Chapter 31

Science Education and Indigenous Learners

Science Education: An International Comprehensive Course Companion

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Introduction

Across the flat, prairie landscape in Canada in an area called, *Wanaskawin* (said Wa-na-skay-win; a Cree word meaning, "being at peace with one's self"[2]) are round boulders of various sizes. From a geological perspective, these rocks ("erratics") are believed to be deposits that formed as the vast glaciers that once covered most of North America retreated at the end of the last global ice age (Rutter, 2013). But to the Northern Plains people who have lived and gathered together in this area of the world for millennia, these boulders are considered to be "rock-people" that have spirits (Regier, 2015). In the taxonomic systems of the original inhabits of Wanaskawin, everything, including rocks, are alive.

Such differences in perspectives towards the natural world are common when comparing the knowledge-systems, or epistemologies, of Western science to traditional Indigenous epistemologies. By, "Indigenous" this chapter refers to the First Peoples to live in an area of the world, those who are indigenous to these regions. These nations were and continue to be varied in political organization, resource use, lifestyle and culture. Amidst this diversity exist traditional knowledge, beliefs and orientations to the world that in some cases conflict with the epistemologies of Western science presented in school-based science education. By "Western" science we refer specifically to the form and approach of science developed in Europe and America that assumes that scientific knowledge is proven and reliable knowledge because it is objectively derived from experience (Chalmers, 1982); it is this form of science that dominates school science education world-wide.

Due to colonization, in order to be 'successful' in school, learners who have an Indigenous inheritance must demonstrate an understanding of the world through Western science that can be quite different than the traditional knowledge of their ancestral culture. This chapter outlines the importance of introducing *all* students to Indigenous ways of knowing and understanding the world; we argue that such inclusion in science education not only leads to a more socially-just, inclusive, decolonizing pedagogy but also helps students develop a more authentic and expansive understanding of the nature of science itself. We will share some key principles teachers can use to include Indigenous views in science education, some considerations when teaching Indigenous learners, and some resources to help teachers include the voices of all students, especially those of Indigenous learners; in this way teachers can model how all are welcome participants in the on-going search to understand the world we share.

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[2] Or, "living in harmony" depending on pronunciation.

1. Making Space for Indigenous Student's Voices

According to the Council of Councils[3] (Perkasa, 2015), 6% of the world's population has an Indigenous inheritance, which means that in any given school, it is likely that some of the students are Indigenous. Teachers in countries that encourage adoption of Indigenous perspectives in science education, such as Australia, New Zealand, and Canada or those looking to infuse more Indigenous perspectives in science education might be inclined to view Indigenous students in their classrooms as a possible source of ideas about Indigenous ways of knowing. This temptation must be avoided for two reasons. First, there is no one "Indigenous world view" that the student could share; Indigenous worldviews vary in history, traditions, practices and philosophies as much as any nations of the world. There are a few very general similarities Indigenous peoples share in their relationship with nature, which we discuss later in this chapter, but for the most part Indigenous societies are remarkably different and therefore a single worldview representing all Indigenous peoples would be superficial to the point of stereotyping. The second reason to avoid calling on an Indigenous learners for insights to Indigenous worldviews is due to the fact that individual students may have a wide variety of experiences of their ancestral histories and views. Some students, while Indigenous, have been raised with little to no contact with their ancestral homelands or knowledge of their traditions; while others have lived their entire lives on their traditional territories and learned aspects of their traditions, and others still, may have been raised in families that are opposed to teaching any aspects of the student's Indigenous background. Indigenous student's experiences are as varied as any students in a classroom; just as it would be unfair to ask a student with an English last name to share their insights of British thinking it is also unfair to put an Indigenous student in a parallel situation. Teachers should thus remember that *any Indigenous student cannot and should not be expected to represent all Indigenous students or share scientific and ecological knowledge of a particular Indigenous Nation.*

