

Knowing Home: Braiding Indigenous Science with Western Science, Book 2

Knowing Home: Braiding Indigenous Science with Western Science, Book 2

EDITED BY GLORIA SNIVELY AND WANOSTSA7 LORNA WILLIAMS



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Published by
ePublishing Services, University of Victoria Libraries
Victoria, British Columbia V8P 5C2
Canada
press@uvic.ca

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Territorial Acknowledgement

We gratefully acknowledge and honour the territory and the lands on which the project originated: the Lekwungen (Songhees), SXIMEŁEŁ (Esquimalt), and WSÁNEĆ (Saanich)



XAXE TFE S?Á, ?TE TE?EW?. XAXE TFE S?Á, ?TE S?ÁL – *Our land is sacred. Our language is sacred.* Artwork by David Underwood (2018).

About the artwork

SÁMI E? XÁLS. U, SDOYEMs TFE SWE?E? I, TFE ŠW?KITES. NI? ?E,ĆÁ, XAXE FIFE? SIÁM. SU JIJE? ?TE T?FU, NI? XÁLS.

LÁ,TE? T?FU MEQ STÁ? E? XÁLS. LÁ,E T?FU MEQ E TFE TOTEL?EW? I, TFE SĆ?NEW? I, TFE ?ÁLE?EM. LÁ,E U, LÁ,E TFE TE?EW? I, TFE S?ÁCEL I, TFE Š?ENO, T?FU MEQ. TÍYELs TFE SĆ?NEW? YÁ, ČSE LÁ,E TFE Š?ENO,. QELE?SEN T?FU, NI? ŠW?KITES. STES ?E,ĆÁ, E TFE S?EL,?ELs E? XÁLS. I, SWE?E? T?FU, NI? S?ÁCEL I, TFE TE?EW? I, TFE Š?ENO,. LÁ,TE? ?E,ĆÁ, T?FU MEQ STÁN E? XÁLS. ?OS TFE ŠW?,LÁLEs E TFE S?E,?EL. ?ES,ÁNW? ?E,ĆÁ, ŠW?,LÁ,Es T?FU NI? S?E,?EL. I,?E,?ELE? TFE S?ÁCEL I, U, SOSESs E? XÁLS E TFE S?E,?EL. TÁ,?I?E? T?FU, MEQ STÁ? E?s ?O,?ELs E? XÁLS. S?Á,TE? ?TE TIÁ, S?AL.

SÁMI E? XÁLS. I, SDOYEMs TFE ŠW?KITES. NI? ?E,ĆÁ, ŠW?JIJE? ?TE TFE XAXE.

The creator wears a blanket, a wool blanket and a W?SÁNEĆ head dress. It is because the creator is sacred, high up and honourable. So we give thanks to the creator.

The creator made everything here: the animals, the fish and the birds. There they all are on the land, in the sky and in the sea. The salmon go upstream from the ocean. Eagle is the creators head dress. It is because eagle is close to the messages from the creator. The wool blanket is everything. It is the land, the sky and the sea. The creator made it all. There are four places of the sun, because the sun moves along the horizons of the rising and setting suns across the four seasons. The sun is the face of the creator, shining light on everything with sacred words. We are gifted this language.

The creator wears a blanket and a W?SÁNEĆ head dress. This is because we give thanks to sacredness.

Foreword

It is a thrill for me to see *Knowing Home: Braiding Indigenous Science with Western Science Books 1 and 2*, and to know that they will be a readily available reference for learners and educators alike. At a time when Canadians are finally embarking on a journey of Truth and Reconciliation with Indigenous Peoples, these insightful edited volumes are both timely and critically important. Together, the co-editors and authors, almost all of them Indigenous, present multiple useful paths towards identifying and recognizing two huge shortfalls in the Canadian educational system to date. One is the abysmal failure of many schools to provide quality education for Indigenous children and youth, particularly in the areas of science, technology and health. This situation is reflected today in the marked underrepresentation of Indigenous students participating in university level programs in these areas, and, further, in the dearth of professional scientists from Indigenous communities across the country. The second gap, equally lamentable, is that students of mainstream western science and technology have been deprived of learning about the immense body of Indigenous scientific knowledge, perspectives and applications acquired and built over generations of dwelling in particular places. The *Knowing Home* books are a wonderful resource that will bring all Canadians to a higher level of understanding in these two areas.

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Distinguished Professor Emeritus and 2015 P. E. Trudeau Fellow
School of Environmental Studies
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Preface

The “Aboriginal Knowledge and Science Education Research Project” was a collaborative venture between the Aboriginal Education Enhancements Branch of the British Columbia Ministry of Education (Canada) and the University of Victoria (Canada), and was created to address issues associated with the under-representation of Indigenous peoples in the sciences. The project had a three-fold purpose: (1) to broadly describe why Indigenous students are under-represented in high school science biology, chemistry, and physics classrooms, (2) to find ways to improve significantly their involvement and achievement in both elementary and high school science leading to post-secondary, and (3) encourage Indigenous people to consider science and health related occupations.

According to Cajete (1999), “Native science evolved in relation to places and is therefore instilled with a ‘sense of place’. Therefore, the first frame of reference for Native science curriculum is reflective of their place” (p. 47). Thus, a key component of the research project was to document the Indigenous science knowledge of specific home communities and to construct an epistemological framework and pedagogical orientation for developing school science programs pertaining to the learning and use of scientific knowledge in the local Indigenous community.

It is anticipated that the project will contribute to the realization of increased participation of Indigenous peoples in the sciences by generating: (a) understanding of the underlying reasons for the lack of participation in upper level sciences courses, (b) knowledge about the lack of participation of Indigenous people in science and health related careers, (c) knowledge of the Indigenous Science of British Columbia Indigenous peoples, (d) knowledge about how children of Indigenous ancestry have a worldview other than the Western scientific worldview, (e) significant research opportunities for Indigenous graduate students, (f) research partnerships amongst Indigenous and non-Indigenous teachers and scholars, (g) directions for leadership and career opportunities in science for Indigenous graduate students, and (h) more effective science education curricula and programs by and with Indigenous scholars and Indigenous communities to be developed, implemented and evaluated.

With the aging population of the Elders in the community, Indigenous Science (IS) knowledge is vulnerable and the urgency to research and document this knowledge is vital to Indigenous peoples and to the global society. We take the view that unless IS is acknowledged as science, Western Science (WS) will continue to completely dominate the science curriculum, and IS will continue to be excluded or given tokenistic inclusion at best. Thus, we take the view that IS and WS can co-exist side by side in the science classroom.

Building a Community of Researchers

By working with Indigenous graduate students, rather than with practiced researchers, this project was unique in that it was designed to provide opportunities for Indigenous peoples to participate in a research project. Although this was an important key element of the research project, it had challenges of working with a cadre of inexperienced graduate students, many of whom were at the beginning stages of taking graduate level research courses.

In an attempt to address the stated purpose of this research, the research team developed an implementation strategy consisting of the following elements: (a) build culturally appropriate research skills amongst graduate students; (b) collect and analyze what Indigenous knowledge based curriculum materials and programs already exist; (c) design a graduate level program of courses to teach basic research techniques and concepts associated with the project; and (d) locate and encourage networks with and amongst researchers and research centres focusing on Indigenous knowledge and science education projects. Six Indigenous graduate students and three non-Indigenous graduate

students volunteered to research specific components of the project deemed relevant to their personal career goals and the needs and goals of their home communities.

During the summer of 2004, an off-campus Graduate Program in Environmental and First Nations Education was offered to both Indigenous and non- Indigenous students in 'Ya?lis (Alert Bay), British Columbia, home of the Kwakwa?ka?'wakw people. The Kwakwa?ka?'wakw, against enormous pressures, have remained close to the essence of their traditional and still viable life-ways. Like other Indigenous peoples who retain their traditional identity, they are in a position to share many of their beliefs and values. They teach through a wide range of means and expressions, and their relationship to the larger society. A key tenet was that environment and culture could not be considered separately, there could be no course on Kwagu?l culture that was not also about the Kwagu?l environment. Common experiences included direct experiences with Elders and scientists, and conducting archival and research associated with historical events related to colonization and decolonization.

The aim of this graduate program was to bring together Indigenous and non- Indigenous persons to work together in learning about the forest and ocean environments, respecting the cultures of Indigenous people, and educating future citizens to make wise decisions regarding long-term sustainable communities and environments. The design of the program and courses followed Indigenous ways of learning; learning by being on the land; learning together by forging a sense of community within the program; learning from the expertise of First Nations communities and the university community. Because the majority of graduate students were full-time teachers, the program was developed to take place in three summer sessions (Snively, 2006; Snively & Williams, 2006). (See Appendix D for a more elaborated description of the research project and graduate program).

Walking Forward

Since Indigenous peoples have developed time-proven approaches to sustaining both community and environment, Elders and young people are concerned that this rich legacy of Indigenous Science with its wealth of environmental knowledge and the wisdom of previous generations could disappear if it is not respected, studied and understood by today's children and youth. A perspective where relationships between home place and all other beings that inhabit the earth is vitally important to all residents—both inheritors of ancient Indigenous Knowledge and wisdom, and newcomers who can experience the engagement, joy and promise of science instilled with a sense of place. The two volumes take a step forward toward preserving and actively using the knowledge, stories, and lessons for today and future generations, and with it a worldview that informs everyday attitudes toward the earth.

Over the past two decades many jurisdictions worldwide have placed Indigenous Knowledge in their science curricula, for example: New Zealand, Australia, and in the United States, Alaska, Hawai'i, New Mexico and Washington. In the spirit of reconciliation, a number of ministries of education and departments of education in Canada have increasingly recognized Indigenous Knowledge as fundamental content in school science.

Indigenous Science encourages a welcoming and interested attitude toward the local, the timeless, and the emotional. All science educators must strive to design new curriculum that represents a balanced perspective, exposing students to multiple ways of understanding science. Indigenous perspectives have the potential to give insight and guidance to the kind of environmental ethics and deep understanding that we must gain as we attempt to solve the increasingly complex problems of the 21st century.

Knowing Home: Books 1 and 2

Knowing Home: Braiding Indigenous Science with Western Science is far more than a set of research papers or curriculum studies. The project outputs include both, but they are incorporated into a theoretical structure that can provide the methodological basis for future efforts that attempt to develop culturally responsive Indigenous Science curricula in home places. It is not just one or two angels to organize, but multiple interwoven approaches and cases that give this project its exceptional importance. Thus, the project outputs have been organized into two books.

Book 1 provides an overview of why traditional knowledge and wisdom should be included in the science curriculum, a window into the science and technologies of the Indigenous peoples who live in Northwestern North America, Indigenous worldview, culturally responsive teaching strategies and curriculum models, and evaluative techniques. It is intended that the rich examples and cases, combined with the resources listed in the appendices, will enable teachers and students to explore Indigenous Science examples in the classroom; and in addition, support the development of culturally appropriate curriculum projects.

Book 2 provides supportive research, case studies, curriculum projects and commentary that extends and enriches the chapters presented in Book 1. The chapters provide rich descriptions related to Indigenous cultural beliefs and values; teacher thinking about Indigenous Science; the perceptions and experiences of successful Indigenous students in secondary science; a metaphorical study of Indigenous students' orientations (scientific, spiritual, utilitarian, aesthetic, and recreational) to the seashore and their adult orientations 19 years later; the use of digital video as a learning tool for secondary Indigenous students; a cross-cultural marine education program involving an exploration of WS and IS related to the local Indigenous culture; and a WSÁNEĆ immersion school program focused on language revitalization and the concept of "knowledge of most worth,"

REFERENCES

- Aikenhead, G., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, 2, 539-591. <http://dx.doi.org/10.1007/s11422-007-9067-8>
- Berkes, F. (2012). *Sacred ecology* (3rd ed.). New York: Routledge.
- Cajete, G. (1999). *Igniting the spark: An Indigenous science education model*. Skyland, NC: Kivaki Press.
- Ogawa, M. (1995). Science education in a multisience perspective. *Science Education*, 79(5), 583-593. <http://dx.doi.org/10.1002/sce.3730790507>
- Snively, G. (2006). The Aboriginal knowledge and science education research project. *Canadian Journal of Native Education*, 29(2), 229-244.
- Snively, G., & Williams, L. (2008). Coming to know: Weaving Aboriginal and Western Science knowledge, language, and literacy into the science classroom. *L1-Educational Studies in Language and Literature*, 8(1), 109-130.

Acknowledgements

This work has evolved as a creative collaboration of many individuals whose encouragement and support became instrumental in the production of this book. The editors gratefully acknowledge all those who made this book possible. We are especially thankful to the participants of the 2003 conference at Dunsmuir Lodge for their oral and written contributions to the Vision statement. Their inspiring thinking and continuing quest for a decolonized science curriculum honours Indigenous people everywhere.

The Indigenous Knowledge and Science Education Project would not have been possible without representatives, encouragement and support from the Ministry of Education, the University of Victoria, school districts, Elders, community resource persons and responsive graduate students.

A very special thanks is extended to Dr. Rick Kool (Royal Roads University) for helping to supervise graduate students, review specific articles, and engage in numerous constructive discussions with students and the editors regarding WS and TEK. We gratefully acknowledge Dr. Glen Aikenhead (University of Saskatchewan) for engaging in numerous scholarly discussions regarding IK, IS, WS, and TEK, and for meticulous editing of manuscripts. We also gratefully acknowledge John Corsiglia (instructor, University of Victoria) for reviewing all the manuscripts, and for continuous support and guidance throughout the project.

Very special thanks are also extended to Gwi'molas Vera Newman the off-campus Elder and resource person coordinator for the 'Yalis (Alert Bay) summer sessions. We gratefully acknowledge Chief Kwaxalanukwa'me' 'Namugwis Bill Cranmer and all those who opened their homes and community to our graduate program and offered their advice and assistance. We also thank Chief Nulis Edwin Newman, Tlalilawikw Pauline Alfred, Chief 'Namugwis Pat Alfred, 'Mam'xu'yugwa Auntie Ethel Alfred, Ga'axstalas Flora Cook, Wadzidalaga Wata Christine Joseph, Makwagila Nella Nelson, 'Waxawidi William Wasden, Jr., and Michael Berry (marine biologist), Dr. Paul Spong (whale researcher) and Dr. David Garrick (anthropologist) who shared their considerable knowledge and wisdom with our graduate students. We also thank T'lakwa'am Gilbert Cook and Vicki Cook, and Chief O'waxalaga'lis Roy Cranmer who took us on overnight camping field trips on their seine boats, and filled us many times with delicious salmon roasted over an open fire. We also thank all those ninogad (wise ones) who shared and allowed their knowledge to be recorded for our use and benefit.

We also thank guest speakers Dr. Budd Hall (then Dean of the Faculty of Education) and Dr. Rajesh Tandan (Society for Participatory Action Research in Asia, New Delhi) for travelling to 'Yalis (Alert Bay) and delivering an inspiring talk and workshop giving new meaning to academic research by redefining relationships between the researcher and the researched subjects.

The collaboration also included Ed McMillan (Sim'oogit W'ii T'axgenx), past Director of Instruction, School District 92, Nisga'a. Project affiliates include the 'Namgis First Nation (Alert Bay), Kwakiutl Band Council (Fort Rupert), the West Shore Centre for Learning and Training (Victoria), the First Nations Education Division of the Victoria School District, the Bulkley Valley School District, the WSÁNEĆ (Saanich) School Board, and the Alert Bay Marine Research Laboratory Society.

We are thankful to those who helped supervise graduate students and provided thoughtful feedback and inspiration on their progress during the project: Dr. Leslie Francis Pelton, Dr. Tim Pelton, and Dr. Ted Riecken. We are also thankful to those who read chapters and offered feedback: Dr. June Wyatt Beynon (Simon Fraser University), Ted Cadwallader (Aboriginal Enhancements Branch, BC Ministry of Education), Dr. Dwayne Donald (University of Alberta), Dr. Frank Elliott (University of Alberta), Dr. Trish Rosborough (Aboriginal Enhancements Branch, BC Ministry of Education), Dr. Nancy Turner (University of Victoria), Kaleb Child (Director of Instruction, North Vancouver Island, and Jean Wilson (reviewer).

We are grateful to Jane Mertz, a skillful and patient editor and good friend. We are grateful to Inba Kehoe and the staff in the Copyright and Scholarly Communication Office at the University of Victoria Libraries, for their thoughtful guidance and support during the production phase of the book. Last, but not least, we acknowledge the hard work, inspiration, and dedication of all those graduate students who conducted research, completed graduate degrees, and contributed chapters for this book.

