keepers. In so doing, teachers should be mindful that it is life-long learning process and focus on providing a true learning opportunity, albeit it may be a small opportunity. Dawn mentioned:

> when I talk with Lisa or Florence or other people is . . . really the value of people having *one good experience* doing this. And how much it can shift them their understanding it's really . . . it's surprising. I've watched it happen in my own courses sometimes with everybody. And it's really, really surprising, like really spectacular things can happen. (Personal communication, August 25, 2015, emphasis added)

Also, Glen mentioned that engaging with IK-S–infused science curricula may start from one or two days of cultural immersion and such immersion is a good starting point. The chapter has illustrated that there are already many "pens and pencils" types of resources and policies supporting IK-S–infused science curricula. What needs to happen now is that teachers and students need to be provided with opportunities to start preparing their head and hearts—and engage in reconciliation with Land and peoples—by building relationships. Also, teachers need to start from somewhere—by engaging with their heads, hearts, and hands. However, as Sa'ke'j

Henderson said, “the path between mind and hearts is tangled and complex” (Personal communication, May 29, 2017). Thus, one must not forget that it is a life-long learning journey and through continuous reflection and strengthening relationships with peoples and land, one can move towards understanding their path between their hearts and mind. As many sharers mentioned, in order for IK-S–infused science curricula to thrive, there must be actions from multiple levels. However, teachers are the “critical nuclear mass” in changing the relationships between IK-S and WMK-S in Eurocentric science education (Glen Aikenhead, March 24, 2016, Personal Communication). In this light, I encourage teachers to start engaging in IK-S–infused science curricula and be mindful that there is no “quick learn and fix” way to do so. It is life-long learning process and it’s a “learning process that has to start somewhere” (Dawn Wiseman, personal communication, August 25, 2015). Also, as Rory said:

> Obviously we’re going to have some setbacks, some failures and not everybody is going to be real comfortable with it. But eventually over time it will sort of become the norm. It might take longer in some cases than in others, but what we have to do is we have to get people to start. Start with this journey and then once you start, then of course the next step will always follow. You will find more ways to integrate, you will find more ways to include more people hopefully will be drawn into the process, and it just eventually becomes your new norm. Your new cultural way of doing science education. (Personal communication, December 12, 2016)

And it also starts from one good experience.

In the next chapter, I reflect on all the ideas and lessons I learned and grappled with throughout the process of this re/search project, going back to the beginning of the circle of this re/search process, the academic and personal purpose.

Chapter Eight: Final Reflections on This Re/search—Yet Another Beginning

In coming to the end of this re/search project, I remembered a story that was told by my (paternal) halmonee.

Figure 18. The Scholarly Man and the Tiger

옛날옛날에, 어떤 선비 한명이 밤에 산을 넘어가고있었는디, 그 산은 아주 컴컴하니 아무것도 보이지가 았았다. 혼자서 저벅저벅 산을 걸어가고있는데, 글쎄 저 컴컴한 굴속에서 호랑이가 보이고있지 않겠느냐, 그래서 그 선비는

A long, long time ago, there was a scholarly man walking on the mountain on a chilly, dark night. It was so dark you couldn't see an inch in front of you. This man was walking on the mountain and he saw a tiger in a cave. Then the man picked up a long wooden stick

옆에있는 길쭉한 나뭇가지를 하나 주어가지고 설랑, 툭 하니 굴에 그 나무를 집어넣더니, 호랑이가, 끽 하고 굴속으로 들어가더란다. 다시 나뭇가지를 굴속에서 빼면, 홱 하니 호랑이가 굴속에서 나오고. 다시 나무를 휙 집어넣으면 호랑이가 끽하고 굴속으로 들어가고, 나뭇가지를 들어갔다 나왔다, 호랑이가 나왔다 들어갔다, 아 글쎄 밤새 그러고 있었지뭐냐. 결국에는 그 선비랑 호랑이는 지쳐서 죽고, 날이 샜는데. 지나가던 나뭇꾼이 이 죽은 선비와 호랑이를 본것이지. 호랑이 가죽을 벗긴다음, 나뭇꾼은 선비랑 호랑이랑 를 잘 뭇어주고, 좋은길 가라고 빌어준뒤, 호랑이 가죽을 팔아서 돈을 많이 벌었단다.

that was near him, and he put the stick into the cave. When he put the stick into the cave, the tiger went further into the cave. When he pulled the stick out of the cave, the tiger came out of the cave. The man's stick went back and forth—and the tiger came in and out—for the entire night. Finally, the scholarly man and the tiger used up all of their energy and died when the sun rose the next morning. A woodcutter who happened to pass by the mountain in the morning saw the bodies of the man and the tiger. The woodcutter buried the bodies of the scholarly man and tiger, and prayed for their afterlife and he sold the skin of the tiger—and he made a lot of money.

The story lingered in my mind while I was writing this dissertation. I decided to create a collage depicting the story and take time to reflect on the story and wait for the questions and wisdom to come *Kemoochly*. While creating the collage, the questions appeared to me: Why had my halmonee told this story to me? Was it a simple bedtime story? Or was there any wisdom embedded in the story? I started to ask questions. What if the scholarly man never put the wooden stick into the cave and never tried to hurt the tiger? What if he simply passed the tiger by? Would they both be alive? Or might he have been killed and eaten by the tiger regardless? Why do humans tend to automatically take the offensive when encountering unfamiliar animals in nature? The outcome of the hostile gesture of the scholarly man was destruction—his death as well as the death of the tiger. What if it was a woodcutter or another person who knew how to live with animals who had encountered the tiger? What would be the end of the story then?

Exploring the overarching guiding question for this re/search project—what are the relationships at play in integrating IK-S in science curricula?—helped me answer these questions that lingered from my halmonee's story. In this chapter, I reflect on the product (i.e., conclusions) from each chapter. Acknowledging that the process is as important as the product (Kovach, 2009), in each chapter, I've reflected on the process of re/search throughout this dissertation. In reflecting on the lessons learned and shared in each chapter, I am engaged in a cycle of learning yet again, trying to see the lessons that did not emerge before.

As Shawn Wilson (2009) mentioned, "if research doesn't change you as a person then you haven't done it right" (p. 135). Indeed, throughout this re/search journey, I have changed as a person and as a re/searcher. As well, my research project changed based on the relationships I built or lack thereof. Thus, in reflecting on each step of the re/search, I focus on the changes and evolution of my own ideas that I experienced and encountered, and also reflect on the lessons and wisdom illustrated throughout this dissertation.

I started this dissertation, in Chapter 1, with the reflection on my personal purpose and motivation of doing this re/search project. This was due to the lesson I received from various Indigenous scholars who emphasized the politics of truths (Kovach, 2009) as well as the importance of relational writing. Also, as Dr. Eber Hampton (1995) said, "memory comes before knowledge" (p. 52). As such, I reflected on my earliest memories of Indigenous cultures and peoples, as well as impacts of White supremacy on my learning and thinking process through autoethnographic study. Reflecting on my memories enabled me to explore my internalized biases and the influences of White supremacy throughout my education and religious practices from my childhood. I stated that my personal purpose of doing this re/search was to engage in a process of "becoming an ally" to Indigenous peoples—particularly, becoming better friends with the girls I met on the reserves. I also learned that becoming an ally is never over (Bishop, 2015) and continual self-reflection is needed.

In the next chapter, I delved into the academic purpose of doing this re/search (Kovach, 2009). I reflected on my understanding and the usages of terms including Indigenous (I), indigenous (i), and decolonization based on the literature and stories told by various Indigenous scholars. In reflecting on the terms *Indigenous* and *indigenous*, I considered my positionality and stated my position as a settler to Turtle Island and indigenous to Korea, thus, not Indigenous. I also reiterated the importance of *being grounded* and knowing my *politics of truths* (Kovach, 2009). I stated my academic purpose as the decolonization of self and institution. As Dr. Fitznor said:

> Decolonization means willingness to see and look back to history behind. Everyone needs to be decolonized. Not only Indigenous peoples. In engaging with decolonizing activity, asking questions such as Where is power dynamics? What do *I* encourage through this activity? are important. Also, decolonizing activity involves supporting Indigenous sovereignty, including Indigenous feminist sovereignty. (Personal communication, March 26, 2016)

As such, I continued to reflect on my history and process of this re/search as well as continued to challenge the *colonial frontier logics* (Donald 2009) that work towards inserting divisiveness between Indigenous and settler peoples. Acknowledging the importance of "looking back" when engaged in a process of decolonization of self (Fitznor, 2016), I reflected on some of the academic encounters I had with IK-S in my trainings in biology and education that influenced the development of this re/search project and showed that it is based on the *relationships* that I built or lack thereof. I also introduced the principles that have guided me throughout the process of this re/search: *Inter esse* (Wiseman, 2016), *Kemoochly* (Fitznor, 2016), and *self-in-relation* (Graveline, 1989; Kovach, 2009).

First, situating my re/search as *inter esse*, I showed my commitment to engage in multiple ways of knowing and doing research. Particularly, I committed to listening to the stories and wisdom of Indigenous Elders, knowledge keepers, and scholars. *Kemoochly*, a "Cree-ish" word meaning "working against" and "in-secret" taught by Dr. Fitznor, has guided me to continue to reflect on my internalized biases and resist my tendency to follow a linear and reductionist approach of doing re/search. It also allowed me to become open to learn and wait for the lessons and ideas to emerge, rather than try to control the re/search process. *Self-in-relation* has reminded me that I am part of this re/search process as well as allowed me to continuously reflect on the process and product of this re/search based on the relationships that I have with others, rather than looking to find a cause and effect.

In the third chapter, I introduced the continuum bar of IK-S as well as the Dancing Amoeba Model. The continuum bar (Figure 7) illustrates the diverse voices and stances on IK-S–infused science curricula.

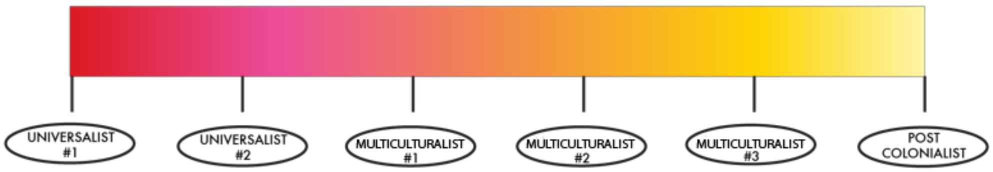

Figure 7. Continuum bar of Different Stances in Science Education (introduced in Chapter 3)

I also argued that current global science education is mainly Eurocentric and dominated by WMK-S due to the neoliberal enclosure of science education and universalism (Strong et al., 2016). As such, WMK-S becomes the commodity for success as well as the "truth" in science education while IK-S continues to be marginalized (Ninnes, 2004). In turn, I argued for science education that encourages a multiplication of knowledges-sciences rather than promoting universalization and the neoliberal enclosure within science education.

I put forwarded the Dancing Amoeba Model (Figure 10), based on the wisdom received by Indigenous Elders as well as literature from both Indigenous and non-Indigenous scholars, to show the relation between diverse K-S and ways in which educators can engage in the multiplication of K-S.

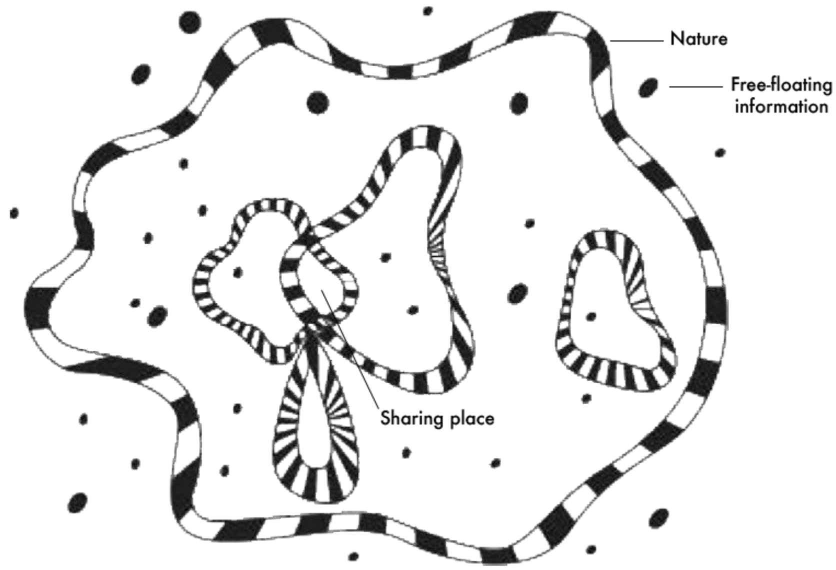

Figure 10. Dancing Amoeba Model (introduced in Chapter 3)

The dancing amoeba played a huge role in this re/search. It guided me to continue to reflect on the relations between multiple ways of knowing as well as the importance of building relationships for research and teaching IK-S–infused science curricula. The Dancing Amoeba Model mainly communicates the following ideas:

1) Nature encompasses us all: Respecting the *sacred ecology*: we are all related (Cajete, 2000). All knowledges-sciences produced from different cultures are part of the big Nature (i.e., Mother Earth) amoeba. Nature should be seen as a living agent that we should build relationships with, rather than as a commodity. As well, nature is always fluid and ever-evolving, therefore it is dancing.
2) K-S amoebas and permeable/protective layers: Based on culture, different knowledges-sciences (K-S) may emerge, thus there are multiple K-S amoebas in our world. Each K-S amoeba is situated in a particular context based on a culture and place, and offers a partial perspective of the world (Haraway, 1988). Moreover, each K-S amoeba is encapsulated

with a permeable layer. Due to globalization as well as the advancement of technology, there is free-floating information that could be shared from one K-S amoeba to another K-S amoeba without building relationships. However, the layer is also protective. Certain knowledge is only available when the relationship is forged based on trust and is not available from the free-floating information (e.g., "pens and pencils" types of resources).