This does not mean, however, that Indigenous students may not have important views to share. Given that being silenced was one aspect of colonialization, teachers may need to take a decolonizing approach in their classroom that *especially* provides an inviting space for Indigenous students to share the knowledge they may hold. One approach that may be helpful is the distinction between the "saying" and the "said" made by the philosopher Emmanuel Levinas. Levinas (1998) calls the "said" as that which has a hold over what someone is saying—in essence, the said is what we *know* and *understand* of what a person means or what they represent and this "said," which is formed at a cultural level, defines our thinking and approach to the Other. Now, with Indigenous students and, really, *all* students, teachers face a difficult challenge: Trying to ignore the said, what they think they know, about this student and to listen attentively to what the student is *saying*—not only in words, but how they act, interact, and live in the world. In other words, being open to the Indigenous student and not thinking of them, particularly, *as* Indigenous in order to allow space for the student to share their ideas and

[3] A foreign policy initiative by G20 countries for research and exchange of information about global trends.

background, and to what the student wishes to *say* including (but not limited to) the student's thoughts and ideas from their Indigenous background. This 'listening' to the 'saying' of Indigenous learners in turn opens possibilities for bringing into science education ancient knowledge coming through the individual voices of the original peoples of that land, thereby introducing to science education new concepts and insights.

Activity 1: Bracketing the Said for the Saying
To understand more fully what Levinas means by 'the saying' and 'said', try this exercise: Choose someone you see on a regular basis. This could be fellow teacher, a professor at your university, a friend, a mentor teacher, a colleague—or someone with whom you have a close relationship, such as a family member or a partner. Now, when you next encounter this person, try to "bracket" everything you know about them, which Levinas calls the "said." In your mind, put your assumptions and anticipations aside and then open yourself to really listening to what this person is saying—try to do this without any judgment or prior interpretive framework based on your knowledge of this person. We call this listening, "being open to surprise" based on what the person is saying. Try this for a week and see if this changes your thinking about this person. In the same way, we advise teachers to approach all of their students, and in particular Indigenous students, open to what these students are saying and depending less on what you think you know about these students.

2. Expanding Science Literacy to include Indigenous Views

In this study of science education and children of the Menominee First Nation (of the Wisconsin region, USA) Douglas Medin and Megan Bang (2014) found that Menominee children were as successful as their non-Indigenous peers in science, but in subsequent grades achievement in science fell disproportion to their peers. This pattern seems characteristic of many Indigenous children around the world (Battiste and Barman, 1995; Krocker, 2004). A "deficit" approach to this apparent achievement trend in school science is a kind of "said" from the previous point in the assumption that there is something inherently wrong with Indigenous students, that these students need better work ethics, study skills, support from parents, etc. This approach maintains that Indigenous students are lacking in the skills or intelligence necessary to become scientifically literate. We examine this is more detail in the next point, but here we wish to remind teachers that Indigenous students are *not* lacking in science literacy, but that their particular literacy about the world may be different. For example, a student with an Indigenous inheritance may have been taught ancestral knowledge about which plants in a forest are suitable for preparing a healing tea, how to remove bark from a tree and not damage the tree, etc. but the student may not know the classification scheme for certain plants (e.g., if they are angiosperms). So, the student in this example is literate about the world, just in different ways. This does not, of course, preclude learning classification schemes to be even *more* literate and the reverse is true for students who do not have an Indigenous background by increasing *their* literacy to include the traditional ways plants were used. Anishinaabe scholar Michael Wassegijig Price explains, "Combining