Our acknowledgements would not be complete without paying tribute to the late Yup'ik science educator and scholar, Dr. Angayuqaq Oscar Kawagley, who taught one of the graduate courses in 'Yalis. Kawagley asserts that strong bridges are built by examining the collective ways people in Eurocentric and Indigenous cultures experience and make sense of their natural worlds. Words cannot capture his inspired teachings and gentle spirit, but the wisdom of his stories will be with us always as we strive to find new approaches to science education that invite all students to participate by articulating a cultural approach to science.

This research was funded in part through grants from the Aboriginal Enhancements Branch of the British Columbia Ministry of Education, the Social Sciences and Humanities Council of Canada, and small grants from the Faculty of Education and the Department of Linguistics at the University of Victoria. The publication of this book was funded by an Open Education Resources grant from [BCcampus](#).

Contributing Authors



Dr. Gloria Snively is Professor Emeritus at the University of Victoria where she taught methods, environmental/marine education, and culture courses. She was Director of the Program in Environmental Education. For 12 years, she was involved with the Asia Pacific whose purpose is to strengthen links between the research community and school environmental education in the Asia-Pacific region. Her work with Indigenous education spans decades and has always been inspired by Indigenous leaders. She enjoys giving natural history walks to students, teachers, park interpreters, First Nations and community groups for 50 years. She prefers to explore forest, ponds and seashores first-hand.



Dr. Wanosts'a7 Lorna Williams OBC *walking in peace* is Lil'wat of the St'at'yem'c First Nation. Her life has been devoted to promoting and restoring Indigenous culture and language. She is an Indigenous educator and language specialist for more than 50 years in diverse settings including Indigenous communities, public schools, and adult education settings. Dr. Williams received her PhD from the University of Victoria as Canada Research Chair in Indigenous Knowledge and Language (co-appointment with Faculty of Education and Department of Linguistics) and an associate professor where she developed and delivered an innovative series of courses on learning and teaching in the Indigenous world.



David Ashurst has been a secondary science teacher in Victoria for 15 years where he currently teaches senior biology, chemistry and Jr. science at Oak Bay High School. He earned an MA in First Nations Environmental Education through UVic in 2009 where his thesis research focused on cross-cultural science education in a marine context. Central to his professional practice is the weaving of Indigenous knowledge into the existing curricular framework, bringing the topics to life and building relationships between traditional and western science cultures. Dave has a passion for the outdoors, particularly the coastal environment, and feels that the understanding of traditional ways of knowing is essential to our connection with and the conservation of this vital environment.



Nan Kendy has lived and worked in Northern BC for 30 years on Witsuwit'en and L'heiwat' territories. She taught elementary school in Moricetown and Smithers. Nan completed an MEd from the University of Victoria in Environmental and First Nations Studies in 2007 and worked as a science instructor in the School of Education at the University of Northern BC in Prince George. Retired, she lives outside Prince George on Nadsilnich Lake where she is president of her conservation association and actively involved in protecting the quality of the lake water for her grandchildren. She ran as a candidate for the Green Party for her riding of Prince George-Valemount in the 2017 BC Election.



Dr. Rick Kool is a transplanted Bostonian who has been a teacher for a long time: science teacher at Ucluelet Secondary School in the mid-1970s, biology and ecology instructor at Douglas College, science educator and interpreter at the Royal BC Museum and BC Parks, and co-creator of the MEd program in Environmental Education and Communication at Royal Roads University. His research interests have ranged from the ecology of single-cell animals living in sand and mud to the walking with dinosaurs, from the errors anthropologists made in understanding Nuuchanulth whaling practices to an examination of various forms of environmental violence.



Mupenkin John Lyall is from Gwa'yasdam's on Gilford Island and is Kwakwaka'wakw. John received his BSc (physics/math) in 1998, his MA in 2009, both from UVic. John has taught for 16 years in the Kingcome Inlet and Vancouver Island, with a strong focus on Indigenous education. John has had two articles published as a co-author. He was a vice principal at Spencer Middle School where he developed an Aboriginal Awareness class in order to increase awareness and understanding of Indigenous ways of knowing for all students. He is currently a vice principal at Edwinstown Community School in SD 62 Sooke.



Dr. Ted Riecken is a professor in the Department of Curriculum and Instruction in the Faculty of Education at the University of Victoria. During his career as an educator he has worked as an elementary school teacher, a university teacher and researcher, and as a dean of education. He co-authored a chapter in this book with Mupenkin John Lyall that grew out of a collaborative project that engaged Indigenous youth in making digital videos about their community, culture, and environment. It was this project that opened Ted's eyes to the importance of two-eyed seeing. His current research interests include educational change and innovation, Indigenous pedagogy, and alternative forms of teaching and learning.



Tye Swallow completed his BEd, secondary program, in 1998 and MA in Curriculum and Instruction in 2005. He has taught in the Saanich and Central Coast School Districts. Since 2001, Tye has worked at the Saanich Adult Education Centre, part of the W̱SÁNEĆ School Board (W̱SB) near Victoria. He has taught senior biology, geography and science to adult learners. He co-created *ÁLE?ENE? From Homeland* with the W̱SÁNEĆ community in 2005, which has since seen several iterations and is now part of the core curriculum of the SENĆOŦEN LENO?ET SCUL,ÁUTW? preschool, Kindergarten to Grade 4 SENĆOŦEN Immersion school. Since 2009 he continues to help facilitate language revitalization at the W̱SB through the S?Á,SEN TFE SENĆOŦEN language apprenticeship program with Elders, current and future teachers of W̱SÁNEĆ.



Anne Tenning is a member of the Stz'uminus First Nation on Vancouver Island. She has a BEd from UBC, and an MA from UVic. She has been an educator for 17 years, working as a teacher, an academic counselor for Indigenous students, and currently as the District Vice-Chancellor of Aboriginal Education in School District 68 Nanaimo Ladysmith. Anne is passionate about Indigenous perspectives and understandings in education, particularly the lasting legacy of residential schools. Anne's mother, Elizabeth Tenning, is a survivor of the Kuper Island Indian Residential School. In 2008, Anne was a recipient of the Governor General's History Award for Excellence in Teaching. In 2015 she was the recipient of the UVic Distinguished Alumni Award for the Faculty of Education.

Contributing Artists



Laura Corsiglia is an artist working in drawing, painting, books and ephemeral practices. She considers people and animals, dreams, mountains and wild thoughts. Born in Vancouver, she grew up in Gitlaxt'aamiks, a Nisga'a First Nation community in the Nass Valley of northern BC, attended Gitlaxt'aamiks Elementary Secondary School. She graduated with an MFA degree from the École des Beaux-Arts de Vancouver. Currently based in California, she co-founded Bird Ally X, a nonprofit rescuing and rehabilitating wild animals and releasing them back to the wild.



Trevor Isaac is a Kwakwaka'wakw artist specializing in two dimensional design. As a child, Isaac loved traditional art but didn't practice the art form until he was in high school. Today, most of his work is dedicated to ceremonial purposes in his home community of Alert Bay. While creating the crest, Isaac feels his cultural knowledge assists his depiction of the unique crest of his peoples. Since 2010, he has been immersed into the cultural practices of his peoples. Although born and raised in Kwakwaka'wakw territory, Isaac has ties to many other language groups from the Pacific Northwest Coast. In addition to being a traditional artist, Isaac is also a traditional Singer and Dancer during potlatch ceremonies. He is a Hereditary Chief within his family and has been a valued member of the U'mista Cultural Centre in Alert Bay, BC since 2010.



Una-Ann is a Tahltan/Tlingit West Coast artist, from northern British Columbia. She presented her work in Langley, BC. Una-Ann has worked as a Cultural Presenter and an Aboriginal Support Worker for the Langley School District for the past twenty-five years. Una-Ann has established herself as an artist and clothing designer. Incorporating her traditional designs with a contemporary flair, she works in various mediums. Una-Ann enjoys sharing her knowledge of Indigenous culture and West Coast art with others. Her artwork, clothing and accessories can be seen at Indigenous art exhibitions, conferences, art shows and cultural festivals.



PENÁĆ – G. David Underwood

PENÁĆ TTE NE SNÁ, I, U, ĆSE LÁ,E SEN E? W?SÁNEĆ. I, Ć?I SEN ?EĆÁ, TTE SENĆOFEN S?ÁL TW?E HELISET.PENÁĆ is my ancestral W?SÁNEĆ name. I am from W?SÁNEĆ. I work with the S language because I want it to live. I have taught SENĆOFEN from nursery to grades 11, in both and language exposure settings. I currently teach SENĆOFEN with the University of Victoria (U W?SENĆOFEN,IST Program and I am a partner in the NE?OL?EW? research project.I received of Fine Arts (B.F.A., 2011), majoring in Visual Arts and a minor in Film Studies. I also have a Education in Indigenous Language Revitalization (M.Ed., 2017) – both of which are from UVic. My project is an auto-ethnographic account of my SENĆOFEN learning, which asks, “SX?ENI,E? Y TW?E SENĆOFEN? – How is that I have come to speak SENĆOFEN?”

PART I
INTRODUCTION AND RESEARCH
FOUNDATIONS



Lift Your Spirit. Artwork by Una-Ann (2018).

We embrace the Cedar tree, the “The Tree of Life”. She teaches us that we all have roots, that with positive energy we can be uplifted to great heights. As we gather holding hands in unity, we pray to Mother Earth. Thanking her for the power and energy to continue living. Our spirits are lifted to embrace the support and the love that many hands in the community have given us.

Chapter 1 - Braiding Indigenous Science with Western Science

GLORIA SNIVELY AND WANOSTS'A7 LORNA WILLIAMS

This chapter was published in Book 1, Updated August 2018

One aim of teaching conventional school science is to enrich all students' lives by conveying how academic scientists understand nature. Some students enjoy understanding their world in a way similar to their science teachers. They share a scientific worldview and enjoy the challenge of the academic mindset as they learn the standards of a scientific discipline. Science-oriented students want to think, talk, and believe the way academic scientists do. Some will eventually become doctors, science teachers, scientists, or engineers.

However, not all students possess such a scientific mindset. Research shows that a majority of students prefer to understand nature through other worldviews (Aikenhead, 2006; Aikenhead & Ogawa, 2007), such as primarily aesthetic, religious, or economic (Cobern, 2000), or orientations such as utilitarian, spiritual, aesthetic, recreational, scientific, or a mix of orientations (Snively, 1986, 1990). These "science-shy" students tend to be much less enthusiastic about thinking, talking, and believing scientifically. Western Science, the science taught in most schools, is neither personally meaningful nor useful to their everyday lives. These students experience school science as a foreign culture and may even become alienated by their school science experiences (Aikenhead, 1996, 2001, 2006).

When growing up, a child encounters the culture of peers, the culture of school, the culture of the science classroom, and the overarching culture of the community and society in which the child lives. The concept of culture is a shared way of living which includes knowing, valuing, interacting with others, feelings, and conventional action (Phelan et al., 1991, p. 228). These characteristics of culture help explain the differences between the pupil's home culture and the culture of school science. It does not take long for a child of traditional Indigenous ancestry to recognize that the knowledge and wisdom of their culture is not welcome at school.

Until recently, almost all Canadian teachers were educated in Eurocentric systems that dismissed Indigenous knowledge as science, and they taught a hidden curriculum that attempts to assimilate Indigenous students into a Western Science framework—forcing some children to abandon their traditional ways of knowing and reconstructing in its place a new scientific way of knowing. The majority of these science-shy students resisted learning by not participating. To their credit, an increasing number of science educators want to understand the cultural influence on school science achievement by students whose cultures and languages differ from the predominant Eurocentric culture and language of science. These students may be of Indigenous ancestry living in traditional home communities, or have grown up in traditional communities and moved to urban centres. They may also be first- or second-generation immigrants from countries in Asia, Africa, or South America. These students likely will not feel comfortable with the culture of Eurocentric science and will have to learn to live in two worlds.

In contemplating a title for – *Knowing Home: Braiding Indigenous Science with Western Science*, the phrase "Knowing Home" is a reflection of the fact that traditional knowledge and wisdom is contextual. The stories and testimonies of Indigenous peoples are usually related to a home place. Indigenous peoples worldwide have an intimate relationship to their home place. In the words of Kimmerer (2013):

To the settler mind, land was property, real estate, capital, or natural resources. But ... to our people, it was everything: identity, our connection to the ancestors, the home ... of non-human kinfolk, our pharmacy, our grocery store, our library, the source of everything that sustained us. Our lands were where our responsibility to

the world was enacted, sacred ground. It belonged to itself; it was a gift, not a commodity, so it could never be bought or sold. (p. 17)

Knowing Home takes us on a timeless journey that is every bit as mythic as it is scientific. It attempts to capture the true reverence between Indigenous peoples and the earth; the relationship that we all, as humans, need to survive. We acknowledge that plants and animals are our oldest and wisest teachers. *Knowing Home Books 1 and 2* constitute a significant step towards unfolding the creative vision of Indigenous scientific knowledge and technology that is derived from an ecology of a home place.

“Braiding Indigenous Science and Western Science” is a metaphor used to establish a particular relationship, an obligation of sorts to give, to receive, and to reciprocate. We braid cedar bark to make beautiful baskets, bracelets, and blankets. When braiding hair, kindness and love can flow between the braids. Linked by braiding, there is a certain reciprocity amongst strands, all the strands hold together. Each strand remains a separate entity, a certain tension is required, but all strands come together to form the whole. When we braid Indigenous Science (IS) with Western Science (WS) we acknowledge that both ways of knowing are legitimate forms of knowledge. For Indigenous peoples, Indigenous Knowledge (Indigenous Science) is a gift. It cannot be simply bought and sold. Certain obligations are attached. The more something is shared, the greater becomes its value.

This book presents concepts and models that have been used for thousands of years to educate Indigenous peoples. It shows us how we can braid Indigenous ways of learning with Western Science to facilitate the science education of Indigenous students, other Indigenous peoples around the world, as well as non-Indigenous students. The braids are seen as a gift to all; to heal, strengthen and keep in motion.

Our intended audience for this book comprises science educators open to, or at least, curious about different cultural perspectives in their field. Our audience is not the professional scientist whose perspective on Indigenous Science is understandably much different from the perspective of science educators. Our audience is the reader who accepts Eurocentric knowledge, but who simultaneously appreciates and understands Indigenous knowledge systems. Thus, in an attempt to take into account the multidimensional cultural world of the learner, this book calls for co-existence, a kind of parallel relationship between Western and Indigenous Science in the science classroom.

The Goals of Cross-cultural Science Education

We believe that the goal of science education is that students develop a richer understanding of science, the nature of science, and scientific inquiry. By nature of science, we do not mean a single prescription for what science is and how it should be conducted. Following Ogawa (1997), a Japanese educator and researcher, we believe that it is important to distinguish between “understanding science” from “believing in science.” A belief in science, scientific attitudes, and scientific ways of thinking is deeply rooted in the western value system. As Ogawa explains, “My position is that whether one can believe in science and scientific worldview or not should be determined, not by the value within western modern science, but by the value within the daily life world of the people concerned” (p. 9).

Thus, drawing from examples in different cultures and stories of classroom practice, we seek to assist educators to feel more comfortable about teaching a pluralist form of science education. The following story describes how one elementary teacher of Indigenous ancestry resolved the conflict between the worldview of her culture and that of incorporating Western Science topics in the science classroom.

Donna's Story

Donna is an elementary teacher of Kwakwaka'wakw ancestry who teaches at the T'lisalagi'lakw Band School in 'Yalis (Alert Bay, BC). She grew up in a very traditional family and has lived all her life in 'Yalis, which is on a small island off the northern coast of Vancouver Island. She has a master's degree from the University of Victoria and is the author of Chapters 12 and 13 in *Knowing Home: Braiding Indigenous Science with Western Science Book 1*. She wanted to focus on the sciences during her undergraduate degree with the intent to show that her Kwakwaka'wakw way of life was science, from making cedar bark clothing to preserving fish. She was excited to take her first biology course at Simon Fraser University, but failed the course because of her own lack of high school science, and that experience ended her interest in pursuing the sciences. It wasn't until she developed her own dzaxwan (oolichan fish) curriculum as part of a research project that she realized she could teach science from both an Indigenous Science and Western Science framework and that the two often overlap. During her undergraduate education, Donna felt like an outsider who was expected to devalue or even abandon her identity and take a different identity similar to her science professors. Donna grew up understanding that animals, plants, and other life forms were her teachers. Like many Indigenous people, she understood that everything is spiritually imbued. "What I've learned from my non- Kwakwaka'wakw world will help me, my family, and community; but I'll always believe our creation story." As Donna states, "the master's program showed me how to teach both Kwakwaka'wakw traditional knowledge and WS side by side" (personal communication, September 5, 2013).

