Indigenizing Science Curriculum with an Eye to Place and Authentic Experience

by

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We accept the Applied Project as confirming to the required standard.

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Abstract

This applied project represents an attempt by the author to find an answer to two questions. First, what are the Indigenous knowledge-forms, appropriate to place, available to give to the next generation? Second, how can these teachings be transmitted in a science classroom in a way that honors both the traditions of science and Indigenous knowledge? This project is a curriculum (in the sense of Currere) that promotes a reconciliation between a scientific world-view and traditional wisdom-in-action.

Keywords: Indigenous Knowledge Systems (IKS), Indigenized Curriculum, Curricular Unit
Acknowledgements

To my children, thank you for putting up with the long work that has kept me from you. To my friends in the place of my work, thank you for your openness and the warm welcome I have received. To Nikki, thank you for your meticulous attention to detail. To Jim, thank you for your experienced final look. To my wife, with whom I share a vision of life that has been enriched by my experiences in this program; thank you for the opportunity to engage in this course of study. Without you, none of this would have been possible.
Dedication

This project is dedicated to Greg, whose inspiration I felt in my heart repeatedly throughout this project.
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Why a Prologue?

Kovach (2009) began with a prologue. “Within Indigenous writing,” she said, “a prologue structures space for introductions while serving a bridging function for non-Indigenous readers. It is a precursory signal to the careful reader that woven throughout the varied forms of our writing – analytical, reflective, expository – there will be story, for our story is who we are” (p. 4). This project seeks to connect to this storytelling quality inherent in Indigenous writing. It is my experience too that story plays an important role in one’s lived experience.

To start, here is a true story: I often see people stand up in front of a crowd and give an oral telling of their tribal and clan affiliation. When I asked questions about why people do this, I discovered that it serves to place a person, to allow others in the room to situate themselves in relation to that person, so that everyone in the room understands the place they come from.

This oral process seems to be the living version of the dead words of a prologue. That only the dead version on paper can be used in this project is a shame. To know me in person is to know me in a way that words cannot convey. However, it is the best that can be worked, and that is why I begin with a prologue.

I start with “I” because for the reader to understand me, my voice must be known. I experience the world only in the moment and I cannot tell the stories using any voice but first person. So, in this thesis, I have “written from my voice, in my style, and it reflects who I am” (Kovach, 2009, p. 8). I want the reader to perceive my voice to help ensure that my words will not be misconstrued. It is, therefore, my responsibility to give enough information to share my voice.

Presently, I am a teacher at a First Nations’ community school. I was invited in to give the students an education in science, but also to serve as a role model and a guide for students.
My experience within the community was a positive one. The staff was welcoming and eager to share those aspects of their lived experiences that would better help me understand the situation within the community. Teachers, students, and parents are—for the most part—open with information about themselves, and I have tried to match this openness with my own, inviting questions and curiosity about my life from the students and community members. From these exchanges, it is clear to me that although the community faces its set of issues; it has a mighty spirit that is ready and willing for the type of growth that engaging in a process of science curriculum indigenization might produce.

I have not provided many details about the community that might allow identification of the community with which I am engaged. The information in my prologue is limited to the information necessary for understanding my intentions. However, there are key characteristics of my work environment that are critical in shaping the stories I hear in my research. To understand the stories I receive in the course of my inquiry, I must know the place and community in which I work. For readers to interpret my findings, it is helpful that I communicate context.
Chapter 1: Necessary Understanding

Building a Framework – My Conceptual Lens

A conceptual framework can be understood as a map or rudder that steers a research endeavor. Although I do not assert to fully articulate a conceptual framework, it is important to recognize who I have been thinking with – and why. This project work has been strongly shaped by the research of Dr. Margaret Kovach. Dr. Kovach is a teacher, researcher, and scholar in Indigenous methodology and Indigenous knowledges.

Dr. Kovach’s (2009) masterful guide *Indigenous Methodologies: Characteristics, Conversations and Contexts* has significantly shaped my thinking. This text has had strong influence on me personally. As my understanding of the hwumuhw community evolves, and I work to interpret that understanding through the lens of indigenous methodologies as outlined by Kovach, my appreciation for my students and their families (in short, the community) grows. Therefore, I feel that drawing on Dr. Kovach’s work has added to my praxis, my wisdom-in-action in the realm of teaching. It has also had deep impact on my project itself.

The small but ever-expanding field of indigenous studies includes important contributions from places as far afield as New Zealand and Africa. Yet despite the varied scholarship available, I chose to “think with” Kovach throughout the development of this graduate applied project. In part my decision rested on finding academic sources from our Canadian context; Dr. Kovach is of Plains Cree and Saulteaux ancestry and works at a Canadian University. I also thought it was important—and powerful—to have an academic lens that balanced out the many male voices embedded in the historiography of hard science. However, the most important reason for deciding to use Kovach’s work as a foundation and a lens for this project was because of the integral role that place has in regard to my project and curricular unit.
The centrality of place obligates that a source as local as possible be used. It ran against the spirit of this project to either go further afield than necessary on issues of methodology. Therefore, Kovach’s (2009) work became central to my own process, shaping how I understood the work of others, my own experiences, and the curricular unit I created that reflects those understanding. Readers will see the work of Dr. Margaret Kovach (2009) referenced heavily; she forms the foundation and lens to this project. Dr. Kovach is who I am “thinking with.”

**Overview of Place and Community Narrative**

To honour the place of my practice, I will begin with an overview of the community, followed by a discussion of terms. I present the overview and narrative before the discussions of terms because the relationships of people, ideas, and actions are the most critical aspect of the project. The terms are linguistic symbols, and fall short of the reality of phenomena, but the *knowing* embodied within the people I am working with is the reality. Because it is of prime significance, I describe it first and attend to its symbols second.

The culture of the people I work with is ancient. It is so old that it is difficult to put into words, similar to describing the distance to the sun. For people that do not come from similarly old cultures, there is no good point of reference. The people of this community manage a body of knowledge stretching back to the most ancient ancestors. This body of knowledge stretches back to long before the invention of writing. It is passed down, commented on, altered, redesigned and implemented by each generation and then the next. The stories of the elders are told and told again, their deeper meanings conveyed through a tradition of oral commentary that attends the story and is available to those who listen to the stories over and again and ask the right questions. Storytelling traditions, amongst other traditions from that ancient period, move forward into the present to be reinterpreted into a world very different from their origins, yet the stories continue...
to form the inner programming of the community. I define the community-held body of knowledge that I call *knowledge-forms* in more detail in the next section.

I will describe the community I am working with by these ancient knowledge-forms. I start with the set of knowledge-forms surrounding a deep connection to the sea that can be represented by a crew canoeing. Much of the sustenance of the people is gathered from the sea. Trade, marriages and ceremonies were all organized according to the vagaries of water transportation. Canoe craft is highly developed, and the community uses the metaphor of the canoe to represent a sense of all pulling together.

Traditional canoes are constructed from red cedar, and could hold eight to fifteen people and their goods. The second ancient knowledge form revolves around the symbol of the red cedar. All parts of this tree are used in ways practical and ceremonial, and is considered a sacred tree, its rootedness a symbol of the community. It features pervasively in construction, art, clothing and ceremonial regalia. Red cedar carries the implication of wisdom or maturity. This belief has been carried forward to the present where, for example, the graduation caps of students are made from woven red cedar. The cedar and the canoe are connected, in that the canoe is made from the cedar. Furthermore, the community believes that the spirits of their ancestors live on inside the cedar tree, and therefore, they are present in the canoe made from the cedar tree.

These knowledge-forms represented by the symbols of the sea and cedar have been re-interpreted by each generation in a unique way. Whereas the ancestors would canoe with all their goods for weeks up and down the coast to build connections, visit family, swap stories, feast, conduct ceremonies, trade, and so forth; they would do all these things to ensure their survival and the prosperity of their community. In the modern community, damage to these traditional
structures has been inflicted from the outside, and the community has been dispersed and disconnected from its traditional knowledge-forms.

However, in exchange, the modern community also has access to more powerful infrastructures. During the summer, someone paying attention to the highways that access the community, as well as related communities across the northwest coast will notice buses and vans with the names of canoe families written on the side. These are groups of people donning a traditional identity and engaging in the wisdoms-in-action that go with the ancient knowledge-forms, living the tradition. Like their ancestors, the prosperity of the community, and therefore the tradition of the knowledge-form itself, survives to the degree that the present generation is successful in reinterpreting the knowledge-form into a wisdom-in-practice appropriate for today.

The last important knowledge-form I will present as a symbol is the Big House. The Big House is a traditional style of building, again made from cedar. Within the Big House can be felt the community dances and rhythms that mark out the traditional calendar. Within the walls of the Big House, the true spirit of the people is expressed. Since I do not have the cultural background to comment on the Big House’s purpose in the deeply attached to place sense a community member would be able to, I must rely on observations of the people that go to the big house. These are the students, EA’s and other teachers in my teaching community, as well as the odd parent I might encounter, together with prior observations of other indigenous communities and information gleaned from informal conversations to make inferences about what I think is going on in the Big House. The youth spend time within it, and when they emerge, they are thought to be people with an established connection to the ancestors through ceremony.

The Big House is filled with the music of the ancestors. People sing old songs and write new ones. These songs are accepted as canon, find their proper place and either stop being
played or are absorbed into the community consciousness. The Big House serves as a storehouse of the most ancient and sacred knowledge-forms, and provides a way for community members to access these. The songs and dances from inside the Big House, which encompasses spirit dances, songs of ceremony, and family mask dances, are kept inside the Big House. Yet, the community considers song and dance exceedingly important outside of the big house, as well. These traditions are preserved in such forms as bone game songs, or canoe paddling songs. Significant fractions of each day at the school I work at are spent practicing and performing these ‘outside the Big House’ traditional song and dance, and provides a space for students and staff to bring forward song, helping to keep these ancient traditions alive.

In the same conversational vein I have been sharing thus far, a description of the challenges this community faces is warranted. Approximately one generation ago marked the dismemberment of the system of residential schools designed to systematically destroy access to the ancient knowledge-forms of this community, and replace it with a menial skill set and a servile mind. The very people whose education had been so grossly distorted have since been empowered to re-create the educational system in a way that respects place and community. The school I work at has emerged as the focus for these aspirations. It is my belief that the problems affecting the present educational environment come from the lack of: knowledge-forms applied in relation to the management of people in a school environment, curricular expertise, multi-departmental organization, and a variety of other positions that the community does not have a way to fill easily. The skill set involved with the large set of skills and knowledges involved might be represented by an empty suit. This ‘empty suit’ also represents a body of knowledge that I assert colonizers have historically wished to keep from colonized peoples; the sorts of
knowledge forms and wisdoms-in-action that a colonized education actively discourages its students from acquiring.

The value of these knowledge-forms is totally culture dependent, and so it can be inferred that these knowledge-forms either (a) never existed in the Indigenous community of this place because they were not required for the functioning of the society as it existed, or (b) were present among the population but were successfully snuffed out by an uncompromising colonial machine. Subsequently, rather than allowing the people of the community a chance to develop their own interpretation of the businessman knowledge-forms, these skills and understandings were actively discouraged through intergenerational trauma and the malingering vestiges of colonialism.

The effects of intergenerational trauma linger still. In Adelson’s (2005) study, substance abuse, low graduation rate, and low employment, all plague the community, well into the era of community-controlled schools. A major part of the community school’s mandate is to address these issues with the community youth. The school therefore plays a critical role in addressing these issues. The generation being educated now is receiving high quality, in-community education, as interpreted by community members who are in roles of authority in the school, at least where people available to fill the roles, and by committed, knowledgeable, and sensitive outsiders where community members are not available.

For the reasons noted above, many knowledge-forms remain unavailable for transmission through the school system. The community’s response is to bring in outside experts as needed. This is the position I am in. As a hired science educational expert, I do not see my highest purpose in replicating a rigid, scientific mindset that stems from the same Eurocentric world-system that has caused such harm to my students. Nor I am here as a test trainer. Helping youth
pass entrance exams for higher education is a fine goal, but the point of education is not simply to pass exams. Instead of the empty sound-symbol associated with a more common definition of science, I see myself as mediating the transmission of a complex and powerful knowledge-form tradition that represents the true nature of science, into a new place, where some but not all the individual wisdoms-in-action associated with this knowledge-form can be found. In short, I am trying to provide the youth a set of wisdoms-in-action that, when mature, will eventually manifest as an authentic expression of the science knowledge-form in the place of the community.

To do this effectively, I must tailor my educational program to the culture as best I can. I must talk to those keepers of traditions, the elders, and discover the stories, the key concepts, and the more ancient knowledge-forms that relate to the study of science and the natural world. I must find out what traditional wisdoms-in-action and modern science share. If efforts in this direction are successful, the next generation of learners will show evidence of integrating traditional ways of knowing with scientific knowledge. I can monitor the on-going manifestation of this process of integration through observation of the development of wisdom-in-action.

**Place**

Inherent to a discussion of education in the First Nations’ context is a discussion of place. Kovach (2009) said:

> Place links present with past and our personal self with kinship groups. What we know flows through us from the ‘echo of generations,’ and our knowledges cannot be universalized because they arise from our experiences with our places. This is why name-place stories matter: they are repositories of science, they tell of relationships, the reveal history, and they hold our identity. (p. 61)
Let me share my own interpretation of place. Keeping in mind that my definition of place is mine alone, and realizing that others may express their thoughts on place quite differently, my understanding of place has rested on “Apache Elder Charles Henry’s point that, in the grand scheme, the meaning which places have in our lives transcends our own momentary existence” (Kovach, 2009, p. 6).

In a First Nations’ context, I have observed place expressed in a transcendental way: the places with which your ancestors were involved are intimately involved with your present life; how you exist in the moment, and how you see the world. This sense of place follows the individual, and to be understood, an individual must be seen in the context of their place.

For my research to adhere to the principles of Indigenous methodologies and conform to the Indigenous practices I have observed, I must communicate my place. My mixed heritage gives me a complex identity when it comes to place. On the one hand, my settler ancestors preserved cultural knowledges for only a few generations at a time. They quickly changed the name of the new places they found themselves, and modeled their social interactions on systems developed in a place far away, in Europe.

