

DISRUPTING STEM EDUCATION BY BRAIDING INDIGENOUS WAYS OF KNOWING AND ENVIRONMENTAL EDUCATION

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Abstract

Learning is inherently connected. It is time to disrupt traditional STEM education by meaningfully embracing multiple perspectives such as Indigenous and environmental education learning principles. Through my story as a white non-indigenous science teacher, we explore the importance of acknowledging one's feelings, the power of storytelling, my journey educating myself and embracing multiple perspectives inside my teaching practice. Because Aboriginal Ways of Being state that the "the deepest learning takes place in lived experience" (BCTF, 2017), I share my process and reflections on designing and implementing a specific unit about clam gardens in a secondary science classroom.

Keywords: Indigenous pedagogy, place-based education, storytelling, science education, Traditional Ecological Knowledge, experiential learning.

Introduction

When I think about learning, I see a giant spider web of connections where one concept or skill is connected to the next, and so forth. Learning goes beyond isolated silos – ie. physics, biology, chemistry, social studies – and expands outside of the classroom doors to the complexity of life. Learning needs to be connected to real-life to gain its meaningfulness. Learning is inherently connected. That concept is shared with Indigenous and environmental education learning principles. “Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, on reciprocal relationships, and a sense of place)” (FNESC, n.d.). The previous statement is one of the nine First Peoples Learning Principles elaborated by the First Nations Steering Committee “to contribute to Reconciliation for all by building a greater understanding of the skills, knowledge, and perspectives of First Peoples for all students” (FNESC, 2016, p. 4).

When looking at environmental education definitions, there is not one specific definition that stands out but there are clear common themes. Based on the analysis of various definitions (BC Ministry of Education, 2010; NAAEE, 2021; UNESCO-UNEP, 1976, 1977), environmental education is taught with a **holistic approach** (connected, interdisciplinary, and integrated) that puts the **learner at the center of their learning on real-world contexts** to increase **awareness** (responsibility, action, and stewardship). When looking at environmental learning principles, the BC Ministry of Education (2010) proposes the acronym C.A.R.E to promote looking at environmental issues through multiple perspectives but also to demonstrate various forms of environmental knowledge.

Figure 1. Use “CARE” to deepen environmental learning.

Figure 2: Use ‘CARE’ to deepen environmental learning



(BC Ministry of Education, 2010)

“Through a consideration of these principles for environmental education, you, as teachers, will come to understand that experiential programs can examine the complexity of natural systems. Human interaction with these systems and the effect on these systems is also examined. You will also learn that holistic forms of environmental education can help your students to develop a sense of respect and appreciation for the natural world. An aesthetic appreciation, along with a scientific understanding of nature, encourages students to learn and act to protect and sustain the environment. This, in turn, can contribute to self-awareness and personal fulfilment.” (BC Ministry of Education, 2010, p. 11)

These tenets of environmental education will not be in all environmental education resources – they are guiding principles.

My Story

As a secondary science teacher, I make a conscious effort to braid Indigenous ways of knowing and environmental education into my teaching practice. I would like to share my humble journey toward reconciliation as a settler on these traditional lands. In that spirit of reconciliation and appreciation for the land, I would like to acknowledge that I am privileged to write these lines, work, and play on the unceded and traditional territories of the x^wməθk^wəyəm (Musqueam), Sk̓wx̓wú7mesh (Squamish), and səliwətəl (Tsleil-Waututh) peoples.

I would like to share a unit about clam gardens that I have co-designed with the Indigenous Support Team of my school district and validated Indigenous resources (FNESC, 2016). This unit targets grade nine students in a francophone school in a minority context in British Columbia on the Pacific Northwest. The students came from different socio-economic backgrounds and each class portrays a wide array of learning disabilities. It is to be noted that the framework presented can be used in a variety of settings, grades, and subjects. I want to acknowledge that my clam garden unit is by no means “perfect” in itself. On the contrary, it depicts well some of the challenges and barriers when one is wanting to integrate Indigenous ways of knowing and environmental education principles in their practice.