When Donna entered the Graduate Program in Environmental and First Nations Education she felt inspired to revisit her plans to teach science to Indigenous students, but first she needed to know more about it:

- What kind of knowledge did she know about from her ancestors?
- What kind of knowledge is Indigenous Knowledge? Is Indigenous Knowledge scientific?
- What kind of knowledge is Western Science?
- What does Indigenous Knowledge have in common with Western Science? How is it different?
- How can teachers implement the wisdom and knowledge of Indigenous Elders into the science classroom in a holistic and respectful way?

Teachers of Indigenous ancestry must discover who they are as teachers of Indigenous children and what they can bring to the classroom that would be relevant and honour the knowledge and wisdom learned from Elders. As teachers and educators, whether Indigenous or non-Indigenous, we can distinguish between understanding an idea and believing it, we contribute our own expertise with the understanding that we do not assume to have *the* one right answer of the way of knowing the natural world.

It becomes essential for teachers of Indigenous children to understand that serving their people is a paramount purpose of Indigenous education. Its purpose is not individual advantage or status. Indigenous children are taught from childhood to contribute to the greater good, to be useful, help one another, and pay attention to Mother Earth.

Similarly, teachers of all ethnic backgrounds must know who they are as teachers when teaching from a pluralist perspective. The following vignette, as told by Snively, describes an elementary science methods class she taught at the University of Victoria and the compelling response of Harjeet, a student of East Indian ancestry.

Harjeet's Story

When teaching my elementary science methods class, I include several sessions devoted to Indigenous Science from a multi-science perspective. This discussion includes the Indigenous Science of the Americas, as well as Chinese, East

Indian, African, and South American peoples. I include a discussion of how over 2000 years ago, East Indian, and North African peoples developed highly effective biodegradable pesticides from neem tree oil. The pesticide is so powerful that it kills swarms of locusts and other harmful insects, yet is biodegradable, and doesn't harm the environment. Neem oil works by blocking the real hormones from working properly—insects forget to eat, mate, or lay eggs, or eggs do not hatch. Neem oil is not known to be harmful to mammals, birds, reptiles, earthworms, or beneficial insects such as butterflies, honeybees, or ladybugs; only chewing and sucking insects. Traditional Ayurvedic medicinal uses of neem has an extensive history of human use in India and surrounding areas for a great variety of therapeutic purposes; including the treatment of acne, fever, leprosy, malaria, and tuberculosis, to name a few (Puri, 1999; Schmutterer, 1995). Discussion focuses on how families in India, if possible, have a neem tree nearby because it is considered a sacred drugstore. In fact, Western scientists and pharmaceutical companies have patented numerous pesticides and medicines from neem tree oil using ancient Indigenous Science knowledge and profited heavily.

After one such discussion, Harjeet, a student of second-generation East Indian ancestry and high achiever, asked to speak further. Harjeet recounted how as a little girl she loved science and wanted to go into the sciences at university, but her parents forbade her to take a science degree. She never understood why. With tears in her eyes, she continued, "Now I know that my parents didn't want me to go into the sciences, because they were afraid I would lose my culture. Now I know that I can focus on science and not lose my culture."

I lost contact with Harjeet for several years. Then, four or five years ago, I received a phone call from an ecstatic Harjeet who was getting dressed to attend graduation ceremonies at Simon Fraser University. Her Masters of Arts degree would be in education, with a specialization in the sciences. She wanted me to know that our discussions of multi-sciences convinced her parents she could study science at university. They understood that in the future, when she teaches science, it will include the science of her people.

Teachers from Indigenous ancestry who come from traditional backgrounds, and those Indigenous peoples from around the world, must discover who they are as teachers incorporating WS alongside IS in the classroom. As well, teachers from European ancestry must ponder how they feel as teachers of Indigenous students and what they can bring to the science classroom that would be relevant and inclusive without being tokenistic and that does not perpetuate assimilative practices.

Thus, we enter a co-learning journey that brings participants together who desire healthier communities and a healthy Mother Earth. Co-learning involves learning from each other, learning about our commonalities and our differences, and learning to weave back and forth between our cultures and beliefs and values as circumstances require. Within our co-learning journey, pluralism is increasingly acknowledged. We also recognize spirituality as central within Indigenous ways of knowing. In this regard, pluralism is increasingly acknowledged in the science classroom, but spirituality is seldom acknowledged. In this book, our understandings recognize spirituality as central within Indigenous ways of knowing. Many Indigenous leaders are adamant that spirituality cannot be separated from the physical world within Indigenous worldviews (Atleo, 2004; Bartlett & Marshall, 2012; Battiste, 2000, 2002, 2010; Battiste & Henderson, 2000; Ermine, 1995; Little Bear, 2000, 2009; McGregor, 2002; MacIvor, 1995; Michell, 2005; Sutherland & Henning, 2009). As Mi'kmaw Elder Albert Marshall explains, "We need to relearn how to talk with and listen to the trees" (Bartlett, et. al., 2012, p. 7).

In this book, our goal is to provide a model of science education that McGregor (2002) called co-existence, which promotes functioning of both systems side-by-side (WS and IS). This co-existence model strongly aligns with the model of "two-eyed seeing," in which an individual draws from two existing knowledge systems in ways dictated by the person's context. "The model of co-existence encourages equality, mutual respect, support, and cooperation" (Bartlett, et. al., 2012, p. 454). By walking in both worlds, or by "two-eyed seeing," Indigenous students in both rural and urban communities gain cultural knowledge and experience essential for accessing power as citizens in a Eurocentric dominated world, while maintaining their cultural roots in Indigenous wisdom traditions. For non-Indigenous students, who often live in impoverished mono-cultural worlds, the practice of walking in both worlds, "two-eyed seeing,"

students can gain access to wisdom-in-action principles for a richer cultural life. Thus, future scientists and engineers will be better prepared to help ensure quality of life, while making wise environmental decisions and sustainable progress on this planet.

It should be noted that we avoid using terms such as “integrating” knowledge systems, because the term is often used to denote two merged systems. The latter would open, and has opened, the door to forms of knowledge domination and assimilation. Integrative implies taking bits and pieces from Indigenous Knowledge and ways of knowing and appending them to Western knowledge and approaches.

Science educators are now being asked to rethink some fundamental issues on science education and establish a new rationale for developing scientific literacy, which fits with a contemporary socio-cultural context. Teachers must work towards an understanding of the cultural ideas and beliefs of their students and assemble a tool kit of teaching methods that are responsive to, and honouring of, all our students’ lived experiences. To enter into a relationship with students whose life-world may be different from that of our own, and to begin to see and understand the world in new ways makes the teaching of science interesting and challenging. It is a worthwhile journey that enriches our lives and one we can enjoy pursuing.

Clarification of Terms

In this book, we use the term Indigenous to refer to the collective First Nations, Métis, and Inuit. We generally worked with First Nations communities in British Columbia and we refer to them as First Nations or by their nation’s name.

Several terms referring to science are used in this book. First, we use the term *science* in a pluralist context, as described by Ogawa (1995, p. 588) as a “rational perceiving of reality,” so both Western and Indigenous Sciences can be categorized under this umbrella. We use WS to represent *Western Science* or Eurocentric Science or Modern Western Science. The science taught in most schools falls into this WS category. We use the term *Indigenous Science* (IS) to refer to the science of Indigenous cultures worldwide. Since the wisdom component of IS is rich in time-tested approaches that sustain both community and environment (Snively & Corsiglia, 2001), we take a pluralist definition of science, because it fosters the teaching of science in culturally responsive ways. Following Warren, et al. (1995), the term Indigenous Knowledge (IK), is defined as “the local knowledge held by Indigenous peoples or local knowledge unique to a given culture or society.” As a concept, Indigenous Knowledge systems correspond to the entire spectrum of philosophy, history, heritage, ethics, flora and fauna, educational processes, and much more. Thus, IK is the broader category that includes IS.

One additional concept, Traditional Ecological Knowledge (TEK) needs to be explained. Although the term TEK came into widespread use in the 1980’s, there is no universally accepted definition. The terms *traditional*, *ecological*, and *knowledge* are themselves ambiguous. As Berkes (1993) points out, societies change over time, constantly adopting new practices and technologies, making it difficult to define a practice as traditional. The term “ecological knowledge” poses definition problems of its own. If ecology is defined narrowly as a branch of biology in the domain of Western Science, then strictly speaking there can be no TEK; most traditional peoples are not modern Western scientists. As well, TEK is not about ecological relationships exclusively, but about many fields of science in its general sense, including agriculture, astronomy, medicine, geology, architecture, navigation, and so on. Even the term “knowledge” as a descriptor for this form of understanding is problematic. According to McGregor (2008), “Native people tend to describe TEK more as a ‘way of life’ than something which can be concisely described or written down” (p. 144). Concepts of TEK and WS are gradually changing as more Indigenous people gain voice in the environmental movement and in science, and science education discourse.

Thus, in this book we use the terms IS and WS. We use TEK more explicitly to refer to the land-related, place-based knowledge of long-resident, usually oral Indigenous peoples, and as noted, consider it a subset of the broader categories

of IS and IK. Although the term TEK arose at a time when ecology was beginning to inform Western knowledge and practices, many working scientists continue to prefer to use the term TEK, rather than IS. According to McGregor (2002, p. 2), whether one calls it Indigenous Science, TEK, or IK, “it is something one does.”

In Canada, government documents in most provinces use TEK interchangeably with IS/IK. Importantly, although the term TEK appears in some science education textbooks and reference books, Ministry of Education documents in most provinces use the terms “Indigenous Knowledge,” or “Indigenous Science,” not “TEK.” In this book, we capitalize Indigenous, Indigenous Science, Indigenous Knowledge, Traditional Ecological Knowledge, Elder, and Western Science.

Finally, we distinguish between the Indigenous Science of various ethnicities, for example, traditional Chinese science, traditional East Indian science, and traditional Japanese science. This distinction simply serves as a way to distinguish between highly heterogeneous groups whose way of knowing nature are both non-Eurocentric and place-based. There are additional concepts that recognize subordinate sciences (Aikenhead & Ogawa, 2007), but these categories are not discussed here because they are deemed beyond the scope of this book. The focus of this book is on the Indigenous Knowledge and Indigenous Science of Canadian Indigenous peoples, and in particular, glimpses the knowledge and science of the Indigenous peoples of Northwestern North America. Such a clear convention is used throughout this manuscript.

About this Book

The science curricula and chapters in Books 1 and 2 of *Knowing Home: Braiding Indigenous Science with Western Science* explore a vision of science education that pays attention to the unique ways of Indigenous teaching and learning. Together the chapters create an image of what a culturally energized science curriculum can look like. Although the book’s authors may not all subscribe to the same interpretation of IS or of IS education, their work or the work of the Elders and resource persons they describe, demonstrate a similar form of understanding. It is imperative that feasible models be placed in the hands of educational practitioners throughout our society in an effort to encourage further investigation as well as hope. *Knowing Home: Braiding Indigenous Science with Western Science Book 2* provides supportive research, case studies and curriculum projects that support and extend the chapters in *Book 1*. This book is divided into three sections to enable readers to either read the book cover to cover or just delve into areas they are specifically interested in reading.

The first section includes three chapters that taken together provide a theoretical, historical, and pedagogical support for the book. [Chapter 2](#), by Nan Kendy, provides a description of teacher workshops in the Witsuwit’en community of Witset (Morisetown), BC that were designed to encourage a transformational process that would deepen teacher thinking about (IS) knowledge while taking into account the knowledge and values of the Witsuwit’en peoples. The workshops engaged Elders, knowledge holders, and teacher excursions into Witsuwit’en territory as a medium for transforming teacher thinking about Indigenous science through cultural learning experiences. The research includes pre- and post-workshop questionnaires, an analysis of the participants’ responses and an overview of the workshops. [Chapter 3](#), by Anne Tenning, uses a metaphor interview to provide a description of the perceptions and experiences of Indigenous students in the greater Victoria school district who were successful in secondary sciences. As a result of the study, Anne makes several recommendations regarding science education that could be helpful for students, teachers, school districts and the BC Ministry of Education.

Section 2 includes 3 chapters by Gloria Snively that describe the orientations towards the seashore (scientific, spiritual, aesthetic, utilitarian, and recreational) of Grade 6 Kwakwaka’wakw students in ‘Yalis (Alert Bay), BC. [Chapter 4](#) describes how language (and in particular metaphor) is an important source of evidence for understanding the way we think and act; and Snively describes the metaphor interview in detail to reveal its subsumed techniques and richness in

illuminating the complexities of a child's belief system. In [chapter 5](#), Snively describes the orientations and beliefs of the Grade 6 students towards basic ecology prior to and after instruction. She describes an instructional strategy that takes into account the students' orientations and how it is possible to increase Indigenous students' understanding of Western Science concepts without changing, in the sense of replacing, the students' preferred spiritual orientation to the seashore. Using the longitudinal study in [chapter 6](#), Snively provides a description of the participants' orientations towards the seashore 19 years after instruction, and explores "significant life experiences" and "life-altering circumstances" that influenced the adults' orientations and choice of career.

Section 3 provides a rich sampling of culturally appropriate curriculum projects that focus on braiding Indigenous Science with Western Science, providing teachers with pedagogical support and resources. [Chapter 7](#), by David Ashurst, Rick Kool, and Gloria Snively describes a cross-cultural marine science program involving students of T'Sou-ke, Scia'new and Pacheedaht ancestry in an Environmental Studies 11/12 class at Edward Milne Community School in the municipality of Sooke, BC. The three-week program involved an exploration of WS and IS, learning about the local Indigenous culture, and the importance of Traditional Ecological Knowledge and Wisdom (TEKW). In [chapter 8](#), John Lyall focuses on the application of video technology to elicit and represent IK and IS. Student researchers at the Westshore Centre for Learning and Training in Colwood, BC, worked with their families, community resource people, and community Elders to identify science-related questions that were of concern to their community. Student videos included: "Seafood for Life," "The Evolution of a People," Scia'new Cultural Events," "Nuu-cha-nulth Language," "The Moon," and "Drug and Alcohol Abuse." [Chapter 9](#), by Tye Swallow brings together a collection of W?SÁNEĆ voices (a First Nations community near Sidney, BC) that taken together answer the question: "What is knowledge of most worth?" In 2012, the W?SÁNEĆ School Board (W?SB) established a SENĆOŦEN immersion school program that includes a language revitalization curriculum. Science education, as with all learning, cannot be learned entirely from the written word of a textbook in a classroom; it must be lived within the local community and experienced in a place-based (non-classroom) context. This story is, in part, about the journey of "SENĆOŦENizing" the school curriculum.

The reader will note that several chapters in both books, *Knowing Home: Braiding Indigenous Science with Western Science Book 1 and 2*, focus on the knowledge and experience of the Kwakwaka'wakw peoples. This focus on the Kwak'wala-speaking peoples is a result of the principal researcher, Gloria Snively, who enjoyed a 40-years-long relationship with the Kwak'wala-speaking peoples, presented several marine education workshops in the community of 'Yális, (Alert Bay), and conducted her doctorate research in association with the Alert Bay Community School and the 'Namgis Band Council. This association eventually led to the establishment of Alert Bay as the site location for the University of Victoria Graduate Program in Environmental Education, and more recently for the University of Victoria Graduate Program in Environmental and First Nations Education. Several articles written by graduate students of Kwakwaka'wakw ancestry are included in *Knowing Home Book 1*.

It is our hope that the science research and curriculum models in this book will plant seeds of thought and deep reflection regarding the under-representation of Indigenous students in the sciences. We must develop the openness and courage to take a creative leap and find in ourselves a vision of science education for all our children. Most important, it is intended that the rich examples and cases of Indigenous Science described in the various chapters, combined with the curricular connections, websites and resources listed in the Appendices [A](#), [B](#), [C](#), and [D](#) of Book 1, will enable pre-service teachers, teachers, districts, and curriculum projects; and serve as starting points for developing a broad range of culturally sensitive learning experiences and curriculum projects.