Activity 2: Researching Constellations

When you look up into the night sky, what patterns do you see? If those patterns include constellations such as the Big Dipper or Orion, you are seeing connections that were first codified by the Greek astronomer Ptolemy using the common constellation patterns used by Arab sea merchants in the Mediterranean. However, the system he codified is not the only way to "join the dots" in the sky and all over the world people Indigenous to their regions used very different arrangements to form their own unique constellations. Try researching, for example, how the Inuit peoples of Northern Canada saw the stars in the sky of the north polar region, or how the constellations of the peoples of Polynesia (see recommended resources at the end of this chapter). For example, Inuit peoples did not see the constellation "Orion" in the northern sky; instead, they the "belt" of Orion was seen as an arrow and the top two stars of Orion's "arms" were seen as part of a completely different constellation related to stories of hunting and family (see *the Arctic Sky* under "Recommended Resources"). Teaching alternate constellations reveals to students in science education that how we "read" the world very much depends on how we are taught to read the world. A fun and effective cross-curricular exercise is to give students a night sky with magnitude 4.0 or brighter stars and have them in groups develop and name their own constellations and also ask students to write a story about how the constellation became known by this name.

indigenous plant knowledge with science and technology expands our breadth of understanding of plants and ecology, an understanding unlike that of our indigenous ancestors" (2011, p.12).

During David's early years as a professor he taught in the Western Canadian province of Saskatchewan. In this region of the world, the Indigenous peoples used a method of classification of nature that is radically different from the systems used in science education. As mentioned in the introduction, the traditional classification systems consider all objects to have a spirit and therefore *everything* is alive. As well, plants and animals are categorized by their function and use to the community; for example, "poison-biting beings" may include spiders and snakes. Embedded in this system is profound respect for every part of nature, but especially the older members, such as trees and rocks, which are considered ancient and therefore have special forms of wisdom they can communicate. While this classification is clearly different from taxonomies taught in traditional, Western science classrooms, if one lived out on the land in this area of the world, the traditional schemes would be far more useful that knowing the phylum and class of, for example, a particular animal. Instead, traditional classification schemes, which themselves are very elaborate in some Indigenous Nations, are really useful for knowing what plants one can eat, which are useful for making rope, which animals are dangerous and which are useful for eating. Prince (2011) conveys that,

> Indigenous names of plants are descriptive, metaphoric and intertwined with the intricacies of the landscape: they indicate relationships to animals and birds; they describe how the Anishnaabe utilized each plant according to its physical characteristics. (p.5)

The key point in this section is that Indigenous students may bring some of their worldview and traditional knowledge about nature to their science classes; these students *are* literate about nature, their knowledge is just *different* from what is usually taught in science classes. Yet this difference is never apparent to students as their science education increasingly focuses on specific content knowledge and memorization, especially after Grade 4, that bears little to no resemblance to the ancestral knowledge of Indigenous peoples. In her study of why some Indigenous students turn away from science, Nikki Krocker observed in her interviews with Indigenous students that they found school science "continually presented as facts students must memorize and regurgitate" (p. 104), and that a science education is, "disconnected from the lives of students and irrelevant to their community and cultural background" (p. 104). The increasing focus on scientific knowledge from Grade 4 onwards in most school science curricula crowds out any other knowledge about the world, including Indigenous knowledge. Krocker and many others argue that including Indigenous ways of reading the world would help to create a science curriculum that is more familiar and more useful to Indigenous students and that this would in turn increase the retention and success of Indigenous students with science education (Berkowitz, 2001; Cajete, 1999; Henderson, 1996; Krocker, 2004). We agree, but add that the exclusion of other forms of knowledge from Grade 4 onwards is not a focus on scientific knowledge but a *delimiting* of what passes as science to the discoveries of "Western" scientists. Inviting alternate views of constellations or classification, we argue, *expands* scientific knowledge to include ways of understanding the world from the perspectives of Indigenous peoples. In other words, science education becomes, we believe, *more* scientific if this education does not exclude forms of understanding that fall outside the present curriculum focus on European/American scientific discovery. Indigenous scientists Cheung (2008) and Price (2011) agree that combining the best of Western science and Indigenous knowledge of place is a superior combination to just one or the other. This kind of curriculum will better students to tackle the challenges of this millennia.