By presenting a concrete example of what it means to integrate Indigenous perspectives inside a science curriculum, I hope to inspire settlers to take their first steps towards representing Indigenous worldviews no matter where they are in their reconciliation journey. During a professional development opportunity, it was shared with me by an Elder that: “We [Indigenous peoples] would rather that you try than you do nothing.” I also connect with this saying by Maya Angelou: “Do the best you can until you know better. Then when you know better, do better”. Furthermore, it is important to use validated resources to ensure that the inclusion of First Peoples’ perspectives is done respectfully and without appropriating First Peoples’ knowledge. These sayings have guided my journey and I share them with future student teachers in my role as a sessional instructor in the Teacher Education Program at Simon Fraser University.

Braiding Indigenous Ways of Knowing

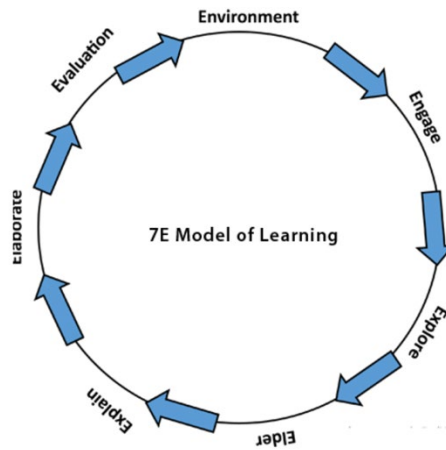
There is a historical tension between STEM education and Indigenous Ways of Knowing. Some portray the two as oppositional when, in reality, there are multiple ways of learning. As teachers, the challenge resides in establishing bridges between the latter. Furthermore, I believe this tension is partly rooted in the uneasiness – or even shame – settlers of this land experience for the generational trauma we have caused to First Nations across Turtle Island. The number one challenge I hear from future science teachers on integrating Indigenous knowledge in STEM education usually goes along the lines of “*I am afraid to make a mistake*” or “*I don’t want to make it worse*”. Shame is paralyzing. We must step outside of its realm to recognize, educate ourselves on the past and current situation to be able to enact the Calls to Action (First Nations University of Canada, 2023).

As a science teacher and settler on this land, I was deeply feeling this tension. Fortunately, I was able to break the cycle of inaction. I initially resonated with the Two-Eyed Seeing approach – a concept presented by Mi’kmaq Elder Albert Marshall (Hatcher, Bartlett, Marshall, & Marshall, 2009). I learned that STEM education and Indigenous knowledge can co-exist and even thrive together. *Toqwa'tu'kl Kjjitaqnn* means “Integrative Science” in the Mi’kmaq language and it brings together “Indigenous and Western knowledge using the guiding principles of ‘Two- Eyed Seeing’ that is, to see from one eye with the strengths of Indigenous ways of knowing, and from the other eye with the strengths of Western ways of knowing, and to use both of these eyes together” (Hatcher et al., 2009, p.3). When we look at this approach with an inclusive lens, “the approach is beneficial to all students because it adds an engaging cultural dimension to science studies, provides context for learning about other nations, and demonstrates that all knowledge has a cultural context” (Hatcher et al., 2009, p.3).

With this approach in my toolbox, I continued navigating the recognition and integration of Indigenous ways of knowing. I then learned about First Peoples pedagogy. FNEESC (2016, p.5) argues that “while each First Nation has its own unique identity, values and practices, there are commonly held understandings of how we interact and learn about the world.” FNEESC states that First Peoples pedagogy is based on the following principles: it is “**learner centred**, [...] **inquiry based**, [...] based on **experiential learning**, emphasize an **awareness of self and others** in equal measure, recognize **the value of group processes** [and] **support a variety of learning styles**” (FNEESC, 2016, p. 5, emphasis added).

Based on those tenets, FNEESC presents an adaptation of the commonly known 5E model of learning (Bybee et al., 2006). The 5E model is widely used to develop experiential learning resources. It has been proven to promote “collaborative, active learning in which students work together to solve problems and investigate new concepts by asking questions, observing, analyzing, and drawing conclusions” (Lesley University, n.d.). The 7E model of learning is similar to the 5E model but with the addition of 2E which stand for Environment and Elder.