Importantly, teachers can download from the Internet all of the black and white illustrations and colour photographs in both Books 1 and 2 to include for instructional purposes in the classroom. When IS and WS coexist respectfully in the science classroom, *all* students will have a greater understanding of the science knowledge, skills, philosophy, and opportunities they need to direct their creative energies to the benefit of our collective futures.

REFERENCES

- Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education*, 27(1), 1-52. <https://doi.org/10.1080/03057269608560077>
- Aikenhead, G. (2001). Integrating western and Aboriginal science: Cross-cultural science teaching. *Research in Science Education*, 31(3), 337-355. <https://doi.org/10.1023/A:1013151709605>
- Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. Ways of knowing in science and mathematics. New York, NY: Teachers College Press.
- Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, 2(3), 539-620. <https://doi.org/10.1007/s11422-007-9067-8>
- Atleo, E. R. (2004). *Tsawalk: A Nuu-chah-nulth worldview*. Vancouver, BC: UBC Press.
- Bartlett, C., Marshall, M., Marshall, A., & Iwama, M. (2012). Integrative science and two-eyed seeing: Enriching the discussion framework for healthy communities. In L.K. Hallstrom, N.P. Guehstorff, & M.W. Parkes (Eds.), *Ecosystems, society, and health: Pathways through diversity, convergence, and integration* (pp. 280-326). Montreal, PQ: McGill Queen's University Press. Retrieved from [http://www.integrativescience.ca/uploads/articles/2012-Bartlett-Marshall-Iwama-Integrative-Science-Two-Eyed-Seeing-enriching-discussion-framework\(authors-draft\).pdf](http://www.integrativescience.ca/uploads/articles/2012-Bartlett-Marshall-Iwama-Integrative-Science-Two-Eyed-Seeing-enriching-discussion-framework(authors-draft).pdf)
- Battiste, M. (2000). Maintaining Aboriginal identity, language, and culture in modern society. In M. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 192-208). Vancouver, BC: UBC Press.
- Battiste, M. (2002). *Indigenous knowledge and pedagogy in First Nations education: A literature review with recommendations*. Ottawa, ON: National Working Group on Education and the Minister of Indian Affairs, Indian and Northern Affairs Canada (INAC).
- Battiste, M. (2010). Nourishing the learning spirit: Learning is our purpose in life. *Education Canada* 50(1), 14-18. Retrieved from <https://www.edcan.ca/wp-content/uploads/EdCan-2010-v50-n1-Battiste.pdf>
- Battiste, M., & Henderson, J. Y. (2000). *Protecting Indigenous knowledge and heritage: A global challenge*. Saskatoon, SK: Purich Publishing.
- Berkes, F. (1993). Traditional ecological knowledge in perspective. In J. T. Inglis (Ed.), *Traditional ecological knowledge: Concepts and cases* (pp. 1-9). Ottawa, ON: International Program on Traditional Ecological Knowledge/International Development Research Centre (IRDC) Books.
- Cobern, W. (2000). *Everyday thoughts about nature: A worldview investigation of important concepts students use to make sense of nature with specific attention to science*. Contemporary trends and issues in science education, Vol. 9. Boston, MA: Kluwer Academic Publishers. <https://doi.org/10.1007/978-94-011-4171-0>
- Ermine, W. J. (1995). Aboriginal epistemology. In M. Battiste & J. Barman (Eds.), *First Nations education in Canada: The circle unfolds* (pp. 101-112). Vancouver, BC: UBC Press.
- Kimmerer, R. W. (2013). *Braiding sweetgrass: Indigenous wisdom, scientific knowledge, and the teachings of plants*. Minneapolis, MN: Milkweed Editions.
- Little Bear, L. (2000). Jagged worldviews colliding. In M. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 77-85). Vancouver, BC: UBC Press.

- Little Bear, L. (2009). *Naturalizing Indigenous Knowledge: Synthesis Paper*. Saskatoon, SK: University of Saskatchewan Aboriginal Education Research Centre and First Nations and Adult Higher Education Consortium. Retrieved from http://www.afn.ca/uploads/files/education/21_2009_july_ccl-alkc_leroy_littlebear_naturalizing_indigenous_knowledge-report.pdf
- 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, BC: UBC Press.
- McGregor, D. (2002). Traditional ecological knowledge and the two-row wampum. *Biodiversity*, 3(3), 8-9. <https://doi.org/10.1080/14888386.2002.9712586>
- McGregor, D. (2008). Linking traditional ecological knowledge and western science: Aboriginal perspectives from the 2000 State of the Lakes Ecosystem conference. *The Canadian Journal of Native Studies*, 28(1), 139-158.
- Michell, H. (2005). Nēhîhâwâk of Reindeer Lake, Canada: Worldview, epistemology and relationships with the natural world. *Australian Journal of Indigenous Education*, 34, 33-43. <https://doi.org/10.1017/S13260110000394X>
- Ogawa, M. (1995). Science education in a multisience perspective. *Science Education*, 79(5), 583-593. <https://doi.org/10.1002/sce.3730790507>
- Ogawa, M. (1997). Socio-culturally relevant STS education. In *Proceedings of binational conference on STS science education*, (pp. 1-12). Taipei, Taiwan: Taiwan National Normal University.
- Phelan, P., Davidson, A. L., & Cao, H. T. (1991). Students' multiple worlds: Negotiating the boundaries of family, peer, and school cultures. *Anthropology & Education Quarterly*, 22(3), 224-250. <https://doi.org/10.1525/aeq.1991.22.3.05x1051k>
- Puri, H. S. (1999). *Neem: The divine tree, Azadirachta indica*. Amsterdam, NLD: Harwood Academic Publishers.
- Schmutterer, H. (Ed.) (1995). *The neem tree: Azadirachta indica A. Juss. and other meliaceous plants: Sources of unique natural products for integrated pest management, medicine, industry and other purposes*. Weinheim, Germany: VCH Verlagsgesellschaft.
- Snively, G. J. (1986). *Sea of images: A study of the relationships amongst students' orientations, beliefs, and science instruction* (Doctoral dissertation). University of British Columbia, Vancouver, BC. Retrieved from <http://hdl.handle.net/2429/27253>
- Snively, G. (1990). Traditional Native Indian beliefs, cultural values, and science instruction. *Canadian Journal of Native Education*, 17(1), 45-59.
- Snively, G., & Corsiglia, J. (2001). Discovering Indigenous science: Implications for science education. *Science Education*, 85(1), 6-34. [https://doi.org/10.1002/1098-237X\(200101\)85:1<6::AID-SCE3>3.0.CO;2-R](https://doi.org/10.1002/1098-237X(200101)85:1<6::AID-SCE3>3.0.CO;2-R)
- Sutherland, D., & Henning, D. (2009). *Ininiwi-Kiskānitamowin: A framework for long-term science education*. *Canadian Journal of Science, Mathematics and Technology Education*, 9(3), 173-190. <https://doi.org/10.1080/14926150903118359>
- Warren, D. M., Slikkerveer, L. J., & Brokensha, D. (Eds.) (1995). *The cultural dimension of development: Indigenous knowledge systems*. London, UK: Intermediate Technology Publications. <https://doi.org/10.3362/9781780444734>

Chapter 2 - Transforming Teacher Thinking about Indigenous Science through Cultural Experiences

NAN KENDY

My first teaching assignment, 30 years ago, was in the Witsuwit'en community of Witset, Moricetown in northern British Columbia, Canada. The elementary school overlooks some of the most spectacular beauty in BC, including the coastal mountain range, hectares of forested lands as far as the eye can see and a canyon where the Widzin Kwah, Bulkley River runs through. The Witsuwit'en peoples have travelled and harvested these lands, forests, and waterways for thousands of years. Like most reserves bordering settler communities many Witsuwit'en students living on reserve are bussed into the neighbouring town on their territory to attend school. The number of students of Indigenous ancestry enrolled in this school district increased from 10% in 1995 to 21% in 2005/2006 and again to 23% in 2014 (School District #54, 2013-2018). Indigenous student enrollment and achievement in the sciences for this northern school district is similar to that reported in the BC Provincial Required Examinations in 2010 and 2011 (Yore et al., 2014). Specifically, Yore et al. reported that Indigenous students' participation in biology, chemistry, and physics in BC continues to be proportionately lower than their non-Indigenous counterparts and there continues to be a performance gap between the two groups with the Indigenous students achieving lower scores on required provincial examinations. Statistics from a study by the Canadian Education Association show that Indigenous students continue to lag behind: "In Canada, there is a critical underrepresentation of Aboriginal [sic] peoples going into science-related programs at the post-secondary level. This has an impact on their ability to participate fully" (Murray, 2015, p. 21).

The Aboriginal Enhancement Agreements, the BC Ministry of Education's Integrated Science Resource Packages (IRP 2005, 2008), as well as the 2015 curriculum, encourage place-based learning experiences and Indigenous community involvement in schools, and suggests ways to include Indigenous Knowledge in the K-10 curriculum alongside the Western science model. These efforts by the BC Ministry of Education suggest that a new paradigm in science education needs to be traversed to attract and inspire Indigenous students to the sciences. The challenge inherent in this process of policy change is in transforming Western science teachers' view of science to include Indigenous Knowledge. Barnhardt and Kawagley's (1998) work details their efforts in trying to facilitate this change. They have identified the difficulty many Western educators and scientists have in understanding Indigenous Science (IS) knowledge.

At the heart of the problem are different worldviews, values, traditions, and histories. These differences form a cultural disconnect that triggers and nourishes misunderstandings and misperceptions on the part of both groups. (p. 10)

For more than a decade we have witnessed a pedagogical shift away from attempting to change students' attitudes about learning Western science paradigms towards changing teachers' attitudes and to valuing Indigenous ways of knowing through teacher professional development.

Teachers as Change Agents

Before teachers can become effective change agents in an educational system that has worked to assimilate First Nations, Métis, and Inuit peoples for over a century we must be able to change our way of thinking. Becoming mindful of our pre-conceived notions, the thoughts and judgments, which impact our teaching practices is imperative. For

Williams (2005) this means being able to “transform our frames of reference through critical reflection ... become aware of our habits of mind and points of view through reading, experiential activity, and interacting with others where we can compare new knowledge with past knowledge” (p. 70).

As a Canadian of European ancestry, participating in First Nations life-ways has transformed my life. My teaching experiences in the north and a spiritual life with my adopted Cree family, under the guidance of the late Joe P. Cardinal and his wife Jenny have played a major role in altering my Euro-centric worldview. Through the lived experience of First Nations ways of being I have come to ally myself with First Nations peoples, and work to honour their ways of knowing in educational practices. Kanu (2005) contends that learning experiences, which are transformational in nature, can lead to change in the classroom and ultimately affect individual students. Her study determined transformational experiences to be the incentive for both non-Indigenous and Indigenous teachers integrating an Indigenous curriculum into their science programs and argued for more transformative experiences to inform teacher practices. This chapter presents a brief summary of an experiential learning journey to encourage a transformational process that would deepen teacher thinking about (IS) knowledge while taking into account the knowledge and values of the Witsuwit'en peoples.

Introducing the Learning Experience

Methodologies

The teacher workshops and data gathering phase of this research project took place on the traditional territory of the Witsuwit'en peoples during the spring and summer of 2006. Aspects of Indigenous methodologies that were central to the lived experience of the Witsuwit'en peoples with whom I was conducting the research such as prayer, song, drumming, gifting and feasting were identified, integrated, and practiced (Kendy, 2007). Engaging in these traditional protocols demonstrated respect and reverence for the values and ethical practices of the Witsuwit'en peoples. “Ceremony focuses attention so that attention becomes intention.... Ceremonies transcend the boundaries of the individual and resonate beyond the human realm” (Kimmerer, 2013, p. 249). Another key component of the methodology was to bring the participants together in a dialogical process, which provided a forum for listening, reflecting, and sharing perspectives. The dialogue circles provided an opportunity for people of different cultures to listen and learn from each other. In order for authentic change to occur for non-Indigenous peoples, it often requires the suspension of their Euro-centric assumptions in order to listen deeply to another point of view. According to Williams and Tanaka (2007), dialogue can lead “to a space that allows for power balances to shift, and cross-cultural meaning making to occur” (p. 7). The dialogue circles helped deepen our understanding of IS enriched by a Witsuwit'en worldview. This chapter includes pre- and post-workshop questionnaires, an analysis of the participants' responses and an overview of the workshops.

Professional Development Model

The land, yin tah, is integral to the Witsuwit'en peoples and their way of life. Their holistic view of the land integrates all knowledge, including IS knowledge. The land, extending to the headwaters of the Widzin Kwah, Bulkley River was central to the teachers' learning experience ([Figure 2.1](#)). For that reason, Workshop 1 was conducted on Witsuwit'en traditional territories. Stories and lessons from the land told by the Elders and knowledge holders informed our learning in Workshop 2. The traditional lunch of oolichan, moose meat, salmon, and berries was gathered from the land (catered by Christine William). The dialogue and brainstorming sessions included discussions about activities on the land for

youth and Elders. The two-way arrows indicate the reciprocal relationship of gratitude and reverence the people have with the land, the water, the plants, and the animals, which became the theme of our learning and understanding of IS knowing. Pre- and post-questionnaires addressed teacher knowledge of First Nations students and IS as it related to the people on whose traditional territories we live and work.

A Working Model for Professional Development

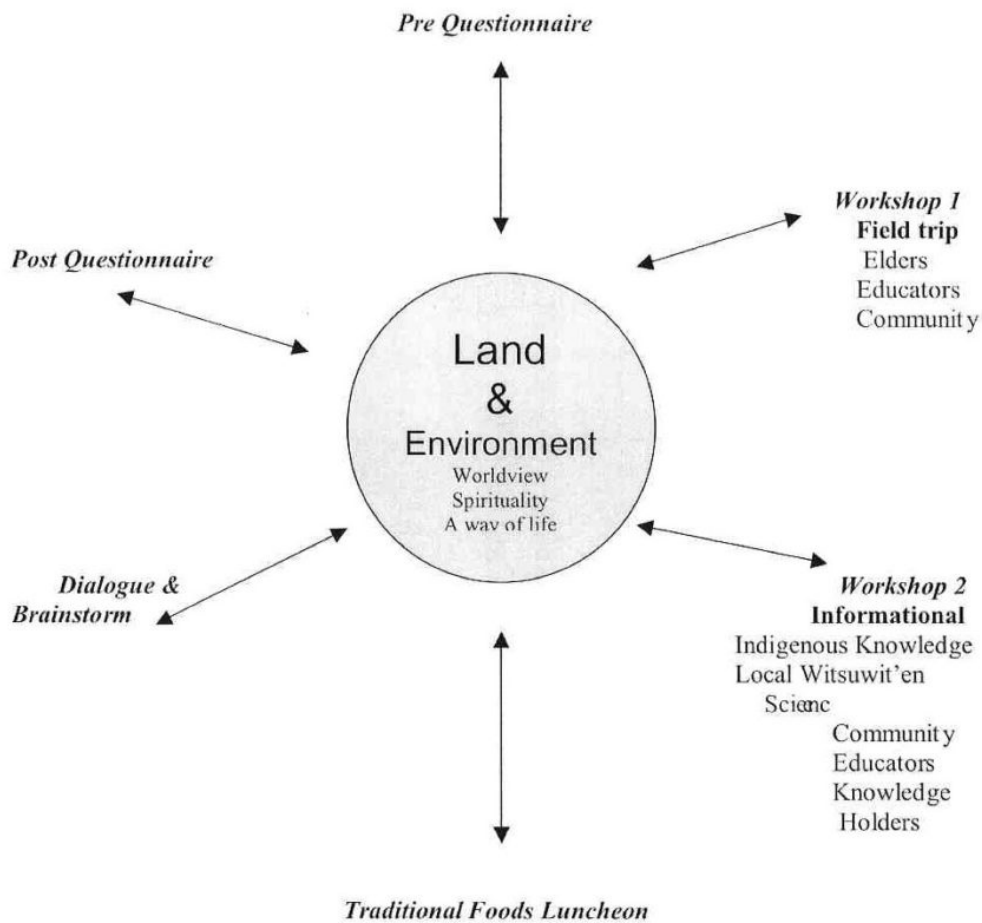


Figure 2.1 ▲ A working model for professional development. (Kendy, 2007, p. 205)

Participants

The Teachers

It became clear through the recruitment process that the teachers who agreed to become involved in this research were life-long learners who were willing to take risks and were open to new ideas. Cajete (1999) explains the elements necessary for science teachers to become change agents:

Becoming open to the paradigm of Indigenous science has some prerequisites, which need to be considered. There must be an understanding and acknowledgement of the history of exploitation of Indigenous peoples by Western culture and science. There must be a willingness on the part of the non-Indigenous teacher to view science from a perspective that is 'inside out, upside down and the other way around' or, more simply put, without bias and with deep vision which allows for a deep examination of habitual thought processes. This means reflecting on Indigenous science based on its own terms and methodologies without stereotyping or trivializing its essential components. (p. 185)

Research participants included eleven elementary school teachers and six high school teachers of biology, chemistry, and physics initially representing Grades K-12. Teacher career experience ranged from 3 years to 44 years. As part of the data collection participants were given pre- and post-questionnaires with the option of anonymity in their responses. Where teachers were quoted, a letter of the alphabet (A-O) was used to protect the identity of the participant.

