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Metaphorical Images of Science: The Perceptions and Experiences of Indigenous Students who are Successful in Senior Secondary Science

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I am a mixed ancestry Coast Salish woman and member of the Stz'uminus First Nation. My father, Keith Tenning, was of mostly European descent and also a small part Japanese. My mother, Elizabeth Tenning (nee Peall), is full First Nation. Though I grew up in Victoria, British Columbia (BC), I always had a connection to the First Nation's part of my identity through my mother, and through my family who live on the reserve in my home community. Visits to Kulleet Bay on Stz'uminus territory have always been a regular part of my life. I learned about our culture through my mother who was initiated into the winter longhouse society when I was four years old. My mother was also one of the best knitters of Cowichan sweaters on Vancouver Island. The beautiful hand-knit sweaters most often depict traditional designs such as the eagle, whale, deer, salmon, and bear. The sweaters have become iconic of Canadian culture, prized by both Indigenous and non-Indigenous people nationally and internationally. One of my favourite childhood memories was lying on the floor and watching my mom as she spun piles of gray, black, and white sheep's wool through her spinner. Though we lived in the city, we were still part of a First Nation's community as we were raised in M'Akola housing—urban townhomes for Indigenous families.

I always enjoyed going to school as a child, and my passion for learning grew once I entered high school and was able to study subjects that I found to be very interesting, including biology. I enjoyed biology so much that I continued to study biology throughout my undergraduate degree at university. When I became a secondary science teacher, I learned that the participation of Indigenous students in several of the senior secondary science courses was minimal compared to that of non-Indigenous students. Though there is research that looks at reasons why Indigenous students are under-represented in the sciences (Canadian Council on Learning, 2007); Provincial Required Examination, 2010/11, as reported in Yore et al., 2014), there is a scarcity of research that looks at the small population of successful Indigenous students who are participating and achieving in Grades 11 and 12 science courses. I wondered if there was something that could be learned from these successful students that would help to improve the participation of Indigenous students in science-related courses. It was the goal of this research study, conducted in 2007, to explore answers to this question.

Rationale

For the purpose of this study, the word "success" referred to the participation and high academic achievement of 67% or higher by Indigenous students in senior secondary (Grade 11 or 12) science courses (biology, chemistry, or physics). The 67% achievement score was selected because when the data for this study was collected, this was the minimum grade point average required by secondary students for admission to most post-secondary institutions in British Columbia. According to this criteria, many Indigenous students are not 'successful' in secondary science courses. In addition, low participation by Indigenous students in secondary science has serious implications for the number of Indigenous students who go on to enroll in science-related programs at the post-secondary level. This in turn has an impact on the number of Indigenous people who go into science and health-related careers.

The Canadian Council on Learning (2007) examined information from the 2001 Census of Canada data and found that Indigenous people were significantly underrepresented in both scientific fields of study and science-based occupations. As well, the BC Provincial Required Examinations (2010/11, as reported in Yore et al., 2014), describe the low participation and the low performance rate of Indigenous students in the sciences compared with non-Indigenous students, and why transforming the science curriculum is necessary for Indigenous students. This under-representation has even larger negative repercussions for Indigenous people at the community level. Indigenous people are striving not only to reassert authority in the areas of economic development and healthcare, but also to settle treaties and attain recognition of Indigenous rights, all of which require community expertise in science and technology (Aikenhead, 2006; Aikenhead & Michell, 2011; MacIvor, 1995; Mullens, 2001; Snively & Williams, 2016). (For a more descriptive discussion of the low participation rate of Indigenous students in the sciences compared with non-Indigenous students in the sciences, see chapter 2, *Knowing Home: Braiding Indigenous Science with Western Science, Book 1,* (2016).

My study was designed to investigate and describe the following:

- The experiences and perceptions of Indigenous students with regard to senior secondary science courses.
- The role that culture plays for Indigenous students who are successful in senior secondary science courses.
- The factors that either contribute to or hinder success by Indigenous students in science-related courses.