3) Sharing place: When multiple K-S amoeba meet, a sharing place (i.e., a third place) may be created. This is a space for building relationships and sharing dialogues. Some may share the knowledges-sciences and go their separate ways, and some new ideas and new K-S may birth out from the interaction in the sharing place.

Through the Dancing Amoeba Model, I continued to reflect on the IK-S representation in Saskatchewan's K-12 documents, stories from the sharers, as well as other historical and political contexts in Saskatchewan. The Dancing Amoeba Model came to me through a dream. Through my experience with the development of the Dancing Amoeba Model, I experienced diverse ways of coming to know. This happened through conversations with people, reflection on the literature, letting my mind relax (Henderson, May 29, 2017, Personal communication), and resisting the linear cause and effect approach of thinking that the model was developed *kemoochly*.

In Chapter 4, I illustrated the methodology I employed for this re/search project. I first acknowledged that my usage of the term *methodology* refers to theory, practice, and ethics (Barad, 2007, 2010). In this re/search, I've learned to think about theory as one of my relations. As such, I continued to reflect on my relationships with theories and realized that theories drove other concepts and ideas that I encountered during the practice of the re/search process (e.g., data collection, analysis, and writing). Indeed, St. Pierre (2013) emphasized the role of theories, as “there are no data without theory that orders and gives classification to the things of the world” (p. 225). I reflected on my neoliberal mentalité (Olssen et al., 2004) and that I need to consider the ways in which neoliberal thinking affects the way I think and do re/search. I also illustrated how my research resonates with Foucault’s (1980) notion of “power as relation.” This involves focusing on the notion of relationships in considering data sources. Foucault’s power as relation led me to Fairclough’s (1989) three-nested model, which emphasized the relation between text, discursive practice, and social practice. Based on the three-nested model, I conceptualized the data sources for this re/search. Recognizing that we are all related, I chose to approach my relationship with my data as an invitation rather than a mere transaction, which required constant reflection throughout the research process. Therefore, I invited curriculum documents for the textual level, stories from different educational stakeholders (whom I refer to as “sharers”) for the discursive level, and the history and policies related to Indigenous education and science education for the social level (Figure 12). I also introduced some of the analytic frameworks such as three aspects of IK-S integration (Lipka et al., 2005): priority scale, notion of consultation, and collaboration (Wiseman, 2016); and the five stages of colonization in integration of IK-S (Afonso, 2012). However, I realized that as much as the re/search project was changing based on the relationships forged, I, as a re/searcher, was also changing. Albeit these analytic frameworks helped me conceptualize and make meaning from the data collected, it was through understanding the role of relationships, specifically looking at the relationships between data, as well as embracing and reflecting on my subjectivity within the re/search process, and waiting patiently with openness to learn through the process, that allowed me to unpack the guiding question of this re/search— what are the relationships at play in IK-S–infused science curricula? I also found the processes of “waiting with mindset of *Kemoochly*” (Fitznor), “letting my mind relax" (Sa'ke'j Henderson, May 29, 2017, personal communication), and "following my cadence" (Tim O'loan, January 30, 2017, personal communication) to be necessary in re/search.

In my methodology section, in Chapter 4, I stated that I planned to use Afonso's (2012) five stages of colonization (Table 4) in identifying Saskatchewan's stage.

Table 4. Five stages of the integration of Indigenous knowledge systems.

1. Colonization	Indigenous knowledges (IK) are not recognized as valued knowledge
2. Decolonization	Awareness of the value of IK starts to take place in debates on curriculum policies in education (i.e., a conduit for assimilation of IK into the Western paradigm)
3. Neo-colonization	Content integration: Process that undermines the cultural values of a society (e.g., integration that teaches Western science to Indigenous students and uses IK as a resource to clarify Western science)
4. Rebirth	Researchers and educators interrogate the lenses through which IK is communicated, argue for the inclusion of IK, and question the way in which it has been included/integrated
5. Theorizing	Researchers and educators are more concerned with justifying the claim for co-existence of different discourses in school curricula and seek to address ontological, axiological, and epistemological issues in including IK in school curricula (e.g., how do we teach IK?)

However, while I tried to categorize the findings from this re/search based on these five stages, I realized that this is not quite possible, as I've learned that engaging with IK-S–infused curricula involves multilevel processes from governments, teachers, and grassroots social movements. Moreover, such multilevel processes are not always chronologically linear, and may happen spontaneously. Thus, I cannot follow a reductionist approach of identifying a stage of colonization and trying to generalize all the cases, historical contexts, policies, and stories I've encountered into a stage. As seen in the examples of teachers' stories illustrated in Chapter 7, different teachers take up the IK-S–infused curricula in different manners based on many different factors, including the relationships forged with Indigenous peoples, school cultures, and so forth. In this light, the only identifiable data source that aligns with Afonso's (2012) framework is the findings from the curriculum documents analysis.

Based on the curriculum documents analysis (Chapter 6), I found that Saskatchewan is closest to the *neo-colonization* stage and moving towards the *rebirth* stage. The neo-colonization stage names "the subject of IKS [IK-S] but teach[es] it within the Western Science framework" (Afonso, 2012, p. 28). According to the SK curriculum documents analysis, IK-S not only appeared as examples of WMK-S–based learning outcomes, IK-S appeared as a knowledge source, along with WMK-S, and detailed descriptions of the similarities and difference of IK-S and WMK-S were introduced in the documents. Both systems are considered to be "empirical and rational" knowledges, and thus earn a place within curriculum documents. Setting the criteria regarding what should be included in science curricula, the Saskatchewan Ministry of Education attempted to avoid the danger of cultural relativism—that all ideas are acceptable in science curricula. In this light, I identified that Saskatchewan is taking a stance as multiculturalists, particularly the hybrid/merging approach based on the continuum bar (figure 7). This position acknowledges that all cultural knowledge offers a partial view of nature (Haraway, 1988) and advocates for IK-S integration to provide a more holistic approach to studying nature. In this approach, rather than providing rationales for the usefulness and benefits of IK-S (i.e., IK-S for sustainability, IK-S for creating culturally relevant curricula), Indigenous knowledges are accepted in the same way as Western modern science, without a hierarchical perception of WMK-S as the universal system of ways of knowing nature and as superior to Indigenous ways of knowing nature (Brayboy & Castagno, 2008).

Moreover, exploring the curriculum documents with Lipka et al.'s (2005) *three aspects of IK-S integration*—content, pedagogical, and contextual—allowed me to look at the ways in which IK-S has been included in K-12 curriculum documents. IK-S was mostly in line with the content aspect. The pedagogical and contextual aspects of IK-S were not included as much. Therefore, I argued that without building relationships with local Indigenous Elders and knowledge keepers, including pedagogical and contextual aspects might be a challenge. Also, I suggested utilizing diverse pedagogic ways of engaging with IK-S–infused curricula (e.g., arts, storytelling, etc.).

Indeed, sharers to whom I spoke acknowledged that Saskatchewan is in “infancy state” or “beginning stage” in engaging with IK-S–infused science curricula and have “decades of projects” on their table. Afonso (2012) mentioned that

> the neo-colonization stage is tricky terrain for curriculum developers because the colonial legacy is covert. Many theorists with good intentions argue for the inclusion of IKS in schools but fall under neo-colonialism because their structures and philosophies maintain Western Science. (p. 29)

Indeed, the history of science education explored in Chapter 5 showed us that the global science education—including Saskatchewan science education—is largely based upon the values and traditions of WMK-S stemming from natural philosophers from Europe. Throughout the re/search, I continued to witness the ways in which neoliberalism, coupled with capitalism, has continued to assert the legacy of WMK-S as the “truth” and the “only kind of science” in education. In turn, I suggested that any stakeholders involved in IK-S–infused science curricula, including policy makers, curriculum developers, teachers, and students, continue to reflect on their internalized assumptions and biases coming from the neoliberal enclosure of science education (Strong et al., 2016) and remain open to multiple ways of coming to know nature. However, while being critical of the influences of such neoliberal enclosure and hegemony of

WMK-S, science education should seek for harmony and balance of WMK-S and IK-S, thus trying to find where they can work together (Lee Maracle, November 2, 2014, personal communication; Elder Charlie Patton, Sauvé Lecture, McGill University, March 12, 2017). Indeed, considering *'why IK-S–infused science curricula in the first place in Saskatchewan,'* the policies, curriculum documents, and stories from the sharers all acknowledge that IK-S–infused science curricula is about the balance and harmony of multiple ways of knowing for our shared future, so that "Indigenous and non-Indigenous can walk alongside each other and learn together" (Tanaka, 2016, p. 196). Meanwhile, I've learned and continue to learn from the sharers that I have met throughout this re/search journey. From their stories, I've learned that there is no universal, right way to engage with IK-S–infused science curricula. However, as my Korean metaphor suggested, we should avoid "pouring water into a bottomless vase" and instead build a strong vase when engaging with IK-S–infused curricula—which starts from preparing heads (mind), hearts, and hands.

In preparing one's head (mind), one should remain open to multiple ways of coming to know nature. Also, one should be mindful that 'we are all related' (Cajete, 2000) and Nature should be seen as a living thing, rather than a commodity for resources. As such, in coming to know nature, rather than studying nature, one should ask questions about "how to be with all relations" (Fitznor, 2007). However, the "brain [head] gets turned off until the heart gets pumping away" (Glen Aikenhead, March 24, 2016, personal communication). To prepare the heart, having a true, authentic learning opportunity with Indigenous peoples is important. My use of "authentic learning" refers to learning that "pumps the heart" and involves emotional engagement and the commitment to ethics and responsibility that comes with the knowledge and learning. Such authentic learning only happens when one builds consensus-based relationship built on trust.

In regards to building relationships with Indigenous peoples, I've learned the importance of knowing and honoring protocol. Protocol is not a perfunctory thing that people do or a checklist. It is really about "establishing a really sacred trust and it's a way of handling sacred knowledge, a way of sharing sacred knowledge. It's a really significant relationship that you're establishing with them" (Ted View, personal communication, November 10, 2016). All the sharers indicated that without relationships, true authentic learning would not happen with Indigenous people. Thus, in engaging with IK-S–infused curricula, the first things should be about learning the protocol, building relationship, and being open to learn and listen.

As Tanaka (2016) suggested, the "notion of reciprocity, 'Giveaway,' and using 'good hands' by having a clear mind and healthy intent are deepened through a focus on physicality and doing" (pp. 22-23). In this light, I argued that teachers need to act and teach what they have learned from Indigenous peoples, thus they can walk the talk and "use their hands." In so doing, I suggested that teachers focus on creating a *sharing place*, as the Dancing Amoeba Model suggests. Also, students and teachers can together reflect on their assumptions and biases to resist the hegemony of WMK-S. As well, teachers should try to offer authentic learning opportunities for students, such that they could further build relationship with Indigenous peoples. All in all, I've learned that in engaging with IK-S–infused curricula, one has to enter into the mindset that it is a life-long learning process and acknowledge their status as a learner, not as an expert. Also, it requires continual relationship building with Indigenous peoples and nature and continual reflection on their assumptions as a result of neoliberal enclosure of science education.

This dissertation is my way of practicing the notion of "reciprocity." As was noted by many sharers, Saskatchewan's efforts to infuse IK-S into the science curriculum is still in "its infancy" (Rory Bergermann, December 12, 2016, personal communication). It will take decades (Glen Aikenhead, March 24, 2016, personal communication) to further improve IK-S infused curricula and to support teachers in delivering such curricula. The Saskatchewan Ministry of Education, and diverse stakeholders from multiple levels (e.g., governments, teachers, and the grassroots movement mentioned in Chapter 7) will have to continue to work together to further improve and create sharing space for our shared future.

This dissertation is a form of report, reflecting on what has been done so far. Particularly, to the Saskatchewan Ministry of Education, this dissertation offers information that might be useful for potential future curriculum renewal and program development such as understanding the historical and political contexts in relation to current curriculum initiatives, and analyzing the current status of IK-S within K-12 curriculum documents and suggestions for future initiatives (e.g., teacher education and professional development) based on teachers' feedback. I hope to stimulate a conversation on how to better prepare teachers to engage with IK-S in science education context. I am sending this dissertation to all my sharers, who are integral to the effort to infuse IK-S into the science curriculum. In so doing, I hope to create a *sharing place* for further reflection and dialogue with and for my sharers, a place to discuss how Saskatchewan's science education can keep moving forward. In particular, I hope to stimulate conversation as to how to better prepare teachers to do the *real work* (Tanaka, 2016) of engaging with an IK-S infused science curriculum.

To the Academia, this dissertation offers a type of writing that shows both process and product of a research project in a candid manner. While many dissertations and other academic articles focus on sharing the 'final' product and choices of the project, in this dissertation, I focused on sharing the process of doing research including an analytic process involving multiple ways of coming to know (including dreaming). Particularly, I shared my mistakes and failures while doing research for this dissertation. I shared the honest process of doing research here in hopes of showing the importance of building relationships prior to the project as well as preparation of one's mind and heart, especially for other novice researchers, particularly those who wish to engage in projects with Indigenous communities. The Dancing Amoeba Model also offers the academic field a visual representation of knowledges-sciences production focusing on building relationships. I hope that this model provides an opportunity for others to continue to engage and converse about the relationships between diverse ways of coming to know nature.