The Elders

Two respected Elders and Hereditary Chiefs from the Witsuwit'en Nation participated in the first workshop. At this time, Gisdewe (Alfred Joseph 1927-2014) was the Hereditary Chief of one of thirteen houses of the five Witsuwit'en clans. He was raised by his grandmother and had a lived experience on the territories. Gisdewe carried with him the historical knowledge of his people. He was instrumental in interviewing and documenting the Elders' oral histories for the famed *Delgamuukw v British Columbia* Supreme Court of Canada case (1997). In this landmark case the Supreme Court respectfully recognized Aboriginal land rights, including Aboriginal title (past and present), Aboriginal law and oral histories. According to Morin (2016) it meant that for the first time, "oral histories had been acknowledged and taken seriously by the courts and the Government of Canada" (p. 326). This case created a duty to consult the Hereditary Chiefs before industry and development could remove resources from their territories. In 2009 Gisdewe was awarded an honorary degree by the University of Northern BC for his life's work.

The second Chief Wigidimsts'ol, the late Dan Michell was a Wing Chief. He had been a hunter, fisher, and trapper on the territories all his life, and knew the political and environmental issues that surround these life-ways from a deeply personal and spiritual place. Both Elders were fluent in their language. Throughout the field trip they conversed in Witsuwit'en, teaching us names and phrases for places along the journey.

Other Participants

Personal face-to-face invitations were extended to the Aboriginal Support Services Educational Team (Asset) workers, the District Principal for Aboriginal Education 'Ilhdesinon Birdie Markert and the Curriculum Developer. These resource people were to guide, inform, and potentially gather materials to build culturally relevant resources. Additional guests in the second instructional workshop included Tsalik Mel Basil (a representative from The Friendship Centre) and Dr. Ross Hoffman (a professor from the University of Northern British Columbia First Nations Studies program). These invited guests discussed Indigenous Knowledge (IK) and Traditional Ecological Knowledge (TEK); and participated in the dialogue circles. Traditional Ecological Knowledge is best described by the Witsuwit'en peoples:

TEK has no equivalent name in Witsuwit'en. Western science tends to break things down into parts, whereas our Ancestors viewed the world as a whole.

The closest way to describe traditional ways of living and knowing comes from two terms: *yin tah* (earth, land, territory) and *?annuc niwh'it'ën* (our way of life, laws, knowledge). *Yin tah ...* is not just the land itself, but all the plants, animals, and people that inhabit it. *?Annuc niwh'it'ën* is determined by this view that all life is connected.

In time, ecologists, biologists, archaeologists and other scientists started to realize that TEK and oral histories offer real longer-term observations about the environment, marking changes over thousands of years, which help confirm or refute scientific theories. (Morin, 2016, p. 74)

Teachers' Thinking Before the Workshops

Pre-Workshop Questionnaire and Findings

The pre-workshop questionnaire inquired into non-Indigenous teachers' thinking about Indigenous student success and IS. What follows are sample questions from the pre-workshop questionnaire and the themes that emerged from the analysis:

1. How many Indigenous students are in your science classes and what Nations are they from?
2. Evidence suggests that Indigenous students are under-represented in the sciences. Why do you think this is the case?
3. Define what science means to you.
4. Do you include IS knowledge in your science program?

Theme 1 – Non-Indigenous teacher thinking about Indigenous students

a) Relationship building. Building relationships with Indigenous students was evidenced in two teacher responses. One high school biology teacher who was experiencing success with Indigenous students explained, "It's really about getting to know the students." One half of the teachers knew the number of Indigenous students in their class. One third of the teachers indicated they knew the Nations represented in their classes.

According to Ignas (2004) and Kanu (2005), lack of relationship between teachers and Indigenous students is consequential to student success. Kanu explains that a mismatch between a student's culture and the culture of the

teacher and classroom sets the student up for failure if teachers aren't able to demonstrate tolerance or sensitivity to the cultural special needs of the child. Ignas has found the best way for Indigenous students to experience success in science is in teacher recognition of an Indigenous perspective in science education.

b) Systemic and Cultural Deficits. Teachers' responses to Indigenous students' under-representation in the sciences fell into two categories: systemic and cultural deficits. Systemic deficits included low self-esteem due to systemic racism, lack of subject relevancy, lack of relevant resources, and Indigenous students' lack of academic skills. The majority of teachers believed lack of student self-esteem is the reason for Indigenous students' under-representation in the sciences. One teacher explained:

Aboriginal [sic] under-representation in the sciences is due to a lack of self-esteem, embedded racism within the system, where Aboriginal students [sic] may feel inadequate and not welcome or cannot identify with the teacher. (Participant D)

Many teachers believed the science curriculum lacked relevancy for Indigenous students. One teacher explained:

My top student in Earth Science 11 is a Cree student. He is a very intelligent fellow and he was a good C+ and B student in Science 9 and 10, but he is an A student in Earth Sc.11. I know he spends a lot of time outside. He is attuned with the outside; he likes to learn more about the things that are relevant to him. (Participant A)

Cultural deficits were identified as lack of student motivation and included socio- economic factors. Teacher participants D, E, L, O indicated there was a lack of home and family support; "Students don't see science as important and education is not a priority for many Aboriginal [sic] families." "Since they don't think science is important there is no focus or concentration. Because of lack of focus they end up with little or no skills and show little interest." "Students are dealing with alcohol, drugs, abuse, and neglect. They don't have time for anything else." Viewing Indigenous students' under-achievement as a cultural deficit in an education system modeled on a Eurocentric paradigm, shifts responsibility away from the teachers and further marginalizes Indigenous students.

Theme 2 – Non-Indigenous teachers' understanding of Western and Indigenous Science and the impact their thinking may have on Indigenous student success in science

a) Conflicting Views of Science. Teachers' definitions of science were mostly based in the Western scientific method construct. This perspective fosters one point-of-view, the Western worldview. A case in point is Participant B's comment in the post-questionnaire:

I would like to emphasize the importance of terminology. I have no problem with 'Aboriginal knowledge' [sic] and 'Aboriginal technology' [sic]. For me 'Aboriginal science' [sic] and 'Native Science' [sic] are artificial terms that I would not use. Scientific thinking and methodology was not part of the Aboriginal [sic] way of thinking and should not be confused with knowledge.

This participant appears to have misinterpreted the holistic, interconnected, and inter-relational knowledge inherent within IS.

b) Contradiction. The data indicates that most of the teachers included aspects of Indigenous Knowledge in their science class although they weren't aware of the scientific implications specific to Indigenous Science. From their responses, many teachers appeared to be teaching something they didn't believe they knew much about. This finding is consistent with previous studies by Aikenhead & Huntley (1999) suggesting that for students who "move from their everyday culture into the culture of school science, the move is called *cultural border crossing* ..." They need a teacher who is a "cultural-broker" to move between the Indigenous cultural worldview and Western science cultural worldview to help students "deal with cultural conflicts that might arise" (p. 160). Other educators (Cajete, 2000; Kawagley, 1999; Haig-Brown, 1992) maintain there is an underlying need for this process to occur in a science classroom in order for Indigenous students to feel validated. Teachers indicated they do IS, but how much or how well they function as cultural brokers is unclear.

Pre-workshop Questionnaire Implications

Western education has failed to accommodate Indigenous students whose knowledge systems and worldviews are different from their Western counter-parts. In order to appreciate IS, teachers would benefit from education in IK and values (Aikenhead & Huntley, 1999; Barnhardt & Kawagley, 1998; Cajete, 1994; Ignas, 2004). Knowledge of the historical background of Indigenous peoples; the effects of colonization including issues of poverty, land, health, and intergenerational trauma from residential school abuse would help teachers build understanding of their interrelation to Indigenous student success. Otherwise, teachers' beliefs and cultural assumptions carry the potential to re-victimize the victims.

The Workshops

The first workshop was a nine-hour experiential field trip to visit the territories of two Witsuwit'en Hereditary Chiefs. The second workshop was a half-day informational session, which included an overview of Indigenous Knowledge (IK) and a local perspective on IK and Traditional Ecological Knowledge (TEK).

Workshop #1

The overall intent of this workshop was to present elements of IS demonstrated by the Witsuwit'en Chiefs' relationship to the land and to identify culturally appropriate and effective ways of teaching and learning science knowledge based on local TEK of land use that maintained sustainable economies and communities for generations. When out on the land the Elders shared their knowledge through stories pertaining to Witsuwit'en ways of knowing and being. These stories were grounded in the holistic knowledge of the Witsuwit'en peoples, their use of science-based knowledge, and their methods for survival in these territories. Stories from the Elders about sacred places, use of place names, and ecological consciousness helped participants to understand that the Witsuwit'en peoples have territories they have been caretaking for centuries, and that it is their close spiritual connection to the ecosystems of these territories that has allowed them to sustain themselves and their culture over time.

Some key concepts of IK as it applies to the Witsuwit'en covered the vastness of the territory, the seasonal cycling of the people through the hills, valleys, and waterways of these lands, and many time-honored traditions. Of particular note was the way in which each of the Chiefs referred to and described their territory. The territories we were on were defined by house boundaries and Witsuwit'en place names the Chiefs could physically point to and talk about. They identified the hills, land benches, mountains, rivers and streams, meadows, as well as, trails and migration routes that define their territory. "Chiefs who knew the boundaries of their territories well had authority that was respected." (Morin, 2016, p. 60). The overriding understanding in defining territorial boundaries and land use is that it is controlled, and the harvesting and regeneration of resources are kept in balance. This is still evident today.

The Elders told stories of the former caribou migrations and ethical stories about the return of the salmon people. *The Boy Who Played with Fish Bones* (Morin, 2016) told by Gisdewe, taught the lesson that the return of the salmon depends on how they are treated. He explained how the Witsuwit'en believe it is important to treat fish and fish bones with respect. In this way the spirit of the fish is honored ensuring the fish will return again the following year. Wigidimsts'ol, talked about traditions of spiritual guidance in naming ceremonies as they applied to him. He described the footprints of their prophet Bini still located on this territory. He shared how the peoples' keen observation skills allowed families from all over the territories to arrive at their summer camp, 75 miles overland from their winter territories, within a few days of each other. We learned how the Witsuwit'en peoples' knowledge of IS stems from their knowledge of plant and animal resources of the forests, plateaus, and valleys. The use of this knowledge for producing food and medicines extends to the tools they design and use for sustainable existence. The IS that persists today is evidenced in their values of protection and management of the natural resources. The Elders explained the technology of the fish traps and the fishing weir and their traditional use as a form of selective harvesting. These ancient technological methods allowed for the identification of different species of fish and for tracking them by their sex and size—returning the spawning females without harm (Morin, 2016, p. 78). Wigidimsts'ol emphasized that the Witsuwit'en peoples' relationship with the land is an ongoing and complex way of life that is continually evolving and changing as they seek a balance with the high demand for traditional resources. (See *The Ways of Our Ancestors* by Morin, 2016, for a treasure trove of significant information about the Witsuwit'en worldview, technology and IK).

The extensive logging and mining observed along this journey served as a comparison study for sustainability practices between corporate economies and Witsuwit'en traditional values. Passing by a long abandoned, silver mine (formerly Equity Silver Mine) teachers were moved to learn that the mine was still responsible for the ongoing acid rock drainage pollution of neighbouring streams and distant water systems. Wigidimsts'ol, told us he had to haul his own water to his isolated cabin because the stream running behind the cabin is polluted from the acid rock drainage. As we approached this Elder's cabin, we could see there was a high level of logging taking place. In the post-workshop questionnaire one of the participants commented:

I can't emphasize enough how profound it was to be with the Elder when he 'discovered' the intense logging around his cabin and on his territory. At that moment, I became very aware that we are 'visitors' on land we think of as our own." (Participant G)

All the territories we were driving through had experienced high levels of logging operations, road building across territories, polluted streambeds and pesticide spraying that impacts the fishing, hunting, and gathering practices of the Witsuwit'en peoples. Wigidimsts'ol, commented earlier on how the logging and mining has disrupted their traditional trap line use and their berry picking opportunities. Participant L commented:

I was amazed when I saw for my own eyes how the forest industry has affected the Aboriginal people. The Elder's concern was for the animals, "Where do they go when the trees are all down?" He told us the reason the logging company gave him for logging his territory was because of the pine beetle bug infestation. When asked about the clear-cut logging, Wigidimsts'ol explained: "The beetles flying ability is limited to short distances, can't fly too far on their own, all this cutting and hauling may be spreading them."

Canadian Forest Products Ltd. (Canfor), the largest producer of softwood lumber in Canada, has operated for decades throughout the Witsuwit'en territories. What stood out for Participant H on this trip was the "continued lack of communication and understanding between industry and First Nations." Another teacher participant commented in the post-workshop questionnaire, "It was very powerful. Their knowledge of their land, their connection to nature, and their past experiences helped me to understand the deep connection that science plays in their culture" (Participant L).

Workshop #2

The second workshop was a half-day informational session held in the Aboriginal Resource Centre that included dialogue circles and brainstorming. Different presenters spoke to the literature on IK, IS, and TEK.

Indigenous Ways of Knowing

Dr. Ross Hoffman, from the University of Northern British Columbia, shared *A Conceptual Framework of Indigenous Knowing* from his doctoral dissertation (2006). He presented on the components of Indigenous Knowledge and the characteristics of how this knowledge is transmitted. This presentation sparked questions such as, "Is Indigenous knowledge genetic?" and "What about those who have grown up in modern times, away from their traditions? Does this still apply?" The prolonged question period and discussion that followed made it apparent this was new information for most of the teacher participants. Post-workshop questionnaire responses indicated teacher appreciation for the Indigenous Knowledge presentation.

Local Traditional Ecological Knowledge (TEK)

Morin recounts the traditional knowledge and wisdom of the Witsuwit'en as practiced on their traditional territories:

Our Ancestors, because of necessity, were keen ecologists. This knowledge was gathered from thousands of years of observation and experience. Understanding how animals and fish reproduced and migrated made our Ancestors better fishers, hunters, and caretakers. In-depth knowledge of animals and their habitats allowed our Ancestors to take what they needed without over-harvesting the creatures they relied upon.

Scientists often refer to this as "Traditional Ecological Knowledge" (TEK). This knowledge, deeply rooted in respect, was expressed through stories and rituals. (2016, pp. 71-72)

Thanks to the work conducted by the House Chiefs and the Office of the Wet'suwet'en [Sic] Natural Resources department I was able to present a poster of a TEK matrix (2005) and a map of the Chiefs' territories depicting traditional land use, including food plants and animals found within each Chiefs' territory. This time-proven knowledge and in-depth information about the local resource areas provided by the Elders and Chiefs and documented through a modern Geographic Information System (GIS) demonstrated how traditional knowledge and contemporary technology can help

protect Witsuwit'en interests and lands for treaty as well as protect against future intensive mining, fishing, and forestry practices (Gauthreau, Mitchell, & Naziel, 2007; Office of the Wet'suwet'en, 2011). I also shared archived photographs of local Witsuwit'en engineering technologies for building bridges, building fish traps, nets and weirs, drying racks, traditional longhouses, carved poles, and canoes to help teachers locate the different scientific principles inherent in Witsuwit'en technologies. A Witsuwit'en cultural teacher presented an authentic tumpline (a belt worn over the top of the forehead and attached to a large pack for carrying supplies) his grandmother had woven. This same teacher also discussed with us the difficulty he and his class experienced trying to construct a traditional conical fish trap. He expressed the mathematical and technological challenges. Mel Basil of Gitxsan and Witsuwit'en heritage explained the concept of controlled burns as a means of sustaining the forests and berries. Traditionally, Witsuwit'en women maintained most berry patches through the use of fire to control brush and increase nutrients in the soil. Hot, quick fires stimulated growth and increased the production of larger berries (Morin, 2016). Mel shared a story that demonstrated how the once abundant and well-tended huckleberry bushes may have contributed to the health of the woodpecker population, which kept the pine beetle population in check. He explained how his people traditionally prescribed burns of the forest to bring health and abundance to the berry patches. The people maintained the growth of the huckleberries; the propagating mature woodpeckers fed the desired huckleberries to their young while they in turn feasted on the pine beetles. This cycle naturally produced more mature woodpeckers and fewer beetles until the settler community intervened in that cycle and made burning illegal. Eventually there were fewer huckleberries which led to fewer mature woodpeckers, who we were told, were the greatest natural predator to the pine beetle.