These systems continue to dominate to this day, but many of these practices are damaging to the place I live, and so are unsustainable over the long term. Even as I discuss place, I am on shaky ground, because I do not have a deep connection to this concept. Yet, I can learn from the Indigenous people of the place I live. “There is a desire among a growing community of non-Indigenous academics to move beyond the binaries found within Indigenous-settler relations to construct new, mutual forms of dialogue, research, theory, and action” (Kovach, 2009, p.12).

Yet, a sense of place has come to me from another source. I am the wrong side Jewish, which means my father is Jewish and so no one calls me Jewish. However, that does not mean
that part of “I” that I trace through my father has not spoken through a Jewish idiom. This part of me thinks of place as something that is, strangely enough, moveable. From my understanding, Jews carry their sense of place with them, as represented by the Ark of the Covenant, which was carried by the people, as they were, essentially, placeless. These people formed a cultural identity that existed beyond land and extended into a worldwide connection shared by millions of people.

Because I have two different notions of place, it is perhaps easier for me to recognize that neither view can really be called the truth. Rather, both provide their own insights and serve as a reminder that there are many perspectives about a concept as broad as place. It is also a reminder that, although Indigenous methodologies inspire me, I can never provide a quality of place that is truly Indigenous and unique to each culture. Instead, my goal is to learn as much as I can about the knowledge systems of the people in the place in which am engaging in educational practice. In that way, I can transform the way I teach, and bring it more in line with the principles of the place I find myself. In this way, I can shape my Eurocentric scientific teaching strategies into something approaching an Indigenous way of knowing and coming to know. As Kovach (2009) stated:

cultural longevity depends on the ability to sustain cultural knowledges. At the heart of a cultural renaissance, Indigenous or otherwise, is a restoration and respectful use of that culture’s knowledge systems. Colonial history has disrupted the ability of Indigenous peoples to uphold knowledges by cultural methodologies. (p.12)

**Wisdom-in-action**

Process skills such as those performed by a scientist engaged in the scientific endeavor, honed to a high degree and are inseparably linked to a body of knowledge, are examples of the specialized type of knowledge I refer to as wisdom-in-action. It can take a long time to develop
this type of knowledge, and so multiple observations over time are necessary to understand its
genesis and development. This type of knowledge stands in contrast to a type of knowledge that
is the knowledge of things. This is the type of knowledge displayed in games of trivia and sits in
encyclopedias and academic journals, and that has ultimately dominated the discourse in
European scientific epistemology. I point this out not to deride one type of knowledge and laud
the other. Rather, it is to put the knowledge of things into its proper place with respect to
development of process skills. The two types of knowledge are interconnected. Improvements in
one improve the other. The entire system benefits from (a) acquiring access to informational
knowledge (what one might call book smarts), and (b) improving process skills (what one might
call street smarts). The synthesis of these two types of knowledge into actions that affect change
in a beneficial way is wisdom-in-action.

**Knowledge-form**

Examples of knowledge-forms pertinent to my research context include woodcarving,
bark harvesting, food gathering, and traditions of medicine, storytelling, dancing, and song
making. The ancient knowledge-forms embedded in these long-held traditional knowledge-forms
are and unique in the following ways. First, each has been re-interpreted and re-transmitted many
thousands of times across generations. Each time, the skills and concepts behind the knowledge-
form were refined, built upon, and abandoned where appropriate. Over the thousands of years of
these knowledge forms existence, they have seen a great number of differing circumstances of
environment both physical and social. Thus, these knowledge forms carry with them a great deal
of power in shaping the practitioner’s understanding of the world. The person who develops
them through to mastery levels is thoroughly affected by their acquisition and practice. Second,
the keepers and administrators of these knowledge-forms, the elders, are keenly aware of the
power and importance of these knowledge-forms and are particular about whom they grant access to and how that access is granted. These considered choices have the function of maintaining the core of the tradition in its passing down, and serves as a seal of legitimacy of the knowledge-form’s pedigree.

Knowledge-forms are composite entities. They represent a mixture of a way of doing something, on the one hand, and a way of interpreting the world, on the other. They carry with them various wisdoms-in-action located around a central activity and include a tradition of commentary, the form of which is an entire subject of study unto itself. A knowledge-form includes practices and knowledges that can be engaged by any number of people, or just one solitary.

Knowledge-forms have the quality of being mimetic. They carry with them their own tradition, or history. When you see someone interpreting a knowledge-form through his or her own wisdom-in-action, you cannot help but take away from the observation of this master a little of his or her own intentionality, his or her own interpretation, into your own wisdom. Because a knowledge-form is not an objective form in the Platonic sense of the universal forms, but rather, a hermeneutic, it implies a re-interpretation between transmissions. Indeed, over time, the knowledge-form manifests differently in even the same individual.

Knowledge-forms share some attributes with scientific concepts, but in some ways are quite different from scientific concepts. Both seek to subject knowledge claims to testing. Both carry with them a tradition of subjection to scrutiny by those thought most suited to the task. Both carry an ever-deepening commentary within them. Both require the application of a large variety of wisdoms-in-action. Both are transmitted through lineages.
Some major hurdles remain when trying to reconcile these different ways of understanding knowledge. While knowledge-forms are interpreted and re-interpreted over time, and thus can lead an individual affecting wisdom-in-action choices that differ from one instant to the next, scientific knowledge declares laws of nature that lead to a deterministic worldview. This worldview prevents real and in-depth understanding of choice.

Science can quantify the number of neurons recruited for a task, and call that learning, but it cannot tell you why an individual decides to do something in a particular way at a particular time. All attempts at simulating human interactions are treated stochastically, dealing with probabilities, or else fail to account for important observed behaviours, and thus fail as complete simulations. Thus, science as it is usually constructed in the European tradition is inadequate as a complete description of reality. However, if the reader can begin to transform their understanding of science into a performance mindset, more fully explored later in this paper, a way to explore the process of Indigenizing science curriculum opens.

The question of choice is central to the analysis of wisdom-in-action. Wisdom-in-action is really a series of choices made over a time frame that leads to successful outcomes on a task, combined with a connection to a knowledge-form that allows for an appraisal of skill, the response to which involves further decision-making expertise. An expert is someone who understands the commentary that follows a knowledge-form, while making decisions at an expert level in its associated wisdoms-in-action. An expert has a way of reflecting on and continuously improving performance of their knowledge-form, and acts to transmit the knowledge-form forward.
Driving Question

My driving question, then, is two-fold. First, what are the Indigenous knowledge-forms, appropriate to place, available to give to the next generation? Second, how can these teachings be transmitted in a science classroom in ways that honor both the traditions of science and Indigenous knowledge? My project is to create a curriculum (in the sense of Currere) that promotes a reconciliation between a scientific world-view and traditional wisdom-in-action.
Chapter 2: Literature review

“All problems must be solved within the context of the culture - otherwise you are just creating another form of assimilation” (Kovach, 2009, p. 75). This meaningful quote, originally attributed to Maurice Squires, must be at the heart of any study inspired by Indigenous methodology. It informs my reasoning for using Indigenous methodologies, as alien as they might be to the academy in general, and my experience in particular.

Kovach (2009) reminded us that “Colonial interruptions of Indigenous culture continue, and there is no way to address tribal epistemologies and Indigenous research frameworks without considering these relations” (p. 76). Within the framework of Indigenous methodologies, “there must also be commentary on why a decolonizing lens matters within Indigenous methodologies as a theoretical positioning, a form of praxis, and how decolonization becomes personally embodied within the lives of Indigenous researchers” (p. 76). Thus, within the scope of my project, it is imperative that I examine my work as a science teacher in a First Nations’ school through a decolonizing lens. To this end, an exploration of science and science education through such a lens is in order.

Science from a European Perspective

To understand the argument for the project that I engaged in, it is necessary to examine the historiography of science. A better understanding of this concept will enable me to better articulate the driving question and propose a method to address it. Just as the physical world cannot be accounted for fully without properly considering the variable of time, so too the abstracted concept of a historiography of science must be viewed as unfurling over time, or in-
Eto (2008) summarized the problems involved in giving a definition of science, as well as providing just such a useful historiography, he stated:

Usually, the question “What is x?” is synonymous to the question “What is the definition of x?” But science usually does not define itself, as it is only philosophy that defines itself. However, philosophy is supposed to define science too, as the task of philosophy is to explain everything, to clarify the idea of everything, or to define everything. The question “What is the definition of science?” or “What is science?” is synonymous to “What does the word ‘science’ mean?”, ”What do people mean by the word ‘science’?” or “What is the idea (idée, concept, characteristic, property, criterion, standard) of science?” However, no dictionary gives a universally agreeable definition of the meaning of the word ‘meaning’. (p. 23)

Eto (2008) also reminded readers that only philosophy investigates itself; science does not define itself. Textbooks in each discipline (e.g., physics) define the territory and method of the discipline, but this is for the educational purpose of the students in the department (physics in this case). Eto suggested that, in order to know the definition of science as such, it is necessary to see what philosophers have said about science.

Beginning with the roots of western science, “ancient philosophers were interested in astronomy and mathematics while Aristoteles (Aristotle) was interested in nature (physika)” (Eto, 2008, p. 24). The famous philosopher, Aristotle, exhibited throughout his life not only a great understanding of things, but he also created structures of knowledge to try to infer relationships. [These relationships are a component of a concept I will discuss in my next chapter.] In any case, while he is mostly known for adding to bodies of knowledge from biology to mathematics to medicine, his true legacy is centered around devising ways to classify things,
devise ways to arrange pieces of the whole hierarchically to draw out relationships between observations, in short, the *performance* of science. This drive to categorize is a major characteristic of a working definition of science, as it has been defined over time.

Eto (2008) noted, “in the period of time known in Europe as the Enlightenment, Kant built a philosophy of mind, ethics, and beauty” (p. 24). “Kant indeed left a strong stamp on the definition of science. [Kant] defines science as an architectonic unity of cognitions... where the relationships between the parts are not the result of an arbitrary assemblage, but are developed according to an end given *a priori* by reason” (Gava, 2014, p. 4). Thus, within large swaths of western traditions of science, scientific knowledge is not simply the observation and description of natural phenomena. It is a huge body of interconnected yet compartmentalized knowledge. Devoted specialists, each examining their own pieces of the universe under a microscope, undertake the development of these bodies of knowledge.

This close and narrow examination of reality is supposed to lead to proposing hypotheses that explain observations. These can then be tested and the results subjected to replication and verification in a way that helps develop a worldview that will eventually lead to a strong theory that explains observations and possibly predicts future observations.

Theories can be turned into models of the world. “Modeling [a system]... allows one to ascertain how well the model’s predictions match reality - that is, how good the theory is” (Schoenfeld, 2008, p. 48). A theory contains within it some abstracted piece of knowledge about the world totally divorced from context, place, or application. In fact, it represents a concerted effort by a long chain of researchers and scientists to create just such a universalized statement.

These models are really the wood of the tree of scientific knowledge. The fruit, the highest expression of science, is a law. A law is a finely tuned description, accomplishing its task
but ignorant of why it works as well as it does (Anticole, 2016). It is a mathematical certainty in all observed frames of reference. This is not to say a law never changes. When it is discovered how to perform experiments in a new frame, a law may be modified or discarded in favour of a more powerful law. However, laws usually resist change because they would not have been adopted if they did not fit the data (Anticole, 2016). Laws inform theories, and the empirical knowledge generated through scientific use of models test laws.

However, at the end of the day, theorists who understand only the laws on which the universe stands and possesses no practical skills cannot, for all their knowledge, be called scientists. For if they will not engage in the work of science, engage in the creative and risk-taking aspects involved in making observations, testing hypothesis, generating theories and building these into models, and finally devising and testing laws, they no longer fit their community’s task. Thus, the traditional Kantian approach to defining science cannot be said to be complete, for it does not consider that science is something that is performed. Rather than being a body of knowledge related architectonically or otherwise, as posited by European epistemologies, science is a living, relational community of scientists doing science.

Science from an Indigenous Perspective

Knudson (2015) stated that “Indigenous epistemology (i.e., how [Indigenous people] come to think about and know reality) is centered in relationality” and that “an object or empirical fact is not considered as important as one's relationship to it, and all people are held accountable to their relations, whether with people, the environment/land, the cosmos, or ideas” (p. 7). Knudson added that:

Conceptions of the ownership of knowledge are broader than in Western thought, such that researchers are seen as mere interpreters of knowledge, which ultimately belongs to
the cosmos… Indigenous knowledge systems are holistic and encompass "the kinetic, affective, and spiritual" alongside cognitive knowledge… This translates into a focus on teaching and learning through hands-on, experiential projects, qualitative work focused on oral tradition, and projects centered on independent learning through listening, observing, and participating… Indigenous teaching and research emphasizes the value of working collaboratively with individuals and groups. (p. 7)

Kovach (2009) has suggested that science, which has a long history of being held up as the highest form of knowing, is not immune to criticism when observed through a lens of decolonization. “In the colonization of Indigenous people, science was used to support an ideological and racist justification for subjecting Indigenous cultures and ways of knowing” (p. 77). Here, the problem is not science per se, but rather pseudo-science offshoots that grew due to misapprehension of the scientific endeavour by European elites.

The misapplication of knowledge discovered through science due to its “rationalist, secular paradigm, discounts the possibility that knowledge arises from happenings that cannot be explained through reductionist means” (Kovach, 2009, p. 78). For example, “Darwinian evolution spawning the understanding in European elites of the pseudoscience of ‘social Darwinism’ had been used as a justification for “genocidal policy towards Indigenous people in the Americas” (p. 77). The European tendency to generalize and rationalize failed to account for the essential relatedness of all people of the world and allowed genocidal madness to seem like normal and acceptable behaviour. Another issue is that “because Indigenous people did not separate reason and spirit, and because they did not espouse an evolutionist theoretical perspective, their beliefs have been viewed as superstitions” (p, 77). An essential reminder is that because Indigenous ways of knowing have not been recognized, Indigenous people have
been excluded from knowledge construction; yet it is evident that Indigenous methodologies can yield real, practicable knowledge of the world.

Ogunniyi (2007) stated that “Indigenous science offers knowledge that Western modern science has not yet learned to produce,” contending that “the current environmental crisis largely caused by scientific and technological activities has forced many scientists to pay increased attention on how to ameliorate the situation through traditional environmental knowledge” (p. 964). Despite the value of Indigenous ways of knowing, entire ways of knowing that come to us through Indigenous experience are discounted.