Figure 2. 7E Model of Learning (adapted and used with permission from FNEESC)



7E Model
Environment
Situate the lessons in the local land and environment. This builds an appreciation for the concept that everything is connected to everything else and taps into a sense of Place.
Engage
Capture student attention and curiosity. Raise scientifically relevant questions. Connect what students know with a new question or idea. Ask a question, show something interesting, pose a problem.
Explore
Experiential. Students observe, record, connect ideas, ask questions, usually in groups. Teachers are coaches and facilitators.
Elder
Elders and other knowledgeable community members represent the Traditional Ecological Knowledge held by the community.
Explain
Describe observations and come up with explanations. Develop vocabulary, apply and interpret evidence. Students reflect on their processes, thinking and conclusions. Teachers guide students with questions and suggest additional resources.

Elaborate
Use information to extend learning to new situations . Make connections to their personal lives and to society.
Evaluation
Students demonstrate their understanding of concepts and skills learned. Teachers ask open-ended questions and encourage students to self-assess their learning.

(FNESC, 2016)

Note. This model provides a framework to begin the planning process and it was instrumental for the co-design of my unit on clam gardens. I have used this model to present a summary of this unit.

Clam garden unit

Environment

Because Indigenous ways of knowing are inherently place-based, it makes sense to start with the environment. In an ideal world, we would have organized a field trip to a local intertidal zone to get a sense of intertidal critters and connect with the environment on a multi-sensory level – smell of fresh ocean air, temperature of water on our feet/hands, sounds of marine creatures, beauty of nature, ... Place-based learning is “a process that centers respect, reciprocity, reverence, humility, and responsibility as values” (Canadian Commission for UNESCO, 2021). These values are essential to engage in meaningful environmental education opportunities and hold the premise for tackling complex global environmental challenges. However, I encountered an issue hindering this venture due to logistical issues and a lack of funding for transportation. In hindsight, I would have planned and applied for funding through numerous grant opportunities in the province. Because the reality is often different from the theory, I did what all educators do daily – use a plan B! Instead, students experienced a multi-sensory experience of clams – the texture, the smell, the appearance, the taste – by cooking a clam chowder in the school’s kitchen. For most students, it was their first time tasting clams. We were also able to see what types of clams were sold in local supermarkets compared to the ones found on local beaches.

Engage

Using an experiential approach to begin the unit has tremendous power to engage students. The latter were engaged in the clam chowder cooking activity because the cooking connects to their everyday life, it is hands-on, and it supports a variety of learning styles allowing for all students to engage.

Explore

At this point, students were curious to learn more about clams. I wanted them to explore Indigenous Resources to find out more about the topic. One of those resources was the [Húyat](#) website. With a simple click, you enter the immersive world of Húyat; our voices, our land. You are welcomed on this website with Indigenous voices speaking in the background about the importance of this land whilst seeing bird-eye videos of their land. You *enter* and find yourself on the main page with options written in Híłzaqv (Heiltsuk) language with an English translation when you hover your mouse on top.

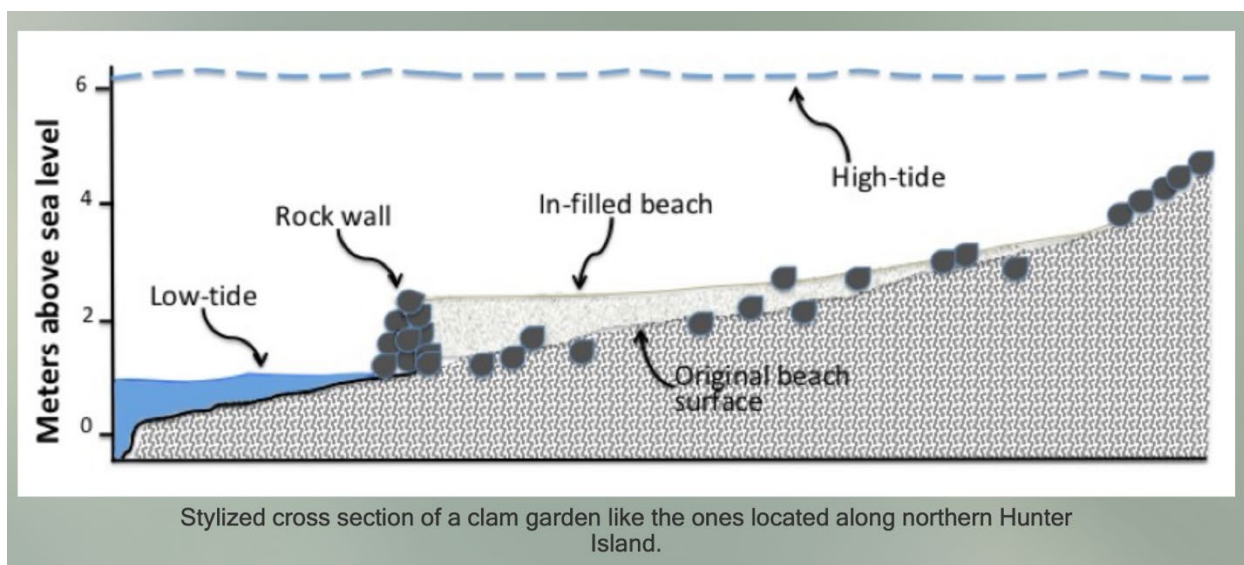
HÚYAT is one of an immense network of culturally important places in Heiltsuk territory. It is the land where Čuṃqlaqs gave birth to her wolf children, and where we have lived for millennia, making our imprint on the land. Húyat collectively refers to several socially and geographically connected bays on northern Hunter Island, located in what is known today as the Central Coast of British Columbia. Húyat is just down the channel from the present-day village of Bella Bella where many of our people now live (Húyat, n.d.).