Coming back to the question of 'What are the relationships at play in integrating Indigenous knowledges-sciences in science curricula?', I have learned that there are three major 'relationships at play': relationships with Nature, relationships with local Indigenous communities and relationships between multiple stakeholders. Acknowledging diverse relationships at play, William Pinar (2011) suggested that curriculum is a "complicated conversation" (p. 43). In this light, engaging with IK-S–infused curricula could be seen as a way to engage in ceremony. As Shawn Wilson (2008) mentioned, "the purpose of ceremony is to build stronger relationships, or bridge the distance between aspects of our cosmos and ourselves" (p. 11). For Saskatchewan's future initiatives, I suggested—based on sharers' stories—focusing on teachers' professional development and education to grow more "catalyst teachers" (Darryl Isbister), as teachers will be acting as a "critical nuclear mass" of bringing changes within the science classroom (Glen Aikenhed).

Meanwhile, I've learned that there is no quick fix, no utilitarian way to engage with IK-S both in science curricula and doing research. I've experienced the changes of the project due to the lack of the relationships I had with the previous potential research sites (e.g., Nunavut and Northern Territory in Australia). Because of the prior relationship I had with Dr. Glen Aikenhead, I was able to meet and build relationships with other sharers in Saskatchewan. Because of my relationships to each of the sharers and their engagement with IK-S–infused science curricula, we had opportunities to have dialogues about IK-S–infused science curricula. Throughout the re/search process, I, too, experienced what Shawn Wilson (2008) referred as "research as a ceremony." Through this research project, I was able to build stronger relationships with myself, theories, peoples, and Land. I was also able to bridge "distance between aspects of our cosmos and ourselves" (Wilson, 2008, p. 11). In a way, I've learned to "let my mind relax" as Dr. Sa'ke'j Henderson told me (personal communication, May 29, 2017) and experienced different ways of coming to know, particularly through dreaming (as my encounters with Dr. Aikenhead and the Dancing Amoeba Model showed).

With regards to the lesson taught by Dr. Laara Fitznor about *Kemoochly* (Chapter 2), I've learned how to wait for lessons to come to me and to "work against" the dominant reductionist model of doing research, thus not rush into finding linear cause and effect relationships. In this way, I've also continued to reflect on my process of becoming an ally (Bishop, 2015). I find such a reflection process happening naturally rather than being forced. When I reached a state of chaos—entropy, just as Sa'ke'j Henderson mentioned—I naturally learned to reflect on the process and let my mind relax and wait for the lessons with openness to multiple ways of coming to know. However, I realized that re/search is a life-long learning process. Thomas and Green (2005) used the Medicinal Wheel to describe this process:

> Once you have journeyed around the wheel, you have the opportunity to learn from your experiences and journey around the wheel again, this time learning from your mistakes . . . . If we remember what the challenges were in our previous journey, then our next journey can be different and more effective. (p. 92)

In my next circle of learning, I hope to continue to engage in exploring ways to continue preparing for the 'shared future' for teachers and students. Academically, I hope to continue projects focusing on teachers' voices. Looking at challenges and stories from teachers' perspectives, particularly their understanding of relationships with local Indigenous peoples' knowledges and practices in relation to the conventional WMK-S, would allow me to better understand ways to engage teachers with the IK-S infused science curricula. In so doing, I hope to continue my work with the ideas from critical-transdisciplinary teaching and dancing amoeba model (chapter 3) in relation to educating mind, heart and hands.

Personally, through this re/search project, I travelled one circle of learning about the notion of "self-in-relations" (Graveline, 1999). I've learned the importance of relationships, the role they play in re/search as well as in the process of getting to know myself as well as nature. I've made mistakes along the way, such as engaging the re/search project without first forging relationships, which actually cost me a lot of time and money in the end. However, it was through these mistakes that I learned the role that relationships play in the process and the product of a re/search project. I commit to continue building relationships with local Indigenous peoples (currently with Mohawk people in Kahnawá:ke) and engage in the process of 'becoming an ally' (Bishop, 2015).

In concluding this dissertation, I am coming back to the story by my halmonee: the story about the scholarly man and the tiger. Though my halmonee is not here with me, the lessons that she told me with the story finally came to me *Kemoochly*. It was about not being afraid and respecting nature and all our relations. I've learned that my halmonee's wisdom regarding respecting ancestors, whether by offering drinks or bowing twice in front of their graves was to honour where I come from and honour the knowledge coming from my own culture, thus *being grounded* (Kovach, 2009). The stories and practices told and taught to me by my halmonee are wisdom, not superstition. I've also learned more about my own identities through reflecting on where I am indigenous to and my connection to the land where my ancestors are from (Kimhae, Korea) and I've become clearer about my positionality as a settler in Canada and a life-long learner who is committed to engaging in the process of becoming an ally to Indigenous peoples.

Throughout this re/search, I've been given much advice by the Indigenous Elders I have encountered with regards to reconciling with the Creator or God. Elders that I have met did not specify whether it is a "Christian God" or Creator or ancestor spirits from my culture. I need to reconcile with the spiritual world. They advised me to meditate, pray, and participate in ceremony. I have not yet reconciled with the spiritual world or the Creator. Perhaps, in my next cycle of learning, I will learn to open my spiritual space and allow another way of coming to know nature. (If not, at least, I now *understand* the role of the spiritual space in coming to know nature through IK-S.) I will continue to learn and reflect and engage in the cycle of life-long learning. The process of learning of this re/search is not over. It is back in the beginning stage, again.

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APPENDIX I: Interview Guiding Questions

Section I: Warm-up and background

1. How long have you been in the field of education?
2. How long have you been involved in Indigenous (and/or science) education?
3. What is your definition of science?

Section II: Views on current approaches to integrating Indigenous perspectives

4. What are your general impressions of current approaches to integrating Indigenous perspectives within science education in Saskatchewan? For example, do you think it is focused more on bringing content, pedagogical, or contextual knowledge? (describe three aspects)
5. Do you think in engaging with the IK-S–infused science curricula, Saskatchewan takes more of a consultation approach or collaboration approach? (explain the collaboration vs. consultative definition)
6. Overall, would you say that Saskatchewan's current approach to integrating Indigenous perspectives is successful?
7. In your view what are some of the negative and positive aspects of integrating Indigenous perspectives in science education?
8. How do you believe the current approach in your country could be improved?
9. In your opinion, should Indigenous-related content be taught in science classrooms in public schools? Why or why not?

Section II: Views on the rationales/benefits of integrating Indigenous perspectives

10. In your opinion, do you think integrating Indigenous perspectives should be for the benefit of only Indigenous students or all students? Why?
11. What could be the benefits and drawbacks of integrating Indigenous perspectives in official science curricula?

Section III: Views on their role as ally

12. (If non-Indigenous) Do you identify as an ally to Indigenous peoples? What does it mean to be an ally for you?
13. (If Indigenous) What do you think of non-Indigenous scholars partaking in initiatives of integrating Indigenous perspectives in science education?
14. How do your personal views about Indigenous peoples influence your current role in developing curricula/writing/researching about the integration of Indigenous perspectives in science?

Concluding Questions

15. Do you have anything else you like to add?
16. Is there anything I have not asked about that you think I should know?
17. Do you have any questions for me?

APPENDIX II: Introductions of Sharers (Saskatchewan)

Below is information about the sharers in this project. They are listed in the chronological order that I met them. I briefly introduce the context in which I was first introduced to them to show the process of forging relationship with these sharers. I also share their biographical information (with a particular focus on their experience in engaging with IK-S–infused science curricula) in their own words. Throughout this re/search process, stories and storytelling became a tool for me to better understand the relations between myself and others. I also grew to understand the role of storytelling in resisting the universalization of human experiences (Stone-Mediatore, 2000). In sharing their introduction in their own words in a form of story, I am celebrating each individual's own experience of engaging with IK-S–infused science curricula. In sharing their introduction in their own words, I also hope for the possibility for future dialogues and forging relationships between the readers (you) and the sharers.

Aikenhead, Glen (Emeritus Professor at University of Saskatchewan)

Dr. Glen Aikenhead is the emeritus professor in Education at University of Saskatchewan. He has been actively researching and teaching cross-cultural science (Indigenous and Western Science). Dr. Aikenhead is, without a doubt, a pioneer in the field of Indigenous science education. His work has been influential in guiding my thinking (and that of many others in the field) in regards to IK-S–infused science curricula from the beginning of my master's program (Year 2011). From the beginning of my PhD program, I started to communicate with him by emails and Skype interviews. The conversation continues to this date through multiple venues (e.g., emails, dreams, and in person). He has continued to encourage me to finish writing this dissertation. I saw him in Montreal in person when he gave a seminar to members of the McGill education community in 2017. When I met him in person, I shared my questions in regards to if this project (or any academic projects) will be beneficial outside of the ivory tower and explained my academic identity struggle as well. His own work and his words have been encouragement for me regarding the possibility of academic projects to engage in shifting the power relations and furthering reconciliation between Indigenous and non-Indigenous peoples in Canada. Dr. Aikenhead suggested that next steps could be research and development project working with teachers by learning about teachers' challenges and needs when engaging with IK-S–infused science curricula. As illustrated in Chapter 2, he has played a role of a bridge and facilitator for me by forging relationships with other stakeholders in Saskatchewan. He introduced me to Dean Elliott, Darryl Isbister, and Ted View. Below is the introduction of Dr. Glen Aikenhead in his own words:

Glen: So you could go to my CV and—It's up to date and it's listed when I taught school, then when I went to graduate school and I started at the University of Saskatchewan in 1971. And then you'll notice that there's a two-year break because in 1975 I wanted to find out what I learned in graduate school that was actually useful in a classroom. So I became a classroom teacher for two years, and that was living in Switzerland at an international school. So I suppose one way to think about it is wanting—if you wanted to know how many years I've been, that would probably start in 1964 when I went into a Master's program in education.

And then I've been in education ever since then. But part of it is school teacher, part of it's been a graduate student. So you can just go to my CV and you can pick that out.

At our university, in our college of education there's—there are two programs specifically for Indigenous students. One is for First Nations, the other is for Métis. And they take the same courses as non-indigenous students do, but they're together to give each other support. And so they don't have to explain to the non-indigenous students what their indigenous culture is all about, they have lots of other better things to do with their time and energy.

So they're separate programs, but the courses are taught in a different way but they take the same examinations at the end. It's a different approach to teaching, but it's the same kind of assessment at the end. I started teaching those sections in elementary methods in the late 1980s. So as an instructor of methods course, I was specifically gearing my teaching for the indigenous students.

But while that was happening, I was developing a grade 10 science textbook with students, grade 10 students and teachers, and that project went on until it was published in 1991. And once it was published, I then decided I wanted to get into indigenous education.

Some—I talked to some elders around some academics here and first of all got involved in the tribal council, Saskatoon Tribal Council and just volunteered for educational things, and got to know the culture over a period of four or five years. And then there was that first publication of mine, the policy paper that was printed in science education in 1997, and that was just putting my thoughts out on paper, on a policy paper.

And so that's—so if you're looking for a date it would be back in about 1987 when I started teaching that in classes. But in terms of focusing on my research program which was in science technology society, you know the STSE, that's what I did for two decades. But the change was not a big change because what I did ever since I went to the University of Saskatchewan, I was working towards the students find relevance in their science teaching and it was their idea of relevance, not the teacher's idea of relevance.

And so all I did was instead of thinking about all students, I focused on indigenous students, and so that began in sort of the early 1990s. And so there was a position paper in 1997. And then my reaction to doing things like that is saying, okay I better put my money where my mouth is. So in 1999 and 2000, during those two years, I collaborated with elders and teachers in isolated communities of northern Saskatchewan and together we developed the project Rekindling Traditions, and that's online.

So that—we did that in order for—because no one had developed materials and the teachers were buying books that came from the United States and wondered why they weren't successful. And it was because, as you know, it's place-based knowledge and indigenous knowledge is place-based and those books were you know from a foreign country.

So the idea of this project, Rekindling Traditions, was to show how materials could be developed in the best possible way. And we started with indigenous knowledge of the community, the community chose a topic like wild rice and there were community people who actually grew wild rice, they were involved. So they helped choose the topic, they were involved, elders involved in each place was involved.

The teacher was connected to all of these people so I—and I spent a whole semester going around to these six different communities—it's five different communities, and that was my job to bring people together and the teachers job was—because their expertise is what's to do in the classroom. So that's what they handled. And we'd come together and I'd be in their classrooms visiting to see what was going on because I had to write everything up, so I needed to know what was going on.

So we came up with six units and in doing so, I got a great deal of experience understanding what's involved in that. And when that was finished there was no interest in—so we've done it and just had to leave it other people's hands to use it as a template of how to make their own place-based units. And so there was a hiatus, a time that there was nothing going on until our government in 2008 decided they were going to put a lot of effort and money into indigenous science education. So that's sort of the story.

Yeah. And I was inspired by the students because I realized very quickly that if the non-indigenous students had as many obstacles in their way of being successful, the non-indigenous students would give up. And so I realized that the indigenous students had a tremendous amount of resiliency and determination, and sometimes they couldn't continue and it was really no fault of their own. Funding dropped because of the federal government and things as I said, right, that were out of their control.