This traditional view of science is contrasted to *tribal methodology* that places “tribal epistemologies at the centre as the guiding force for research choices. Tribal methodology calls for a minimal integration of decolonizing theory into methodology through the documenting of the historical experience of colonial relations” (Kovach, 2009, p. 80). Kovach went on to assert that, “from a knowledge paradigm perspective, this conceptualization clearly identifies an epistemological positioning distinct from Western ways of knowing, but weaves decolonizing analysis throughout” (p. 81).

Indigenous epistemologies give us tools with which to investigate the natural world through a lens of action. Viewing the world through a lens of action is not unprecedented in European views of science. Ogunniyi (2007) pointed out that “while the emphasis in most science curricula in the 1950s–1960s was on process or methods of science, the emphasis in the late 1960s and the 1970s was on the product; that is, knowledge of science in form of facts, concepts, and generalizations” (p. 964). Here, in this realm of science-as-action, we can find common ground with what Ogunniyi (2007) called Indigenous Knowledge Systems (IKS):
… definitions of what IKS entail abound in the literature. But despite the varied definitions associated with the construct, there is consensus that IKS is a way of knowing and interpreting experiences peculiar or innate to particular cultural groups. IKS refer to a conglomeration of knowledge systems encompassing science, technology, religion, language, philosophy, politics, and other socio-economic systems. Within this framework, IKS are not just about artefacts, but the epistemologies, ontologies, and metaphysical systems underpinning these artefacts and the way they are used to create a sense of wholeness, relatedness, or complementariness amidst a collocation of human dilemmas. In short, IKS is a redemptive, holistic, and transcendental view of human experiences with the cosmos. Unlike science, whose ethos is reductionism, IKS celebrates plurality, diversity, and the holism of human experiences. (p. 965)

**Decolonizing Science**

Ogunniyi (2007) described how “Gunstone and White (2000), in agreement with many others…have come to the conclusion that the issue now appears to be not one of abandonment and replacement, but one of addition” (p. 968). Thus, the way forward in teaching science in a First Nations’ community is neither to impose a European understanding of science onto the classroom community, nor to completely give up on the endeavour of understanding the natural world through scientific processes. Rather:

- a teacher faced with the task of implementing a Science- IKs curriculum might ask the following questions, among others: What models of the nature of science or IKS are reflected in the curriculum? What theoretical constructs, textbooks, or guides are available on the subject? What instructional methods are amenable to the integration of
science and IKS? What assessment protocols are most suitable in determining the students’ understanding of the NOS and IKS? (Ogunniyi, 2007, p. 969)

A key aspect of decolonizing methodology is a requirement to “give back to community members in a way that is useful to them. Giving back involves knowing what ‘useful’ means, therefore having a relationship with the community, so that the community can identify what is relevant, is key” (Kovach, 2009, p. 82). Thus, “Indigenous research frameworks shift the power of the researcher in controlling the research process and outcome. Methodologically, this means gathering knowledge that allows for voice and representational involvement in interpreting findings. A powerful method for achieving this desire is the use of story, life history, oral history, unstructured interviews, and other processes that allow participants to share their experiences on their terms (p. 82).

**Indigenizing Curriculum**

Castellon (2017) reminded educators of the importance of addressing the call to action of the Truth and Reconciliation Commission, “particularly the call to integrate Indigenous knowledge and teaching methods into classroom” (p. 2). Therefore, it is vital that educators use “different ‘ways of knowing’ [which] means that we approach learning and knowledge in different ways and use different methods to learn” (p. 2). Oker (2014) presented a Dane-zaa perspective on this process. For example, Oker stated that “Indigenous thinking links us to the depths of the earth: our knowledge system builds upon thousands of years of life experiences and environmental tradition. Our quest is to understand the sacredness of a tree so we may discover the relationship between a material world and our spiritual consciousness” (Oker, 2014, para. 2). The goals of the process of curriculum indigenization should be to, “combine an Indigenous knowledge system with emerging scientific knowledge so we may transform our conscious
mind” (Oker, 2014, para. 8). Thus, the methods, processes and goals of an indigenized science curriculum are all different from a colonialized scientific paradigm.

Because every Indigenous community is unique in terms of those elements of indigenized curriculum that are culturally specific, not only from the wider, colonizing society, but also from each other, it is necessary to reinvent the wheel in many cases. For example, the worldview and spiritual understandings Oker (2014) records from the Dane-zaa cannot be applied universally to all First Nations’ people. In creating indigenized curriculum, it is therefore necessary that I research those beliefs and ways of knowing that are intrinsic to the community in which I am working.

**Story as an Expression of Indigenous Method of Science**

As a method, story has a purpose in that it assists in the work of decolonizing thought. “Story... is a means to give voice to the marginalized and assists in creating outcomes from research that are in line with the needs of the community” (Kovach, 2009, p. 100). Because tribal stories are not meant to be oriented within the linearity of time, they instead link the research endeavour to place, and can help us understand the nature of science as being in-action. Therefore, the use of story as a major method is integral to Indigenous methodologies. The qualities of the stories used, as well as the information surrounding these stories is both a prime indicator of how far Indigenous methodologies have informed a researcher and a way to judge the quality of the research endeavour.

Kovach (2009) asserted that story has been considered a legitimate form of knowing amongst tribal societies since time immemorial; story is of central importance as a mode of knowledge generation that is ancient, permeating human history and all levels of society. Thus, story within Indigenous methodologies serves a variety of purposes and takes a variety of forms.
It is incumbent upon researchers, who collect and derive meaning from Indigenous stories, to collect and maintain these meta-purposes surrounding the stories we hear and to avoid pitfalls inherent in decontextualizing and reductively treating the knowledge surrounding these stories. Indigenous oral histories differ from academic research in that they do not share conventional categorical boundaries. Rather, as Kovach reminds researchers, they include religious teachings, metaphysical links, cultural insights, history, linguistic structures, literary and aesthetic form, and Indigenous truths. Stories can also parallel the results of academic research; they provide insight from observations, experience, interactions, and intuitions that can assist in developing a theory about a phenomenon.

Gibbs (2007) mentioned that within the realm of ethnographic research (to which this project is conceptually related), the conceptualizations, definitions and hypotheses that are held by the researcher are provisional, and performed within the framework of an ongoing relationship with data collection. Therefore, within Indigenous methodologies, “highly structured interviews are not congruent with accessing knowledges that imbue both the fluidity and regulation of the storyteller’s role within oral tradition, or that respond to the relational nature of Indigenous research” (Kovach, 2009, p. 123); instead, methods that are congruent with tribal epistemology include approaches such as a conversational method that involves an open-ended structure that is flexible enough to accommodate principles of native oral traditions are methods are more congruent with tribal epistemologies.

Stories are interrelated with this meaning-making process. Indigenous inquiry involves observation, sensory experience, contextual knowledge, and recognition of patterns, while drawing upon external and internal sources and inward knowledges are equally important within Indigenous inquiry so they “become a formal part of the meaning-making aspect of research”
(Kovach, 2009, p. 127). Thus, highly-specific knowledge that is rooted in place is the goal in interpreting Indigenous stories, and highly reliant on context. Kovach (2009) mentioned that Indigenous story offers knowledge relevant to one’s life in a personal, particular way. Therefore, when using story, as a research method, the main idea is not to sift through the words looking for some universal truth, but rather to apply the teachings from the story to one’s own life, one’s praxis. Although Kovach asserted that stories are more fully rooted place than to time, Cohen, Manion, and Morrison (2013) suggested that temporality is important because stories catch chronology of events as they unfold over time; this can enable the researcher to infer causality, coupled with the dramatic and dramaturgical power of carefully chosen words. Last, Gibbs (2007) commented that narratives can help researchers and readers to understand the experiences of participants and cultures, and contribute to the structuring of identity (as, indeed, is the case with life histories and biographies).

**Pedagogical Reflection Journal**

A pedagogical reflection journal is “a form of reflective writing which researchers engage in during a project and through which they document their personal experience of the research process” (Borg, 2001, p. 157). The use of this journal, and the subsequent analysis of the information within it allows researchers clarify initial thoughts and wonderings that can have significance for a study. Borg (2001) revealed further purposes of the pedagogical reflection journal that include:

… [serving] as a reminder of past ideas and events which guided subsequent action. The journal provide[s] a database from which precise information could be retrieved at a later date [and] serv[es] as a means of reminding myself … [of]… earlier stage[s] of study and [suggests ways to] us[e] this information as the basis for subsequent action. (p.171)
During the creation of my pedagogical reflection journal, I observed aspects of the
community I was working in through the lens of story, as described under the heading *Story as
an Expression of Indigenous Methodologies*, while abiding by the purposes and methods outlined
in the *Pedagogical Reflection Journal*. Thus, the development of my pedagogical reflection
journal was done with an eye to story.

**Teacher Turnover and the Importance of Persistence of Vision**

The single biggest problem facing any action on the part of First Nations’ communities to
creating decolonized educational capacity is the plague of high staff turnover, both amongst
teaching staff and administration. Ronfeldt, Loeb, and Wyckoff (2013) found:

> teacher turnover rates can be high, particularly in schools serving low-income, non-
> White, and low-achieving student populations. Nationally, about 30% of new teachers
> leave the profession within 5 years, and the turnover rate is about 50% higher in high-
> poverty schools as compared to more affluent ones. Teacher turnover rates also tend to be
> higher in urban and lower-performing schools. (p. 5)

The above quote comes from research work done in the United States, but these high
turnover rates are an expression of the difficulty of the job. Money attracts talent, and those with
money and access to resources have more to invest in their children. Those with poor access, on
the other hand, can become stuck in a generational cycle of poverty from which escape is
difficult.

Thus, even in purportedly egalitarian educational systems such as the Canadian system,
 systemic inequalities arise. On one hand, moneyed communities of the urban elite can offer long
tenure, benefits, high pay, help with accommodation (to offset the astronomical cost of living in
the urban center), easy access to professional development, networking opportunities and so
forth. On the other hand, rural, poor, and especially First Nations’ communities have little to offer teachers in terms of any of the above listed criteria. Here, underpaid, overworked teachers are quick to burn out and rotate into jobs in the urban environment. Thus, teachers outside of urban centers are often new to the profession and inexperienced. Training and professional development are also more difficult to get in these rural parts of the province, and so the problem is compounded as these inexperienced teachers cannot gain experience easily.

Many factors affecting the draw of teachers to cities and away from rural and First Nations’ communities are beyond the scope of this paper. The fact remains: First Nations’ communities are robbed of quality teaching talent by processes that are out of the hands of the First Nations’ schools to control. “When teachers leave, low-income schools have a difficult time attracting new teachers and so end up hiring inexperienced and less prepared teachers” (Ronfeldt et al., 2013, p. 6). Ronfeldt et al.’s study suggested that poor and inaccessible communities suffer more greatly the effects of the educational emigration. The effects of this educational emigration include: a negative impact on student achievement; an absence of organizational knowledge important to the effective program implementation; negative effects on faculty interactions and school climate. It is vital that organizations, such as classrooms or schools, take seriously the problem of staff turnover, given the seemingly inevitable nature of the issue.

In my own experience, this effect is magnified with students in special education programs. These students need a constant and predictable atmosphere, and the constantly in-flux environment created by high teacher turnover is antithetical to the goal of meeting these needs. I have come to believe that the single most effective step an educator at a First Nations’ school can take is to participate somehow in bridging the gap between teacher permanence and impermanence. Staff turnover is inevitable, but classrooms and schools do not have to be
unprepared for it. One solution is to prepare training materials and processes that will enable schools to proceed with their programmatic goals and vision despite the predicted high turnover of staff. Because turnover among administration can be just as high as teacher turnover, I believe it is also necessary to bypass, in some sense, the administration with this project, and leave the finished product directly to my successor teacher. In the instance of a First Nations school, these materials should be prepared in consultation with the community, so that the values and methods that are preserved in the institution of the school are those that will be most reflective of the community’s values and provide the most pedagogically powerful methods.

My hope is that, when I inevitably leave my position as science teacher at this school, the next science teacher will not have to spend an entire year (at least) becoming knowledgeable about and acclimated to the environment of this First Nation’s school (all the while losing ground viz. student achievement). Rather, they will be able to jump in with both feet and become a fully-functional member of the education team more quickly. My goal is that this project will enable better teaching and learning, and will have a stronger and more widespread effect than any individual or even classroom level intervention on increasing student achievement across the board. I also hope that this project will have an especially strong effect on those students receiving special education. My feeling is that special education benefits even more from intact classroom continuity as these students benefit the most from the predictability and structure denied to them through the talent vacuum effect.
Chapter 3: The Design Process and Rationale

Curricular Unit

What is it? The Curricular Unit attached as the appendix is a unique presentation of an indigenized science curriculum—aligned with B.C. curriculum. This unit is an introduction to the world of the microscopic cell, as expressed through familiar metaphor and the tradition of oral storytelling. It is also a study of family dynamics as expressed by students during a period of observation and reflective practice, grounded in place. Last, it is a way of thinking about curriculum that recognizes how educators are also changed by the very curriculum they perform. Indeed, through the performance of this curriculum, the educator becomes immersed in a learning process designed to develop an increased awareness of the culture in which they teach. This improved awareness will help inform an educator’s assessment of students’ growing range of process skills as related to the performance of science.

Who is it for? This curriculum is hyper-attenuated for the community for which it has been created, but is general enough to be of use to any teacher of eighth grade science in a First Nations’ community school. It has been created in the spirit of reconciliation, and in consultation with members of the community. It is for use by the teacher next year who picks up the task of teaching this unit and wishes to align his or her own practice with teaching best practices. It is for an audience that prefers modalities of the spoken word over textual literacy. The curriculum is for anyone who would benefit from a hands-on approach to bridging the cultural divide of the scientifically informed worldview and the traditional ways of knowing of the community in the place of their own educational practice. Last, it is for anyone who shares Ronfeldt et al.’s (2013)
worries with respect to teacher turnover in impoverished schools, and seeks to face the
challenges of high teacher turnover with practical solutions.