Study Site

The research study site was Victoria, British Columbia, located at the southernmost tip of Vancouver Island, on the traditional territories of the Coast and Straits Salish people. There are three major First Nations groups on Vancouver Island, including the Coast Salish, the Nuu-chah-nulth, and the Kwakwa̱ka̱'wakw. Each First Nation is made up of separate communities. The First Nations that are local to the Victoria area include the Lekwungen people—the Songhees and the Esquimalt. As the capital of BC and as the second largest city in the province, Victoria is a large urban setting that brings together Indigenous people from all across Canada. The diverse population in Victoria includes First Nations, Inuit, and Métis peoples who come from a wide range of ancestral lands both near and far. With the exception of the local First Nations, the majority of Indigenous people in Victoria are living away from their home nations. The diversity of the Indigenous population in Victoria is reflected in the Indigenous student populations in the various public schools.

Participants and Methodology

The participants of this case study consisted of 10 self-identified Indigenous students from the Greater Victoria School District who were taking, or had taken, at least one senior-level (Grade 11 or 12) science course (biology, chemistry or physics) and were achieving, or did achieve 67% or higher in a science course. The participant group consisted of four males and six females. The ten participants were attending, or had attended a total of five different high schools within the Greater Victoria School District. Two of the participants were recent high school graduates.

This research was conducted using a range of qualitative research techniques, including a metaphor interview, a literal interview, and a focus group interview (Tenning, 2010). The data was collected between March and June 2007.

The Metaphor Interview

The metaphor interview was the foundational research technique that I used to learn about the participants' perceptions about and experiences in senior-secondary science courses. The metaphor interview allowed me to get closer to the intuitive core of the participants' understanding of science. Beck (1978) explains:

> Metaphors mediate between our abstract and more concrete thoughts. A metaphor points to the existence of a given set of abstract relationships hidden within some immediately graspable image. By doing so, it helps to ground our conceptual structures in the reality of concrete experience. (p. 84)

Techniques for metaphoric interviewing and analysis were adapted from the work of Snively (1986, 1987, 1990). Snively developed a unique set of metaphor questions and literal interviews to analyze grade 6 students' orientations (beliefs and values) towards the coastal shoreline. For this study, the metaphor questions needed to be appropriate to the different language skills, experience, cognitive abilities of young adults, and the varied social and cultural background of the participants. By using this technique, Snively (1987) found:

> In addition to probing for beliefs, the metaphor interviews probed what the students think is desirable and how they felt. The metaphor interview did more than probe for single beliefs and/or single values or single emotions. By asking the students to project responses onto metaphors in an imaginative way, the students were less likely to be consciously aware of the beliefs and values that they were communicating. The metaphor interviews allowed the study of how, in most situations, a complex cluster of beliefs, values and feelings influenced the students' response. (p. 443)

See chapter 4 for a more complete description of the metaphor interview and how metaphors mediate between our abstract thoughts and more concrete experiences.

In my study, the metaphor interview began with the most open-ended questions, so as to not influence the participants by any of the questions that followed (in which options were often provided). For example, participants were asked the question: "If science was an animal, what animal would it be and why?" Snively (1986) points out that "why" is an essential component of the metaphoric interview technique as the participants' reasoning for their choice provides the most insightful data.

Next, participants were asked "If science were one of more of the following, what would it be and why?" Three sets of possible answers were provided, with each set consisting of five options. For example, the options in set 1 included "a car," "a totem pole," "a circle," "a tree," and "a drum."

The next set of questions explored the participants' relationship or role in science. Participants were asked to complete the statement, "I am to science as …" and there were four sets of possible answers, with each set consisting of three options. The options for the first set were, "a driver is to a car," "a mechanic is to a car," and "a passenger is to a car." Then the participant was asked to identify his or her relationship in the chosen metaphor and to elaborate by answering the "why?" question. For instance, if they selected "car": are they "the driver to the car," the "mechanic to the car," or the "passenger to the car?" The participant was then asked to elaborate on why they believed this metaphor expressed their relationship to science.