Another key consideration for teachers is how the pedagogy of science changes after Grade 4. In the primary school years of Kindergarten to Grade 3 science education tends to be more hands-on, inquiry-based learning, such as discovering the properties of magnets or planting beans to determine how they grow towards light. Intermediate elementary school science shifts its pedagogy towards content memorization that increases with each grade as students learn classification schemes used in Western science, weather patterns, the names of types of rocks, etc. The shift is from what scientists practice, their form of inquiry, towards what Western science has discovered. While we recognize that sharing and memorizing knowledge is a part of science, we also support curriculum guidelines for science that emphasize the *processes* of a place-based science. A more inquiry and place-based approach to science at higher grades would move from an increasingly transmissive, written approach that discourages oral ways of demonstrating understanding to a more holistic approach. This emphasis on written over oral methods of learning and teaching affects all students, but particularly Indigenous students whose ancestral cultures tend to values this approach more highly. We argue, then, it's not Indigenous students who need to change or adapt to science education but the pedagogy of science education itself that needs to become more hands-on, inquiry based at all levels (elementary through to post-secondary) for the benefit of all students.

3. Beyond Border Crossing

Western science, as mentioned in the previous section, was born in the development of inductive, experimental approaches to understanding nature first by Islamic scholars then picked up in the work of Occam, Bacon and other Europeans. The spectacular discoveries of science as an experimental approach were linked to economic prosperity early in the European mind, especially with discoveries in shipbuilding, navigation and materials development enabled movement of European capitalist interests to all regions of the world (Johnson, 1991). In this way, science became a exported ideology of conquering nature as per Biblical injunction as a means to a better life, where "better" meant economic prosperity through the development of nature. Those closest to the epistemology of progress through Western science and technological invention understood, valued and appreciated Western science. Thereby, the children of these cultures, or those at least familiar with this particular view of science, were at an advantage in science education to those children from cultures with different approaches to understanding the world. Indigenous students, in particular, find that their ancestral cultures do not share the same values of the dominant societies and, in particular for this chapter, experience different approaches culturally towards nature.

For example, most Indigenous cultures, as a broad generalization, approach Nature with an attitude of *respect*. There is not a fundamental split between humans and nature that informs Western science; instead, Indigenous cultures tend to see themselves as *part* of Nature, or creation. In addition, Indigenous peoples do not see themselves as above nature, that is rocks, trees, animals, insects, waterways, but rather beneath them – recognizing that as humans we are useless and helpless without these things – a vast difference to the hierarchy of humans as the top creatures in the natural world according to western philosophies due to our perceived superior thought processes. Another fundamental difference is the assumption among Indigenous cultures that Nature is infused with spirits that play an active, historical role in relationships (MacIvor, 1995; Ermine, 1995). These two features, the assumption of being part of Nature that is also spirit-filled, marks what Arun Agrawal calls, "striking differences" (p. 2, 2004) between Indigenous cultural approaches to the world than the approaches of Western science.

Many science educators argue that one way to encourage the success of Indigenous students in science is for teachers to become "brokers" of the two cultures by guiding Indigenous students on how to cross over from the borders of their culture to the borders of science, much like learning to live in a country different from one's own. For example, Glen Aikenhead, the leader in making this argument, claims that "learning Western science for most Aboriginal students is a cross-cultural event" (2001, p. 340) as students move from their, "everyday cultures associated with home to the culture of Western science" (p. 340). It is the job of teachers, argues Aikenhead, to enable students to be exposed to and understand the world of Western science while at the same time retaining space and respect for their Indigenous worldviews; in this way teachers can serve as cultural brokers for Indigenous students (Aikenhead, 2006).