**Genesis of the Idea**

Paraphrasing Bruner (1986), humans make meaning and think in terms of ‘storied text’,
which catch the human condition (pp. 5-7). These words capture human intentionality and the
vividness of human experience fully, as well as the multiple perspectives and lived realities
(‘subjective landscapes’) of participants. I find myself professionally intrigued by this subjective
landscape, as experienced by the native sons and daughters of the land. I wish to delve into the
minds of my students, so that I might better understand them.

Like Bruner (1986), I modeled the world starting as metaphors and metamorphosing into
empirical statements supported by verifiable data. That is to say, I generated and then verified
data about the development of wisdom-in-action as young people in the community traditionally
experienced it. I did these things through my meticulous maintenance of a pedagogical response
journal, in which I collected and reflected on statements made by students and other staff over a
period of three months. During this time, I verified the data by checking the meanings of
statements made with relevant sources of information, namely, community members and other
school staff. Last, I analyzed the data for useful themes and common Hu’qumi’num linguistic
patterns and storytelling traditions I gleaned from the listening of many stories. I then made these
themes, words, and traditions a central focus of the science story I wished to tell.

At its core, this project was a tool to let a successor teacher gain meaningful insight into
the science program as practiced by the present science teacher, to help secure continuity of
education. It allows my successors to pick up my voice, to be a surrogate me – should they
choose, until they are on firm footing to establish a voice of their own. It also allows students to
continue in a familiar paradigm, freeing them to focus on learning the material rather than learning the peculiarities and vagaries of a new teacher.

**Project Initiation**

To initiate the project, I created a repository of data to act as a basis for interpretation. I utilized a self-study method that offered “a structure to sort and scaffold” (Samaras, 2011, p. 89) the mutations of data. I initiated a personal inquiry into my research question that aligned with the five critical components of self-study as defined by Samaras (2011). This repository was a personally-situated inquiry emerging from observations of my classroom, the community I am practicing within, and myself.

This repository, or pedagogical reflection journal, commenced at the beginning of the school year. It represented a running record of the noted phrases, concepts, and ‘principles’ that I heard mentioned or discussed commonly within the community. Within the pedagogical response journal, I also generated questions and directions for further study that I brought to community members for clarification and elucidation. For example, from this pedagogical reflection journal, I engaged with an Elder about the words, stories and representations embedded within the curricular unit. From this journal, I gained the needed perspective and knowledge to create the curricular unit, described in more detail under project design.

**Ethical Considerations**

Because education is an area of historical contention between First Nations’ communities and the larger Canadian society, I thought it vital to go about the task of creating the curricular unit by subjecting this creation to the process of co-creation. Therefore, an additional feature of my project is that it represents a genuine example of cross-cultural communication. By the nature
of the role I perform at the school, I am in the privileged position of being able to oversee, guide and nurture a significant transformation of values. In its healthiest form, this transformation of values is reciprocal, benevolent, and consensual.

Therefore, I sought and received feedback from the community throughout the process of creating the curricular unit. The process of project co-creation is in the spirit of reconciliation. As a proponent of the broadening of the concept of knowing to include ways of knowing commonly excluded from the academic discourse, this research project sought to remain centered with the principles of reconciliation. Indeed, as the creator and first subject of the project, I have tried to embody these principles to the best of my ability. My hope is that the incarnation of those efforts toward reconciliation that I call this project will be, in a sense, safe for use, with some modification, in First Nations’ contexts beyond the particular community for and with whom it was developed. I call this unit “safe” for use in a First Nation’s school because it provides a framework that allows the expression and development of Indigenous worldviews contemporaneously with the expression and development of scientifically based worldviews.

Principle 4 from Truth and Reconciliation of Canada (TRC) (2015) has stated: “Reconciliation requires constructive action on addressing the ongoing legacies of colonialism that have had destructive impacts on Aboriginal peoples’ education, cultures, languages, health, child welfare, the administration of justice, and economic opportunities and prosperity” (para. 1). Therefore, it is not enough to do nothing and hope that Indigenous’ communities can make their way forward without access to effective and appropriate scientific education.

However, history has taught me that those who push an agenda in education can make grave mistakes, even human rights abuses. Principle 8 from the TRC (2015) has stated that “supporting Aboriginal peoples’ cultural revitalization and integrating Indigenous knowledge
systems, oral histories, laws, protocols, and connections to the land into the reconciliation process are essential” (para. 1). This project is grounded in reconciliation and requires that I, as the creator and first subject of the curriculum, seek knowledge about these knowledge systems, oral histories, laws, protocols, and connections to the land, and work them into the curriculum. Additionally, Principle 10 from TRC (2015) has read, “reconciliation requires sustained public education and dialogue, including youth engagement, about the history and legacy of residential schools, Treaties, and Aboriginal rights, as well as the historical and contemporary contributions of Aboriginal peoples to Canadian society” (para. 1).

In their discussion of the educational history of First Nations people in British Columbia from pre-contact to approximately 1992, Kirkness and Bowman (1992) paint a picture of the First Nations people of British Columbia as a people who had originally had a deep connection to nature, as well as a cultural respect for the development of the person. The subsequent establishment of at first missionary and later government run residential schools interrupted this style of intergenerational knowledge transfer. Kirkness and Bowman go on to suggest that the next phase of indigenous education was integration, in which provincial governments of Canada took it upon themselves to educate First Nations’ students. This process, begun in the late 1940’s, occurred without consultation of any sort with the communities involved, and no special preparations or curricula were created to accommodate the incoming learners.

One of the terrible effects of residential schools, beyond the obvious trauma, is the spectacularly lackluster science education provided to Indigenous people. “Residential schools provided a very basic education designed to prepare students for futures as working farmers, housemaids, mechanics, or the like” (Kirkness & Bowman, 1992, p. 10). As previously noted, First Nations’ people were educated to be a servile class. Scientific ways of thinking are
powerfully liberating. Therefore, above all other ways of knowing, except perhaps advanced mathematics, effective scientific education was almost completely denied to First Nations people from this era of active residential schooling.

The integration generation of students was served only slightly better by the education system. The active and systematic abuses ended, but science was not taught in a manner conducive to learning for many Indigenous people. Rather, it was taught as the achievement of the European colonialist, for the most part. Few attempts at teaching according to traditional methods, content, or language were ever made. In short, the First Nations’ person had gone from being hated to being ignored.

That era did not end that long ago, and is indeed still ongoing for many people. There have only been two or so generations between the generation of residential school survivors and the present high school student. As a result, few family units have had the opportunity to acquire generational wisdom around scientific thinking. That most powerful and important tool of intergenerational knowledge transmission amongst First Nations’ people, the Elder/Junior relationship, is not presently equipped to handle scientific skills and thinking within the First Nations’ context, because the elder generation doesn’t have much knowledge in this realm. Therefore, many Indigenous communities lack scientific fluency.

To ensure that this developing fluency remains within the spirit of reconciliation, it was vital that I enter into dialogue with the community itself. To ensure this dialogue, and keep in line with Kovach’s (2009) method of solving all problems within the context of the culture, I sought the input of an appropriate Elder. My intention was to make myself the subject of a traditional educational exchange in the form of an elder/junior relationship. Thus, I approached a community Elder. This Elder was imminently qualified, being both a previous administrator for
the school, and a graduate of the same university as I. I began with a traditional gift offering of tea and visiting, and from that point forward, we worked together to talk about what was important for the project.

**Project Design**

The preservation and transmission of knowledge-forms from across huge time spans is an incredible cultural feat that Indigenous people of the world participate in that is foreign to the understanding and functioning of modern mainstream society, which suffers from pathological paramnesia. The beginning of my design methodology was an investigation to increase my cultural sensibility and knowledge of place, largely guided by Borg (2001), so that I could, as explained by Kovach (2009), “move beyond the binaries found within Indigenous-settler relations” (p. 12).

Because of the importance of story to Indigenous culture, and the central importance of oral knowledge transmission to a traditional way of life, the curricular unit took the form of stories that blend scientific concepts with Indigenous language and knowledge-forms. This work is logically possible because, in the vein of theorists such as Eto (2008), Schoenfeld (2008), and Anticole (2016), the project constructs science as something that scientists do, rather than as a body of knowledge. At its core, the education surrounding wisdoms-in-action associated with science is best conducted by the explicit performance of the curriculum. For example, I have noted in my pedagogical reflection journal that the cell is a unit made of a multitude of parts that work together for the betterment of the whole. After discussion with my Elder, it became apparent that this way of envisioning how cells work is a good example of the idea of *nut’samut*, or “we all pull together”. As Ogunniyi (2007) noted, this approach is not absent from the so-
called western science education curriculum either. The construction of science as a performance accounts for the decision to base the curricular unit on storytelling.

The next step of my design methodology was to take the authenticated observations I had made over the course of the first phase and build a set of stories that incorporated the aspects of the culture that would allow students to feel a sense of familiarity with the curricular unit.

Prescribed learning outcomes (PLOs). The basis of the science curriculum that was woven into the stories is found in the relevant PLOs from “British Columbia’s New Curriculum” (B.C. Ministry of Education, 2016a). I assert that the development of a personal wisdom-in-action of the usage of scientific thinking and performance skills represents the point of intersection between scientific competency and Indigenous ways of knowing. Therefore, I relegated curricular content to a secondary importance. I determined that I could serve the community of learners better in developing both Indigenous and scientific knowledge by focusing on the curricular competencies portion of the new British Columbia curriculum. The competencies I have linked to in this unit are the following, from B.C. Ministry of Education (2016a), under the heading of Competencies:

- Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest.
- Apply First Peoples’ perspectives and knowledge, other ways of knowing, and local knowledge as sources of information.
- Experience and interpret the local environment.
- Construct and use a range of methods to represent patterns or relationships in data, including tables, graphs, keys, models, and digital technologies as appropriate.
• Communicate ideas, findings, and solutions to problems, using scientific language, representations, and digital technologies as appropriate.
• Express and reflect on a variety of experiences and perspectives of place. (n.p.)

Hul’qumi’num. Woven into the stories are words spoken in Hul’qumi’num. I carefully selected these words to help develop fluency amongst students, as well as to provide a way for concepts surrounding the cell to be symbolized using the traditional language. I meant this feature, in particular, to help legitimize the project in the mind of the community, as well as provide a vehicle through which students can bring home scientific concepts to the dinner table, so to speak. Additionally, these words provide a source of Indigenous authenticity to the curriculum of a non-Indigenous teacher.

I took the following steps to ensure that the use of these words in the context of my science curriculum remained within the spirit of reconciliation: (a) I selected ten English concepts that represented important concepts within a unit on the structure and functioning of the cell; (b) I translated these words into Hul’qumi’num using the Qu’wut’sun Hul’qumi’num’ (2007) category dictionary, as supplied by the Elder (Quw’utsun Syuw’entst Lelum, 2007); (c) where possible, I hyperlinked the word to the recorded pronunciation available on the First Voices website (“Stzuminus”, 2000/2017); (d) where a pronunciation of the word was not available, I found a proficient speaker to record the word for me; and (e) I incorporated the following words with their attendant meanings into the project:

Lelum (house)
Kw’a’luhw (chum/dog salmon)
Maaluqwut (mixed together)
Tl’aqw’iwsum (organized for storage)
Hi’wa’qw (Chief)

‘Uy’uy’mut s-athus (Beautiful face)

Snas (fat)

S-welh-x s-athus (Rough mannered face)

Slepche-k (pancake)

T-en (mother)

‘Ey’x sxuxi’nlu (crab legs)

**Assessment.** Assessing wisdom-in-action is not a simple matter. Unlike content knowledge, which can be demonstrated through testing, interview or other form of one-off interaction, development in the domain of wisdom-in-action must be observed over an extended period. Because this period of observation produces what I can only describe as a series of still pictures, analysis must be applied to the combined result of many observations, made in a variety of ways. This process creates what is essentially an animation of the developing wisdom-in-action. The final purpose of this assessment, in the context of Indigenous education, is to allow the educator to intervene in the learner’s technique or understanding with just the right bit of advice or action to propel the learner to higher planes of knowing.

The unit I have produced comes with suggested assessment tools. These do not represent the assessment itself. The assessment itself can only be done through the teachers’ own application of the wisdom-in-action of assessment. The tools that accompany the curricular unit are intended to provide the teacher with ways to take snap-shots of learner’s momentary learning, from which educators can build their own assessment of a student’s growing wisdom-in-action.
These assessment tools take the form of a system of progressive guided model building that I intended to allow the learner to display and build upon their learning and the teacher to assess the student’s learning at any given point in the unit. This evolving model of the cell as seen through Indigenous ways of knowing provides an educator a glimpse into the learner’s thinking and allows the educator to assess the student appropriately on their connected developing wisdom-in-action. The following is a system of formative assessment.:

- Make a model of this special house (2D or 3D). Build or draw the walls of the house and label them *Cell Wall*. We will continue to update this model as the unit progresses.
- Compare your picture to a real cell wall.
- Using a textbook or diagram, label the parts of the cell as you build your model, and the functions of the cell wall that you heard about in the story or read from a textbook. Label the features of the house with these scientific names as well.
- Add the water on the inside of the house to your model, label it *Cytoplasm* and explain in your own words what the cytoplasm is.
- Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the cytoplasm that you heard about in the story or read from a textbook.
- Add the special room where the Chief stays to your model. Label it *Nucleus* and explain in your own words what the nucleus does.
- Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the nucleus that you heard about in the story or read from a textbook.
• Add the smooth-skinned Chief’s daughter to your model. Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the smooth ER that you heard about in the story or read from a textbook.

• Add the rough-skinned Chief’s daughter to your model. Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the rough ER that you heard about in the story or read from a textbook.

The following steps represent the cumulative assessment at the end of the unit:

• What ways can you connect together these different shapes: wires, rhomboids, spirals?

• Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the smooth ER that you heard about in the story or read from a textbook.

• Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the smooth ER that you heard about in the story or read from a textbook. Take the proteins built in the last period and package them up for delivery. (Put them in a box or an envelope as if getting it ready for the post.)