The next question was, "Which one of the following images best describes how science is taught in school and why?" There were again three sets of possible answers, with each set having 5 options. The options for the first set were "a car," "a boat," "a garden," "a forest," and "a factory."

Lastly, participants were asked, "If the way that science is taught could be changed, which one of the following metaphors best describes the way that you would like to see it taught and why?" Participants were provided with all 15 metaphor options used in the previous questions to choose from. In addition to the options for the first set (presented in the paragraph above) were the options for the second set ("a prison," "a longhouse," "a computer," "a carving," and "a tree") and third set ("a painting," "a medicine wheel," "a church," "a calculator," and "a sport"). All of the metaphor questions yielded very insightful responses from the participants, though the responses to the last metaphor question provided some of the richest answers in the study. (See Appendix A for the complete set of metaphor questions).

The Literal Interview

The literal interview served to validate the findings in the metaphor interview and also to provide additional background information about the participants with regard to their actual experiences in science courses. The information from the literal interviews was used to help write a profile summary for each participant. Participants were asked questions regarding their interests, goals, and their Indigenous ancestry. They were also asked to share some of their experiences as Indigenous students, and as Indigenous science students. Some of the experiences, or stories, that the participants were asked to share in this study included recounting their earliest memories of studying science, times when they felt successful in science, and times when they didn't feel successful in science.

The use of the literal interview allowed for a more concrete exploration of abstract ideas discussed in the metaphor interview. It also allowed me to address important topics that were not part of the metaphor interview, such as the participants' thoughts about specific aspects of Indigenous Science and Western Science. I also sequenced the literal interview after the metaphor interview because I did not want to influence any of the participant's metaphor responses by any ideas raised in the literal interview questions. The literal interview questions were more direct and specific than the metaphor interview questions, so having the metaphor interview first also served as an "icebreaker" of sorts and allowed for greater rapport and comfort to be established between the participants and myself. (See chapters 4 and 5 for a description of how Snively developed the metaphor interview, and how literal interviews can be used to validate the findings in metaphor interviews).

The Focus Group

At the end of the study, the participants were invited to come together to participate in a focus group discussion. The purpose of using this research method was to reaffirm and validate the participants' perspectives shared during the individual interviews by re-asking many of the same overall questions in the focus group as were asked in the individual interviews.

Due to the busy schedules only half of the participants were able to attend the focus group, but the findings showed a high level of consistency between what the participants said in the focus group compared to what each of them said in their individual interviews. This consistency demonstrated that the participants held strong to their perceptions, and that they did not alter their perceptions even in the group setting. The focus group also allowed me to share preliminary findings with the participants to ensure that I was on the right track with my analysis, and that I could go forward with writing my results. I wanted to confirm that I was representing the participants in an accurate way, and the focus group provided the opportunity for this dialogue to happen.

The Process of Analysis

In analyzing the data and writing up the report, I gave each participant a pseudonym to protect their identity. I wrote a profile of each participant highlighting themes, patterns, and significant content from the individual interviews. The next step was to look for themes across all ten interviews as a whole. To group the themes holistically, I used a mind-map process which showed how all of the themes were essentially connected to the central premise of this study, namely the experiences and perceptions of Indigenous students who were successful in their science courses. Three overriding themes emerged from the data as a whole: the perceptions of participants, secondary science experiences, and participant recommendations. Each of these three areas then became the basis of the next set of mind-maps. Associated sub-themes were placed around each of the central themes. I then read the transcripts and added pertinent references next to each sub-theme in the form of codes. The process of analysis was not about breaking apart the data, but grouping data into themes that emerged from across the interviews. What emerged was an intricately detailed picture of ten incredible Indigenous science students, rich in insights and perspectives about secondary science.