So I really developed an admiration for them and I guess that was the major motivation of well now that I've finished this textbook on STS education, I want to make a contribution that will be of benefit to the indigenous students.

Isbister, Darryl (First Nations, Inuit and Métis Education Coordinator, Saskatoon Public Schools Division)

Darryl Isbister is a Métis citizen currently working as a First Nations, Inuit, and Métis Education Coordinator at Saskatoon Public School Division. I was first introduced to him through the resource book published by Saskatoon Public Schools Division (2014), entitled *Enhancing School Science with Indigenous Knowledge: What We Know from Teachers and Research*. Darryl was one of the coauthors of this book. Later, Dr. Aikenhead put me in touch with Darryl. Darryl and I spoke once over the phone for this project. Later, I continue to email him with some of the questions I had (especially with regards to the four imperatives on IK-S–infused curricula). Darryl is the only Indigenous sharer for this project. He also encouraged me to continue my work as an ally. Below is his introduction in his own words:

Darryl: I'm a Métis citizen. My family comes from the Kinistino area of this land we call Saskatchewan, that we live in. I've been in education for I think this is my 19th year now.

And I started out as a high school teacher, and spent 13 years in six different collegiates here in Saskatoon. And primary field was in history, but I do have a minor in math, and have done some teaching in science, and other areas, just because we get asked to do things here in Saskatoon that sometimes are out of our general teaching area. And I'm the kind of person who always just says yes, and figures out a way to do things. Grew up in Saskatoon. Actually ended up taking over from my grade 12 history teacher at one point—which is kind of a—an interesting transition to walk back into the classroom that I was taught my history in, and see that not many things had changed on the walls. And it was a little overwhelming to think that I was about to walk down the same path as the person who inspired me quite a bit to become an educator.

I began my role as a consultant for a First Nations Inuit and Métis education, in fall of 2011. And this—that's where I really dove into the science aspect of incorporating indigenous knowledge into science. It was one of the first pieces that was added to my portfolio. And so since then, I've taken a strong interest in working with the teachers in our division, around helping them, I guess the best way to say it, is to authentically include indigenous ways of knowing, being, and doing, into the science curriculum specifically. Now fortunately, that project had spurred on some other supports within our division, and we've been able to broaden it to some other subject areas—some of the more traditional subject areas, where teachers, you know, they're able to see the more logical connections. But it was that one that really—it was that one that really, really helped me as an educator, take the first steps into, how do we do this in the most authentic way? So still doing it. Not as much, just because funding is always an issue. And so we do what we can with what we have, and we try and build capacity within our teachers, so that they themselves can become mentors for new teachers, and other teachers in their buildings. But it—it just—I guess it just looks a little different than it did in 2011, because we have built some of that capacity [in]. So it's—but it's also something we're continuing to look to find ways that we can fund it, and working with external sources, partners in the community, to find ways to build our capacity even further.

Elliott, Dean (Science Education Consultant at the Ministry Education of Saskatchewan)
Dr. Dean Elliott is a science education consultant for the Saskatchewan Ministry of Education. Before his current role as a consultant, he worked as a high school science teacher. I was first introduced to Dean through his coauthored article with Dr. Glen Aikenhead: "An Emerging

Decolonizing Science Education in Canada" in 2010. It was through this article that I got to know some of the process and context of the IK-S–infused science curricula in Saskatchewan. Later, Dr. Aikenhead introduced me to Dean. Dean and I spoke twice for this project. During these conversations, Dean shared the whole context and process of how the current IK-S–infused science curricula came to be and his experience in collaborating with Elders and teachers in making Saskatchewan's customized textbooks (with Pearson). Though the textbook stories and analysis were not shared in this dissertation, I hope to share his experiences and the analysis from the textbook in other venues such as conference presentations and other articles. Dean also helped me in establish relationships with other sharers. It was through Dean that I met Tina and Rory (and he also recommended me to talk to Ted), classroom teachers for this project. Below is an introduction told by Dean:

Dean: I grew up in Saskatoon. I was a high school science teacher there for about 14 years then I spent a couple of years as the educational technology consultant for that school division. So, it's school division with about 55 schools, so I helped teachers incorporate technology into their teaching. On the way, I did a masters at the University of Oregon on using technology, such as data loggers in the classroom. And then I moved to Georgia and worked on my PhD at the University of Georgia, so I lived down there for a few years and did the PhD in instructional technology and design. And then came back here, and so I've been in this role at the ministry for 14 years now and so my job is to write all of the science curriculum K-12 in English.

And then I have a colleague I work with that does the same work in French. And so we started renewing all of our curriculum, like not just science, but all of our curriculums back in 2009 and we did grade 6 to 9 then we did grades 1 to 5 and then the last five years I've been working on our high school courses. And part of our renewal, as a province, was a push to better infuse indigenous ways of knowing into our curriculum, because we have the greatest percentage of indigenous students in the country and we know that unfortunately those students are not doing very well compared to other students. And in secondary science, that's one of the areas, secondary science and math, that they're doing least well, so. I won't go further than that, because I'll let your questions guide it, but you'll discover I could talk for hours on the things we've done and the way we've engaged elders, so. So, that gives you a little bit of background where we're at.

View, Ted (Former High School Science Teacher, Principal, Greater Saskatoon Catholic Schools Division)

Ted View is a principle at an elementary school in Saskatoon. Before his current position, he was a science classroom teacher and vice-principal in Saskatchewan. Ted also finished his Master's in Education at University of Saskatchewan. In his Master's thesis, titled "Mîyo Pîkiskwatitowin (Speaking to Each Other in a Good Way): The Significance of Culture Brokers in Cross-Cultural Collaboration with Aboriginal Peoples" (2016), Ted shared his experience and stories of working with teachers, the Ministry of Education, and Indigenous Elders for Saskatchewan's customized textbook development process. I was first introduced to Ted in 2016 through Dr. Aikenhead for this project. Ted and I have continued to have conversations around the topics of IK-S–infused science curricula, the importance of researcher preparation for projects engaging with Indigenous peoples, our own experience exploring our own cultural identities in the third space, and more. Through conversations with Ted, I could reflect on the importance of protocol and the meaning of tobacco and my positionality as a newcomer but settler in Canada. Ted and I are working on a paper and a conference presentation on our own shared and individual (Asian-Canadian) experience in learning from Indigenous Elders in our research process as well as the own cultural identities negotiation process in Canada. Below is the introduction of Ted, in his own words:

Ted: I'm entering my sixteenth year of teaching. Well, right now I'm in an administrator, so I've been a vice-principal for five years and this is my first year as principal.

I started my career—I moved to Alberta after I got my Bachelors of Education. I also have a Bachelor's of Science—I got that first. My Bachelor's of Science is in Botany from the U of S, and then I got a Bachelor's of Education, because I taught in the [land] and I really like teaching, so I decided I would naturally become a teacher.

So in 2001 I got my first teaching position in Brooks, Alberta, and Brooks, Alberta is predominantly a Eurocentric—no, it's rural, very much a Caucasian, middle class community. I experienced racism when I was out there, because of the colour of my skin. It was, you know, the turn of the millennium and still I faced racism. I was called a Commy and a Chink up there, so I didn't quite fit in with the culture out there either.

Not everyone was like that, mind you. Most of the people in the community were really welcoming, but I did have experiences of racism out there.

And then I was nearly burnt-out there as a teacher, because it was a small community and I did a lot of coaching and a lot of work, so I was really tired. Because I spent most of my weekends travelling with sports teams and teaching a full load.

And then in my third year, I met my wife—and I needed to move back to the city of Saskatoon. And I was offered a position with Saskatoon Catholic, and at that time I didn't know what my placement was going to be, but the superintendent hired me, asked me if I was open to culture and I said yeah, definitely.

So I was placed at a school called Joe Duquette—today it's called Oskayak—and I believe that Joe Duquette is the school that changed my life. When I first got there on the first day, I didn't—I was immersed in culture immediately. We did a smudge, and if you know anything about smudge ceremony, a smudge ceremony is a blessing ceremony where the [Oskâpêwis 00:05:12], so the helper, what they do is they light sweet grass or sage or cedar or tobacco, but in this case it was sage. And the smudge is passed around in clockwise fashion, first to the women on the eastern side of the circle, then to the men on the western side of the circle. And the helper carries it around and you basically take the smoke and you wash yourself with the smoke—the action of washing the smoke over your body is to help cleanse. But the elders also teach us that the smoke carries our prayers to Creator.

And after the smudge is done, the elder at that time—and his name was Simon [Ketwahat]—he said a prayer, and that was our welcome—my first introduction into the indigenous world of the Nehiyaw people—Nehiyaw people are Cree people, so in English we call them Cree…Cree call themselves Nehiyaw, so for the remainder of our interview, I'll refer to them as Nehiyaw people.

So that was my first introduction into Nehiyaw culture, and it was a very different integration into a very different culture, and it really opened my eyes. The first couple of months, I have to say, were really tough. Oskayak at that time—or Joe Duquette at that time—was a school that welcomed a lot of young people from First Nations backgrounds that had a really hard life.

And I believe the hard life that they led was a result of intergenerational violence as a result of colonisation and residential school. Since—like over the years, since I've been reading more about colonization and doing my own learning and writing my Masters, I've learned that a lot of that tumult stems from the fact that their kinship systems were broken through colonization, where the government deliberately prevented First Nations from practicing their ceremony, taking children forcibly from their homes. The Sixties Scoop was an example, where families were separated and kids growing up in a place where they were taught that their values didn't matter, that they're not allowed to practice their spiritual ways and that they were—like all sorts of horrible things said about them, like being dirty and being terrible people.

And if you grew up with that sort of discrimination, you started growing into adults that believe it. And that just fosters more generations ….

So I believe that the young people that I worked with at Oskayak were victims; they were people that suffered from many, many generations of colonization and that what you see at residential school.

So the first two months were really hard, because I still thought in a Western way, and I wasn't sensitized to the issues around me. I just thought that these kids were impolite and rude. My first aha moment, or my wake-up moment, was when I interacted with a wonderful lady, Norma Jensen.

Norma Jensen is a teacher—she was a teacher-librarian, she taught History there—and she was a member of the staff since the school opened. Originally Oskayak school, before it became Joe Duquette, was called the Indian Survival School, and even the name can tell you that that seemed pretty harsh, but Indian Survival meant the survival of their culture. And Norma was one of the first teachers there, and she was there when I was there, so she taught there for about thirty years.

And when she saw me interact with a young person, she questioned me, so I was having—I was talking to a student and I was asking why he wasn't doing his homework, and I was giving the young man a hard time. So after I spoke with him and he left, Norma asked me, so why were you giving him such a hard time about homework? And I said well, part of his grade is homework, so he needs to do that, so I was thinking in a very Western way.

And she told me that implicit in the word homework is the idea of home, and she said, that young man has no home. I asked her what she meant and she said that he doesn't have a family, like he's alone, he lives in a men's shelter, and when he can't find a room in the men's shelter, he lives under the bridge, or he sleeps under the bridge—the Broadway Bridge.

And that, for me, I didn't know what to say after that. That was a crushing moment. See, and I'm an immigrant person. My family is from Vietnam and everything we have, everything that we got, was a result of the generosity of Canadians bringing us to Canada. We became who we were and successful as we were, because of the generosity of Canadians, so I couldn't understand that in Canada, how can the people who are here—the first people here—were treated this way, so it was a real crisis for me.

And so that memory still haunts me, I think about it quite a lot, and so from that moment I really wanted to know more about Nehiyaw people, and really wanted to understand young what was happening to the young people. The school had—but so when I was there, I was invited into ceremony with many of the elders and the teachers there. They taught me to drum and sing, and I sang with the [drumming] group every day after school. And when I left Oskayak, the Elders there had made a drum and they blessed the drum and they gave it to me. And so today, when I teach, I will sing and drum with the kids. And so it has become part of my practice.

After I left Oskayak, I had the opportunity to help that curriculum in the science for the province, and through that I got to know Dean Elliott and many others. Glen Aikenhead was one of my profs at the University of Saskatchewan, and with that work, I ended up working on the Pearson Saskatchewan science textbooks, and my role was to go and to interview elders.

And I wrote profiles of the elders there after I'd developed relationships with them. So I drove to the reserves, offered elders tobacco as a part of their protocol, and I visited with them. And the first few visits where just to get to know them. I didn't even ask them any questions. And then I would offer my requests and they would call me later, or I would call them later to find out if they were willing to do the textbooks for us.

And so I learned a lot through that as well. So I got to visit Elders from all the different language groups in the province, and for seven or eight years, that's what I did; I drove around the province and met elders. Pardon me, I was teaching fulltime at that time as well, but on the weekends or evenings, I'd drive out to visit different elders, to gather their stories for a science textbook.

And over the years I've been very fortunate to attend many ceremonies. So I've attended several sweat lodges, feasts, pow-wows, round dances. I even was once asked by an elder to be a helper at a sundown ceremony, so I was very fortunate there. So I was his Oskâpêwis or one of his Oskâpêwis, so it was really an honour.

So that's a little bit my journey for the last twelve or thirteen years in my work with indigenous people.

Bergermann, Rory (High School Science Teacher, Prairie Sprit School Division)

Rory Bergermann is a high school science teacher in Saskatchewan. He also has been a part of curriculum writing team for Saskatchewan's high school science program. I got to know Rory from Dean Elliott (a science education consultant). Rory and I spoke once for this project over the phone. Rory shared his experience in the curriculum writing process as well as teaching with IK-S–infused science curricula. Later, we communicated via email. Rory sent me the graphic he created for Physical Science 20 wherein he delved into the relation between IK-S and WMK-S on the topic of matter. Though the graphic was not introduced in the findings stories in this dissertation, the graphic helped me to witness and appreciate Rory's engagement in exploring relations between ideas and communities.