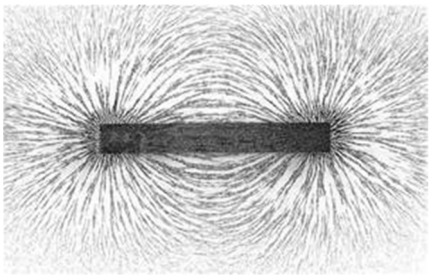
We are troubled by this pedagogical advice for several reasons. First, as we point out earlier, some Indigenous students may come from homes where their everyday culture is essentially the same as the dominate culture, so for these students there really is

not any borders, at least in terms of science education, to cross. But a deeper concern is also evident in the call for teachers to be brokers of such border crossing. Essentially, border crossing is a pedagogy that does not challenge or critique the crossing itself, which in turn makes this 'uncritical brokering' a form of colonialization. It is as if teachers are saying, "Here's science, let me show you how to understand science *because you are Indigenous*." We acknowledge that those advocating for border crossing respect and admire Indigenous cultures and have the best interests of Indigenous students at heart, i.e., helping these students be successful in their negotiation of the dominate culture, but essentially border crossing is a pedagogy of accommodation to the Western world that leaves unchallenged the culture of science.

We advocate instead for *cultural encounters* and that these encounters with Indigenous perspectives is important *regardless whether there are Indigenous students in the science classroom or not.* To explain our idea, we offer the following exercise:

Activity 3: What is True? The Question of the Northern Lights.

Cover a standard bar magnet with a large sheet of paper—make sure the magnet under the centre of the paper. Now sprinkle some iron filings over the paper. If you don't have access to iron filings, small paper clips will do. The result should look something like the picture below:



The Earth, according to Modern Science, is also a giant magnet and has similar magnetic fields, which is why a compass works to point out the north and south poles (although the magnetic poles are about 20 degrees away from the geographic poles). Now, according to science, when particles from the Sun collide with the Earth's atmosphere, these particles are attracted to the north and south magnetic poles of our planet, and the interaction of these particles with the atmosphere in those locations causes the Northern Lights (aurora borealis) and the Southern Lights (aurora australis). However, the Indigenous Nations in Northern Canada, for example, teach a completely different interpretation of this phenomenon. Many Nations teach that the lights are the appearance of departed ancestors, sometimes dancing, sometimes playing a ball game in the sky.

The question to consider as a science teacher: Which interpretation is true? On one hand, the explanation by Western science can be tested and examined, so it can be found to be true within the parameters of experimentation set out by science. But is the Indigenous explanation false? Is there any way to determine if this explanation is true or false? If not, then the lights we see could be *simply* the interactions of particles in the sky or, and this is where we reach the limits of scientific inquiry, these lights *could also* be ancestors dancing—Western science is limited in this way in that it is void of interplay with the spiritual world, which is equally and real and valued by Indigenous peoples as part of the natural world.

Encountering traditional Indigenous views of the Northern lights reveals the limits of science to particular interpretations that can be tested. The belief that *only* views that can be tested through science can establish what is true or not is called, "scientism." In effect, but likely not the intention, school science promotes scientism by excluding any other interpretations of phenomenon. This is an issue precisely because there are questions beyond the limits of scientific examination, such as questions concerning the existence of a Creator. These questions are larger than science, or "metaphysical" in nature. So, one benefit of introducing students to alternate views of phenomenon is to teach students that Western science is helpful, of course, but also limited; to introduce to students that Western scientific approaches is not the only way to understand the world we share.

There is much to be learned by other cultural ways of approaching nature. As Michael Michie notes, "Indigenous science reminds me that there are other ways of looking at the world and that knowledge is valued in different ways. Indigenous science gives me another perspective in the world" (2002, p. 36-37). For example, dreamcatchers are made by some Indigenous nations in North America and the idea of a dreamcatcher has spread beyond Indigenous cultures as well. One form of making a dreamcatcher involves using shoots of a red willow tree. However, before cutting branches to make the dreamcatcher, the person must offer thanks to the tree for the sacrifice of the branch and leave a gift (in prairie cultures this is often tobacco). This practice is in response to the belief that the tree has a spirit that requires respect and therefore acts of gratitude. Indigenous peoples relationship with nature was an understanding to never take too much from one place or one plant, so as to ensure sustainability and not to overly disrupt the interactive and synergous relationships within every ecosystem.