Students' Perceptions about Science

The majority of the participants expressed various criticisms about science. The participant who was the most critical of science was Fiona, who perceived science as something man-made, inconsistent, and constantly changing. When asked to define "science," Fiona said, "Science is a method of understanding and postulating the world. It is a social construction and its theories are not proven." During the metaphor interview Fiona said that science is like: 1) "a circle" because "it is continuously being revised and changed and drawing different conclusions, but it doesn't really end," and 2) "a car" because "it is made by man and it's not natural." Later in the literal interview, Fiona explained:

> Science is taught in an absolute way like there are no other approaches.... We only learn Western Science, of a European sense, like what old European guys thought.

She also viewed science as being very oppositional to an Indigenous worldview and saw science as having a negative impact on Indigenous people's efforts to gain recognition of Indigenous rights and title.

Several participants expressed that the content of science courses seemed driven by the prescribed curriculum and/or provincial exams. Elaine stated that science was taught like "a church" because "you don't have the freedom of learning what you want. They, like the school board, decide the curriculum and you have to follow it and it's kind of religious that way … it's whatever everyone is being taught. It's all the same." Similarly, Howard said that science is taught like "a factory" because "everyone learns the same thing and we're all taught the same, so we end up with the same [knowledge] base coming out of it." Maya explained that, "a lot of the teachers, especially in Grade 12 … really seem to go by the curriculum and the provincial exams. It all seems like one big lead up to the provincial exams." Tara's explained why she thought that science is taught like "a car" and what "a forest" represented:

> A car 'cause they [science teachers] speed right through and they teach you a whole bunch of stuff … and they try to get it done in six months or whatever, and it seems like a lot of information in that time period. A forest because it's so big and there's so much information that you have to learn about and you just cram it all in and sometimes it's hard to remember it.

When asked to generate her own metaphor for how science is taught, Tara said that it is taught like "a race," and explained, "to see who finishes and who does the best, but then only a few remember how to do it and they will try to race to the end and finish." Tara made an insightful observation in saying that the pace of science classes can be too fast for some students, resulting in some students not making it to the end of the course. In the literal interview, Tara also observed that there are many lab activities included in the textbooks, but she said that these were often skipped over in class due to a lack of time. The criticisms that the participants had about how science is taught, such as being repetitive, boring, unimaginative, too fast, heavy on notes and memorization all seem to be rooted in the larger issue of the vast and seemingly overwhelming curriculum that teachers are expected to teach in a limited amount of time.

One striking similarity amongst the participants is that nine out of ten described having a predominantly passive role in their science education experiences. This trend was revealed in the metaphor interview questions that explored each participant's relationship with science. This passive relationship with science fell into two categories: (1) lack of involvement within science classes, or (2) lack of self-direction in science education. An example of the first category is from Tim, who said, "I've kind of been like an audience of science. I haven't done much in science. I haven't really taken control of science or made science." An example of the second category is from Wendy, who stated, "I feel like I don't really get to figure things out for myself. I'm kind of told them and then tested on them rather that figuring it out myself or directing my studies."

Despite their criticisms all the participants were able to identify aspects about science education that they liked. The majority of participants enjoyed hands-on learning opportunities through lab-work, dissections, or field trips. All of the participants identified specific science knowledge that was interesting and/or relevant to them. All but one of the participants recounted a vivid memory of learning science as a child, and the memories that they described were all hands-on or creative experiences in science. Many of the participants felt a sense of pride or accomplishment from doing well in science. For example, Tara explained:

> I like how there's so many experiments you can do and it's challenging, but in the end, you feel like you gave your best and you feel happy that you found the answer to what you were doing. It gives you a sense of pride or something.

This sense of pride from taking and completing secondary science was a common theme in Tara's metaphor and literal interviews.

Regarding future connections to science, five of the participants said that science would not be a part of their post-secondary or career futures, even though three of these same participants had once considered science-related careers when they were younger. Interestingly, these same three participants had all decided to pursue Indigenous post-secondary areas of study instead of science. For example, when Fiona started university, she had planned to study biochemistry and microbiology, and eventually go into medicine. When I asked her why she changed her mind, she spoke about the impact that taking an Indigenous-issues course at university had on her:

> I decided in my first year that I just wanted to take other things 'cause I hadn't experienced all of these classes—you don't get them in high school. I found out about these other things that really bothered me and I felt I needed to know about [them] and maybe somehow change, or bring it to other people's attention and I kind of just forgot about the whole science thing. This is more important—like, what can I do if I get a degree in microbiology for my community or for people, other than the people in my waiting room?