Below is his introduction in his own words:

Rory: I convocated from the University of Saskatchewan in 1992, and that's the year that I began my teaching career. I have a major in mathematics and a double minor in chemistry and physics, and those have been the areas that I have been teaching for my entire career now. Spanning that entire time.

So I got involved with the Saskatchewan Science Curriculum Renewal in about 2011, was roughly when we began. The process of science renewal started a long time before that, but that's sort of when I entered the picture.

> There was—you've already spoken to Dr. Glen Aikenhead about indigenous perspectives and indigenous knowledge systems. And Dr. Glen Aikenhead was actually a professor of mine at the University of Saskatchewan, and you've already consulted with Dean Elliot, and Dean and I have worked very closely on the Saskatchewan Curriculum Renewal since 2011. So I've been a—I was one of the curriculum writers for the new Physical Science 20 curriculum, which would have been sort of a blend of Chemistry 20 and Physics 20, rolled into one course.… But the first day that the curriculum writers, there was four of us. I was one of four people that met with Dean Elliott, the Saskatchewan ministry science consultant, when the five of us sat down together and we, you know, got to know each other and sort of got an idea of who we all were and the task that was before us, this is all on day one and probably within the first hour of us sitting down and meeting, there was some discussion about where science renewal has been in the younger grades, what stage we're at, and now the challenge that is before us is number one, to take these big pieces of the puzzle and create the outcomes and indicators, but more importantly there has got to be this emphasis on infusing indigenous knowledge or ways of knowing into our curriculum.
>
> And we admitted, you know, right at the beginning that this was probably going to be more of a challenge because when we talk about chemistry and physics, this is very much a traditional reductionist approach, or very knowledge and content heavy studying or part of science so—and just in the work that had been done throughout the Grade 3 to 9 science renewal and the resource development, they understood that anything that was related to Earth science, whether it was ecosystems of health science or anything that involved the environment, there was very rich dialogue between First Nations elders and knowledge keepers and the curriculum writers, and they had very—a very good discussions that were able to help form and shape the curriculum. But they said when we get to physical science; it's going to be much more challenging.
>
> So we were put—that was put to us right at the beginning. And I like to think that was one of the contributions that I was able to make. Dr. Glen Aikenhead actually came to meet with us on day one just to talk about First Nations perspectives and Euro-Canadian science education or ways of looking at the world.

Rioux, Tina (High School Science Teacher, Saskatoon Public Schools Division)

Tina Rioux is a high school science teacher in Saskatchewan. I first was introduced to Tina by Dean Elliott. Tina and I spoke once for this project. Tina discussed the problem-based courses that she led with her colleagues as well as her experience with sweats with her students. Tina is a Chinese-descent Canadian. She and I also shared our own identity as non-European descendent-Settlers and the ways in which our racial and cultural identities and experience with negotiating with different cultures have benefited us in negotiating with WMK-S and IK-S. Below is her introduction in her own words.

Tina: Okay, well, this is my twentieth year of teaching. I started out in Prince Albert and I taught for two years there and then I moved back to Saskatoon and I spent a year at Bedford Road Collegiate, which is a community school on the west side of Saskatoon.

And then I spent one class at a school further west, which is called Mount Royal Collegiate. The following year I got hired on at Mount Royal only, so I spent nine years there altogether and then eventually I needed a change, so I transferred over to Evan Hardy, which is where I am now.

It is predominantly more of a middle class/very diverse population of students, and so less Indigenous population, for sure. So the indigenous population at Mount Royal, I think at the time I was there, was about 15%, and at my current school we might have a couple of Indigenous students per grade, although it is increasing now. This year we have more students than before at Evan Hardy, but I think we have less than 50 declared students in the total school of seven hundred and fifty kids. This is in very different than at Mount Royal and Bedford Road where half my classes were indigenous. There was a big difference in how you teach and some of the approaches that you have to use.

That's kind of in a brief nutshell of my teaching experience….

I'm Chinese, and like my parents are both from China and my husband's French, that's why my last name—but my last name was Wong before, so I pull in my own culture as well and talk about Asian culture, and then I parallel it with the indigenous culture. In a lot of ways there are so many parallels, and a lot of my students, like I said, are mostly East Indian, Muslim and Hindu—I have both—and then I have a ton of Asian students as well.

So for them, I think that makes the connection a little bit easier to understand, when I talk about my own culture and my own experiences, you know, with my dad and sort of what he taught me growing up. And then I kind of mirror that with the indigenous culture; a lot of those students get it a little bit easier.

The white students are there and they completely understand as well, so it's an interesting tool, because it is so much more diversity in terms of many more cultures, yeah.

Appendix III: Curriculum Analysis Data Examples

Science Kindergarten (2010)

Life science: Living things in our environment.

Outcome	Total number of Indicators	Indigenous-related Indicator	Examples of Indigenous-related Indicators
LTK.1 Examine observable characteristics of plants, animals, and people in their local environment [CP, SI] *Note:* *SI: scientific inquiry learning context* *CP: Cultural perspectives learning context*	10	2	c. Seek out information about the observable characteristics of plants, animals, and people from a variety of sources, such as family members, friends, Elders, knowledge keepers, and scientists. (p. 59) *Contextual* Priority scale assigned (3) f. Explore portrayals of plants, animals, and people through stories and artwork from various cultures, including First nations and Metis. (p. 60) *Pedagogical* Priority scale assigned (3) Note: *Analysis based on Lipka's three areas of integration (content, pedagogical, and contextual)*

Physical science: Observing Forces and Energy

Outcome	Total number of Indicators	Indigenous-related Indicator	Examples of Indigenous-related Indicators
FEK. 1 Examine the effects of physical forces, magnetic forces, light energy, sound energy, and heat energy, on objects in their environment [SI] *Note:* *SI: scientific inquiry learning context (SI)*	8	0	

Physical science: materials and Objects (MO)

Outcome	Total number of Indicators	Indigenous-related Indicator	Examples of Indigenous-related Indicators
MOK.1 Investigate observable characteristics of familiar objects and materials in their environment. [SI]	9	0	

Earth and Space Science: Exploring our natural surroundings (NS)

Outcome	Total number of Indicators	Indigenous-related Indicator	Examples of Indigenous-related Indicators
NSK. 1 Explore features of their natural surroundings (e.g., soil, water, landform, and weather conditions), including changes to those surroundings over time. [DM, SI]	7	0	

Science Grade 1 (2011)

Life science-Animal Growth and changes (AN)

Outcome	Total number of Indicators	Indigenous-related Indicator	Examples of Indigenous-related Indicators
LT 1.1. Differentiate between living things according to observable characteristics, including appearance, and behavior. [CP, SI]	13	2	a.Use a variety of sources of information and ideas (e.g., picture books including non-fiction texts, Elders, naturalists, videos, Internet sites, and personal observations) to learn about observable characteristics of living things. (p. 27). *Contextual* Priority scale assigned (1) d. Engage in personal, scientific, and Indigenous ways of organizing understanding of living things (p.27) *Content* Priority scale assigned (4) Note: *Analysis based on Lipka's three areas of integration (content, pedagogical, and contextual)*
LT 1.2 Analyze different ways in which plants, animals, and humans interact with various natural and constructed environments to meet their basic needs [CP, DM, SI]	11	0	

Physical Science- Using Objects and Materials (OM)

Outcome	Total number of Indicators	Indigenous-related Indicator	Examples of Indigenous-related Indicators
OM. 1.1 Investigate observable characteristics and uses of natural and constructed objects and materials in their environment [CP, SI]	13	0	

OM. 1.2 Examine methods of altering and combining materials to create objects that meet student- and/or teacher-specified criteria [SI, TPS]	9	0	

Physical Science- Using Our senses (SE)

Outcome	Total	Indigenous	Example
SE 1.1 Investigate characteristics of the five traditional external senses (i.e., sight, sound, smell, touch, and taste) in humans and animals. [CP, SI]	10	0	
SE 1.2 Explore how humans and animals use their senses to interact with their environment [CP, DM, SI]	12	0	

Earth and Space science- daily and seasonal changes (DS)

Outcome	Total	Indigenous	Example
DS.1.1 compare and represent daily and seasonal changes of natural phenomena through observing, measuring, sequencing and recording. [CP, SI]	10	1	d. Examine ways in which various cultures, including First Nations and Metis, represent daily and seasonal changes through oral traditions and artistic works. (p.33) 3 Content/pedagogical
DS 1.2 Inquire into the ways in which plants, animals, and humans adapt to daily and seasonal changes by changing their appearance, behavior, and/or location. [CP, DM, SI]	9	0	

Science Grade 2 (2011)

Life science- Animal Growth and Change (AN)

Outcome	Total number of Indicators	Indigenous-related Indicator	Examples of Indigenous-related Indicators
AN. 2.1 Analyze the growth and development of familiar animals, including birds, fish, insects, reptiles, amphibians, and mammals, during their life cycles. [CP, SI]	10	2	a. Use a variety of resources (e.g., Elder, naturalist, zookeeper, park warden, pet store, books, pictures and videos) to find information about the life cycles of living things. (p. 27) 1 contextual b. recognize the cyclic nature of Mother Earth expressed by the Medicine Wheel, including life cycles and seasonal behaviours of animals 4 Content/pedagogical
AN. 2.2 Compare the growth and development of humans with that of familiar animals [CP, SI]	8	0	
AN 2.3 Assess the interdependence of humans and animals in natural and constructed environments [CP, DM]	7	1	c. Examine the importance of **sacredness of** animals in First Nations, Metis and other cultures. (p. 28) 4 Content

Physical Science- Liquids and Solids (LS)

Outcome	Total	Indigenous	Example
LS 2.1 Investigate Properties (e.g., colour, taste, smell, shape, and texture) of familiar liquids and solids. [SI]	11	0	
L.S. 2.2 Investigate interactions between liquids and solids, and technologies based on those interactions. [CP, SI, TPS]	10	0	

Physical Science- Motion and Relative Position (MP)

Outcome	Total	Indigenous	Example

MP 2.1 Analyze methods of determining the position of objects relative to other objects. [SI]	10	0	
MP 2.2 Investigate factors, including friction, which affect the motion of natural and constructed objects, including self. [SI]	12	1	k. provide examples of technologies (e.g., skate, snowshoe, bicycle, ski, kayak, curling slider, and wheel chair) that are designed to make it easier for people and constructed objects to move on different surfaces (p. 32) 1 content

Earth and Space Science- Air and Water in the Environment (AW)

Outcome	Total	Indigenous	Example
AW 2.1 Investigate properties of air and water (in all three states of matter) within their environment [SI, TPS]	10	0	
AW 2.2 Assess the importance of air and water for the health and survival of living things, including self, and the environment. [CP, DM]	10	1	c.Recognize the importance of air and water as two of the four elements (i.e., air, water, earth, fire) in Mother Earth in First Nations, Metis and other cultures. (p. 34) 4 Content

Science Grade 3 (2011)

(PL)

outcome	Total indicators	Indigenous indicator	example
PL 3.1 investigate the growth and development of plants, including the conditions necessary for germination. [CP, SI]	14	0	
PL3.2 Analyze the interdependence among plants, individuals, society, and the environment [CP, DM, SI]	14	2	b. research traditional and contemporary uses of plants or parts of plants, such as food, beverages, medicine, arts, seed banks, shade, wind breaks, erosion protection, cultural celebrations, and products like dyes, shelter, and clothing. (p. 28) 4 Content c. examine the significance to some First nations and metis people of offering tobacco during harvesting and how that purpose differs from using the tobacco plant for smoking (p.28) 4 Content

Physical science- structure and materials (SM)

outcome	Total # of indicators	Indigenous # of indicators	example
SM 3.1. Investigate properties of materials and methods of joinery used in structures [CP, TPS]	9	0	
SM 3.2 Assess the function and characteristics of strong, stable, and balanced natural and human-built structures [CP, TPS]	16	3	d. compare the characteristics of solid (e.g., sand castle, mountain, and dam), frame (e.g., partition wall, hockey net, and spider web,) and shell (e.g., igloo, bike helmet, balloon, and drink can) structures. (p. 30) 1 Content

			f. compare the characteristics of different types of shelter (e.g., tent, igloo, hut, boat, castle, tipi, yurt, and house) constructed by people throughout the world, past and present. (p. 30) 1 Content i.develop and carry out a plan to construct a simple structure such as a tower, bridge, tipi, or bird feeder that meets teacher or student-specified criteria related to strength, stability, and function (p. 30) 2 Content

Physical science: Magnetism and Static Electricity (ME)

outcome	Total # of indicators	Indigenous # of indicators	example
ME 3.1. Investigate the characteristics of contact (e.g., push, pull, and friction) and non-contact (e.g., magnetic and static electric) forces [SI]	9	0	
ME 3.2. Assess effects of practical applications of magnetic and static electric forces on individuals and society [CP, TPS]	10	0	

Earth and Space Science: Exploring Soils (ES)

outcome	Total # of indicators	Indigenous # of indicators	example
ES 3.1. Investigate the characteristics, including soil composition and ability to absorb water, of different types of soils in their environment [SI]	10	0	
ES 3.2. Analyze the interdependence between soil and living things, including the importance of soil for individuals, society, and all components of the environment [CP, DM]	9	1	a.Suggest ways in which individuals and communities value and use soil, including the importance of Mother Earth for First Nations and Metis peoples. [CP] (p. 34) 3 Content