This website was born from a collaboration between the Heiltsuk Nation, researchers and project partners from Simon Fraser University, the University of Victoria, and Greencoast Media. The knowledge used to construct this website comes from diverse sources — from Heiltsuk memories, language, and oral traditions but also “community-initiated research, ethnographic sources, and archival documents assembled in the Heiltsuk Cultural Education Center (HCEC), as well as about 30 interviews conducted specifically for this project” (Húyat, n.d.). Not only is it possible for viewers to view a video presenting traditional AND scientific knowledge thriving together, but this resource is also a concrete example of the Two-Eyed Seeing approach. It is a compelling testament to the power of stories and other ways of knowing. Simply telling students that stories and oral traditions are a form of knowledge does not resonate as much as **experiencing** a concrete powerful example such as Húyat. This aspect of the unit is significant because it allows for experiential learning of an abstract concept but also it connects to the sense of place by connecting with local First Nations and the stories about their lands. Because the site provides beautiful images and videos of remote places, it also allows for an alternative entry point to foster an aesthetic appreciation of the environment/land. Because of its close ties to outdoor education, we often assume that environmental education must take place outdoors. Environmental education *can* take place outside, but it is *not* a requirement.

Through their exploration of the website, students were able to see images of clam gardens and understand what they are. For those of you who haven't looked it up already, you might be intrigued as to what clam gardens are. Students can find the following information through their exploration of Húyat. Clam gardens are traditional and sustainable practices designed by Coastal First Nations for a sustainable and abundant harvest of clams.

Clam gardens are rock-walled terraces that our ancestors built at the lowest low tide to increase the particular tidal zone in which clams thrive. By creating a terrace at a particular place above sea level, sediment could accumulate behind the rock walls and then clams could flourish. [...] Archaeologists have not been able to date the clam gardens in our territory, but based on work elsewhere on the coast, they could be several thousands of years old. Interestingly, most of the clam gardens in Húyat are not located in central Húyat – where the majority of people lived. People in central Húyat almost certainly held the rights to harvest clams from these other bays (Húyat, n.d.).

Figure 3. Stylized cross-section of a clam garden like the ones located along northern Hunter Island



(Húyat, n.d.)

Note. Figure 2 allows for a better understanding of what a clam garden would look like. This information is shared on the website through text, figures, and a video which allows for differentiation.

Elder

When we reached out to Elders in our community, they weren't available to visit. It was an unfortunate situation because they represent the Traditional Ecological Knowledge (TEK) held within the community. But I like to think that when one door closes, another one opens. "Teachers are encouraged to develop local units that speak to the local sense of place and non-appropriated knowledge of local First Nations, in collaboration with knowledgeable community members" (FNESC, 2016, p.16). The discovery of Húyat allowed me to connect with other knowledge keepers. It also triggered an encounter with a passionate individual who helped me expand my understanding of clam gardens in general but most importantly she shared her relationship with Indigenous knowledge. Dr. Dana Lepofsky is a local SFU professor and archeologist who has worked on the Húyat project and other various research projects in collaboration with Coastal Indigenous Peoples. She has a profound appreciation for Traditional Ecological Knowledge and for the Elders who shared their stories with her. As a scientist, she understands the value behind the Two-Eyed Seeing approach and she was able to present her *discoveries* on clam gardens (for the Western World) through articles based on data gathered from diverse sources. She explains:

I incorporate diverse technical and methodological approaches in my research, including interviews with knowledge holders, ethnohistoric research, geomorphology, archaeological survey and excavation, paleoethnobotany, and paleoecology. My recognition of the value of different disciplines and kinds of knowledge has led me to believe strongly in multi-disciplinary and collaborative research (Lepofsky, n.d.).