Dialogue Circles

Sharing participants' own experiences of WS education and then reflecting on their field experiences in dialogue circles helped deepen educators' understanding of the holistic nature of IS and ways of knowing. The inherent value of dialogue between different cultural groups is illuminated by this teacher's comment:

The whole idea of the balance between the huckleberry bushes and the burning and the woodpeckers and the beetles, I mean that's fantastic! If we can all help our students gain a better sensitivity to balances like that you know we all gain. (Participant A)

Brainstorming ideas to integrate cross-cultural science initiatives included: partnering teachers with Elders and resource people from the Witsuwit'en community; developing grade specific experiential learning opportunities based on the curriculum requirements to increase local cultural and scientific understanding; school and district wide thematic planning that acknowledges IK, TEK and IS systems; incentives to encourage Indigenous Science Fairs; and ongoing mandatory workshops on culturally appropriate teaching methods and professional development in local IK and Indigenous history.

Teachers' Responses to the Workshops

Post-Questionnaire Findings and Implications

The analysis of teacher responses presented re-occurring thoughts and points of view that were grouped into themes and restructured into a narrative report. These themes continue from the pre-questionnaire.

Sample questions from the post-workshops questionnaire:

1. After the field trip and dialogue what stands out for you about your experience?
2. Have the workshops changed your thinking about Witsuwit'en knowledge and culture? If so, in what way?
3. Do you think you could include IK and IS in your science classes? Why or why not?
4. What do you think might be some barriers to teaching IS in the classroom?
5. What do you think some benefits might be of teaching IS in your class?

Theme 3 – The Power of Experience

Participants used terms like “profound,” “aware,” “wonderful,” “surprised,” “impressive,” “interesting,” and “powerful” to explain what stood out for them from this professional development experience. Overall the teachers believed they gained a deeper and broader knowledge of the Witsuwit'en peoples:

This opportunity to go with these people and have them say this about the land and the catalogue that they have. I didn't know they had territory out there and I certainly didn't know how they interacted with that territory. After that day I got all that knowledge. You get it in a roundabout way, from listening and not from the traditional WASP ways. It's quite impressive. (Participant J)

Another participant explained:

I appreciated having genuine experts share their knowledge about land management and relationships with the environment.... It seemed to me that the day spent on the Elders' territory took us into a time/philosophy machine where values of respect, responsibility, and relationships were the most important values. It made me realize the amount of technology and science that exists amongst the Aboriginal culture; a science that in my view surpasses often what we think as scientific. (Participant K)

The participants acquired knowledge on many levels about the Witsuwit'en peoples they didn't previously know:

I was surprised by the kindness of the Elders and guest speakers towards us. They were so welcoming and open with us despite our lack of knowledge and the racism they must all experience at the hands of us whites and the history of the terrible relationship between whites and the Aboriginals in the past. (Participant I)

This new knowledge provided insights:

I think that the complexity of the culture that was certainly here before us, stood out for me. Complexity in diet, in political structure, in rules, you know all those things surprised me, that it would be that complex! It

certainly made me interested in looking into it in greater detail. (Participant A)

Teachers began to identify elements of IS:

Astronomy and navigation/orienteering are considerations for me to explore. I'll try to use physical, biological, and technological examples in my science classes. (Participant G)

Most teachers indicated a greater awareness of another point of view, underlining the importance of inviting Witsuwit'en resource people into their classes in the future. Teachers recognized Indigenous technology as, "not just out there (Inuit, kayaks) but as localized." One participant wrote, "I hadn't thought in terms of Aboriginal science and knowledge in regards to conservation and sustainability in nature" (Participant I). Teachers agreed, "the experiences opened lines of communication." They expressed respect for the local Witsuwit'en culture and a more positive outlook toward Witsuwit'en peoples; "more hope"; a sense that a "better understanding of the history and culture of the people leads to greater tolerance;" and the ability to "see more possibilities." "Anybody who lives here should know about the people who have lived around here in the past and their former way of life" (Participant B). A teacher of 26 years wrote, "The dialogue made me very aware of how closely Aboriginal people are linked to the land. I've been rethinking my teaching in order to be more holistic" (Participant G). This same participant crystallized the reflective actions necessary to evoke teacher change, "I used the time to make connections between past beliefs and emerging understandings."

Theme 4 – Barriers to Teaching Indigenous Science

Participants cited lack of time and resources as well as curriculum restraints as barriers to teaching IS. While many wanted to address IS knowledge in their classrooms they were not sure about what is considered public vs. private knowledge. Many teachers felt uncomfortable and unknowledgeable in teaching IS. They identified a need for additional training and teacher friendly resource materials. Specifically, they asked for more role models (Indigenous teachers), more field experiences led by Elders, more resources and materials developed in concert with Indigenous educators as ways to connect with the knowledge holders. Elementary teachers asked the Indigenous educators for help in gathering local Indigenous resources to meet the learning outcomes in the BC Ministry of Education's Indigenous Science curriculum. It was understood that this meant meeting the IS learning outcomes in Ministry documents that were in the process of being revised and updated. Many teachers expressed a willingness to work alongside Indigenous educators to create materials defined by the local Witsuwit'en community as meaningful to Indigenous student knowledge.

Theme 5 – Benefits

Most teachers believed that including IK and IS in science curriculum would foster role models, pride, self-esteem, and respect amongst the Indigenous students and an appreciation for Indigenous skills and expertise amongst the non-Indigenous students. As a result of the workshops the majority of teachers agreed that IK, including IS, provides a holistic perspective for students to consider in their thinking. They felt that demonstrating additional ways to think about and do science would broaden students' views of science, allow for more applied science and increase student participation in the sciences.

Unpacking the Learning Experience

Challenges

Western models of science education have a great deal to learn from Indigenous scholars, Elders, and teachers. Two critical challenges that need to be addressed in education are spirituality in science and Indigenous language development. Indigenous language and spirituality are rooted in the land and are dependent on the relationship of the people with the land.

Spirituality

In the pre-workshop questionnaire Participant A referred to the perspective of spirit in IS as not being science, “Things that are more spiritually based necessarily wouldn’t be science, but things of the practical world that people picked up are.” Another teacher questioned how the link to spirituality fit into science? During our fieldtrip out on the land, Western science-based teachers were introduced to the idea that all knowledge is sacred. Various spiritual teachings demonstrated the physical, biological, and spiritual fusion of the environment with the Witsuwit’en knowledge systems:

It was marvelous to hear about the markings at birth. One fellow was marked with a feather and the agility of a squirrel, so he would be strong and would be able to walk, climb, and hunt for his clan. (Participant J)

In the post-workshop questionnaire, Participant A explained that they should be better prepared for the spiritual aspects:

You can’t just talk about the person who predicted, Bini their prophet, because for the Western people it loses all relevance, their eyes glass over. You have to prepare others for that kind of experience. Those things are so extremely important because how do you get to know about people?

This example from the non-Indigenous teacher explains the need for change in science education. Many non-Indigenous peoples are challenged by the fact that spirituality is an important component of IS. It is a complex subject and needs to be respectfully addressed in science education. Respected Witsuwit’en Elder Killset Violet Gellenbeck explains:

I think that the Witsuwit’en Nation is no different than any other nation in that we look at everything around us as being spiritual. And, when we say that, we’re talking about everything that grows on this earth and everything that walks and crawls on this earth: the water, the seasons, the food and the animals. (Morin, 2016, p. 78)

The late Dr. Oscar Kawagley and Yupiaq Elder was educated both traditionally by his grandmother and in Western education, cites the seriousness for educators ignoring this disparity:

My own undergraduate science education was derived from textbooks, laboratory manuals, and learning through the scientific method. These teaching and learning processes do not, however, take advantage of the students' environment, or the environment's ecological processes. Nor do they prepare the student to recognize a creative force flowing in and around them at all times. The removal of the mystical force from scientific processes has rendered a society...that no longer honors and reveres nature, but often misuses, abuses, and disrespects it. (Kawagley, 1995, p. 89)

Teachers indicated the need to be “reminded of the importance” of spirit to knowledge and the importance of studying science from and with the land. For example, biology teacher Participant C stated, “I was reminded of the importance of taking students out to experience the learning on the land when studying fish, herbal medicines, and the forest.” This knowledge seems critical for WS education to attract and retain Indigenous youth. Supporting an Indigenous perspective of reverence, which seeks respect for the plants and animals and demonstrates thanksgiving for the life forms that support and feed mankind may help all students to ultimately deal effectively with sustainability and resource issues.

Conclusion

The Elders, in their role as teachers, sparked an interest into how their spiritual connectedness to the land informs their past, present, and future. Their holistic lessons of “sustainable prosperity” introduced concepts of reverence and synergy in relation to all living things. This Witsuwit'en worldview of science presented a cumulative and intergenerational model that not only embodied many principles of Western scientific methods (observing, questioning, predicting, theorizing, experimenting, and adapting); but also incorporated deep, powerful experiences and wise traditional practices derived from an intimacy with the earth. This shared knowledge provided educators with a holistic, bioregional model that incorporates the human being into the story of local ecology passed down through generations and suggests how to live in “good relation” to our natural environment. Engaging science teachers in a dialogue with Witsuwit'en knowledge holders contributed to teacher understanding and respect for their Witsuwit'en neighbours. Teacher responses summed it up very well, “It is important that people learn the history of how things came to be and just listen to each other,” and “It is important to know the history of the First Peoples to build relationship and understanding amongst all people.”

When I was canvassing the school district for teachers to take part in the workshops, I was led by my intuition. I didn't know exactly what would happen out on the land with the Elders, but my intuition told me I was looking for teachers who would come to experience, reflect, and interpret their own learning from their own point of reference. This then is precisely the essence of experiential learning. The teacher responses captured in this study came from their direct experiences on the field trip, the informational workshop, the traditional foods luncheon, and the dialogue circles. Their experiences came from consciously engaging in relationships, travelling the land, tasting the nourishment that comes from that land, dialoguing, questioning, and listening while all the time relating their experiences to their own epistemologies and in some cases making new meaning out of old perceptions. This type of learning is not one dimensional, it takes place on many levels in many moments of time, all in relation to what we already know and who we are, but conceived by our relationship to the land. And this is where non-Indigenous peoples may find Indigenous Knowledge a blessing. As Kimmerer (2013, 2017) explains, it is not enough to love the land we need to also learn to respect it and to heal it.

When teachers choose to go out on the land and experience the land through an Indigenous lens they are opening doors to a future in which teachers can become facilitators between the youth and the Elders, setting up the opportunities necessary to allow holistic learning to take place. Through consultations with respected, local, Elders teachers can provide the place and space necessary for knowledge holders to pass along the oral histories to youth as they have done

for tens of thousands of years, connecting the next generation to their culture and Traditional Ecological Knowledge. As educators, we can make the conscious choice to recognize Indigenous Elders and Indigenous students as resources and assets to the education system and to science knowing, and provide a learning space for that knowledge to thrive.

REFERENCES

- Aikenhead, G., & Huntley, B. (1999). Teachers' views on Aboriginal students learning western and aboriginal science. *Canadian Journal of Native Education*, 23(2), 159-175.
- Barnhardt, R., & Kawagley, O.A. (1998). Culture, chaos, and complexity: Catalysts for change in Indigenous education. ANKN. Retrieved from <http://www.ankn.uaf.edu/Curriculum/Articles/BarnhardtKawagley/ccc.html>
- British Columbia Ministry of Education. (2005). *Science K-7 integrated resource package* [IRP], Draft, 1-328. Victoria, BC: Author.
- British Columbia Ministry of Education. (2008). *Science 8-10 integrated resource package* [IRP], Victoria, BC: Author.
- British Columbia Ministry of Education. (2015) *BC's new curriculum: Science*. Victoria, BC: Author. Retrieved from <https://curriculum.gov.bc.ca/curriculum/science/introduction>
- Cajete, G. (1994). *Look to the mountain: An ecology of Indigenous education* (1st ed.). Durango, CO: Kivaki Press. Retrieved from <http://files.eric.ed.gov/fulltext/ED375993.pdf>
- Cajete, G. (1999). *Igniting the sparkle: An Indigenous science education model*. Skyland, NC: Kivaki Press.
- Cajete, G. (2000). Indigenous knowledge: The pueblo metaphor of indigenous education. In M. Battiste (Ed.), *Reclaiming indigenous voice and vision* (pp. 181-191). Vancouver, BC: UBC Press.
- Delgamuukw v British Columbia*, [1997] 3 S.C.R. 1010.
- Gauthreau, N., Mitchell, C. & Naziel, W. (2007) *Witsuwit'en use study for the proposed Blue Pearl Inc's Davidson Project*. Moricetown, BC.
- Gisday Wa & Delgam Uukw. (1989). *The spirit in the land: The opening statement of the Gitksan and Wet'suwet'en hereditary chiefs in the Supreme Court of British Columbia*, Gabriola BC: Reflections.
- Haig-Brown, C. (1992). Choosing border work. *Canadian Journal of Native Education*, 19(1), 96-116.
- Hoffman, R. (2006). *Rekindling the fire: The impact of Raymond Harris's work with the Plains Cree* (Doctoral dissertation). Trent University, Peterborough, ON. Retrieved from <http://www.collectionscanada.gc.ca/obj/thesescanada/vol2/002/NR15721.PDF>
- Ignas, V. (2004). Opening doors to the future: Applying local knowledge in curriculum development. *Canadian Journal of Native Education*, 28(1/2), 49-60.
- Kanu, Y. (2005). Teachers' perceptions of the integration of Aboriginal culture into the high school curriculum. *Alberta Journal of Educational Research*, 51(1), 50-68. Retrieved from <http://ajer.journalhosting.ucalgary.ca/index.php/ajer/article/view/498>