There is no possible way to carry out an experiment on whether the tree is animated by a spirit or not, but consider: What would our modern world be like if each time humans came to use a tree, or mineral, we gave thanks for its life, or considered how our use may disrupt the ecosystem in which it lives? Is there not, embedded in this ancient practice, a lesson of value on how to live with care and thoughtfulness on Earth? Bringing Indigenous views into science education also brings alternates to exploitation of natural resources and a form of environmentalism that could assist to avoid some of the catastrophic disasters that at present seem inevitably ahead. We further advocate that science education would better serve humanity if respect for nature and being part of nature were a fundamental part of all science curricula.

Finally, encounters with different cultural perspectives can serve to bring students to a more authentic and holistic view of science. The origins of Western science lie in openness to questions, a sense that there lies behind every explanation more to learn. One of the most important philosophers of science of the 20th century, Carl Popper, argues that science never arrives at a true explanation of how nature works, but works to develop more and more useful and accurate explanations (Popper, 1963). He argues against premature closure of any explanation and, indeed, the history of science proves that one explanation of how nature works, such as classical Newtonian mechanics, is actually not accurate when investigating the nature of matter at the sub-atomic level. Being open to questioning and understanding lies at the heart of science. Indigenous perspectives can compliment Western science and assist with forming new questions to explore or in some cases reinforce discoveries in science with human experience. Instead of delegating

Indigenous views as "mythological" or "superstitious" scientists and science educators could respectfully honour this wisdom shared by a "[p]eople that have a long tenure within a particular region [who] have gained much knowledge about the ecology of place" (Price, 2011, p. 11). Actually *authentically including* Indigenous perspectives in science education opens up explanations of nature and thus reveals new possibilities for inquiry. This is not "border crossing" or accommodation of Indigenous learners to the said of science but widening the circle of human understanding of nature by *including* Indigenous views.

4. Learning to incorporate Indigenous worldviews in Science Education

Increasingly teachers are being asked to include Indigenous knowledge in their science curriculum. How might teachers, the majority without an Indigenous inheritance, authentically bring Indigenous views into their science classrooms? In this section, we offer some practical advice for those who wish to expand the concept of science with their students.

A. Indigenous knowledge is place-based

While some Indigenous scientific knowledge transcends place (such as the discovery of the foundation for the drug Aspirin from the root of a tree having a numbing effect), much knowledge is place-based. Realizing and acknowledging that the inclusion of knowledge teachers may be seeking, lives on the land and is connected to the territories in which they live, may prompt a (re)discovery of that place. As simple as beginning to understand which plant and animals species are native to that place and which were introduced is a good start.

B. Indigenous knowledge is held in community

There are some Indigenous scientist and authors who publish their knowledge about Indigenous science. Gregory Cajete, a Tewa scholar, and Michael Wassegijig Price are excellent examples of this practice, having found ways to share the knowledge of their people appropriately and authentically. However, the majority of Indigenous 'scientific' knowledge and worldviews 'lives' in community and on the land. These knowledges are specific to the places they are from and are generally held by the eldest generations of a community. Growing relationships with the local people, becoming a trusted ally worthy of having access to this knowledge, and further still involving these respected Elders and knowledge keepers join your school community and your classroom is a privilege to be earned but well worth the effort.

C. Build trust

Genuine relationships built on time spent, respectful presence and trust are key. In order to gain access to local, place-based knowledge teachers will need to build authentic

relationships with the local people of the territory. Getting to know who the knowledge keepers are and how to respectfully and appropriate request help (see next section) and build up one's own knowledge is foundational to meaningful inclusion of Indigenous worldviews in science education.

D. Learn local protocols

Be sure to observe local protocols as they are being conducted and also respectfully inquire as to how you can come to know the Elders and knowledge keepers in a community and be so fortunate as to learn from them and perhaps even have them share their knowledge in your school or classroom. Humility and patience is key here. One must understand that Indigenous people's cultures are fundamentally different at the core and even ways of asking for and gaining access to knowledge are worlds different from Western ways of knowing and being. For instance, some Indigenous cultures believe certain plant knowledge can only be passed on through ceremony with those who are well-suited and prepared to receive it to avoid exploitation and possible harm.