She was able to talk directly to my students about her role as a scientist in the field partnering with local First Nations. She talked about her first-hand experience with TEK and how it has helped her further her understanding of the sustainable and traditional practices of clam gardens. To me, that is learning that expands beyond the classroom doors. Although it is portrayed as such, science is not objective, and it does not come from a textbook or a powerpoint – it is relational. As a scientist, you need to be ready to learn from your peers and other ways of knowing. Teaching explicitly the nature of science is unfortunately underrepresented in school science.

Explain

Above I explained how students began forming their understanding about clam gardens through a confirmation inquiry on the Húyat website. Additional resources for a more thorough understanding came from the resources in Unit 1 about Traditional Ecological Knowledge (FNESC, 2016) where clam gardens are cited as a TEK example. Learning about the Traditional Ecological Knowledge of Indigenous peoples is a prescribed concept within the science curriculum in British Columbia. Beyond that, it can significantly enhance students' appreciation

and respect for TEK. This exposure to TEK sparked a conversation about other areas where TEK could come into our lives.

Furthermore, multiple concepts and skills were developed and connected back to the concept of sustainability behind clam gardens. Some of the concepts included matter cycles, sustainability, invasive and indigenous species, bioaccumulation, and biomagnification. Using a concrete example helped support the understanding of abstract concepts – ie. bioaccumulation. When looking at the acronym C.A.R.E for environmental education, clam gardens touched on numerous aspects – the **C**omplexity of systems involved in clam gardens and the interconnectedness nature of TEK, the **A**esthetic design of intertidal terraces and global appreciation for the environment, our **R**esponsibility as stewards of the land to protect and promote sustainable practices, and finally hope that the study of the environment can help students develop an environmental **E**thic. “[...] responsible action requires an examination of values. Environmental education provides an opportunity for students to question cultural assumptions that lead to social conflict and environmental crises” (BC Ministry of Education, 2010). It’s time to start valuing TEK and Indigenous ways of knowing as important knowledge.

Elaborate

Students were able to extend their learning in multiple ways. First, their interaction with a scientist was a meaningful opportunity to learn about the realities of field research. Seeing concrete examples of career options is important for students to start forming their ideas about what happens outside of school science. In addition, seeing that a distinguished scientist uses TEK in her practice breaks down further the historical tension between Western and Indigenous science.

After learning about a sustainable practice such as clam gardens, students were asked to extend their understanding of sustainability to other areas of their lives. They had to develop a solution for a sustainability issue and present their pitch to the audience. This project was conducive to students reflecting on possible sustainable solutions they could implement in their lives or their community. Students were asked to develop a concrete plan that allowed them – or someone – to put it into action if they were inclined to do so. Their pitch to the classroom had to include enough details for us to see the feasibility of this project coming to fruition. Providing real-world examples helps motivate students because it allows them to make essential connections with their learning. Furthermore, developing solutions fosters students’ agency and allows them to feel empowered. When presenting their solution, they were asked to connect with TEK principles and elaborate on which was applicable. “As educators, we need to facilitate students’ understandings of what constitutes responsible action toward the environment and help students to act responsibly in their personal lives” (BC Ministry of Education, 2010). This project was a good opportunity for students to apply their learning about sustainable practices to new situations.

Evaluation

Students were evaluated on multiple criteria that included targeted content, curricular competencies, and core competencies. Their comprehension of concepts was evaluated on how they could apply their conceptual understanding to known and new situations through a variety of questions. Some of the concepts and skills evaluated included being able to explain how the clam gardens were a good example of sustainability, explain how clams were affected by bioaccumulation, explain how TEK is valuable to research and our understanding of the interconnection of the world surrounding us. For some of the questions, students were able to exercise choice on how to demonstrate their understanding through a written explanation, annotated drawings, or a little presentation to younger students.