Summative assessment: In a comic, represent all the steps needed for the family inside the house to catch and eat their food.
Chapter 4: Reflection

Summary of Process

My original intention was to create a research project that would serve as a bridge between cultures and allow the controlled transmission of knowledge between them. After failing to obtain ethical approval, the research project morphed into a professional project. Due to my original intention, I spent time simply listening to and thinking about the words and actions of those around me to establish a sense of appropriate and inappropriate representation of Indigenous thought and experience within the curriculum. My purpose was to increase my cultural sensibility and knowledge of place so that both my research and I could, as explained by Kovach (2009), “move beyond the binaries found within Indigenous-settler relations” (p. 12). The recording and accompanying analysis of these experiences amounts to my pedagogical response journal.

After I made the decision to transform my research project into a professional project, I changed my focus from passively observing my environment to actively bridging science and traditional knowledge in a way that is both effective and ethical. The pedagogical response journal transformed from a living document of near-real time actions and my responses to them into the subject of an analysis that would lead to an enriched understanding and appreciation for the people with whom I practice my profession.

From the beginning, I envisioned the curricular unit as a chance for collaborative procedures to produce a work that reflected authentic experience. Keeping in line with Kovach’s (2009) method of solving all problems within the context of the culture, I sought the input of an appropriate Elder. As noted earlier, my intention was to make myself the subject of a traditional educational exchange in the form of an elder/junior relationship. I aimed to develop from this
relationship an appreciation for some of the nuances that mark traditional educational practices as well as expand my pedagogical repertoire with the hope of improving educational outcomes for students.

The curricular module in this project is a result of this process of observation and assessment followed by a period of actively connecting with members of the community in various ways to clarify and confirm what I had gleaned from my observation period. The interactions occurred in ways both intentional and serendipitous, allowing me to thoughtfully and intentionally create the curricular module (Appendix A) and then access the resources and teachings required to keep it within the Indigenous paradigm.

**Extent of Project**

Appendix A was created within the confines of a highly specific community setting. However, with relation to that specific audience, it remains generic enough to avoid being viewed as an act of appropriation or misrepresentation. Beyond the single community, the module’s style can be described as *hwulmuw* (First Nations’ person) inspired and themed.

As a science educator, I fervently believe that an understanding of science is vital to the optimal development of every human being on the planet and the functioning of humanity on the planet. I also acknowledge the potential for cultural destruction that lies in the shadow pedagogy on the other side of science education. It is the duty of the science educator to be open to bending the way traditional science constructs its scientific narrative. Both Eurocentric science and Indigenous ways of knowing are enriched by acknowledging and listening to the cultural stories of the other. Science improves by expanding our ways of accessing the truth. As Kovach (2009) suggested, through this expansion, praxis can be improved between Indigenous and settler societies.
In the vein of theorists such as Eto (2008), Schoenfeld (2008), and Anticole (2016), this project constructed science as a set of *wisdom-in-action*, as performed by scientists. As Ogunniyi (2007) noted this approach is not absent from the so-called Western science education curriculum either. This construction accounts for the decisions surrounding the performative aspects of storytelling as the format of choice for knowledge transmission.

In the best-case scenario, when someone in a position to shape the minds of children is in charge of such vital learning as represented by the science curriculum, the intended audience will be one that already has a healthy dose of the *hwulmuw* spirit. In line with Knudson’s (2015) ideas of a broader epistemology of knowledge ownership, where an insider to the community is unavailable, and where someone with a real connection to First Nations’ culture cannot be found to fill the necessary role, an outside expert has to be brought in. The danger is that this outside expert is in a position to cause cultural damage, intentionally or not. Therefore, the duty of the educator is to stay within the spirit of reconciliation when designing these kinds of culture-bridging projects. Experts such as Aikenhead (1996) and Ogunniyi (2007) agree that the curriculum should encourage traditional and scientific beliefs to co-exist. This project does that by superimposing the science curricula into a structure familiar to the intended audience.

Giving science a familiar structure was a challenge. I facilitated this work by keeping a daily record, which, in time, allowed me to build up the reserve of knowledge about students’ lived experiences that I needed to replicate the general family structure and character reactions likely encountered in the homes of students.¹ Decisions surrounding interactions between characters in appendix A are based on the log of information embedded in my pedagogical response journal, largely inspired by Borg (2001).

1 See Appendix A for the story of the Chief and his three children as the structure for explaining a cell.
This curricular module serves as a sleeve of protection against the sort of anti-cultural attitudes that serve to colonize young minds. While educators are using it, whether they are culturally in-tune or not, new or experienced to working in a First Nations’ context, whether they are skilled in decolonizing ways of thought or not, these educators can be sure they are relying on a curriculum that is culturally in-tune, that has been grounded in intense observation and subsequent answer-seeking. Therefore, the end user of this curricular module (the teacher) does not need to be connected to the First Nations’ world at all to be able to use this curriculum. They can perform the work of a science educator in a way true to place, without worrying about overstepping boundaries. I hope this curriculum will encourage the educator to put their best effort going forward into creating their own curricula as they become more culturally aware.

This curricular module also addressed Ronfeldt et al.’s (2013) worries with respect to teacher turn over in impoverished schools by providing an incoming teacher with a powerful tool with which to jumpstart the slow adjustment process, shortening the time it takes for the new educator to achieve a functional awareness of the community. The curricular unit allows not only for optimal educational flow, but also provides the new educator a better opportunity to make the most out of the time they have, teaching in that school. Below I used the points from the Content heading (B.C. Ministry of Education, 2016a):

- living things respire, grow, take in nutrients, produce waste, respond to stimuli, and reproduce;
- living things are made of one or more cells;
- all cells come from pre-existing cells;
- the cell is a basic unit of life;
- cells contain structures that carry out essential functions;
● [cells perform] cellular respiration. (n.p.)

The intended process skills this project aims to develop in students were also taken from B.C. Ministry of Education (2016a) under the heading Curricular Competencies:

● demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest;

● apply First Peoples’ perspectives and knowledge, other ways of knowing, and local knowledge as sources of information;

● experience and interpret the local environment;

● construct and use a range of methods to represent patterns or relationships in data, including tables, graphs, keys, models, and digital technologies as appropriate;

● communicate ideas, findings, and solutions to problems, using scientific language, representations, and digital technologies as appropriate;

● express and reflect on a variety of experiences and perspectives of place. (n.p.)

These concepts are transmitted through the medium of an orally transmitted story. At the same time, students are provided with experiences that are intended to have the effect of developing wisdom-in-action around scientific, academic and representational skills.

With some adaptation, this curricular module could be successfully applied to many First Nations’ communities that make their livelihood through cedar, seafood, and story. Much of the iconography and framing plot relies on elements that are common to cultures from all along the west coast and into the interior of British Columbia. Furthermore, although I lack firm evidence, I believe that not only is the curricular module transferrable to other communities, but also the lessons I’ve learned designing this curricular module might be generalized to apply to other classrooms, both within Indigenous communities and the public system.
In summary, the curricular module follows a teacher with little knowledge of Indigenous culture practices to provide a culturally appropriate science unit for a community that has been historically locked out of the science curriculum design process.

**Limitations on Design**

This curricular unit is of intermediate difficulty, at the very least, in terms of successful implementation. Certainly, this curricular unit is best suited for those educators who possess natural storytelling skills and keen observation skills. In addition, a strong understanding of science, as an activity that is performed, is a necessary trait for the purveyor of this curricular module. Since the performance of the stories take on lives of their own, and the storytelling itself is a reciprocal process, both the educator and the students improve their wisdom-in-action through its utilization.

Time constraints on project development mean that I was unable to include all that I would have liked within it. This is a utility project. It could serve as the kernel for a fully-developed and integrated unit that would include many features aimed at improving both its accessibility and relevance. The cultural learning at the core of this project is its most valuable component. It is my hope that science educators working in Indigenous contexts will find this project an excellent starting point for their own attempts to construct ethical scientific knowledge in individual situations. I hope they can take what I have started, reinterpret it through their own lens (as is the way in the oral traditions), and expand upon it in a manner suits their subjective worldviews.

I consider it a failure of this project that I was unable to consult with a community member more explicitly on the topic of wisdom-in-action. In this instance, community engagement could have included more time spent with the Elder, building a deeper relationship
between us, allowing easier communication and a deeper insight into the culture. Although it is clear mechanisms exist through which guiding communications about wisdom-in-action are transacted from Elder partner to Junior, I have been relatively unsuccessful in my attempts to receive explicit teaching on the subject. Therefore, I consider the section in the curricular unit that discusses assessment to be the based on mostly my own observations alone, rather than explicitly verified inquiry as the narrative component was.

Through my pedagogical response journal, I have learned that this blind spot is, to some degree, unavoidable. The nature of assessing skills development through the lens of wisdom-in-action is inherently ‘in the moment’, and resists being put down on paper. Wisdom-in-action means being in flow with students, staying in the moment with the most effective forms of communication available, and helping students learn to self-regulate and develop technique and skill, thus improving their wisdom-in-action through contact with an educator. However, despite the difficulty in having a clear assessment criteria on paper, it is the completed product, whether it be a hand drum, a bone carving or any other expression of learning, that serves as a testament to the development of a wisdom-in-action; and through this completed product development is ultimately judged.

As an example of a blind-spot appearing in the curricular unit, consider the blondness of the beautiful faced daughter (‘Uy’uy’mus s-athus). The blondness of this character can be rationalized in a number of ways. For example, she is blonde because the fat (snas) that she manipulates is yellow like butter (but also like oolichan oil, a traditional Frist Nations trade item, for example). Alternatively, perhaps she is blonde because she is a bit vain, and so bleaches her hair. In either case, it is possible that I am applying a Eurocentric standard to the character. It
was not until this lens was exposed for me that I considered it might exist at all. So, despite my rationalizations, I will alter the characters’ hair to black.

Additionally, I learned there are knowledges that can only to be shared in certain circumstances, in line with the principles stated in *What we have learned: Principles of Truth and Reconciliation of Canada* (Truth and Reconciliation Commission, 2015). Thus, my personal pedagogical reflection journal, which I put much effort in, is not attached to this project. The exclusion of the pedagogical response journal means that I leave certain decisions surrounding assessment in the hands of the next teacher who will be using this curricular module. I have drawn attention to the fact that every thought, feeling and circumstance, large or small, that my students had expressed while developing their science model has left a mark on the project. I believe everything a teacher needs to know about a student’s developing wisdom-in-action can be gained from repeated observation over time as the student deals with the practicalities of project creation. Through this process, a science educator can discern the unfolding of a student’s development, and modulate his or her own behaviour accordingly to facilitate effective learning.

This formative assessment eventually leads to a cumulative assessment, which I consider a much fairer assessment plan, especially in a First Nations’ context, as opposed to more traditional assessment tools, for example, examinations. The details of this formative assessment are necessarily unique to each educator and constitute an expression of the teachers’ own wisdom-in-action in the realm of their educational praxis. However, the cumulative assessment is considered a final product, and not part of the individual’s attempts prior to the creation of the final product. It is in a sense an artificial, but necessary cutting off point.

A final limitation of this project is the degree to which it is able to support student development through differentiated instruction. From its inception, this project has been
predicated on the notion that the types of support and strategies provided by the differentiated instruction movement is fully effective in handling any classroom, and represents a good jumping off point for the improvement of any curricula. Inherent to the philosophy of differentiated instruction is the notion that quality curriculum is available and that a student’s poor showing might not be attributed to any other cause until quality curriculum is available. I contend that the notion of “quality” must include the notion of naturalized to place, as far as is possible. This project, therefore, is an attempt to bridge this curriculum gap.

This project invites users to enter the storytelling process and place their own marks upon the delivery of the curricular module through the development and application of their own practices of differentiated learning. In other words, an educator should feel free to approach the delivery of the material in a flexible way, without being constrained by the exact format represented by Appendix A.

Features that “maximize student growth and individual success” (Tomlinson & Allan, 2000, p. 4) in the domain of science education might include, but are not limited to: (a) visuals, such as cut-outs, puppets or carvings that can be used to represent characters; (b) songs, chants or catch-phrases attached to certain characters; (c) games of manual dexterity (for example, lahali [the bone game], or cat’s cradle, to develop manual skills at a lower level; (d) crafts such as cedar weaving or drum-making to develop higher-order skills; (e) local traditions and knowledge, such as the kitchen and the preparation of food.

Areas of Further Development

Areas of potential expansion in the Grade 8 curriculum included the following from B.C. Ministry of Education (2016a):
• there is debate as to whether or not to classify viruses as living things;
• prokaryotic and eukaryotic cells;
• plant and animal cells;
• photosynthesis. (n.p.)

Further areas for expansion can be found at the Grade 9 level in B.C.’s New Curriculum document (2016b). The curricular content such as mitosis and meiosis could be expanded using the same characters already created in the Grade 8 unit. Additional areas for expansion of can also be found in the curricular competencies at the Grade 9 level of B.C. Ministry of Education (2016b), which aimed at allowing students to:

• select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data;
• experience and interpret the local environment;
• construct, analyze, and interpret graphs (including interpolation and extrapolation), models and/or diagrams;
• apply First Peoples’ perspectives and knowledge, other ways of knowing, and local knowledge as sources of information;
• evaluate the validity and limitations of a model or analogy in relation to the phenomenon modeled (n.p.)

Implementing this curricular module allows science educators to develop wisdom-in-action and refine the application of their professional skills in relation to place-based education. As this happens, we gain the ability to make ethical and experientially sound decisions for ourselves almost intuitively. In short, we internalize the curriculum. By performing the attached curricular unit, educators themselves become more in tune with the communities they are
working in and embody the principles of reconciliation, facilitating their development into their role as educator. In short, use of this curriculum allows educators to “express and reflect on a variety of experiences, perspectives, and worldviews through place” (B.C. Ministry of Education, 2016a, n.p.). Further, B.C. Ministry of Education (2016a) goes on to note that “place is any environment, locality, or context with which people interact to learn, create memory, reflect on history, connect with culture, and establish identity. The connection between people and place is foundational to First Peoples’ perspectives of the world” (n.p.).

The above notion of place helps educators new to the community answer these key questions about their work environment and context, as voiced by B.C. Ministry of Education (2016a):

- How does place inform your questions and inquiries?
- How does place influence your ability to plan and conduct an inquiry and make predictions about outcomes?
- How does your understanding of place affect the ways in which you collect evidence and evaluate it?
- How can your understanding of place influence project designs?
- How do the place-based experiences and stories of others affect the ways in which you communicate and collaborate? (n.p.)