Sammel (2005) explains,

> It is also essential to learn how to incorporate Elders and their knowledge into the educational system. Their experiences and knowledge are based on an oral tradition. Although the knowledge of some Elders has been included in books, Elder knowledge cannot be solely found in books. The Elders are the keepers of knowledge. It is their job to protect that knowledge and relay that knowledge in appropriate situations. It is knowledge to be shared, if and when it is appropriate. But one must ask to be taught in ways that are respectful and appropriate to the traditions from which that Elder comes" (p. 6).

Summary

1. Avoid calling on Indigenous learners as sole representatives of their culture.
2. Bracket the "said"; what you think you know about Indigenous peoples, to make space for what you might be able to learn.
3. In order to more effectively engage learners past Grade 4, aim for a more interactive, hands-on, inquiry-based, place-based approach to teaching students science.
4. Rather than a deficit model of teaching Indigenous learners, remember that Indigenous learners and their family/community members may have vast place-based knowledge and alternative ways of seeing the world; this contribution increases the science literacy of all students.
5. Teaching Indigenous learners is more than border crossing; genuine contributions from both Indigenous and Western scientific worldviews provide greater understandings of the world.

Recommended Resources

A. Books

Bridging cultures: Indigenous and scientific ways of knowing nature (2011) by Glen Aikenhead & Herman Michell; Don Mills, Ontario, Canada: Pearson Education; ISBN-13: 9780132105576

Integrating Aboriginal perspectives into the curriculum: A Resource for curriculum developers, teachers and administrators (2003). Manitoba Education and Youth; ISBN: 0771124716.

Keepers of the Earth: Native American Stories and Environmental Activities for Children (1997) by Michael J. Caduto and Joseph Bruchac; Fulcrum Publishing; ISBN-10: 1555910270.

Keepers of the Night: Native Stories and Nocturnal Activities for Children (1994) by Michael Caduto and Joseph Bruchac; Fifth House Books; ISBN-10: 1895618398.

Lighting the seventh fire (1994) by David Peat; Carol Publishing; ISBN-10: 1559722495.

The Arctic Sky: Inuit Astronomy, Star Lore, and Legend (1998) by John Macdonald; Royal Ontario Museum/Nunavut Research Institute; ISBN-10: 0888544278.

The New Patterns in the Sky: Myths and Legends of the Stars (1988) by Julius D. W. Staal; McDonald and Woodward Publishing Company; ISBN-10: 0939923041.

They Dance in the Sky: Native American Star Myths (2007) by Ray A. Williamson and Jean Guard Monroe; HMH Books for Young Readers; ISBN-10: 0618809120.

B. Journal articles; see references as well as the following:

Blades, D. (1997). Towards a postmodern science education curriculum-discourse: Repetition of a dream catcher. *Journal of Educational Thought, 31(1),* 31-44.

Brandt, C. B. and Kosko, K. (2009). The power of the earth is a circle. In W.M. Roth and K. Tobin (Eds.), *The world of science education: Handbook of Research in North America* (pp. 389-407). Amsterdam: Sense.

Chinn, P. (2008). Connecting traditional ecological knowledge and Western science. In A.J. Rodriguez (Ed.), *The multiple faces of agency: Innovative strategies for effecting change in urban school contexts* (pp. 1-27). Amsterdam: Sense.

Oberg, A., Blades, D. & Thom, J. S. (2007). Untying a dreamcatcher: Coming to understand possibilities for teaching students of Aboriginal inheritance. *Educational Studies 42*(2), 111-139.

Snively, G. and Corsiglia, J. (2001). Discovering Indigenous science: Implications for science education. *Science Education, 84,* 6-34.