Connections with other areas of study: None

Science Grade 4 (2011)

Life science: Habitats and communities (HC)

outcome	Total # of indicators	Indigenous # of indicators	example
HC 4.1. Investigate the interdependence of plants and animals, including humans, within habitats and communities. [CP, SI]	13	0	
HC 4.2. Analyze the structures and behaviours of plants and animals that enable them to exist in various habitats [SI]	10	0	
HC 4.3. Assess the effects of natural and human activities on habitats and communities and propose actions to maintain or restore habitats. [CP, DM]	10	2 (+1?)	a.Recognize and discuss the role of traditional knowledge in learning about, valuing, and caring for plants and animals within local habitats and communities. (p. 29)[cp] 4 contextual g. Investigate how both scientists' and traditional knowledge keeper's knowledge of plant growth and development has led to the development of agricultural methods and techniques (e.g., tillage, hydroponics, nutrient management, pest control, crop rotation, companion plants, and plant breeding) that affect habitats and communities. (p. 29)[cp] 4 Content

Physical science: Light (LI)

outcome	Total # of indicators	Indigenous # of indicators	example
LI 4.1. Investigate the characteristics and physical properties of natural and artificial sources of light in the environment [CP, SI]	9	1	c. Examine the significance of light in First Nations and Metis stories, legends, and spirituality, including the role of fire, lightning, aurorae, and Thunderbird. (p. 30) [cp] 4 pedagogical
LI 4.2. Analyze how light interacts with different objects and materials to create phenomena such as shadows, reflection, refraction, and dispersion. [SI]	10	0	
LI 43. Assess personal, societal, and environmental impacts of light-related technological innovations including optical devices. [DM, TPS]	13	0	

Physical science: Sound (SO)

outcome	Total # of indicators	Indigenous # of indicators	example
SO 4.1. Explore natural and artificial sources of sound in the environment and how those sounds are detected by humans and animals. [CP, SI]	10	0	
SO 4.2. Draw conclusions about the characteristics and physical properties of sound, including pitch and loudness, based on observation. [CP, SI]	12	0	
SO 4.3. Assess personal, societal, and environmental impacts of sound-related technologies [DM, TPS]	11	0	

Earth and space science: Rocks, Minerals, and Erosions (RM)

outcomes	Total # of indicators	Indigenous # of indicators	examples
RM 4.1. Investigate physical properties of rocks and minerals, including those found in the local environment. [CP, SI]	12	0	
RM 4.2. Assess how human uses of rocks and minerals impact self, society, and the environment [DM]	11	1	a.Discuss ways in which people of different cultures value, respect, and use rocks and minerals, including First Nations and Metis connections to Mother Earth (p. 36) [DM/ CP?] 3 Content
RM 4.3. Analyze how weathering, erosion, and fossils provide evidence to support human understanding of the formation of land forms on Earth [CP, SI, TPS]	14	1	a.Construct a visual representation of the diversity of landscapes and landforms throughout Saskatchewan, including those that have significance for First Nations and Metis people. (p. 37) 3 Content

Connections with other areas of study: none

Science Grade 5 (2011)

Life Science: Human Body Systems (HB)

outcome	Total # of indicators	Indigenous # of indicators	example
HB 5.1. Analyze personal and societal requirements for, and the impact of, maintaining a healthy human body. [CP, DM]	11	3	a.Examine methods and perspectives of various cultures, including First Nations and Metis, which have contributed to knowledge about maintaining a healthy body (e.g., balance inherent in the Medicine Wheel). (p. 27) 3 Content b. Identify local knowledge, including the effects of traditional life styles, that contributes to human understanding of maintaining a healthy body. (p. 27) 3 Content h. Compare personal diets and those of people who live in different communities and countries worldwide to *Canada's Food Guide and Canada's Food Guide-First Nations, Metis, and Inuit*. (p. 27) 4 Content
HB5.2 Investigate the structure, function, and major organs of one or more human body systems such as the digestive, excretory, respiratory, circulatory, nervous muscular, and skeletal systems. [SI, TPS]	11	0	
HB 5.3. Assess how multiple human body systems function together to enable people to move, grow, and react to stimuli. [SI]	7	0	

Physical science: properties and changes of materials (MC)

outcomes	Total # of indicators	Indigenous # of indicators	examples
MC 5.1. Investigate the characteristics and physical properties of materials in solid, liquid, and gaseous states of matter. [CP, SI]	10	1	c. Discuss the importance of water, in all states of matter, as a sacred substance within First Nations and Metis cultures. (p. 30) 4 Content

MC 5.2. Investigate how reversible and non-reversible changes, including changes or state, alter materials. [SI]	14	0	
MC 5.3. Assess how the production, use, and disposal of raw materials and manufactured products affect self, society, and the environment. [DM, SI]	11	(+2?) * they are not explicitly mentioned about 'traditional/ Indigenous' – but opens up a learning opportunity for Indigenous students to learn about 'their' communities	f. identify locations in their communities and in Saskatchewan where agricultural and industrial manufacturing occurs, what products are created and tested, which raw materials are used, and how by-products and waste are disposed. (p. 32) Contextual j. Investigate how natural and manufactured products (e.g., tires, computers, tress, garbage, paper, scrap metal, house construction materials, food, clothing, oil, and automobiles) are disposed of personally, in their communities, and in Saskatchewan. (p. 32) Contextual

Physical science: Forces and simple machines (FM)

outcomes	Total # of indicators	Indigenous # of indicators	examples
FM 5.1 Analyze the effects of gravitational, magnetic, and mechanical forces, including friction, on the movement of objects [CP, SI]	14	0	
FM 5.2. Investigating characteristics of simple machines, including levers, wheels and axles, pulleys, inclined planes, screws, and wedges, for moving and lifting loads. [SI, TPS]	15	0	
FM 5.3. Assess how natural and man-made forces and simple machines affect individuals, society, and the environment [CP, DM, SI]	13	(+3?) 'in their community'	a.provide examples of simple and complex machines used at home, in school, and throughout their community. (p. 35) contextual f. identify the benefits and disadvantages of practical examples of levers (e.g., pliers, teeter-totter, bottle opener, wheelbarrow, and fishing rod) on their lives and in their community. (p. 35) contextual j. Examine the types of tasks in the community that have been and are being currently accomplished using wedges (e.g., shim, splitting maul, knife, axe, and chisel) (p. 36) contextual

Earth and Space science: Weather

outcomes	Total # of indicators	Indigenous # of indicators	examples
WE 5.1. Measure and represent local weather, including temperature, wind speed and direction, amount of sunlight, precipitation, relative humidity, and cloud cover [CP, SI , TPS]	12	0	
WE 5.2. Investigate local, national, and global weather conditions, including the role of air movement and solar energy transfer. [SI]	14	1	k. examine weather lore and animal behaviours in traditional and contemporary cultures as tools to predict weather conditions. (p.38) 4 content
WE 5.3. Analyze the impact of weather on society and the environment, including technologies that help humans address weather conditions. [DM]	10	2 (+1)	g. examine how scientists and traditional knowledge keepers can collaborate to provide a more comprehensive understanding of the effects of weather on people and the environment (p. 39). 4 Content h. research traditional and contemporary technological innovations and products related to clothing, shelter, agriculture, and transportation that various cultures have developed to address various types of weather conditions. (p. 39) 4 Content

Connections to other areas of study: none

Science Grade 6 (2009)
Life science: diversity of living things. (DL)

outcomes	Total # of indicators	Indigenous # of indicators	examples
DL 6.1 Recognize, describe, and appreciate the diversity of living things in local and other ecosystems, and explore related careers. [CP, SI]	6	1	e. analyze how First Nations and Metis art and storytelling highlight movement and/or behaviour of living things and reflect a worldview that values all living things (p. 30) 4 pedagogical
DL 6.2 Examine how humans organize understanding of the diversity of living things [CP, SI]	8	2	d. explore local First Nations and Metis methods of organizing understanding of living things (e.g., two-leggeds, four-leggeds, winged-ones, swimmers, trees, and grasses) and the criteria underlying that understanding (e.g., where animals are found, how animals move, and the uses of plants). (p. 30) 4 pedagogical e. describe how aspects of First Nations and Metis worldviews (e.g., holistic, interconnectedness, valuing of place-based knowledge) shape their systems of organizing understanding of living things. (p. 31) 4 content
DL 6.3. Analyze the characteristics and behaviours of vertebrates (i.e., mammals, birds, reptiles, amphibians, and fish) and invertebrates [SI]	5	0	
DL 6.4 Examine and describe structures and behaviours that help: - Individual living organisms survive in their environments in the short term - Species of living organisms adapt to their environments in the long term. [CP, DM,SI]	14	1	g. gather information from a variety of sources (e.g., Elder, traditional knowledge keeper, naturalist, textbook, non-fiction book, museum display, encyclopaedia, and website) to answer student-generated questions about the structural and behavioural adaptations of organisms. (p. 32) 1 Contextual
DL 6. 5 Assess effects of micro-organisms on past and present society, and contributions of science and technology to	7	1	e. compare cultural (including First Nations and Metis), historical, and scientific understandings and explanations of disease, including the contributions of scientists such as John Snow and Louis Pasteur to the germ theory (p. 33)

human understanding of micro-organisms [CP, DM, SI]			3 content

Physical science: Understanding Electricity (EL)

outcomes	Total # of indicators	Indigenous # of indicators	examples
EL 6.1 Assess personal, societal, economic, and environmental impacts of electricity use in Saskatchewan and propose actions to reduce those impacts [CP, DM]	6	0	
EL 6.2 Investigate the characteristics and applications of static electric charges, conductors, insulators, switches, and electromagnetism [SI]	12	0	
EL 6.3 Explain and model the properties of simple series and parallel circuits [SI, TPS]	8	0	

Physical science: Principles of Flight (FL)

outcomes	Total # of indicators	Indigenous # of indicators	examples
FL 6.1 Examine connections between human fascination with flight and technologies and careers based on the scientific principles of flight. [CP, DM, SI]	8	2	b. show how First Nations and Metis art and storytelling highlight understanding of and respect for birds (p. 36) 4 pedagogical f. Describe examples of traditional and modern technologies developed by First Nations, Metis, and other cultures that are based on principles of flight (e.g., atlatl, bow and arrow, sling shot, catapult, boomerang, and trebuchet). (p. 36) 4 content
FL 6.2 Investigate how the forces of thrust, drag, lift, and gravity act on living things and constructed devices that flies through the air. [SI]	8	0	

FL 6.3 Design a working prototype of a flying object that meets specified performance criteria [TPS]	10	0	

Earth and Space science: our solar system (SS)

outcomes	Total # of indicators	Indigenous # of indicators	examples
SS 6.1 Research and represent the physical characteristics of the major components of the solar system, including the sun, planets, moons, asteroids, and comets [CP, SI]	9	1	f. Describe objects in the heavens, as indicated through First Nations and Metis art and stories or by Elders or traditional knowledge keepers (p. 38) 4 content
SS 6.2 Assess the efficacy of various methods of representing and interpreting astronomical phenomena, including phases, eclipses, and seasons. [CP, SI]	9	1	a.Examine how people of different cultures, including First Nations, have recorded (e.g., medicine wheel, Mayan calendar, Stonehenge, pyramids) and used understandings of astronomical phenomena (e.g., positions of the stars and/or planets) to solve practical problems such as the appropriate time to plant and harvest crops, to support navigation on land and water, or to foretell significant events through stories and legends. (p. 39) 3 content
SS 6.3 Evaluate past, current, and possible future contributions of space exploration programs including space probes and human spaceflight, which support living and working in the inner solar system [DM, TPS]	7	0	

Connections with Other Areas of Study

Arts Education:
The conceptual focus for Grade 6 Arts Education is “Identity”. This focus includes investigations of how identity is influenced by factors such as cultural heritage and personal interests. Connections between arts education and science may include:…

… “Examine ways that First Nations and Metis art and storytelling highlight movement and behaviour of living things, and understanding of and respect for birds and other living things that fly.” (p. 42- 43)

Science Grades 7 (2009)
Life Science: Interactions within Ecosystems (IE)

outcomes	Total # of indicators	Indigenous # of indicators	examples
IE 7.1 Relate key aspects of Indigenous knowledge to their understanding of ecosystems [CP] (p. 30)*** 5	4	4	a.gather information about traditional Indigenous practices with respect to the relationships and connections between people and their ecological environment 4 content b. examine key aspects of Indigenous knowledge and First Nations and Metis people's practices that contribute to understanding of ecosystems and the interactions of their components. 4 content c. Provide specific examples of Indigenous knowledge in understanding the components of their ecosystems. 4 content 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 4 content
IE 7.2 Observe, illustrate, and analyze living organisms within local ecosystems as part of interconnected food webs, populations, and communities. [SI]	12		
IE 7.3 Evaluate biogeochemical cycles (water, carbon, and nitrogen) as representations of energy flow and the cycling of matter through ecosystems [??]	10	0	
IE 7.4 Analyze how ecosystems change in response to natural and human influences, and propose actions to reduce the impact of human behaviour on a specific ecosystem. [DM, CP]	8		

Physical science: Mixtures and solutions

outcomes	Total # of indicators	Indigenous # of indicators	examples
MS 7.1 Distinguish between pure substances and mixtures (mechanical mixtures and solutions) using the particle model of matter [SI, CP]	10	0	
MS 7.2 Investigate methods of separating the components of mechanical mixtures and solutions, and analyze the impact of industrial and agricultural applications of those methods. [SI, TPS]	11	0	
MS 7.3 Investigate the properties and applications of solutions, including solubility and concentration. [SI, DM]	10	0	

Physical science: Heat and Temperature (HT)

outcomes	Total # of indicators	Indigenous # of indicators	examples
HT 7.1 Assess the impact of past and current heating and cooling technologies related to food, clothing, and shelter on self, society, and the environment. [TPS, DM, CP]	9	0	
HT 7.2 Explain how understanding differences between states of matter and the effect of heat on changes in state provide evidence for the particle theory [SI]	8	0	
HT 7.3 Investigate principles and applications of heat transfer via the processes of conduction, convention, and radiation. [SI]	8	0	

Earth and Space Science: Earth’s Crust and Resources (EC)

outcomes	Total # of indicators	Indigenous # of indicators	examples
EC 7.1. analyze societal and environmental impacts of historical and	9	0	

current catastrophic geological events, and scientific understanding of movements and forces within Earth's crust [SI]			
EC 7.2 Identify locations and processes used to extract Earth's geological resources and examine the impacts of those locations and processes on society and the environment [SI, DM, CP]	11		
EC 7.3 Investigate the characteristics and formation of the surface geology of Saskatchewan, including soil, and identify correlations between surface geology and past, present, and possible future land uses. [DM, SI]	12	0	

Connections with Other Areas of Study.