**Conclusion**

I began this project months ago. The words I wrote in the early drafts of what was then a research thesis came from my naive self and were the product of a line of experiences that begin in my early years. This conclusion represents both the words of my naive, younger self and the words of my current self, who had gained the experiences of two years spent deep in study, observation and reflection.
In short, in the artifact of the curricular unit, I also have two valuable personal histories. The artifact is embedded with the many sessions, stories, and discussions that went into the creation of this project. These experiences have forever altered my practice as a teacher and have given me a unique and powerful place-based outlook on education that I will always attempt to honor. The second record is represented by the drafts and re-drafts, the stepping on my own toes with an Elder, the awkward colliding with obstacles unseen, and therefore unavoidable. In short, it is a record of mistakes and lessons learned or, at least, lessons in learning.

These lessons learned, which were at the heart of the curricular unit I have created, are the product of an intense investigation that began with my two-fold research question. First, what are the Indigenous knowledge-forms, appropriate to place, available to give to the next generation? Second, how can these teachings be transmitted in a science classroom in a way that honors both the traditions of science and Indigenous knowledge?

I believe this project is a strong attempt to develop knowledge around the first, and a reasonably well-developed framework for attacking the second. I hope that this curricular unit will allow any educator that comes after me, even if that educator is just a later version of me, to meet students where they are, rather than starting from zero. I hope this curriculum will allow for the development of minds that are prepared to view the world through both scientific and cultural eyes. Lastly, I hope that this curricular unit will represent continuity over time, and that this continuity will facilitate the development of wisdom-in-action at a higher level, with a higher degree of accessibility than has ever been accomplished before between community and science education.
Final words

I conclude that these two records together, that of my success and that of my failures, are the true measure of the development of my wisdom-in-action. Only by assessing the final product in the light of the record of mistakes can true development be measured. Because the full record of my mistakes is ultimately only available to me, I am the sole person capable of truly evaluating my own development. However, the same cannot be said for the successes and failures of a school, and of the children it attempts to teach. I hope that the work I have done in building bridges will continue beyond a single school year, so that the scientific education of the community’s youth will not be impeded by the myriad of factors that make this sort of education difficult.

Finally, I hope that the educator who picks up the torch of science teacher at the community school at the center of this project will be able to build confidence and connections within the community through the knowledge embedded in the curricular unit. In addition, I hope this project and develop cultural understanding, so that the process of indigenizing the science curriculum can be carried forward.
References


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Appendix A: Indigenized Cell Unit
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SECTION ONE: THINKING

Overview

This unit has two parallel functions. The most obvious is that function which seeks to give students the best science education possible. The second function is to introduce you, the educator, to the language, which will help you understand the culture in a way that nothing else can.

As a committed and passionate science teacher new to working in this community, I am sure you have a million questions about the best way to teach the children of this community. After all, as a science teacher, you cannot help but hold a large part of your students developing psyche in your hand. It is probably not entirely clear to you how you can teach the subject matter in a way that is respectful to or even honoring of traditional beliefs. Rest assured, conflicts of worldview are certain to arise. So how does one teach science harmoniously? A truly satisfying answer to this and other big questions that bring personal beliefs held deeply into conflict can ultimately only come from inside you. This handbook will introduce you to a way of thinking about science education that you can integrate into your science curriculum.

Why This Curricular Unit?

This unit will give you what you need in order to get started as an effective teacher in this community, time and familiarity. Time to get to know staff and students on a personal level, to build the contacts you need to begin to find answers to the questions you have; time to build relationship and safety between teacher and student, and within the student-student paradigm; time to become familiar with the community; time for the community, with its ways and traditions, to become familiar to you.
Once familiarity is established, teaching in this community will seem as natural as teaching in your own backyard. However, getting to this point of familiarity is not always easy. Many people just do not work out in a First Nation’s community school. Many change jobs before the benefits of patience kick in, and so they do not have the chance to become effective in the community. Whether because they do not feel cut out for it, or because the community has turned against their style, students dearly feel the failure to service the community’s educational needs. Students miss valuable instructional time and quality curricula. Furthermore, the need to over-assess student abilities created by poor staff retention exacerbates the problem of wasted time. From a differentiated design perspective, this unit will allow you to bring scientific education to students at their level, without having to guess and check student levels or excessively test in an attempt to decide educational placement, addressing the problem of lost time.

SECTION TWO: OBSERVING

Introduction to the Culture

As noted above, this unit will address the issue of lost time, and buy you the time you need to build relationship and develop safety. It will also provide you, the educator, with an ‘in’ to the culture. It will introduce you to some common Hul’qumi’num words that will accelerate your journey to familiarity, and act as an ‘in’ to the family dynamics and household structure of many of your students.

Lastly, the performance of this unit will introduce you to a view of assessment that is based on observation and narrative building around the development of process skills. I call this way of looking at assessment wisdom-in-action, and it is built on a foundation of personal
experience and academic study. I hope that after you have completed this unit, you will incorporate what you have learned about wisdom-in-action with you as you move forward in your practice.

**Argument for Centrality of Language:**

Though it might seem onerous at first, try to use the Hul’qumi’num words in the course of the unit as much as possible. In every instance of a Hul’qumi’num word, I have provided an equivalent expression in English. These translations are very literal, and for the most part trustworthy, since I am not stretching them beyond their literal meaning. However, I stretch the meaning of words beyond their literal meanings in several instances. In these instances, I have purposefully relied on these created word combinations to prevent inappropriate usages from ingraining in the language.

Though the risk of undue interference exists, it is rational to acknowledge that all languages change, mutate and adapt over time. If we (the educational community) can help create a generation that successfully integrates traditional language and culture with a scientific worldview, we will be making progress towards a strong and independent nation, forwarding the work of decolonization. The ultimate expression of this strong position would be the emergence of the use of a shared Hul’qumi’num scientific vocabulary such as the one that is currently embryonic, that would allow the sort of generational transference of wisdom-in-action through oral and kinetic channels so integral to the functioning of indigenous community structure.

If students can begin to think about their use of science in their place, using their inherited language, they can begin to solve the problems of modernity in Indigenous terms, and establish the strong position in life that all parents wish for their children.
Notes on Obtaining Functional Fluency

Please consider the compound Hul’qumi’num words as completely experimental. Keep in mind that every branch, every family, has its own unique set of teachings. These include teachings about the pronunciation and usage of words in Hul’qumi’num. Where possible, the Qu’wut’sun dictionary and pronunciations from First Voices (http://www.firstvoices.com/en/HULQUMINUM/welcome) are good guidance.

The optimal situation for teaching pronunciations is to try to remain as close to place as possible, which means learning and using Hul’qumi’num words yourself. To do this, ask students, community members, and other teachers how they would pronounce the word. At the end of the day, make up your own mind when pronunciation is controversial. Just do not stop trying to speak for fear of doing it wrong.

Disclaimer

Lastly, you must treat the construction of compound Hul’qumi’num words as uncertain. It is possible Hul’qumi’num orthography does not allow for the compounds as I have constructed them. I have not checked them myself because even after months of inquiry into the issue, I have not found a satisfactory answer. Use these compounds at your own risk. If you prefer, use the English equivalent phrase alone whenever you encounter a word of which you are uncertain. However, the power in this unit comes from your willingness to use the Hul’qumi’num as it appears.

The tradition, as I understand it, is that if ever someone challenges your pronunciation or usage, you agree with him or her, repeat it the way he or she suggest in front of that elder, and then rely on your own judgment about a pronunciation or usage issue. It is important to
remember, as an outsider, all the different variations you encounter and to treat multiple
pronunciations as correct, and to back down whenever necessary.

With that said, I encourage the new science teacher to be unafraid in approaching the
language aspects of this unit. The language is a window into place unlike any other that is
available.

A note on metaphor choice

I chose the particular symbols that represent the various scientific concepts embedded in this
unit because they fit one or more of the following criteria:

1. They are symbols that are familiar and common to the story-telling traditions of the
   community. Examples of these words include lelum (house), kw’a’luhw (chum salmon)
   and hi’wa’qw (chief).

2. They are words that are either common or contain common sounds, and thus encourage
   language development amongst developing learners. Words in this category include
   maaluqwut (mixed together), ‘Ey’x sxuxi’nu (crab legs) snas (fat), ten (mother).

3. They are words and compounds being used in a non-literal way to represent concepts for
   which there is no easy translation in Hul’qumi’num. This category contains the words
   tl’aqw’iwsum (organized for storage), ‘uy’uy’mut sathus (beautiful face), s-welh-x s-
   athus (rough mannered face), and slepche-k (pancake).

   For example, the metaphor of a wall of fish representing phospholipid bilayer was chosen
because the word kw’a’luhw (chum salmon) appears in most Hul’qumi’num language primers
under the entry for “kw’”, and thus it is an example of an early stage language acquisition
milestone. Additionally, because the community I am working in has for so long made its
livelihood from fishing, and many stories feature tales involving interactions with the kw’a’luhw
(chum salmon), it seemed a very appropriate place to start the work of indigenizing the science curriculum. I made many such decisions in the process of building this unit, which I based on my own experience, observations and interactions with other community members, including elders and other educators.

Usage Agreement

These story fragments may be illustrated, turned into puppets, animated or otherwise represented. Performance, voicing and pacing of the following story fragments is in the hands of the educator. As far as possible, preserve the wording of the stories, especially for repetitive segments. The repetitive nature of the story is the central aspect of its telling.

SECTION THREE: ACTING

Content

This supplementary package contains eight story fragments that help describe the appearance and functioning of a cell through Indigenous knowledge systems. In this unit, students interact with a curriculum that explores the anatomy and functions of the cell through the metaphor of a traditionally organized family living in a house. These story fragments are open for use in a multitude of ways that suits your style as an educator.

Unit Overview

<table>
<thead>
<tr>
<th>Knowledge forms compared</th>
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<tbody>
<tr>
<td>- The cell to a traditionally arranged household</td>
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<tr>
<th>Developing wisdom-in-action</th>
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<tr>
<td>- Connecting creation to intention through iterative increasing complexity of knowledge form comparison.</td>
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</table>
• Bridging traditional and scientific knowledge forms by linking the metaphor of the house to the reality of the cell - comparing the house from the story to a model of a cell.

<table>
<thead>
<tr>
<th>Content</th>
<th>This package covers the following British Columbia learning standards</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Cell theory</td>
</tr>
<tr>
<td></td>
<td>• living things are made of one or more cells</td>
</tr>
<tr>
<td></td>
<td>• all cells come from pre-existing cells</td>
</tr>
<tr>
<td></td>
<td>• the cell is a basic unit of life</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Curricular competencies</th>
<th>Curriculum competencies:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest</td>
</tr>
<tr>
<td></td>
<td>• Apply First Peoples perspectives and knowledge, other ways of knowing, and local knowledge as sources of information</td>
</tr>
<tr>
<td></td>
<td>• Experience and interpret the local environment</td>
</tr>
<tr>
<td></td>
<td>• Construct and use a range of methods to represent patterns or relationships in data, including tables, graphs, keys, models, and digital technologies as appropriate</td>
</tr>
<tr>
<td></td>
<td>• Communicate ideas, findings, and solutions to problems, using scientific language, representations, and digital technologies as appropriate</td>
</tr>
<tr>
<td></td>
<td>• Express and reflect on a variety of experiences and perspectives of place</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indigenous content specific to local community</th>
<th>Apply First Peoples perspectives and knowledge, other ways of knowing, and local knowledge as sources of information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Everything in the cell pulls together as one, nut sumat.</td>
</tr>
</tbody>
</table>

### Story 1: Cell Membranes

<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Phospholipid bilayer, hydrophobic, hydrophilic, selective permeability</th>
</tr>
</thead>
</table>

**Story 1**

A person lives inside a house with family; parents, sisters, brothers, grandparents, cat and dog. Inside of all of these living things is another kind of house. As I describe the special house inside of all these beings, I want you to close your eyes and picture this house.
The lelum (house) has walls that goes all the way around and separates the inside of the house from the outside of the house. These walls are a special kind of wall though, because they are made of kw’a’luhw (chum/dog salmon). The walls have two layers, and both are made of fish. The fish are not arranged all higgledy-piggledy though, with some heads pointing one way, and others the tails pointing that way, too. Instead, the walls are built so that on the outside wall, the one facing the outside, all the fish heads are pointing out, so that if you were standing outside, it looks like the wall of fish is about to swim towards you, with all their tails pointing inwards, towards the fire-pit.

**Representation part 1**

Draw this wall -

The second wall, the inside wall - do you remember I mentioned a second wall? - is also made from fish. However, these fish are arranged exactly opposite, so that their heads are pointing towards the center of the house, with their tails pointing the same direction as the heads of the fish on the outside wall.

**Representation part 2**

Draw the second line of fish -

Let us take a second to look at what we have just drawn. If you were careful about how you drew your picture, perhaps you noticed that the fish are swimming away from each other.

There is another strange thing about this house. It is completely full of water on the inside, and completely surrounded by water on the outside. Even though the house is wet on the outside and wet on the inside, the water on the inside and the water on the outside are not the same.

**Hydrophobic, hydrophilic**

How can this be so? Well...

These two walls made of fish look like they are going to swim away from each other. However, they never swim away from each other. Instead, they splash their tails in the space between the walls and push all the water out from between them, so that there is no water between the two walls of fish. All the fish work together *nut sumat* to keep this space free of water.

Why are the fish keeping the water out of the space between the walls? That is simple. The fish want to keep the water outside the
### Selective permeability

*This lesson might take two or more days – don’t go too fast*

House and the water that is inside the house separate, so that the two waters will not mix. The water on the inside is a special kind of water, and I will tell you more about it next class.

That is enough for now. Let us see what you remember about the story I just told you.

### Learning activity

(On-going and developing cell diagram or 3D model over the course of the unit)

Make a model of this special house (2D or 3D). Build or draw the walls of the house and label them *Cell Wall*. We will continue to update this model as the unit progresses.

Compare your picture to a real cell wall. Using a textbook or diagram, label the parts of the cell as you build your model, and the functions of the cell wall that you heard about in the story or read from a textbook. Label the features of the house with these scientific names as well.