- Kawagley, A.O. (1995). *A Yupiaq worldview: A pathway to ecology and spirit*. Prospect Heights, IL: Waveland Press.
- Kawagley, A.O. (1999). Yupiaq education revisited Alaska native education: History and adaption in the new millenium. *Journal of American Indian Education* 39(1), 31-51. Retrieved from <http://www.ankn.uaf.edu/Curriculum/Articles/OscarKawagley/yer.html>
- Kendy, N. (2007). *Gathering teachers' ideas and beliefs about science and creating space for Traditional Knowledge in the science classroom* (Master's thesis), University of Victoria, Victoria, BC. Retrieved from <http://hdl.handle.net/1828/966>
- Kimmerer, R. W. (2013). *Braiding sweetgrass: Indigenous wisdom, scientific knowledge, and the teachings of plants*. Minneapolis, MN: Milkweed Editions.
- Kimmerer, R. (2017). Indigenous science: Let our voices be heard. Retrieved from <http://www.esf.edu/indigenous-science-letter/>
- Meyer, M. (2008). Indigenous and authentic: Hawaiian epistemology and the triangulation of meaning. In N. Denzin, Y. Lincoln, & L. Smith (Eds.). *Handbook of Critical and Indigenous Methodologies* (pp. 217-232). London, UK: Sage Publications.
- Morin, M.H. (2016). *Niwhts'ide'ni Hibi'it'en – The ways of our ancestors. Witsuwit'en history & culture throughout the millennia*, (2nd ed.). Smithers & Moricetown, BC: School District #54 (Bulkley Valley) and Wisuwit'en Language and Culture Authority.
- Murray, J.J. (2015). Re-visioning science education in Canada: A new polar identity and purpose. *Education Canada*, 55(4), 18-21. Retrieved from <http://www.cea-ace.ca/education-canada/article/re-visioning-science-education-canada>
- Office of the Wet'suwet'en. (2011). *Wet'suwet'en rights and title and Enbridge's Northern Gateway Pipelines Project* [Office of the Wet'suwet'en Natural Resources Department submission to the Northern Gateway Joint Review Panel]. Wet'suwet'en territory, BC: the author. Retrieved from http://www.wetsuweten.com/images/uploads/Wetsuweten_Written_Submission_revised.pdf
- School District #54 (2013-2018). *'Alhk'ikh ' Hēdlīh – Walking together: A framework for the enhancement of Aboriginal education in the Bulkley Valley*. Bulkley Valley, BC: Author. Retrieved from <http://www2.gov.bc.ca/assets/gov/education/administration/kindergarten-to-grade-12/aboriginal-education/enhancement-agreements/framework/sd54.pdf>
- Snively, G., & Williams, Wanosts'7 L. (Eds.). (2016). *Knowing home: Braiding Indigenous science with western science*, Book 1. Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>
- Williams, L. (2005). *Mapping a journey to change: Teachers and facilitator learning together* (Doctoral dissertation). University of Tennessee, Knoxville, TN. Retrieved from http://trace.tennessee.edu/utk_graddiss/2319/
- Williams, L., & Tanaka, M. (2007). Schalay'nung Sxwey'ga Emerging cross-cultural pedagogy in the academy. *Educational Insights*, 11(3). Retrieved from <http://insights.ogpr.educ.ubc.ca/v11n03/articles/williams/williams.html>
- Yore, L.D., Pelton, F.P., Neill, B.W., Pelton, T.W., Anderson, J.O., & Milford, T.M. (2014). Closing the science, mathematics, and reading gaps from a Canadian perspective: Implications for STEM mainstream and pipeline

literacy. In J.V. Clark (Ed.), *Closing the Achievement Gap from an International Perspective: Transforming STEM for Effective Education* (pp. 73-104). New York, NY: Springer. https://doi.org/10.1007/978-94-007-4357-1_5

Chapter 3 - Metaphorical Images of Sciences: The Perceptions and Experiences of Indigenous Students who are Successful in Senior Secondary Science

CATHLEEN ANNE TENNING

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 peoples 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 peoples 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 peoples 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 peoples at the community level. Indigenous peoples 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 peoples. There are three major First Nations groups on Vancouver Island, including the Coast Salish, the Nuu-chah-nulth, and the Kwakwaka'wakw. Each First Nation is made up of separate communities. The First Nations that are local to the Victoria area include the Lekwungen peoples—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 peoples 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 peoples 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 peoples’ 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 than 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 (2007) 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 British Columbia. 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 peoples 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 peoples] 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 extra-curricular 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 gauge 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. In addition, 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 peoples or communities through 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 peoples in the future. As Indigenous peoples 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.

REFERENCES

- Adamuti-Trache, M. (2006). *Who Likes Science and Why?: Individual, family, and teacher effects*. University of British Columbia: Canadian Council on Learning.
- Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. Ways of knowing in science and mathematics. New York, NY: Teachers College Press.
- Aikenhead, G. & Michell, H. (2011). *Bridging cultures: Indigenous and scientific ways of knowing nature*. Toronto, ON: Pearson Canada.
- Beck, B. (1978). The metaphor as a mediator between semantic and analogic modes of thought. *Current Anthropology*, 19(1), 83-97.
- British Columbia Ministry of Education (n.d.). *Provincial Reports*. Victoria, BC, Canada. Retrieved from <http://www.bced.gov.bc.ca/reporting/>
- British Columbia Ministry of Education (2011a). *Provincial optional examinations–2010/11; Provincial public and independent schools combined*. Victoria, BC: Author.
- British Columbia Ministry of Education (2011b). *Provincial required examinations–2010/11; Provincial public and independent schools combined*. Victoria, BC: Author.
- Cajete, G.A. (1999). *Igniting the Sparkle: An Indigenous Science Education Model*. Skyland, NC: Kivaki Press Inc.
- Canadian Council on Learning (2007). *Lessons in learning: The cultural divide in science education for Aboriginal learners*. Ottawa, ON: Author. Retrieved from <http://www.ccl-cca.ca/pdfs/LessonsInLearning/Feb-01-07-The-cultural-divide-in-science.pdf>
- Canadian Council on Learning (2009). *The State of Aboriginal Learning in Canada: A Holistic Approach to Measuring Success*. Ottawa, ON: Author. Retrieved from http://www.ccl-cca.ca/pdfs/StateAboriginalLearning/SAL-FINALReport_EN.PDF.
- 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, BC: UBC Press.
- Mosconi, J., & Emmett, J. (2003). Effects of a values clarification curriculum on high school students' definitions of success. *Professional School Counseling*, 7(2), 68-79.
- Mullens, A. (2001). Why aboriginal students aren't taking science, *University Affairs*, November 8-17.
- Snively, G. (1986). *Sea of images: A study of the relationships amongst students' orientation, beliefs, and science instruction* (Doctoral dissertation). University of British Columbia, Vancouver, BC. Retrieved from <http://hdl.handle.net/2429/27253>

Snively, G. (1987). The metaphor interview and the analyses of conceptual change. In J.D. Novak (Chair), *Proceedings conducted at the Second International Seminar of Misconceptions and Educational Strategies in Science and Mathematics*, Ithaca, NY: Cornell University.

Snively, G. (1990). Traditional Native Indian beliefs: cultural values, and science instruction. *Canadian Journal of Native Education*, 17(1), 45-59.

Snively, G., & Williams, L. (2016). Why transforming the science curriculum is necessary for Aboriginal students. In G. Snively & L. Williams (Eds.), *Knowing home: Braiding Indigenous science with Western science*, Book 1 (pp.13-34). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Tenning, A. (2010). *Metaphorical images of science: The perceptions and experiences of Aboriginal Students who are successful in senior secondary science* (Master's thesis). University of Victoria, Victoria, BC. Retrieved from <http://hdl.handle.net/1828/2758>

Yore, L.D., Pelton, F.P., Neill, B.W., Pelton, T.W., Anderson, J.O., & Milford, T.M. (2014). Closing the science, mathematics, and reading gaps from a Canadian perspective: Implications for STEM mainstream and pipeline literacy. In J.V. Clark (Ed.), *Closing the Achievement Gap from an International Perspective: Transforming STEM for Effective Education* (pp. 73-104). New York: Springer. https://doi.org/10.1007/978-94-007-4357-1_5

PART II

SEA OF IMAGES: A METAPHORICAL STUDY



Sculpins. Artwork by Trevor Isaac (2018).

The Sculpin

My people used to be known as the Kwakiutl, but we referred to ourselves as Kwakwa?ka??wakw, meaning Kwakwala-Speakers.

Our ancient traditions tell us that every animal had a human being inside. Sometimes, the animals transformed into first ancestors of our tribes. Sometimes the different animals brought teachings, or shaped our world, transforming into mountains, boulders, rivers; changing animal's appearances and other permanent transformations. The sculpin has many different histories associated with the different families. Some families use this important figure as a crest on totem poles, some use dance masks, and some may have the sculpin painted on the house front where guests enter through the large mouth. When you see this crest figure, it may appear the same, but the historic meaning to the family who displays the crest may be completely unique compared to others who may have rights to display the same creature.

Gilakas'la,
Trevor Isaac

Kwakwaka'wakw: Colonization, Resistance, and Revitalization of Culture

GLORIA SNIVELY

Background

In this section Snively describes research conducted in 1982 to explore the orientations towards the seashore (scientific, spiritual, aesthetic, utilitarian, recreational) of Grade 6 Kwakwaka'wakw students in 'Yalis (Alert Bay), BC. It describes an instructional strategy that took into account the students orientations (belief systems) during instruction and how it is possible to increase a students' understanding of Western Science concepts without changing, in the sense of replacing the students' preferred orientations. Snively returned to interview the adults 19 years after instruction, and explored "significant life experiences" and "life-altering circumstances" that influenced the adults' orientations and choice of career.

This background is provided to enable the reader a glimpse into the complexities of historical and cultural changes that took place in 'Yalis over the years that influenced the lives of the participants, both as students and as adults.

Who are the Kwakwaka'wakw?

The Kwakwaka'wakw (pronounced Kwak-wak-ya-wak) are the original inhabitants of northern Vancouver Island, BC, the adjacent mainland, and the islands in between. There are tribes or nations with their own names and big houses, each an independent entity, all speaking the Kwakwaka language that make up the Kwakwaka'wakw. Today, the term Kwakiutl only refers to those from the village of Fort Rupert (Cedar Hill Long House, 2018). The number of tribes has fluctuated over time ranging from 29 to approximately 19 today due to amalgamation. "Some of these 'amalgamated' tribes are waking back up and sharing their ancestral history through potlatch" (Trevor Isaac, personal communication, 2018).

The Potlatch Means "To Give"

The potlatch is a ceremony where the stories of the Kwakwaka'wakw peoples are celebrated. It gives witness to important events such as a birth, marriage, name giving, standing up as a new chief, and death. To potlatch means "to give" (Griffin, 2016, p. 1). "The people we invite are not only guests. They are also witnesses of our potlatch and we give them presents for being a witness" (U'mista Cultural Centre, 2018). As Trevor Isaac, collections assistant for the U'mista, explains, "The more you potlatch, the higher your status. If you're a tribe that potlatches more than others, your tribe will gain status (McNeel, 2012, p. 2).

In Indigenous cultures, teaching the next generation is passed on through oral traditions and is incorporated in stories, songs and ceremonies. The people dance to show their history since their history is always passed on in songs and dances. In essence, so long as the potlatch existed, the Eurocentric conditioning of church, school and government were ineffectual. (U'mista Cultural Centre, 2018)

When Indigenous peoples are not allowed to tell their stories, there is a breakdown of language and cultural traditions. For the Kwakwaka'wakw, as explained by Donna Cranmer:

The teachings and creation stories show the next generation how to live, share and maya'xala (treat others and all things the way you want to be treated [respect]) all things. In Indigenous cultures, teaching every generation is illustrated in stories, songs and ceremonies. Each listener takes away the teachings and meanings from the stories and songs, and uses the principles to help them in their own lives. (2016, p. 181)

As colonization progressed, the potlatch changed as well. But, as long as the potlatch existed, the civilizing mission of these forces was ineffectual. Their purpose was undermined, their authority threatened. The government may not have understood what the potlatch was, but knew well what it stood for—the intactness of an Indigenous culture.

The Potlatch Made a Crime

In 1884, the Canadian government made it a crime to take part in a potlatch, calling it an immoral and heathen practice. During these “dark years” many chiefs held potlatches in secret locations to continue the culture, giving gifts and passing along stories and teachings on to the next generation (Griffin, 2016).

On December 25, 1921, Chief Dan Cranmer held a huge potlatch on remote Village Island in Kwakwaka'wakw territory. Somehow, Indian Agent William Halliday heard about the potlatch and its location. Aided by BC Provincial Police officers, Halliday arrested 45 people. Their crime, “giving speeches, dancing, and carrying and receiving gifts” (Griffin, 2016, p. 1). Of those arrested, 22 were given suspended sentences, three were remanded on appeal, and 20 men and women were sent to Okalla Prison near Vancouver for two months for first offenders and three months for second offenders (Griffin, 2016).

Additionally, more than 600 masks, rattles, and family heirlooms were confiscated. The treatment of the sacred ceremonial objects was deeply offensive to Cranmer and other Kwakwaka'wakw. Most of the objects were divided up and shipped east to various museums, including the Royal Ontario Museum in Toronto, the British Museum in London, and the Smithsonian Institute's National Museum of the American Indian in New York (Griffin, 2016).

The arrest of Cranmer and his guests didn't stop the Kwakwaka'wakw from holding secret potlatches in order to strengthen family ties by passing on objects such as hats, coppers, and masks, and giving witness to family dances, songs, titles, and stories.

The potlatch ban remained in effect until 1951. The first legal potlatch was held, by Kwakwaka'wakw Chief Mungo Martin, in 1952 to celebrate the completion of his Big House in Victoria in Thunderbird Park at the BC Provincial Museum (Griffin, 2016).

Return of the Potlatch Regalia

The first real effort to repatriate the potlatch objects started in the late 1950's and early 1960's when Chief Jimmy Sewid and others began to work towards the repatriation of their treasures. A few years later, with support from the Canadian National Museum of Man (National Museum), an agreement was reached to bring the objects home under the condition that a museum be constructed to house and care for the collection. 1983, the U'mista Cultural Centre in 'Yalis (Alert Bay) and the Nuyumbalees Museum in Cape Mudge, Quadra Island, were opened to celebrate the return of the National Museums' portion of the potlatch regalia (U'mista Cultural Centre, 2018).

The Cranmer family hosted a potlatch to celebrate the opening of the U'mista Cultural Centre, which served to recognize the vitality of the potlatch, art production, language, singing and dancing. At the opening ceremony, the film *Box of Treasures* was showcased. As described by Trevor Isaac:

A box of treasures, to me, means a physical box which contains ceremonial artifacts, such as rattles, masks.... All hereditary chiefs would own a box of treasures that falls within his family's history and origin stories that would be passed on to the next generations; including masks, songs, dances, names, all spiritual. (Dos Polocas, 2017)

Gloria Cranmer Webster spoke at the opening ceremony:

We came very close to losing our culture, our language, for a lot of people even interest in knowing about those things. We're lucky; we're very fortunate that we've this centre in which to try and build some of this store of knowledge that all of us need to know who we are. (Olin & U'mista Cultural Society, 1983)

At the opening of the U'mista Cultural Centre, Robert Joseph, (Hereditary Chief of the Gwawaenuk First Nation, and resident of Cape Mudge), spoke of the impact of acculturation efforts on his people:

You heard some of my other chiefs' talk about losing their language; you heard some of our people talk about losing our dances and our songs, our legends. It's not an easy thing for a man to do that. It's like stripping away your soul, and there's nothing worse than that. (Olin & U'mista Cultural Society, 1983)

He also emphasized the importance of preserving the Kwakwaka'wakw culture and the knowledge that seniors and Elders in the community held at that time through U'mista:

The old people are the links to our history. So that the past does not die with them, their memories and stories are being recorded at the center. (Olin & U'mista Cultural Society, 1983)

In addition to storing and displaying objects, the U'mista Cultural Centre focused on preserving intangible parts of Kwakwaka'wakw culture through language classes, dance programs, oral history recording projects, film projects, temporary exhibitions and traveling exhibits. Gloria Cranmer Webster laments:

U'mista means the return of something important.... We've won some victories, the people in this area. The masks have come home. The old people are teaching the children what they know. We're rebuilding and we're growing stronger in all sorts of ways. We use this center as a focus of that rebuilding. (Webster, quoted in Olin & U'mista Cultural Society, 1983)

Gloria Cranmer Webster's words as well as many other's included in the documentary including Agnes Alfred, Robert Joseph, and Chief Bill Cranmer emphasize the importance of this repatriation as a victory for the ?Namgis, Weka'yi, Mamalilik?ala, and the Kwakwaka'wakw as a whole.

Resurgence of Kwakwaka'wakw Art and Culture

Kwakwaka'wakw art has a long history of tradition, innovation and inventiveness, and colours that go beyond the traditional. Haida artist Bill Reid was quoted as saying that "the Kwakiutl were explosive. If there was a colour, they used it" (Cedar Hill Long House, 2018).