Two of the participants said that science might be in their futures, and only three said that science would be a part of their professional futures. Of these three participants, one planned to go into sports medicine, one wanted to become a biochemist or a physicist, and another was interested in becoming a wildlife photographer. It is interesting to note that even though all of the participants achieved high academic success in senior-secondary science, a significant majority did not plan to continue studying science at the post-secondary level or to pursue science-related careers. These results are similar to findings from a research report commissioned by the Canadian Council of Learning entitled *Who Likes Science and Why?* in which surveys were completed by approximately 23,200 thirteen to sixteen-year old students in Canada:

> It is certainly discouraging to find that, although over 85% of students in this study agree that science is useful for society, too many remain disengaged from the process of science learning; in fact, less than 40% expect to use science in their careers … [This study] builds on previous research which indicates participation and success in mathematics and science … involves not only skills and knowledge, but is largely determined by positive attitudes towards these disciplines during school years. (Adamuti-Trache, 2006, Abstract section)

It is crucial to make secondary science more engaging and interesting for Indigenous students if we hope to inspire more of them to continue in science-related studies or careers.

Participant Feedback

Improving Science Education

For the most part, this participant group had a positive and holistic understanding of what constitutes "science." This observation is based on the metaphors that the participants chose to describe science (e.g., as an animal and as an object), their responses to metaphor choices, and their individual definitions of "science." Some of the most useful outcomes of this study were the recommendations the participants made on how they believed science education could be improved. These suggestions came from both the metaphor and literal interviews, though the responses from the metaphor interviews were particularly insightful in describing the changes that the participants would like to see. Wendy said that she would like to see science taught more like "a sport":

> A sport is so much more engaging and actively involved, so not just like sitting in class, like copying the page we are reading out of the textbook and copying down notes. That doesn't really involve students and get them interested.

Tim selected "a painting," and explained: "It's creative. It seems like a lot of science classes are just learning and remembering [but] painting takes a lot of creativity and it would be more fun to learn." Howard explained why he would like to see science taught more like "a boat": to "let us explore what *we* choose to explore and go as deep as we choose" and "you can choose your path and explore the ocean, lake, or whatever."

Fiona and Tara said that they would like to see other cultural perspectives included in the way science is taught. Fiona said that she would like to see science taught more like "a garden" because this would "teach [students] that science isn't the only option" and also like "a medicine wheel" because this would "take in components more of a circle—it has different components, but they are all kind of equal, so you don't really give more weight to one of them."

All of the participant's recommendations on how to improve science education show an inverse relationship with the aspects of science that they dislike—namely that science education can be rote, restrictive, and compulsory, whereas the participants would like to see it taught in a much more interactive, creative, inclusive and learner-centred way. If school science does not engage or interest students, then they are less likely to invest in science beyond their high school years.

The Role of Culture

For some of the students, the lack of Indigenous Science in their science curriculum did not hinder their success in school science. All of the participants were living in Victoria, off-reserve, and away from their cultural communities. Indigenous ancestry for the majority of the participants came from areas outside of BC. Most of the participants had mixed Indigenous and non-Indigenous ancestry and most described having a limited level of cultural connection. The participants largely represented urban Indigenous students who had spent limited time in their home communities. Only a few of the participants described being culturally connected through the study of Indigenous courses or programs in school, and only one participant described returning to his Indigenous community regularly to participate in cultural activities. Living off-reserve and away from Indigenous ancestral communities is common to many Indigenous students in the Greater Victoria School District and this participant group is representative of the Indigenous cultural diversity that exists in the large, urban setting of Victoria. During the time these students were in school, there was no room in the prescribed science curriculum for Indigenous Science knowledge.