---

### Story 2: Cytoplasm

#### Vocabulary

Waste products, Homeostasis, Passive Transport, Active Transport, Channel Protein

#### Review

Do you remember the special lelum (house) we were learning about yesterday? The one that had walls made of kw’a’lühw (chum/dog salmon) that were swimming in opposite directions? Well, today I am going to tell you a story about how the water on the inside of the house is different from the water on the outside of the house.

The water on the outside of the house carries within it many different things that the people in the house need to live. It carries food for the people to eat. It carries air for the people to breathe, and it carries messages from other houses so that the people in the house can know about what is going on with their neighbours.

This outside water also carries things that the people in the house do not need. It is where the people that live in the house put their
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste products</td>
<td>waste, their garbage. Living in the outside water are also creatures and predators that could hurt the people inside the house. All of these things, good and bad for the people in the house, are maaluqwut, (mixed together) in the wrong amounts, so that the people inside the house cannot take in the good for fear of letting in the bad. Now, draw on your picture representations of the things that you find in the water outside the house-</td>
</tr>
<tr>
<td>Homeostasis</td>
<td>The water on the inside of the house, on the other hand, is kept tl’aqw’iwsum (organized for storage). There is exactly the right amount of air and food for the people inside the house to be comfortable, and the waste and monsters on the outside cannot get inside the house unless the Chief lets them in, on purpose or by accident. Now, draw on your picture representations of those things found in the water inside the house</td>
</tr>
<tr>
<td>Representation part one</td>
<td>On the other hand, some things can get in the house without the Chief opening a special door. The air from outside can come in the house and squeeze through the spaces between the fish-walls, without needing a door. The spent air inside the house can get out in the same way. If the water in the house does not have enough food in it, the Chief opens up more food shaped doors and lets in more food. If there is a message in the outside water that the Chief would like to hear, he opens up a message-sized door in the house and lets it in from outside.</td>
</tr>
<tr>
<td>Passive Transport</td>
<td>The strangest thing about this house is that it does not have just one or two doors. The house has many doors, some large, some small. Some doors open by themselves and some doors only open when the Chief opens them. In addition, the number of doors into the house can be many or few, depending on the needs of the people on the inside of the house. Finally, draw on your picture representations of some doors that can be found in the wall</td>
</tr>
<tr>
<td>Active Transport</td>
<td></td>
</tr>
<tr>
<td>Channel Protein</td>
<td></td>
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</tbody>
</table>
### Representation part 2

In the way I have described above, the water on the inside of the house, the walls of the house, and the Chief, all work together -- *nut'samut* -- to make sure that everyone living inside the house has what they need.

### Learning activity

**On-going and developing cell diagram or 3D model over several lessons**

Add the water on the inside of the house to your model, label it *Cytoplasm* and explain in your own words what the cytoplasm is.

Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the cytoplasm that you heard about in the story or read from a textbook.

### Story 3: Nucleus

<table>
<thead>
<tr>
<th>Vocabulary</th>
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</thead>
<tbody>
<tr>
<td>Nucleus, nuclear envelope, DNA, intracellular messaging, DNA replication</td>
</tr>
</tbody>
</table>

**Review**

Do you remember the special house we were learning about yesterday? The one that had walls made of fish that were swimming in opposite directions? The house where the water on the inside is kept separate from the water on the outside of the cell? The house where the Chief can decide how many doors and of what type these should be? Can anyone tell me what sorts of things can get through the wall of fish without anyone’s help? What sorts of things need the Chiefs help to get through the walls?

The Chief of this house is a peculiar person. He is called hi’wa’qw and he lives inside a special room in the middle of the house. This special room has another set of walls just like the ones that surround the lelum (house). Just like the outside wall, this wall also has two layers of kw’a’luhw (chum/dog salmon)

One layer has the heads of the fish facing outwards, while the other layer faces inwards. Just like the wall outside the house, these fish
| Nuclear envelope | splash their tales and get rid of all the water in the space between them.  
**Possible question:** Why is the house two layers thick?  
*Use this opportunity to look at a cross section of the phospholipid bilayer and discover the resemblance of the hydrophilic and hydrophobic ends of the bilayer to fish.*  
The Chief is not the only person in the house to have a special room like this, but his room is the biggest room in the house, and he is very, very large so he never ever leaves it to visit anyone else in the house.

| DNA | Draw the Chief in his special room. Then draw a thought bubble above his head  
The Chief, being the chief of his house, has all the knowledge of how to build a good house and be a good leader of the household. He knows a great many things.  
He knows how to make doors of different sizes for the walls.  
He knows what kind of messages to send to neighbouring houses, and when to send them.  
He knows when the water inside the house has too much or not enough of one thing or another.  
In the thought bubble you drew, draw or write the things that the Chief knows.

| Representation 1 | Because he never leaves his special room, he needs assistants to help him carry out the business of the house. He does this by sending messages through the walls of his room. These are similar to the messages that move through the water outside the house, between neighbouring houses, except that these messages do not go through the wall around the house. These messages only go through the wall to the Chief’s room. These messages are meant for other members of the household, telling them what they should do.  
Hi’wa’qw (The Chief) has another very important job to carry out. When the house gets too big, and there are too many people inside... |
<table>
<thead>
<tr>
<th>Intracellular messaging</th>
<th>the cell, the Chief calls for a new house to be built, the same as the old one, complete with exact copies of all the people in the house. How this second house is built is a story for another day.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellular reproduction</td>
<td></td>
</tr>
<tr>
<td>Learning activity</td>
<td>Add the special room where the Chief stays to your model label it <em>Nucleus</em> and explain in your own words what the nucleus/chief does. Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the nucleus that you heard about in the story or read from a textbook.</td>
</tr>
<tr>
<td><strong>Story 4: Smooth Endoplasmic Reticulum</strong></td>
<td></td>
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<tr>
<td>Vocabulary: Smooth endoplasmic reticulum, hormone, fat-storing</td>
<td>Do you remember the special house we were learning about yesterday? The one that had walls made of fish that were swimming in opposite directions? The house where the water on the inside is kept separate from the water on the outside of the cell? The house where the Chief can decide how many doors and of what type these should be? The house where the Chief decides when to build a new house?</td>
</tr>
<tr>
<td>Story 4</td>
<td>Can anyone tell me how the Chief decides when to build a new house?</td>
</tr>
<tr>
<td>Smooth ER</td>
<td>It may seem like the Chief is the only person in this house that really matters, making all these important decisions about who or what gets in the cell, when to build a new house and so forth. However, the Chief never, ever leaves his room. That is why he needs the help of other people that live inside the house. To help keep everyone in the house healthy and happy, Hi’wa’kw (the Chief) has the help of his three daughters. These three daughters are as peculiar as their father is. The first daughter has smooth skin and smooth hair. That is why she is called ‘Uy’uy’mut s-athus (Beautiful face). The work that she helps her father with is in making the messages that leave their house and go to neighbouring houses. Her father, the Chief, has a special, tiny window through which he whispers past the walls of his room and tells his daughter the messages he’d like her to record. Upon hearing the message, ‘Uy’uy’mut s-athus (Beautiful face) does something very strange. Draw the smooth faced sister and the tiny window to the Chief’s room from which she hears his messages. This daughter takes a lump of fat, like play dough that has been floating in the water inside the house. Then she molds it in her hands until it is a shape that other houses will recognize and understand. If the Chief wants to let other houses know that there is not enough air in the water outside the house, she’ll mold the fat into the shape that means ‘air’, and the message will travel to the houses that are in charge of air. If the Chief wants other houses to know that the monsters in the water outside are getting vicious and mean, she’ll mold the lump of fat into a shape that means ‘monsters’ and send it to the houses that are in charge of killing monsters. Using a lump of play-dough, make a shape that means something to you. Explain and record its meaning. ‘Uy’uy’mut s-athus (Beautiful face) has another job, too. Some of her lumps of fat do not have a shape that means anything. She keeps these in a special bag for times when there is not enough food. At these times, the people in the house can grab these lumps of fat to eat.</td>
</tr>
<tr>
<td>Representation 1</td>
<td></td>
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<tr>
<td>Hormone building function</td>
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<td>Representation 2</td>
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<tr>
<td>Fat storing function</td>
<td>The smooth skinned daughter is not alone, however. She needs the help of the other two sisters to make sure everyone in the house can work together and be happy. They work <em>nut’samut</em>.</td>
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<tr>
<td>----------------------</td>
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<tr>
<td>Learning activity</td>
<td>Add the smooth skinned Chief’s daughter to your model</td>
</tr>
<tr>
<td>(On-going and</td>
<td>Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the smooth ER that you heard about in the story or read from a textbook.</td>
</tr>
<tr>
<td>developing cell</td>
<td></td>
</tr>
<tr>
<td>diagram or 3D model</td>
<td></td>
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<tr>
<td>over several lessons</td>
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<table>
<thead>
<tr>
<th><strong>Story 5: Rough Endoplasmic Reticulum</strong></th>
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<tbody>
<tr>
<td><strong>Vocabulary</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
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<td></td>
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<tr>
<td><strong>Story 5</strong></td>
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<tr>
<td><strong>Ribosomes</strong></td>
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</table>
Protein creation

Draw a picture of the bumpy faced sister. When you are done drawing, I will tell you a story about a fight between the two sisters.

S-welh-x s-athus (Rough mannered face) job in the house is similar really, to her sister, the smooth-faced sister. They both build things. It’s just that the bumpy-faced sister makes things out of a very special kind of material. The smooth faced sister never got to play with this special material. She would always complain, “It is because she gets to play with the really fun stuff! I want a turn to play with the fun stuff!”

This is the key to understanding ‘Uy’uy’mut s-athus (Beautiful face). For though having bumps coming out of your face might be considered ugly by some, the smooth faced sister cannot do what only S-welh-x s-athus (Rough mannered face) can do.

The jealousy started because the material S-welh-x s-athus (Rough mannered face) uses is very special stuff, and can be made into a huge number of different shapes. Sure, the fat that the smooth faced sister holds in her hand can be used to make molecules, or as an stored for energy later. However, S-welh-x s-athus (Rough mannered face) makes something even more astonishing. She makes little structures out of spirals, rectangles and thin tubing. The countless ways these can be put together are almost limitless. All together, these are your body’s tissues. Your organs, nerves, bones, tendons, these are all made out of proteins that are made in the house inside you.

The smooth faced sister would complain to their father, the Chief, but their father never did anything about it. The smooth faced daughter was never taught how to build the complex and beautiful sculptures that the bumpy faced sister built with her special material. Even though the Chief always said he loved his girls the same, the smooth faced daughter never managed to shake the feeling in the back of her mind that maybe her father just might love her rough-faced sister a tiny bit more than her.

Therefore, Uy’uy’mut s-athus (Beautiful face) would say “I want a turn to make the beautiful shapes” and S-welh-x s-athus (Rough mannered face), who would be worn out from working on and on without rest, would snap back at her sister, “Shut up you lazy good for nothing!”

The Chief is very wise, but he doesn’t really care about the feelings of others. Only rarely does he do anything about the quarrels of his
children. As long as they keep performing their household duties and don’t disrespect him out loud, he ignores the sisters completely. But their bickering became so bad one time that he almost came out of his room one night to say:

“I’m going to say this once, and you better listen!

In order for me to have some peace and quiet in this house, we all need to work. That means, we all pull together as one. We don’t all have the same job, but we are all pulling together. Uy’uy’ut s-athus (Beautiful face), please, stick to what you are good at. Shape the blobs of fat into messages to send to our neighbours. And please, store the leftover blobs of fat in your special bag.

And my daughter, S-welh-x s-athus (Rough mannered face). Keep making the beautiful variety of shapes with all the rods, spirals and rhomboids you love to play with. Keep putting them together in such a huge variety of ways. Add these shapes to S-welh-x s-athus (Rough mannered face)’s head.

Work together for the benefit of everyone! Do not fight amongst yourselves, but work as one to stay alive. That is what I call nu’u’sumut”.

<p>| Learning activity (On-going and developing cell diagram or 3D model over several lessons) | Add the rough skinned Chief’s daughter to your model. Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the rough ER that you heard about in the story or read from a textbook. Spin off: Just like S-welh-x s-athus (Rough mannered face), students can experiment with the different things they can build with the shapes that make proteins. You need: • Wires • Rhomboids • Spirals |</p>
<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Golgi Apparatus, Macromolecule, Cis-face, Trans-face, Lysosome, Vesicle, Exocytosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review</td>
<td>Do you remember the special house and the people that live inside it?</td>
</tr>
<tr>
<td></td>
<td>What are the walls of the house like?</td>
</tr>
<tr>
<td></td>
<td>Who lives in the house?</td>
</tr>
<tr>
<td></td>
<td>What does ‘Uy’uy’mut s-athus (Beautiful face) like to use to make her messages?</td>
</tr>
<tr>
<td></td>
<td>What shapes does the S-welh-x s-athus (Rough mannered face) use to make her sculptures?</td>
</tr>
<tr>
<td>Story 6</td>
<td>In the house which has two layers of fish for walls, where the smooth faced sister and the bumpy faced sister lived with their father the Chief who keeps to himself in his special room that also has walls of fish, lives another sibling.</td>
</tr>
<tr>
<td>Golgi Apparatus</td>
<td>This sibling is named Slepche-k (pancake). He is so called because his body resembles a stack of pancakes on a plate. He was the brother to the two sisters, but he didn’t have much of a family resemblance. Everyone said he took after his mother.</td>
</tr>
<tr>
<td>Packaging</td>
<td>Being the youngest of the siblings, Slepche-k (pancake) is often teased and tormented by his siblings. When his older sister made either a packet of fat marked with the sign for ‘air’ or ‘food’, sometimes she would become bored of her toy and throw it at Slepche-k (pancake). Her aim wasn’t very good, and so her packages would bounce off the walls of the house. But she would keep throwing her packages at Slepche-k (pancake) until eventually some would become stuck on the back of his head.</td>
</tr>
<tr>
<td>Macromolecule function</td>
<td>Or perhaps his other sister made some fantastic sculpture out of proteins. She would display it high up so that everyone could see how clever she was. But being young and clumsy, Slepche-k</td>
</tr>
</tbody>
</table>
(pancake) accidentally knocks it off the wall, only for it to bounce off the walls and and strike him on the back of his head.

Whenever the fighting got so bad that their father was forced to yell from his room, the sisters would always blame Slepche-k (pancake). His father would then make poor Slepche-k (pancake) grab the mop and clean up any messes of fats and proteins that he saw.