C. Websites

Aboriginal Curriculum Integration Project: Science Lessons Index
http://abed.sd79.bc.ca/acip/indexfiles/science_lessons_index.html
Aboriginal Nations Education Division – Resources (Science)
https://aned.sd61.bc.ca/resources.aspx
Living Knowledge: Indigenous Knowledge in Science Education
http://livingknowledge.anu.edu.au/html/educators/
The Windspeaker Classroom
http://www.ammsa.com/content/classroom-edition
15 Strategies for Teachers of Aboriginal Students
http://www.ictinc.ca/blog/15-strategies-for-teachers-of-aboriginal-students

References

Agrawal, A. (2004). Indigenous and scientific knowledge: Some critical comments. *IK Monitor, 3(3),* 1-9.

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

Aikenhead, G. (2006). *Science education for everyday life.* New York: Althouse.

Battiste, M. & Barman, J. (1995). *First Nations education in Canada: The circle unfolds.* Vancouver, Canada: UBC Press.

Berkowitz, P. (2001). Western science meets Mi'kmaq knowledge. *University Affairs* (University of Victoria), 16-20.

Cajete, G. A. (1999). *Igniting the spark: An Indigenous science education model.* Asheville, North Carolina: Kivaki Press.

Chalmers, A. F. (1982). *What is this thing called science?* Queensland, Australia: University of Queensland Press.

Cheung, M. (2008). The reductionist-holistic worldview dilemma. *MAI Journal: A New Zealand Journal of Indigenous Scholarship, 3(5),* 1-7.

Ermine, W. (1995). Aboriginal epistemology. In M. Battiste and J. Barman (Eds.), *First Nations education in Canada: The circle unfolds* (pp. 101-112). Vancouver: UBC Press.

Henderson, M. (1996). A Mohawk vision of education. *Green Teacher, 49,* 15-18.

Johnson, P. (1991). *The birth of the Modern.* New York: Harper-Collins.

Krocker, N. (2004). *Discussions on science curriculum: Stories told from northern places.* Unpublished Masters Thesis, Department of Curriculum and Instruction, University of Victoria, Victoria, Canada.

Levinas, E. (1998). *Otherwise than being* (A. Lingis, Trans.). Pittsburgh, Pennsylvania: Duquesne University Press.

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

Medin, D. L. & Bang, M. (2014). *Who's asking?: Native science, western science, and science education*. Cambridge, Massachusetts: MIT Press.

Michie, M. (2002). Why Indigenous science should be included in the school science curriculum. *Australian Science Teachers' Journal, 48(2),* 36-40.
Perkasa, V. (2015). *The world conference on Indigenous Peoples: A view from Indonesia*. Council of Councils. Retrieved from http://www.cfr.org/councilofcouncils/global_memos/p33476
Popper, K. (1963). *Conjectures and Refutations: The Growth of Scientific Knowledge*, London: Routledge.
Prince, M.W. (2011). Indigenous taxonomy: Ethnobotany and sacred names. In P. Boyer (Ed.), *Ancient wisdom, modern science: The integration of Native knowledge in math and science at tribally controlled colleges and universities* (pp. 1-13). Pablo, Montana: Salish Kootenai College Press.
Regier, J. (2015). *Integrating First Nations and Metis Content and Perspective: Grade 4 Earth and Space Sciences; Rocks, Minerals, and Erosion*. Duck Lake, Saskatchewan, Canada: Prairie School Division No. 246.
Rutter, N. W. (2013). Glaciation. In *The Canadian Encyclopedia* (Anthony Wilson-Smith, Pub.). Retrieved from http://www.thecanadianencyclopedia.ca/en/article/glaciation/
Sammel, A. (2005). *Aboriginal perspectives into the teaching and learning of science education: Beginning the conversations in Southern Saskatchewan.* Regina, Saskatchewan, Canada: SIDRU Publications.

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David Blades is Professor of Science Education and Curriculum Theory in the Faculty of Education at the University of Victoria. His scholarship examines the theory and philosophy of science education, including a recent exploration of aesthetics in science education. David was born in Victoria and in his spare time, which is never enough, loves to explore the islands of the Salish Sea.

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