Arts Education.
The conceptual focus for Grade 7 Arts Education is "Place". This focus includes investigations of relationships between the arts and the land; local geography; regional, urban, and/or rural environments. Connections between arts education and science may include:

- 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 digeridoos, Inuit throat singing, beading, First Nations drums and flutes). (p. 44).

Science Grades 8 (2009)

Life science: Cells, Tissues, Organs, and Systems (CS)

outcomes	Total # of indicators	Indigenous # of indicators	examples
CS 8.1. Analyze the characteristics of cells, and compare structural and functional characteristics of plant and animal cells. [SI]	11	0	
CS 8.2 Demonstrate proficiency in the use of a compound light microscope to observe plant and animal cells [SI]	5	0	
CS 8.3. Distinguish structural and functional relationships among cells, tissues, organs, and organ systems in humans and how this knowledge is important to various careers. [CP, SI]	8	0	
CS 8.4. Analyze how the interdependence of organ systems contributes to the healthy functioning of the human body. [CP, DM, SI]	11	1	a.examine First Nations and Metis perspectives on the interdependence and connectedness of human body systems and the sacredness of life (p. 31). pedagogical 4

Physical science: Optics and Vision (OP)

outcomes	Total # of indicators	Indigenous # of indicators	examples
OP 8.1 Identify and describe, through experimentation, sources and properties of visible light including: - rectilinear propagation - reflection - refraction [SI]	10	0	
OP 8.2. Explore properties and applications of optics-related technologies, including concave and convex mirrors and lenses. [SI, TPS]	8	0	

OP 8.3. Compare the nature and properties of human vision with optical devices and vision in other living organisms [CP, SI]	7	0	
OP 8.4 Evaluate the impact of electromagnetic radiation-based technologies on self and community [CP, DM, SI]	6	0	

Physical science: Forces, fluids, and Density (FD)

outcomes	Total # of indicators	Indigenous # of indicators	examples
FD 8.1 Investigate and represent the density of solids, liquids, and gases based on the particle theory of matter. [SI, TPS]	10	0	
FD 8.2 Examine the effects of forces in and on objects in fluids, including the buoyant force. [??]	12	0	
FD. 8.3 Investigate and describe physical properties of fluids (liquids and gases), including viscosity and compressibility [SI]	11	0	
FD. 8.4. Identify and interpret the scientific principles underlying the functioning of natural and constructed fluid systems. [CP, SI]	7	0	

Earth and Space science: Water systems on Earth (WS)

outcomes	Total # of indicators	Indigenous # of indicators	examples
WS 8.1 analyze the impact of natural and human-induced changes to the characteristics and distribution of water in local, regional, and national ecosystems.	8	1	c.examine the significance of water to First Nations and Metis people of Saskatchewan, including water as an essential element of life, transportation, water quality, fishing practices, and treaty rights regarding fishing. (p. 39) 4 content/pedagogical/contextual

WS 8.2 Examine how wind, water, and ice have shaped and continue to shape the Canadian landscape. [DM, SI]	9	1	c. explain the meaning and significance of the forces that shape the landscape to First Nations and Metis people. (p. 40) 4 content
WS 8.3 Analyze natural factors and human practices that affect productivity and species distribution in marine and fresh water environments. [CP, DM, SI]	9	1	a.examine the ways in which First Nations and Metis people traditionally valued, depended upon, and cared for aquatic wildlife and plants in Saskatchewan and Canada. (p.41) 4 content

Connections with other areas of Study: none

Science Grades 9 (2009)

Life science: reproduction and Human development (RE)

outcomes	Total # of indicators	Indigenous # of indicators	examples
RE 9.1 Examine the process of and influences on the transfer of genetic information and the impact of that understanding on society past and present [CP, DM]	9	0	
RE 9.2 Observe and describe the significance of cellular reproductive processes, including mitosis and meiosis [CP, SI]	7	0	
RE 9.3 Describe the processes and implications of sexual and asexual reproduction in plants and animals [SI]	7	0	
RE 9.4 Analyze the process of human reproduction, including the influence of reproductive and contraceptive technologies. [SI, DM]	6	1	d. acknowledge differing cultural perspectives, including First Nations and Metis perspectives, regarding the sacredness, interconnectedness, and beginning of human life. (p. 32). 3 pedagogical

Physical science: Atoms and Elements (AE)

outcomes	Total # of indicators	Indigenous # of indicators	examples
AE 9.1 Distinguish between physical and chemical properties of common substances, including those found in household, commercial, industrial, and agricultural applications.	11	1	b. explore local knowledge of properties of matter and traditional uses of substances, including medicines. (p.32) 4 content
AE 9.2 Analyze historical explanations of the structure of matter up to and including: - Dalton model - Thomson model - Rutherford model	9	1	c. Describe First Nations and Metis views on the nature and structure of matter. (p.33) 4 content

- Bohr model of the atom [SI]			
AE 9.3. Demonstrate an understanding of the classification of pure substances (elements and compounds), including the development and nature of the Periodic table. [SI]	14	0	

Physical science: Characteristics of Electricity (CE)

outcomes	Total # of indicators	Indigenous # of indicators	examples
CE 9.1. Demonstrate and analyze characteristics of static electric charge and current electricity, including historical and cultural understanding. [CP, SI, TPS]	13	1	d. examine how the importance of lightning in First Nations and Metis culture is conveyed through stories and legends. (p. 35) 4 pedagogical
CE 9.2 Analyze the relationships that exist among voltage, current, and resistance in series and parallel circuits. [SI]	8	0	
CE 9.3 Assess operating principles, costs, and efficiencies of devices that produce or use electrical energy [SI, TPS]	8	0	
CE 9.4 Critique impacts of past, current, and possible future methods of small and large scale electrical energy production and distribution in Saskatchewan [DM, TK]	7	1	a.provide examples of how technological developments related to the production and distribution of electrical energy have affected and continue to affect self and community, including electricity use on reserves, traditional lands, and traditional life in Saskatchewan. (p. 38) 3 content

Earth and Space science: Exploring our Universe (EU)

outcomes	Total # of indicators	Indigenous # of indicators	examples
EU 9.1 Inquire into the motion and characteristics of astronomical bodies in our solar system and the universe [SI]	12	0	

EU 9.2 Analyze scientific explanations of the formation and evolution of our solar system and the universe [SI]	5	0	
EU 9.3 Examine how various cultures, past and present, including First Nations and Metis, understand and represent astronomical phenomenon [CP]	4	2	a.Describe First Nations and Metis perspectives on the origin of the solar system and the universe. (p.40) 4 pedagogical b.Identify how worldviews related to astronomical phenomenon are expressed through First Nations and Metis stories and oral traditions (p. 40) 4 pedagogical
EU 9.4 Analyze human capabilities for exploring and understanding the universe, including technologies and programs that support such exploration [DM, TPS]	10	0	

Connections to other areas of study: none.

Science Grade 10 (2015)

Career Investigation

Outcome	Total Number of Indicators	Indigenous Number	Example
SCI10- CI1 Investigate career paths related to various branches and sub-branches of science [DM]	9	0	

Climate and Ecosystem Dynamics

Outcome	Total Number of Indicators	Indigenous Number	Example
SCI10- CD1 Assess the implications of human actions on the local and global climate and the sustainability of ecosystems. [DM, SI]	12	2	c. Research how people from Aboriginal and other cultures view relationships between living organisms and their ecosystems, and the role of humans in those relationships. (p. 33) 4 Content d. examine the positions of First Nations and government agencies responsible for the stewardship and management of resources, including the duty to consult. (p. 33) 4 content
SCI10-CD2 Investigate factors that influence Earth's climate system, including the role of the natural greenhouse effect. [DM,SI]	12	0	
SCI10- CD3 Examine biodiversity through the analysis of interactions among populations within communities. [DM, SI]	12	1	g. Examine ways in which scientists collaborate with Elders, knowledge keepers and other community members to gather and interpret data related to biotic components of ecosystems. (p. 35) 4 content
SCI10- CD4 Investigate the role of feedback mechanisms in biogeochemical cycles	9	1	e. explore Indigenous ways of understanding the role of mater and energy in the environment. (p. 36) 4

and in maintaining stability in ecosystems. [CP, DM, SI]			content

Chemical relations

Outcome	Total Number of Indicators	Indigenous Number	Example
SCI10- CR1 Explore the properties of chemical reactions, including the role of energy changes, and applications of acids and bases. [CP, SI]	10	1	b. research the ways in which people, including First Nations and Metis, from various times and cultures have applied their understanding of the transformation of materials to produce new substances. (p. 37) 3 content
SCI10- CR2 Name and write formulas for common ionic and molecular chemical compounds, including acids and bases. [SI]	13	0	
SCI10- CD3 Examine biodiversity through the analysis of interactions among populations within communities. [DM, SI]	9	0	
SCI10- CR4 Investigate the role of feedback mechanisms in biogeochemical cycles and in maintaining stability in ecosystems. [CP, DM, SI]	11	0	

Force and Motion in Our World

Outcome	Total Number of Indicators	Indigenous Number	Example
SCI10- CR1 Explore the properties of chemical reactions, including the role of energy changes, and applications of acids and bases. [CP, SI]	6	1	a. Create a representation of different types of motion and motion-related technologies from various cultures, including First Nations and Metis (p.41) 3 pedagogical

SCI10- CR2 Name and write formulas for common ionic and molecular chemical compounds, including acids and bases. [SI]	9	0	
SCI10- CD3 Examine biodiversity through the analysis of interactions among populations within communities. [DM, SI]	8	0	
SCI10- CD4 Investigate the role of feedback mechanisms in biogeochemical cycles and in maintaining stability in ecosystems. [CP, DM, SI]	7	0	

Health Science 20 (2017)

Career Exploration

Outcome	Total Number of Indicators	Indigenous Number	Example
HS20- CE1 Analyze and explore health-science related occupations in Saskatchewan, Canada and the world. [CP, DM]	9	0	

Student-Directed Study

Outcome	Total Number of Indicators	Indigenous Number	Example
HS20- SDS1 Create and Carry out a plan to explore one or more topics of personal interest relevant to health Science 20 [DM, SI, TPS]	10	0	

Health Care Philosophes and Ethics

Outcome	Total	Indigenous	Example
HS 20- HC 1 Analyze how Western, Indigenous ,traditional, complementary and alternative approaches to health care can contribute to a holistic (e.g., mental, emotional, physical, and spiritual) perspective of health [CP, DM, SI]	10	4	B. Discuss the importance of and difficulties in defining terms such as Western, Indigenous, traditional, complementary and alternative approaches to health care within a global context. (p. 33) 2 Content c.assess how practitioners of Western, Indigenous, traditional, complementary and alternative approaches to health care address health, Wellness, illness, disease, and treatment through beliefs and practices such as Circle of Life, disharmony of body energies, being symptom free and healthy lifestyle choices. (p. 33) 4 content d.Identify where Western, Indigenous, traditional, complementary and alternative approaches to health care are offered in your community and elsewhere in Saskatchewan (p. 33) 4

			contextual
HS 20- HC 2 Examine how personal, cultural, and societal beliefs affect ethical decisions regarding health care. [CP, DM, SI]	11	2	d.Contrast how procedures to prevent illness, such as immunizations, vitamin supplements, physical activity, nutrition and prayer, might be viewed from the perspective of Western, Indigenous, traditional, complementary and alternative approaches to health care. (p.34) 2 Content e. Examine ethical considerations related to various practices and treatments (e.g., chemotherapy, radiation, acupuncture, sweat lodge, blood transfusions, herbal remedies and hydrotherapy) that might be considered in Western, Indigenous, traditional, complementary and alternative approaches to health care. (p.34) 4 Content

Human Body

Outcome	Total	Indigenous	Example
HS 20- HB1 Analyze the anatomy and physiology of a healthy human. [CP, SI]	9	1	a.Examine First Nations, Metis and other holistic perspectives of the human body. (p. 35) 4 Content
HS 20- HB2 Investigate the effects of various injuries, disorders and disease on human cells, tissues, organs and systems. [SI, DM]	8	0	