Whether an accident caused by clumsiness or a deliberate provocation, some of these proteins and fats would end up stuck on the back of poor Slepche-k’s (pancake) head. To make matters worse, the sisters would hurl insults at the poor boy. “You’re ugly Slepche-k (pancake)!” shouted the smooth faced sister. “Stop being so lazy!” called the bumpy faced sister.

Sometimes, the sibling taunting gets so bad that Pancake becomes furious. At these times, Slepche-k (pancake) starts pulling at his face. Pulling and pinching, he takes pieces of his face off of the bones of his skull.

Slepche-k (pancake) is not content to simply harm himself in anger, however. No, Slepche-k (pancake) is plotting a way to keep his sisters from harassing him for good. To this end, Slepche-k (pancake) rolls the pieces of his face out flat with a rolling pin. In his rage, he pulls out the proteins and fatty messages that are stuck to the back of his head and places them into the flattened pieces of his face. When he wraps the flesh around the fats and proteins, the flesh of his face transforms into fish. In fact, these are the very same fish, the very same stuff that the walls of the house are made of.

Next, Slepche-k (pancake) says to his sisters, “I am so fed up with the two of you; I am taking your toys and throwing them where you can’t reach them.

With this, he throws the fats and the proteins that are all wrapped up in his package of skin made of fish and throws them as hard as he can against the wall.

What happens next is really quite astonishing.

This time, the package does not bounce off the walls of the house the way the fats and proteins do. Instead, when the package touches

| Cis-face | Whenever the fighting got so bad that their father was forced to yell from his room, the sisters would always blame Slepche-k (pancake). His father would then make poor Slepche-k (pancake) grab the mop and clean up any messes of fats and proteins that he saw. |
| Lysosome | Whether an accident caused by clumsiness or a deliberate provocation, some of these proteins and fats would end up stuck on the back of poor Slepche-k’s (pancake) head. To make matters worse, the sisters would hurl insults at the poor boy. “You’re ugly Slepche-k (pancake)!” shouted the smooth faced sister. “Stop being so lazy!” called the bumpy faced sister. |
| Trans-face | Sometimes, the sibling taunting gets so bad that Pancake becomes furious. At these times, Slepche-k (pancake) starts pulling at his face. Pulling and pinching, he takes pieces of his face off of the bones of his skull. |
| Vesicle | Slepche-k (pancake) is not content to simply harm himself in anger, however. No, Slepche-k (pancake) is plotting a way to keep his sisters from harassing him for good. To this end, Slepche-k (pancake) rolls the pieces of his face out flat with a rolling pin. In his rage, he pulls out the proteins and fatty messages that are stuck to the back of his head and places them into the flattened pieces of his face. When he wraps the flesh around the fats and proteins, the flesh of his face transforms into fish. In fact, these are the very same fish, the very same stuff that the walls of the house are made of. |
|          | Next, Slepche-k (pancake) says to his sisters, “I am so fed up with the two of you; I am taking your toys and throwing them where you can’t reach them. |
|          | With this, he throws the fats and the proteins that are all wrapped up in his package of skin made of fish and throws them as hard as he can against the wall. |
|          | What happens next is really quite astonishing. |
|          | This time, the package does not bounce off the walls of the house the way the fats and proteins do. Instead, when the package touches |
| Exocytosis | the wall, the fish that were the package join the fish that make the wall, and become part of the wall itself.

As for the proteins and fats that make the contents of the package, well, something quite different happens to these. These fats and proteins are pushed through the wall of the house, through the space between the walls where the tails of the inside wall of fish and the tails of the outside wall of fish splash all the water out, and leave the house and enter the water outside the house.

“Hahaha!” Laughs Slepche-k (pancake). “Now my sisters cannot harass me anymore”. Indeed, after Slepche-k (pancake) throws their toys away, the sisters are too busy making more fatty messages and proteins to be much of a bother to Slepche-k (pancake), at least for a little while.

The siblings did not understand the bigger picture, but their father, the Chief, watched his children as they continued their nonsense with approval. You see, the children, in their own way, were ensuring the prosperity of their household. Those proteins and fats were needed in other houses. These needed to be sent out into the water outside, just as the siblings were accomplishing through their rivalry. And so, without even knowing it, and despite their constant bickering, the 3 siblings contribute to the well-being of their entire family, nut’sumat.

| Learning activity (On-going and developing cell diagram or 3D model over several lessons) | Add Slepche-k (pancake) to your model

Compare your model to a real cell. Using a textbook or diagram, label the parts of the cell as you build your model and the functions of the smooth ER that you heard about in the story or read from a textbook.

Take the proteins built in the last period and package them up for delivery. (Put them in a box or an envelope as if getting it ready for the post).

<table>
<thead>
<tr>
<th>Story 7: Mitochondria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vocabulary</strong></td>
</tr>
</tbody>
</table>
| Review | Do you remember the special house and the people that live inside it?  
What was the name of the only boy in the family?  
When his sisters threw things, what happened when they hit the wall?  
What side of his head did the boy get proteins and fats stuck in?  
What did the boy do with the things that were stuck to the back of his head?  
Why was their father the Chief happy to see his children squabble? |
|---|---|
| Story 7 | The last member of the household, but certainly not the least is, of course Ten (Mother).  
Ten (Mother) performs an incredibly important job in the household.  
In fact, without mother, no one in the household can do their job.  
“We’re hungry Ten (Mother)!” the bumpy faced sister tells her Ten (Mother) one day. “We want to eat!”  
Ten (Mother) looks in her pantry. But the cupboards are bare, and she has nothing to feed her children.  
“Ten (Mother)!” calls Father. “Where is my dinner?”  
Ten (Mother) gets frustrated. She calls back to Father. “You have not caught me any food! How can I make my babies dinner if you do not bring me something to cook?”  
“Fine”, the Chief grumbles, as he comes up with a plan.  
Father then asks his daughter, S-welh-x s-athus (Rough mannered face) to make a special door, through which he could cast his fishing line.  
S-welh-x s-athus makes the door, just as she was good at doing. Her father casts out his fishing line through the door and soon enough he nabs something.  
“Help me pull, Slepche-k (pancake) my son!” Yells the Hi’wa’qw (Chief) |
**SECTION FOUR: DEVELOPING WISDOM-IN-ACTION**

**Definition**

As noted in the overview, the performance of this unit will introduce you to a view of assessment that lies on a foundation on observation and narrative building around the development of process skills. I call this way of looking at assessment *wisdom-in-action*, and I conceive of it as being built on a foundation of personal experience and academic study.
Process skills such as those performed by a scientist engaged in the scientific endeavour, honed to a high degree and inseparably linked to a body of knowledge, are an example of the specialized type of knowledge I refer to as wisdom-in-action. So is the carving of a canoe, as performed by a master who has honed his craft over thousands of hours, who has certain knowledge of the way his chosen material will change and alter in his hands. It can take a long time to develop this type of knowledge mixed with skill, and so multiple observations over time are necessary to detect its genesis and development.

Wisdom-in-action, therefore, is a blend of this type of skills-based knowledge and the knowledge of things. That is to say, the type of knowledge displayed in games of trivia and sits in encyclopedias and academic journals. The development of these two types of knowledge over time is interconnected. Improvements in one can improve the other. The entire system benefits from a) acquiring access to informational knowledge (what one might call book smarts) and b) improving process skills (what one might call street smarts). The synthesis of these two types of knowledge into actions that affect positive development are ones that develop wisdom-in-action. The stories, modeling and representations embedded in this unit provide many opportunities for you, as the science educator, to assess the development of wisdom-in-action in your students.

The inadequacy of other kinds of formal assessments to capture development in these process skills leads to the most important facet of approaching the problem of assessment through a wisdom-in-action paradigm; the educator seeks to observe and record student development over time. Meaning; throughout the process of learning, the educator and the student are in a feedback cycle that involves the educator observing and entering the students subjective mindset, while, at the same time, the student is able to learn from the teacher and elevate their own wisdom-in-action through interaction with the teacher.
Formative Assessment

The basis of the development of wisdom-in-action as the defining assessment paradigm is the idea that the teacher/student paradigm is at its most functional when the teacher is able to most closely ‘resonate’ with the student. That is, when a teacher takes the time to understand the student, to be witness to and conscious of the students unfolding potential. The more awareness the teacher has of the student’s subjective world, the better they will be able to resonate with the student and the stronger the feedback loop. For example, as long as the feedback loop is operational, a teacher can anticipate and correct a student’s mistakes as they occur, and work with the student to develop wisdom-in-action around the issue. Lastly, this state of resonance also provides the opportunity to pass on teachings that will foster growth and give direction to the student in the future, planting seeds, so to speak.

Entering into this shared wisdom-in-action resonance mode with students is a culturally fair way of gaining insight into and assessing students’ learning. While I acknowledge the utility of things like testing and leveling students, my experience shows that while a focus on accommodation is warranted, excessive focus on a learner’s failings results in a collapsing personal curricula that ends in the failure of student and teacher alike.

In a sense, the educator becomes like a researcher in the midst of a self-design study, where the focus is not the self, but the student. As you get to understand the student, you begin to have insights into their development. Development may be at a different speed, or in different directions than you are used to, but rest assured, development is always occurring.

In order to make a full assessment of a student’s wisdom-in-action, you must be aware of the individual at a level deeper than the closed off and private image of the teacher that exists for many people. You must invest time and energy in understanding the thoughts, feelings, and the
issues faced by your students. The better you know of them, the better a guide of wisdom-in-action you will become.

Ultimately, the only person equipped to assess the fullness of their personal wisdom-in-action is themselves, since only they (and even then, only partially) have full awareness of said thoughts and feelings. However, this fact cannot dissuade you from attempting to use the information available to you to assess student learning as it is occurring, guiding the student to a higher levels of self awareness and internalized motivation.

**Cumulative Assessment**

In the course of the educational experience, it sometimes becomes necessary to hold up a section of the continuous unfolding that is development in order to provide feedback about the developmental process itself. Whether this is to suit the needs of an educational system that demands grades, or to provide a student with the self-knowledge required to attain the next step in their development, this is the purview of cumulative assessment.

Cumulative means increased by successive additions, and it is in that exact sense that an assessment should be cumulative. Here, the final project requires the student use all the skills introduced and developed in the course of the unit. In each successive stage of the curricular unit, students revisit and practice the skills that go into their developing scientific wisdom-in-action. Assessment means trying to capture each expression of this developing wisdom-in-action, noting it in some way, even if only in the teachers mind for the short term, for comparison against successive attempts. As the teacher observes the student and begins building a personal narrative around their skills and abilities, the focus must remain on taking actions that lead to improving process skills, rather than on “assessment” in the sense of deciding a letter grade.
The cumulative assessment is the final record of the successes and failures implicit in the development of a student’s wisdom-in-action. Since the development of the student’s wisdom-in-action is reflective of the formative assessment and ensuing wisdom-in-action development as it emanates from the teacher, it contains not only a multitude of information on that student’s true development, but also information about your own practice as a teacher.

The key to this information is the resonance built on relationship. The cumulative assessment is worthless without the formative assessment. Only through a concerted effort to get to know your students on a personal level will you be able to meaningfully interpret the products of their development through analysis of the cumulative assessment. Only when you can see the final product through the lens of a student’s lived experience (which takes time), can you have real knowledge about that students’ development.

**Example of Assessment**

To help you grasp exactly what I mean, let me use the first three figures provided in the *table of figures* and a sort of fake case study to illustrate how you can use developing wisdom-in-action to make both formative and cumulative assessments. Imagine that the images below as beyond perfect examples of the types of outputs that may emerge from this unit.
The first step to assessing the student’s achievement is to choose a curricular competency. In the case of the above example, I choose “Communicate ideas, findings, and solutions to problems, using scientific language, representations, and digital technologies as appropriate.”

Next, the teacher has to look for evidence of it in the output. This might show up in all sorts of unexpected ways, so try not to limit yourself too much in what you consider viable output. In the case of this example, I notice that from the first to the second graphic, the student has begun to use arrows, icons, and labels in English and Hul’qumi’num. I notice that between the second and the third graphic, the student has removed information deemed irrelevant, while preserving a consistent symbology across assessments. Thus, it seems to meet or exceed communication goals. Coming from a student, I would judge this project very highly. Of course, knowing the truth of its genesis as my own creation, I must judge this product more stringently. This illustrates the importance of relationship building and the formative assessment piece.

As the unit progresses and process skills activate repeatedly, more and more snapshots of students’ developing wisdom-in-action become available. The increased abundance of these snapshots makes assessment progressively more meaningful. As time goes by and the cumulative assessment becomes more complex, the story of the developing wisdom-in-action of skills related to science slowly unfolds and becomes plain to both the teacher and the student. Teacher
and student can then realize the final purpose of the cumulative assessment; to provide feedback that shows the student how to make the best choices possible with the resources at hand.

Conclusion

The curricular unit presented in this handbook represents a concerted effort to bring effective science education to Stz’uminus Community School. By adopting the curricular unit attached to this handbook, you are showing that you care about reconciliation. Even more importantly, you are creating a bridge that will allow a mixture of worldviews that is respectful and consensual. You are adopting a curriculum that will give you a shortcut to safety and familiarity that will allow you to become an effective teacher in this community in no time. You will be left with a deeper appreciation and knowledge of the culture and language of the students you teach, as well an insight into the family structure so important to the sense of community. As you move past this unit and begin to make the class your own, you gain an appreciation for a view of assessment that prizes the development of process skills through teacher intervention that does not rely on strong textual literacy skills. You will also benefit from the crash course the curricular unit provides you with in cultural literacy. In short, by using this curriculum, you will become an asset to the learners of this community.

Table Of Figures

Figure 1
Sequence I graphic i: Cell Membrane
Figure 2
Sequence I graphic ii: Inside and outside the cell

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Doors

CELL MEMBRANE

Glycoprotein
Carbohydrate
Glycolipid
Cholesterol
Integral protein

Alpha-helix protein
Channel protein
Peripheral protein

No water zone
Tl’aqw’iwsun
Figure 3
Sequence I graphic iii: Cytoplasm

maaluqwut

Doors

Cytoplasm

No water zone

Tl’aqw’iwsun

SOS
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