Their analyzing skills were evaluated when they made sense of Dr. Lepofsky's research data on clam gardens. Other competencies – design skills, communication skills, and creativity – were also evaluated through a performance task which was their pitch done either in-person or via pre-recorded video.

Circling back to the Environment

For the students' pitch, I invited the administration to attend. When you offer students an audience to present their work, the result is often elevated. In addition, the principal was highly motivated to bring to fruition the solutions students were proposing for the school. An example of that was a rain barrel installed at school to water the school's garden. This iterative model is conducive to learning expanding beyond the classroom doors.

Storytelling

Let's look at the way storytelling was embedded not only inside this unit but also in this article. "Learning is embedded in memory, history, and story" (FNESC, n.d.). Stories are everywhere – oral stories of Coastal First Nations on the Húyat website, Dr. Lepofsky's research journey embracing Indigenous knowledge, and students' stories about the solutions they found to real-world problems, my own reconciliation journey, ... As stated by Aboriginal ways of knowing and being, "important teachings emerge through stories" (BCTF, 2017). While Indigenous Peoples have understood the power of storytelling for quite some time, recent neuroscience research corroborates that "our brains are socially and emotionally hard-wired to absorb stories" (Oliver, 2023, p. 1). When we listen to stories involving some facts, our understanding process involves an emotional component which activates the amygdala in concert with the hippocampus – two independent memory systems (Oliver, 2023). The level of emotional arousal during encoding correlates highly with subsequent recall (McGaugh, 2004). "That is why we can more easily recall an emotive story than a dry statement of several facts" (Oliver, 2023). Morris et al. (2019) argue that "narratives structured as stories facilitate experiential processing, heightening affective engagement and emotional arousal, which serve as an impetus for action-taking" (p. 1). Not only do students remember better stories than factual

knowledge, but they also are more likely to act consequently – i.e.. engage in pro-environmental behavior (Morris et al., 2019).

Climate change education is an important component of both environmental education and Indigenous learning principles. “Learning involves recognizing the consequences of one’s actions” (FNESC, n.d.). However, throughout Canada, climate change education is mostly an afterthought. Only a third of educators teach about climate change and for those who do, it represents between one to ten hours of instruction per year or semester (Field, Stevens, Spiropolous, & Acton, 2021). In addition, climate change education is often limited to simplified technical scientific concepts (Field et al., 2021). I would argue that this strictly conceptual approach – far from emotions – is in dissonance with the eco-anxiety felt by an increasing number of students worldwide (Hickman et al., 2021). According to Field et al. (2021), 46% of students aged 12-18 years old are aware that human-caused climate change is happening, but they do not believe they can do anything about it. Hopelessness leads to inaction and anxiety. Communicating effectively climate change information to diverse – sometimes non-scientific – audiences require us to consider alternative approaches to analytical narratives. Storytelling can act as a powerful tool. Science is done by scientists all over the world. When we talk about science in general, these people’s stories of exploring the unknown are important and maybe even more powerful than simple scientific facts. Stories don’t necessarily need to be told. Going back to climate change education, stories about the solutions and actions needed for our future on this planet can also be **co-created** with our learners, our community, Indigenous Peoples, and ourselves. Climate change isn’t a subject to be taught – it’s a crisis to explore together.

Conclusion

Braiding new perspectives inside STEM education can feel like a colossal task but it does not have to be. There are multiple entry points for all to begin somewhere. I have shared with you my story of disrupting STEM education to model vulnerability. “Learning is a journey that takes courage, patience and humility” (BCTF, 2017). My journey started by acknowledging my feelings on different perspectives, educating myself and embracing different ways of learning, and establishing meaningful connections within the community. The story does not end – it continues with me sharing, growing, and acknowledging that it is not an easy task, but it is worth it. All educators must start and pursue their reconciliation journey by enacting the Calls to Action (First Nations University of Canada, 2023). It is our honour and duty to do so. Besides, if we go back to our spider web of learning. “Learning recognizes the role of indigenous knowledge” (FNESC, n.d.). Indigenous ways of knowing and environmental education are part of the learning web. We just need to make the connections.