Nutrition

Outcome	Total	Indigenous	Example

HS 20- NU 1 Assess the importance of macronutrients (i.e., carbohydrates, proteins and fats) and micronutrients (e.g., vitamins, minerals and phytochemicals) in maintaining human health. [CP, SI]	13	0	
HS 20 –NU 2 Analyze dietary choices based on personal and cultural beliefs and scientific understanding of nutrition. [SI, CP]	13	2	F.Examine how the dietary recommendations in Eating well with Canada's Food Guide and Eating Well with Canada's Food Guide-First Nations, Inuit and Metis compares with recommendations in food guides from other countries (p. 38) 4 Content m. Examine how various eating practices (e.g., pre-contact First Nations and Metis, kosher, halal and fasting practices during observations such as Lent and Ramadan) are based upon cultural and religious beliefs. (p. 38) 1 Content

Diagnostics and Treatment

Outcome	Total	Indigenous	Example
HS 20- DT 1 Explore the tools and procedures used to diagnose and monitor medical conditions [CP, SI, TPS]	10	1	I. Identify differences in tools and procedures used in diagnosing illness from the perspectives of Western, Indigenous, traditional, complementary and alternative approaches to health care. (p.39) 4 content

HS 20- DT2 Assess the importance of interpreting diagnostic findings to support treatment options for specific pathologies. [DM, SI, CP]	7	1	g. describe various treatment options that might be considered at various stages of a specific pathology from the perspective of Western, Indigenous, traditional, complementary and/or alternative approaches to health care. (p. 40). 4 content

Complementary medicine generally refers to using a non-mainstream approach together with conventional (Western) medicine (p.42).
Indigenous health care is an integrative approach that seeks to balance the mind, body and spirit with community and environment (p.43).
Traditional medicine is the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness. (p. 45)
Wellness is generally used to mean a healthy balance of the mind, body and spirit that results in an overall feeling of well-being. (p.45).
Western medicine, also called allopathic medicine, conventional medicine, mainstream medicine and evidence-based medicine is a system in which doctors, nurses, pharmacists, therapists and other conventional healthcare providers treat symptoms and disease using drugs, radiation or surgery. (p.45).

Physical Science 20 (2017)

Career Exploration

Outcome	Total	Indigenous	Example
PS20- CE1 Analyze and explore physical science related occupations in Saskatchewan, Canada and the world. [CP, DM]	8	0	

Student-Directed Study

Outcome	Total	Indigenous	Example
PS20- SDS1 Create and carry out a plan to explore one or more topics of personal interest relevant to Physical Science 20 in depth [DM, SI, TPS]	7	0	

Heat

Outcome	Total	Indigenous	Example
PS20- HT1 Analyze qualitatively and quantitatively, the effect of heat on matter during temperature changes and changes of state using kinetic molecular theory [CP, DM, SI]	15	1	b.Explore the importance of heat and fire for First Nations and Metis peoples and how they use their understanding of heat transfer to solve practical problems related to cooking and shelter. (p. 33) 4 Content

PS20- HT2 Determine the quantities of heat involved in chemical reactions through experimentations and calculation [SI, TPS]	10	0	

Foundations of Chemistry

Outcome	Total	Indigenous	Example
PS 20- FC1 Predict products of the five basic types of chemical reactions and evaluate the impact of these reactions on society and the environment [DM, SI]	12	0	
PS 20- FC 2 Construct an understanding of the mole as a unit for measuring the amount of substance [DM, SI]	10	0	
PS 20- FC 3 Use stoichiometry to determine the relative amounts of substances consumed and produced in chemical reactions [SI]	12	0	

Properties of Waves

Outcome	Total	Indigenous	Example
PS 20- PW1 Investigate the properties and characteristics of one- , two- and three-dimensional waves in at least three different media (e.g., springs, ropes, air and water) [SI]	14	1	b.examine First Nations and Metis perspectives on waves, including wave as carrier of energy (p. 38). 4 Content
PS20- PW2	8	0	

Examine, using physical materials, ray diagrams and mathematical equations, how waves reflect from a variety of barriers. [DM, SI]			
PS 20- PW3 Analyze, using physical materials, ray diagrams and mathematical equations, how waves refract at boundaries between different media [DM, SI]	7	0	

Environmental Science 20 (2017)

Career Exploration

Outcome	Total	Indigenous	Example
ES 20- CE1. Analyze and explore environmental science related career paths in Saskatchewan, Canada and the world. [CP, DM]	11	0	

Student-Directed Study

Outcome	Total	Indigenous	Example
ES 20- SDS1 Create and carry out a plan to explore one or more topics of personal interest relevant to Environmental Science 20 in depth. [CP, DM, SI, TPS]	15	0	

The Nature of Environmental Science

Outcome	Total	Indigenous	Example
ES20- ES1 Examine the methods, mindsets and purposes of environmental science. [CP, DM]	11	2/2	c.Analyze how different worldviews (e.g., anthropocentric, biocentric and ecocentric) are expressed through various environmental action plans or environmental policies developed by individuals, industry, government and non-governmental organizations and First Nations, Metis and Inuit group. (p. 33) 4 Content d. Recognize essential characteristics of First Nations and Metis worldviews regarding the environment, including the importance of the four elements (i.e., earth, water, wind and fire), a sense of interconnectedness with the environment and respect for Mother Earth. (p.33) 4 Content

Atmosphere and Human Health

Outcome	Total	Indigenous	Example
ES 20-AH 1 Assess the impact of human activities on indoor and outdoor air quality and the need for regulations and mitigating technologies to minimize risks to human health. [SI, DM]	9	0	
ES 20- AH 2 Analyze the production, reliability, and uses of geoscience data to investigate the effects of a changing climate on society and the environment. [CP, DM, SI]	12	0	

Human populations and Pollution

Outcome	Total	Indigenous	Example
ES 20- HP1 Investigate technologies and processes used for mitigating and managing resource use, waste generation and pollution associated with a growing human population. [CP, DM. SI]	11	1	c.Research First Nations and Metis beliefs and practices that demonstrate a sustainable perspective on using resources wisely and minimalizing waste. (p. 36). 4 content

Aquatic Systems.

Outcome	Total	Indigenous	Example
ES 20- AS 1 Analyze the function and condition of fresh water aquatic systems such as rivers, streams, lakes, wetlands and watersheds. [CP, DM, SI]	9	0	
ES20- AS 2	11	1	i.investigate the role of muskeg and moss in water filtration and food preservation for First Nations and Metis and other communities. (p. 38) 4 content

Assess the importance of maintaining healthy water for humans and the environment. [SI, DM]			

Terrestrial Systems

Outcome	Total	Indigenous	Example
ES20- TE1 Analyze the importance of soils as an integral component of terrestrial ecosystems. [SI, DM, CP]	12	1	a.Discuss how First Nations and Metis people value soil as an integral component of Mother Earth, including traditional ways of looking after soil. 4 content
ES20- TE2 Examine the role plants play in an ecosystem, including the ways in which humans use plants. [SI, CP, DM]	10	1	b. examine the significance (e.g., medicinal, spiritual, nutritional and shelter) of plants, including tobacco, in First Nations and Metis cultures (p. 40). 4 content
ES20- TE3 Recognize the need for intact habitat to support animal populations and biodiversity. [SI, CP, DM]	10	1/1	b.describe examples of First Nations and Metis peoples' contributions in recognizing the effects of natural and human- caused changes to habitat on historical migration patterns of animals in Saskatchewan. (p. 41) 4 content c. examine how habitat management and protection decisions are influenced by the extent to which Indigenous land rights (e.g., custodians of the land versus individual land ownership) are reflected through the spirit and intent of various treaties. (p. 41) 4 content

Biology 30 (2017)

Student-Directed Study

Outcome	Total	Indigenous	Example
BI30-SDS1 Create and carry out a plan to explore one or more topics of personal interest relevant to Biology 30 in depth [DM, SI, TPS]	7	0	

Life and Evolution

Outcome	Total	Indigenous	Example
BI30-LE1 Explore how scientific understandings of life and its characteristics change in light of new evidence. [CP, DM]	7	1	b.Distinguish among scientific, First Nations, Metis, Inuit and other cultural perspectives with respect to the question of what constitutes life. (p. 32) 4 content
BI30-LE2 Examine the significance of evolution as a key unifying theme in biology through the principles, processes and patterns of biological evolution [SI, DM]	13	0	

Organization of life

Outcome	Total	Indigenous	Example
BI30-OL1 Investigate cell structure and processes, including energy transfer and transport of materials, in unicellular and multicellular organisms which are representative of each kingdom. [SI, TPS]	10	0	
BI30-OL2 Compare the anatomies, physiologies and behaviors of multicellular organisms including protists, fungi, plants and animals [SI]	8	1	c.Research First Nations and Metis perspectives regarding the use of living things for scientific research. (p. 35). 4 content

BI30-OL3 Explore how the dynamic nature of biological classification reflects advances in scientific understanding of relationships among organisms. [SI, CP]	9	1	b.Research how First Nations, Metis and Inuit peoples represent their understandings of relationships among living things. (p. 36) 4 Content/pedagogical

Genetics and Biotechnology

Outcome	Total	Indigenous	Example
BI30- GB1 Explore classical (i.e., Mendelian) and current (i.e., chromosomal) understandings of biological inheritance [SI]	11	0	
BI30- GB2 Investigate how genetic information is stored, transmitted and expressed at the molecular level. [SI, CP]	9	0	
BI30- GB3 Explore the impacts of historical, current and emerging biotechnologies on self, society and the environment.	10	0	

Earth Science 30 (2016)

Career Exploration

Outcome	Total	Indigenous	Example
ES30-CE1 Analyze and explore earth-science related career paths in Saskatchewan, Canada and the world.	8	0	

Student- Directed Study

Outcome	Total	Indigenous	Example
ES30- SDS1 Create a product that demonstrates a deeper understanding of a topic covered in Earth Science 30	9	0	

Foundations of Earth Science

Outcome	Total	Indigenous	Example
ES30- F01 Examine the multi-disciplinary nature of earth science.	11	1	i.Recognize how historical and contemporary observations, including those made by First Nations and Metis peoples, contribute to a greater understanding of earth's processes (p.6) 4 content
ES30- F01 Examine the evidence for and the importance of plate tectonics theory in explaining geological features.	12	0	
ES30-F03 Assess the importance of the geologic time scale, radiometric dating and the fossil record to current understanding of Earth's geological history.	10	0	

Lithosphere

Outcome	Total	Indigenous	Example
ES30- LS1 Analyze surface geography as a product of weathering, erosion and mass wasting	10	0	
ES30- LS2 Examine the processes that lead to the formation of rocks and minerals	10	0	
ES30- LS3 Investigate the processes and technologies used to locate and extract mineral resources and fossils fuels locally, provincially and globally.	13	1	j.Examine the moral and legal obligations of governments and companies involved in resource development with respect to traditional lands and treaties with First Nations, Metis and indigenous people worldwide (p. 9) 4 content

Atmosphere and Hydrosphere

Outcome	Total	Indigenous	Example
ES30-AH 1 Correlate major changes in Earth's atmosphere over geologic time with corresponding changes in the biosphere and other components of the geosphere.	12	0	
ES30- AH 2 Investigate how the hydrosphere interests with and impacts the biosphere and other components of the geosphere.	10	0	
ES30-AH3 Investigate the impact of atmospheric and hydrospheric processes on society and the environment.	10	0	

Chemistry 30 (2017)

Student- Directed Study

Outcome	Total	Indigenous	Example
CH30- SDS1 Create and carry out a plan to explore one or more topics of personal interest relevant to Chemistry 30 in depth	7	0	

Chemical Bonding and Materials Science

Outcome	Total	Indigenous	Example
CH30- MS1 Examine the role of valence electrons in the formation of chemical bonds	10	0	
CH30- MS2 Investigate how the properties of materials are dependent on their underlying intermolecular and intramolecular forces	9	0	
CH30-MS3 Explore the nature and classification of organic compounds, and their uses in modern materials.	13	1	i.Research how First Nations and Metis people used organic compounds as medicines and to make soap and cleaning products. (p.34) 4 Content
CH30- MS4 Determine the suitability of materials for use in specific applications [DM, TPS]	9	2	d.explore how First Nations and Metis people used their understanding of material properties to determine their use (e.g., different species of wood used for burning, smoking and creating structures for housing and transportation)(p.35) 4 content e.Research First Nations and Metis beliefs regarding the ethical treatment of Mother Earth with respect to the gathering, creating, using and disposing of materials (p.35)

			4 content

Chemical Equilibria

Outcome	Total	Indigenous	Example
CH30- EQ1 Consider, qualitatively and quantitatively, the characteristics and applications of equilibrium systems in chemical reactions	14	0	
CH30- EQ2 Analyze aqueous solution equilibria including solubility-product constants	9	0	
CH30- EQ3 Observe and analyze phenomena related to acid-base reactions and equilibrium [SI, DM]	13	1	a.Identify examples of acid-base reactions in the manufacture and use of consumer products (e.g., foods, cosmetics, pharmaceuticals and cleaners), industrial processes (e.g., resource extraction and refining, mine tailing), agricultural processes (e.g., fertilizer and pesticide application) and First Nations and Metis practices such as tanning hides (p.39) 4 Content

Electrochemistry

Outcome	Total	Indigenous	Example
CH30- EC1 Investigate the chemistry of oxidation and reduction (redox) reactions.	8	0	
CH30- EC2	9	0	

Examine applications of electrochemistry of their impact on society and the environment			