The participants described their overall experience in school and in their science classes as being mostly the same as that of non-Indigenous students. A few participants described particular racist or discriminatory incidents at school. One participant said that she would have looked just like any other student in her science classes from an outsider's perspective, but she was very aware from an internal perspective that she was usually the only Indigenous student in her science classes.

Importantly, when I asked the participants during their individual literal interviews if Indigenous people have "science," all ten replied "yes." When I asked if IK or IS had ever been included in their science courses, all ten participants said "no." Next, I asked if IK and IS should be included in science, and all but one participant said "yes" (Russell was the only participant to answer "maybe"). The participants were able to provide several examples of IK and reasons why they believed that this knowledge should be included in science courses. Even though the participants overall had limited cultural connections, they still had an affinity towards learning about IK. In fact, it was shown in three (Fiona, Abby, and Tara) of the participants' responses that being introduced to IK through their studies at the secondary or post-secondary level shifted their personal goals and their worldviews away from their previous goals of studying Western-based science at the post-secondary level to studying fields focused in IK.

Several participants gave traditional medicine and environmental awareness as examples of IK. Wendy suggested that this knowledge could help to protect the environment:

> Especially with the medicine and stuff, just using the natural environment to actually help them … especially nowadays, people definitely abuse the resources we have. The [Indigenous people] have more ability to be, like one with nature, as opposed to just stripping nature of everything and so … just as far as their views were, they respected and utilized their environment in a more productive way.

A few of the participants also said that the inclusion of IK in science education would give all students a wider perspective about science. Perhaps the most profound reason some participants gave as to why IK should be included in science is the benefit that would be derived by Indigenous students. Tara stated that including IK in science, "would be a good way to learn things, especially for Indigenous students—they'd get more into it, instead of thinking, 'oh, this is boring' and they'd maybe want to explore more sciences if they were learning about their own people." Fiona explained that Western Science is "contradictory to what you're taught at home, so it's just reinforcing that 'living in two worlds' kind of thing." These responses show that several of the participants were aware that the inclusion of IK will not only generate a stronger connection by Indigenous students to science by reflecting their culture, but could also foster a greater sense of interest in the sciences, which could lead to more Indigenous students pursuing the sciences.

Factors that Contribute to or Hinder Success

The participants of this study represent a highly successful group of Indigenous students. Each of them was in the final stages of completing high school, or had already graduated and moved onto post-secondary studies. In reviewing their experiences in school, a few commonalities stood out. Firstly, all ten participants had a connection to high school outside of their regular classroom studies, meaning that each of them was involved with clubs, teams, or other extracurricular activities. A report by the Canadian Council on Learning (2009) states:

> Research shows that participation in recreational and cultural activities is linked to increased expectations for young people about their future education.... Young people who participate more frequently in recreational and cultural activities tend to complete college or university programs more often than those who participate less or never participate. (p. 38)

Participation in extracurricular activities represents a genuine investment by students in their education and pursuit of self-interests.

Second, all of the participants had his or her own understanding of what it meant to be successful and could identify factors that had contributed to their success in school. The majority of participants said that internal motivation was an important factor in achieving school success, and several also stated the positive influence of role models or feeling a desire to please family. These students did well in school because they were motivated and because they had supportive families who were interested in how they were doing in school. "Research shows that the quality of family relationships can significantly affect a child's development and educational outcomes, largely because parenting styles and practices bear a strong influence on a child's attitudes and efforts in school" (Canadian Council on Learning, 2009, p. 19). Also, the participants identified coping strategies that they could use when school became difficult.

Third, all of the participants had long-term goals. Even if they were not exactly sure what they were going to study at post-secondary or what career path they would take, all of the participants expressed ideas about what they were going to do after high school. Having a vision of their futures seemed to be an important contributing factor towards school success. The post-secondary or career goals for the majority of the participants were inspired by experiences or courses taken at the secondary level.