Bibliography

- BC Ministry of Education. (2010). Environmental learning and experience: An Interdisciplinary guide and video clips for teacher (2007). Retrieved from http://www.bced.gov.bc.ca/environment_ed/.
- BCTF. (2017). Aboriginal ways of knowing, (July), 2017.
- Bybee, R. W., Taylor, J. a, Gardner, A, Scotter, P. V, Powell, J. C., Westbrook, A, & Landes, N. (2006). The BSCS 5E instructional model: Origins, effectiveness, and applications. *Bscs*, 1–19. Retrieved from papers://dee23da0-e34b-4588-b624-f878b46d7b3d/Paper/p424.
- Canadian Commission for UNESCO. (2021). Land as teacher: Understanding Indigenous land-based education. Retrieved from <https://en.cunesco.ca/idealab/indigenous-land-based-education>.
- Field, E., Stevens, J., Spiropolous, G., & Acton, K. (2021). Canada, climate change and education: Opportunities for public and formal education A project of With support from Focus on British Columbia Regional Report.
- First Nations University of Canada. (2023). What are the Truth & Reconciliation Commission’s 94 Calls to Action & How Are We Working Toward Achieving Them Today? Retrieved July 31, 2023, from <https://www.reconciliationeducation.ca/what-are-truth-and-reconciliation-commission-94-calls-to-action>.
- FNESC. (n.d.). *First Peoples Principles of Learning*. Vancouver, BC. Retrieved from <http://www.fnesc.ca/wp/wp-content/uploads/2015/09/PUB-LFP-POSTER-Principles-of-Learning-First-Peoples-poster-11x17.pdf>.
- FNESC. (2016). Science FIRST PEOPLES Teacher Resource Guide.
- Hatcher, A., Bartlett, C., Marshall, M., & Marshall, A. (2009). Two-Eyed Seeing: A cross-cultural science journey. *Green Teacher*, 17(Fall), 3–6.
- Hickman, C., Marks, E., Pihkala, P., Clayton, S., Lewandowski, R. E., Mayall, E. E., ... van Susteren, L. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *The Lancet Planetary Health*, 5(12), e863–e873. [https://doi.org/10.1016/S2542-5196\(21\)00278-3](https://doi.org/10.1016/S2542-5196(21)00278-3)
- Húyat. (n.d.). Húyat. Retrieved from <http://hauyat.ca/>.
- Lepofsky, D. (n.d.). SFU’s biography of Dana Lepofsky. Retrieved July 31, 2023, from <http://www.sfu.ca/archaeology/about/people/faculty/dlepofsky.html>.
- Lesley University. (n.d.). Empowering students: The 5E model explained. Retrieved July 31, 2023, from <https://lesley.edu/article/empowering-students-the-5e-model-explained#:~:text=The 5E Model%2C developed in,%2C analyzing%2C and drawing conclusions>.
- McGaugh, J. L. (2004). The amygdala modulates the consolidation of memories of emotionally arousing experiences. *Annual Review of Neuroscience*, 27, 1–28. <https://doi.org/10.1146/annurev.neuro.27.070203.144157>

- Morris, B. S., Chrysochou, P., Christensen, J. D., Orquin, J. L., Barraza, J., Zak, P. J., & Mitkidis, P. (2019). Stories vs. facts: triggering emotion and action-taking on climate change. *Climatic Change*, 154(1–2), 19–36. <https://doi.org/10.1007/s10584-019-02425-6>
- NAAEE. (2021). *Environmental education materials: Guidelines for excellence*. Washington, DC. Retrieved from <http://resources.spaces3.com/3725a5c0-f0ab-4039-9bd2-c5dbd9bcb34f.pdf>.
- Oliver, C. A. (2023). The social brain and the neuroscience of storytelling. *Teaching Science Students to Communicate: A Practical Guide*, 31–38. https://doi.org/10.1007/978-3-030-91628-2_4
- UNESCO-UNEP. (1976). The Belgrade charter on environmental education. *Prospects*, 6(1), 135–136. <https://doi.org/10.1007/BF02220144>
- UNESCO-UNEP. (1977). Tbilisi declaration. *Environmental Policy and Law*, 3(3–4), 196. [https://doi.org/10.1016/S0378-777X\(77\)80134](https://doi.org/10.1016/S0378-777X(77)80134)