All of the participants achieved academic success in senior secondary science courses, but when asked what made them "successful" science students, they gave a range of different indicators of personal success in science. The majority of participants felt successful in science because of their work ethic towards science, including the extra effort that they made to do well, practicing good study or work habits, or being able to help other students. Good grades, test marks, and report cards were also important, but not as important as the personal feeling of accomplishment that was associated with these results. Half of the participants said that they felt successful in science because of the knowledge that they had gained from taking the courses. A few of the participants also said that they had a natural ability to do well in science, likely connected to their overall interest in or affinity for the sciences. Adamuti-Trache (2006) states: "interests, values, beliefs, attitudes, and self-confidence are individual attributes that support achievement and success in any practice, be it science, sports, or writing" (p. 15).

The results of this study raise many questions that could be addressed through further study and research. All of the participants were living in the large urban setting of Victoria, and the majority had spent minimal if any time in their home communities. The participants described having an overall limited level of cultural connection, though they also articulated that having Indigenous ancestry was an important aspect of their identities. These participants were able to navigate quite comfortably through their secondary education program and senior-secondary science courses. For the most part, they did not feel different from other students due to their Indigenous ancestry. This study raises an important question: Do Indigenous students who have stronger cultural connections perceive secondary science differently, and what impact does this have on their participation, achievement, and experiences in senior-secondary science? It would be valuable to conduct a similar study with Indigenous students who are living in their home communities to gage their experiences and perceptions about science.

Recommendations

As a result of this study, there are several recommendations that can be made regarding science education that could be helpful for students, teachers, school districts and the BC Ministry of Education. The participants of this study have reinforced the importance of teaching to a variety of different student-learning styles. Students need to be given ample opportunities to explore topics that are of interest to them. Students are more likely to develop a deeper interest in science if they are engaged in hands-on, participatory experiences, rather than passive situations that place an emphasis on rote methods of acquiring knowledge, including lectures, notes and memorization. Such methods of instruction are also in stark contrast with traditional Indigenous ways of learning (which includes, but is not limited to, learning situated in a natural environment, experiential learning, and collaborative learning) and this may further alienate Indigenous students who bring with them a strong sense of cultural connection.

The results of this study provide grounds to make recommendations to the Ministry of Education to incorporate (IK) and (IS) at every level of science education. According to Cajete (1999), "we are all capable of having more than one internally consistent mindset concerning reality. Western scientific schooling often makes it seem otherwise, and such conditioning eventually stifles creative learning" (p. 140).

Indigenous content should be included in all science courses, particularly at the senior-secondary level. Grades 11 and 12 are formative years for students as they transition into adulthood. Hodson defined adolescence as "a crucial transition stage in the formation of lasting attitudes, aspirations, and viewpoints" (as cited in Mosconi & Emmett, 2003, p. 70). It is therefore essential for adolescents to continue seeing IK and IS represented and valued beyond the Grade 10 year as this exposure may have a major influence in their post-secondary career goals and aspirations. In addition, a new course could be developed that focuses on IK and IS (but not exclusive of Western-based science) as an option for all students in satisfying their science graduation requirements.

Another recommendation is to incorporate learning outcomes in the senior-secondary science curriculum that would require students to research post-secondary science areas and also science-related careers. According to Brown's value-based career theory, "a student must have career direction before she or he is motivated to set goals toward that end. According to this theory, a person's values are formed through continuous interaction with family, school, and other environmental influences" (as cited in Mosconi & Emmett, 2003, p. 76). For Indigenous students, this type of learning outcome at the senior-secondary level would allow them to see that science education could help them empower or assist Indigenous people or communities though healthcare, resource management, or research.

It is vital that Indigenous science students take on endeavours that will enable them to further protect Indigenous communities, resources, and the overall health and wellness of Indigenous people in the future. As Indigenous people work to empower their communities and to become more autonomous, the need for Indigenous scientists and health practitioners could not be greater. In order to meet this need, we must re-evaluate our science education programs and means of delivery, learn from the Elders, and listen to the advice from our Indigenous students in deciding what changes need to be made to enable all students to be successful in school science.

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