The resurgence of Kwakwaka'wakw art since the 1950's, after the potlatch ban was lifted, has been remarkable, and largely credited to Mungo Martin, one of the most distinguished Kwakwaka'wakw carvers:

Hired by the Royal BC Museum, Martin brought traditional Kwakwaka'wakw culture and knowledge out of the banned potlatch era and into the open, inspiring a new generation of northwest coast artists. (Cedar Hill Long House, 2018)

The U'mista Cultural Museum continues to support a burgeoning Kwakwaka'wakw art and culture revival movement through its collections in Alert Bay, and its collaborations with cultural museums world-wide. Trevor Isaac, collections and education assistant for the U'mista Cultural Museum, talks about his experiences overseas at the opening of traveling exhibits and conferences in which he has been invited to speak:

It's very uplifting I suppose, how eager people are to learn about U'mista. Also in the museum world, U'mista is a very small organization.... For a museum of that scale to be known worldwide is pretty powerful and I think it says a lot about our culture but also the hard work of the people who held on to their memories or their masks, the potlatch collection, and those who made it their mission to get these artefacts returned.... It's really great to hear people's interest... The collection lives in people's consciousness as an important piece of First Nations and Canadian history, so much so that people travel from as far as Australia or Germany to see the collection. (Trevor Isaac, personal communication to Emma Knight, June 14, 2013, as recounted in Knight, 2013, p. 126)

The National Museum's ongoing relationship and acceptance of obligation to the complete return of the potlatch collection led to the National Museum assisting in the return of the remainder of the collection. This was illustrative of a broader desire in the Canadian museums sector, to recognize the value of Indigenous culture in Canada. As E.S. Rogers, Curator of Ethnology at the Royal Ontario Museum wrote to W.E. Taylor, Director of the National Museum:

We do not feel that one can establish a museum in Alert Bay and merely forget the matter. One must be concerned with all the Indians of Canada and whether or not they also are entitled to similar consideration, not because of the Potlatch Law, now void, but as Canada's first citizens. It is an exceedingly fine line that has been drawn here, between Alert Bay and elsewhere in Canada. (Rogers, E.S., 1971, October 26)

The story of the Kwakwaka'wakw and of the "dark years" is not a singular story. Throughout Canada the cultural prejudices and the missionary and political agendas of the majority culture served to undermine actual Indigenous knowledge and claims on the land and its natural resources. This colonial agenda was repeated worldwide where Eurocentric interests competed for land and resources.

As educators, we have an obligation to future generations to assist in the resurgence and revitalization of all Indigenous cultures. The world must acknowledge the paramount importance of Indigenous knowledge systems, and promote a moral, emotional, intelligent, environmentally sustainable and perhaps sacred relationship with the land and all its peoples.

REFERENCES

- Griffin, K. (2016, December 23). This Week in History, 1921: Mass arrests at Kwakwaka'wakw potlatch took place Christmas Day. *Vancouver Sun*, p. 27. Retrieved from <https://vancouversun.com/news/local-news/this-week-in-history-1921-mass-arrests-at-kwakwakawakw-potlatch-took-place-christmas-day>
- Cranmer, D. (2016). Dzaxwan (oolichan fish): Stories my Elders told me. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1. Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>
- Rogers, E.S. (1971, October 26). [Letter to W.E Taylor]. Canadian Museum of Civilization Ethnology Archives. Andrea L. Laforet Collection. Dr. Andrea Laforet Fonds. E 2010.14 (B13 F 3-4).
- Dos Polocas. (2017, March 2). *Trevor Isaac* [Video File]. Retrieved from <https://youtu.be/e530bZCqmwk>
- Knight, E. (2013). *The Kwakwaka'wakw potlatch collection and its many social contexts: Constructing a collection of object biography* (Master's Thesis). University of Toronto, Toronto, ON. Retrieved from <https://tspace.library.utoronto.ca/handle/1807/42997>
- Cedar Hill Long House. (2018). *Kwakwaka'wakw art: A Northwest Coast tradition*. Victoria, BC: Cedar Hill Long House Art Publishing. Retrieved from <https://www.cedarhilllonghouse.ca/blog/kwakwakawakw-art-northwest-coast-tradition>
- McNeel, J. (2012, August 20). Northern Vancouver Island's past and present. *Indian Country Today*. Retrieved from <https://newsmaven.io/indiancountrytoday/archive/northern-vancouver-island-s-past-and-present-9CEfhjDUQkK5jftNgNVIVQ/>
- Olin, C. & U'mista Cultural Society. (1983). *Box of treasures* [Documentary film]. Watertown, MA: Documentary Educational Resources.

U'mista Cultural Centre. (2018). *The history of the potlatch collection*. Alert Bay, BC: U'mista Cultural Society.
Retrieved from <https://www.umista.ca/pages/collection-history>

Chapter 4 - The Metaphor Interview and Kwakwa?ka?wakw Students' Orientations to the Seashore

GLORIA SNIVELY

I wish to gratefully acknowledge Chief Kwaxalanukwa'me' Namugwis Bill Cranmer and all those at the Namgis Band Council for supporting this research, in particular Yakudtlas'dzi George Speck and the late Hayalkan Lawrence Ambers. Special thanks are also extended to Ga'axstalas Flora Cook, principal of the Alert Bay Elementary School for supporting the research study from the outset, and for providing me with continuous guidance and support. Special thanks to the Kwakwala language and culture teachers, Mam'xu'yugwa Auntie Ethel Alfred, Gwi'molas Vera Newman, Tlalilawikw Pauline Alfred, and Tidi Nelson, who provided much needed advice and for sharing their considerable knowledge and wisdom with myself and the class of Grade 6 students. A very special thank you to all the students who took part in this study, for sharing their experiences and reflections, and for allowing their stories to be told for our benefit.

As a newcomer and woman who has enjoyed working with First Peoples for over 40 years, I have attempted to present the stories of the 'Yalis students and Elders as best I can. It is my hope that their stories and accounts may be helpful to researchers, curriculum developers, and teachers who are developing an awareness of the complex issues involved in teaching science in communities comprised of both Indigenous and non-Indigenous students.

In 1982, when the initial data was collected for my research, the University of British Columbia Ethics Review Board required that the location of studies in Indigenous communities be anonymized for the protection of youthful participants and that the names of communities be given pseudonyms. Thus, the doctoral dissertation identified the location of the study as "Salmon Cove." However, recent consultations with the community and most importantly the students participants (now adults), has made it possible to reveal that the research described in this chapter took place in Alert Bay ('Yalis), BC, its real location. Additionally, words that were used by the researcher and by participants in 1982 to describe Indigenous peoples such as "Native Indian" or "status" and "non-status Indian" have been edited or deleted to reflect current terminology. In addition, identifying the location as 'Yalis has enabled a richer and more accurate description of the traditional Indigenous culture, as well as the historical events that helped shape the students' orientations towards the seashore. It is hoped this description is more in keeping with our contemporary and personal journeys of truth and reconciliation.

Many years ago, while walking along a sandy beach, I became fascinated with watching children play. Some drew pictures of mom, dad, and little brother; others drew pictures of eagles or fishing boats. Several children busily built intricate roadways, castles, or forts. A number of other children imagined themselves to be road-graders, dump trucks, or forklifts and made power sounds as they collected and shaped the sand and mud. The children would run up and down the beach making wonderful loops and dives with outstretched wings; imagining themselves to be graceful seagulls or jet planes. A few must have imagined themselves killer whales, seals, or salmon, for they ran with marvelous undulating movements, swimming upside down and jumping out of the water. One little boy imagined himself to be a thunderbird with eyes bulging and breathing thunder and lightning out of his head. When one really takes the time to view children's play, one becomes aware of the use of metaphor as fundamental to human communication. This becoming of a graceful seagull, a soaring jet plane, or a magnificent thunderbird is a process whereby children understand their experiences through metaphor.

This chapter describes how language (and in particular metaphor) is an important source of evidence for understanding the way we think and act; and describes the metaphor interview in detail to reveal its subsumed techniques and its

richness in illuminating the complexities of a child's belief system. Next, the chapter provides an outline of the four metaphor formats constructed for the analysis of the students' orientations to the seashore, and briefly explores how the metaphor interviews take into account the linguistic and socio-cultural background of the child.

The research described in this chapter is part of a larger study in the general area of research on children's thinking about seashore relationships (predator/prey, habitat/food changes, etc.)—research which supports the view that children's prior beliefs and values need to be taken seriously, and incorporated into the instructional setting (Snively, 1986, 1990).

[Chapter 4](#) describes how the metaphor interviews were used to identify the Grade 6 students' orientations to the seashore, as well as the relationship between the students' orientations and their social and cultural background. [Chapter 5](#) describes the students' beliefs about seashore relationships prior to instruction, how the teacher attempted to take into account the students' preferred orientations during instruction, and the students' beliefs about seashore relationships after instruction. In other words, the chapter sought to explore the question: Can instruction enable students with a preferred spiritual orientation to the seashore understand marine ecology concepts without replacing, in the sense of changing, the students' preferred spiritual orientation? Finally, [chapter 6](#) provides a description of the longitudinal study I conducted 19 years later—when I located and interviewed the same individuals, now adults to determine if their orientations, life experiences and aspirations had changed.

Background to the Study

Students bring to the classroom ideas based on prior experiences. These ideas or beliefs have an impact upon the ways in which they respond to and interpret lessons in science. Researchers have been able to identify and describe such intuitive views for a range of specific phenomena, and they have also established that such views can be remarkably persistent.

Typically, researchers in science education have addressed the notion of constructed meaning by analyzing students' cognitive beliefs about a narrow set of concepts or topic area. Scant and insufficient attention has been given to the values that underlie children's thinking about the world. Researchers try to distinguish among cognitive, affective, and psycho-motor domains, but in fact, they cannot be separated; nor can they authentically capture the perspectives of Indigenous students who understand humans in terms of a holistic amalgam of their intellectual, emotional, physical, and spiritual dimensions. One way of attempting to capture some of the complex interplay among these human dimensions is by constructing an orientation. In this research, "an orientation means a tendency for an individual to understand and experience the world through an interpretive framework, embodying a coherent set of beliefs and values" (Snively, 1986, p. 11). By looking for patterns in the students' thinking towards the seashore I was able to identify five different dimensions or orientations: scientific, spiritual, utilitarian, aesthetic, and recreational.

The five different orientations share many characteristics with the concept of worldview. Cajete (2000) defines worldview as "a set of assumptions and beliefs that form the basis of a people's comprehension of the world" (p. 62). A worldview provides the lens or filter from which an individual views the world. For example, Indigenous scholars propose that there is a shared worldview amongst Indigenous peoples in which humans are intrinsically connected to the natural world (Atleo, 2004; Battiste, 2000, 2002; Cajete, 2000; Kawagley, 1995; Little Bear, 2000; McGregor, 2004, 2005; Michell, 2007; Michell, et. al., 2008). While a worldview corresponds to the entire spectrum of the way an individual views the world, the typology of orientations (scientific, spiritual, aesthetic, utilitarian, recreational) is more narrowly defined and can be understood as a focused component of a more broadly defined worldview. Thus, a worldview is an all-encompassing concept that includes orientations.

Orientations are thought to be deeply rooted aspects of our conceptual system and not easily accessible with normal probing techniques such as pencil and paper tests or even conventional interview techniques. One of the ways of understanding these broad intellectual commitments is to look more carefully at the nature of metaphorical thinking in children.

Only in the last 30 to 40 years have metaphors been viewed as a fundamental aspect of the human communication process that affects the ways in which we perceive, think, and act. In their seminal work, *Metaphors We Live By*, Lakoff and Johnson (1980) claimed that metaphors are pervasive in everyday life—“Our ordinary conceptual system in terms of which we both think and act is fundamentally metaphorical in nature” (p. 3). But our conceptual system is not something we are normally aware of. We simply think and act more or less automatically along certain lines. Just what these lines are is by no means obvious. “Since communication is based on the same conceptual system that we use in thinking and acting, language is an important source of evidence for what that system is like” (p. 3).

Lakoff and Johnson consider some cultural metaphors that are coherent with an up-down, hierarchical relationship. For example, in Eurocentric cultures, “more is better,” “bigger is better,” and “faster is better,” are values that are deeply imbedded. Not all cultures give the same priorities to such metaphors. There are cultures where balance and centrality play a much more important role than it does in Eurocentric cultures. There are cultures where passivity is valued more than activity. Lakoff and Johnson cite the Westernization of cultures throughout the world as partly a matter of introducing the “time is money” metaphor into those cultures. “Much of cultural change, [they postulate], arises from the introduction of new metaphorical concepts and the loss of old ones” (p. 145). But it is by no means an easy matter to change the metaphors we live by. Because each person’s view of “time” and “money” may be different, “the same metaphor that gives new meaning to one person’s experiences will not give new meaning to another” (p. 22).

In taking an experiential view of metaphor, Lakoff and Johnson insist that personal perception, feeling, and encounter form the real ground that supports understanding. They argue that metaphor is not a peripheral and merely stylistic feature, but a central feature of human thought. The work of Lakoff and Johnson has implications for classroom instruction and learning. It suggests that metaphor is an important source of evidence for identifying and analyzing students’ prior conceptions. Since metaphor is fundamental to the human communication process, language is an important source of evidence for analyzing what their natural conceptions are like.

Lakoff and Johnson suggest possible sources for students’ prior conceptions. The experiential basis of metaphor suggests that the students’ conceptions are products of their life experience, that is, their bodies, mental capacities, emotional and spiritual makeup, and the way they interact with the physical, social, and cultural environments. It suggests that science educators need to attend to themes that extend further than previously explored.

Over the past several years researchers have used metaphor interviews to look at students’ thinking in environmental and science education projects, for example, to look at effective environmental education professional development for teachers (Ross, 2003), early adolescent environmental involvement amongst 10 to 12 year old children from 66 countries (Blanchet-Cohen, 2008, 2010), and the perceptions and experiences of Indigenous students who are successful in senior secondary science (Tenning, 2010).

I agree with Lakoff and Johnson in their view that language involves “whole systems” of concepts rather than “individual words” or “individual concepts.” My concern for how children comprehend their own experiences at the seashore suggests that the students’ conceptions about the seashore emerge from their interactions with one another and with the world (both urban and natural environments), and must be understood in relation to interactional properties such as sensory experiences, emotions, and culture.

Participants and Methodology

My study in 1982 (Snively, 1986, 1987, 1990) involved the collection and analysis, by metaphor and literal interviews, of students' orientations and belief before and after instruction, as well as interviews six months later. The participants consisted of a class of 20 (N=20) Grade 6 students in 'Yalis (Alert Bay). With the intent of protecting the privacy of the young participants, all students were assigned pseudonyms.

'Yalis is located on Cormorant Island within the area known as the Broughton Archipelago, within the territory of the 'Namgis First Nation, one of 19 remaining Kwak'waka speaking nations. The Nimpkish watershed is the largest on Vancouver Island. According to the legend of the river's origin, it was the salmon runs that gave birth to the Kwakwaka'wakw peoples. The First Nations community is located at one side of the island and a community largely of European extraction is located at the other. The Namgis cemetery, located in the center of the community, has some of the finest totem poles on the coast (Figure 4.1 and Figure 4.2).



Figure 4.1 ▲ The killer whale sign "Welcome-Alert Bay-Gilakas'la" greets visitors arriving in 'Yalis, Cormorant Island at the ferry dock. Photo by Gloria Snively (1982).



Figure 4.2 ▲ Memorial poles in the 'Yalis cemetery. Photo by Gloria Snively (1982).

At the time of this study, commercial fishing was the major source of income for both groups (Figure 4.3).



Figure 4.3 ▲ Fishing boats anchored in the 'Yalis harbor. Photo by Gloria Snively (1982).

'Yalis has had a long history of human habitation. It was used as a winter dwelling place by the Kwakwaka'wakw who realized that the unique shape of the bay offered protection against winter gales. The arrival of the Europeans and the realization of abundant fish stocks in the area brought with it the establishment of the fish saltery (processing plant) and canneries (Figure 4.4). Many Kwakwaka'wakw women worked in the canneries while the men worked on fishing boats catching mainly herring and salmon.



Figure 4.4 ▲ View of Alert Bay cannery with fishing boats the Sasu, the President, and the J.R.D. alongside pier, 1923. Photographer unknown. Photo courtesy of University of British Columbia Library Rare Books and Special Collections, Fisherman Publishing Society fonds. BC_1532_1318_1. Public Domain.

Gradually 'Yalis became the centre of the whole area where schools, shipyard, seaplane dock, hotels, and stores sprang up. In 1982, the most imposing building in 'Yalis was the largely abandoned three-story brick Indian Residential School that had been funded by the Canadian government and run by the Anglican Church ([Figure 4.5](#)).



Figure 4.5 ▲ St. Michael's Indian Residential School entrance, with two students on the driveway, Alert Bay, British Columbia, ca. 1970. House posts relocated from Kwakwaka'wakw village. The first residential school in Alert Bay was built in 1882. St. Michael's Indian Residential School (pictured) was built in 1929 as a regional facility for Indigenous communities from Campbell River to Prince Rupert, BC. Photographer unknown. Courtesy of Library and Archives Canada. Crown Copyright.

Four churches were represented in 'Yalis: Anglican, Catholic, House of Prayer, and Pentecostal. Despite a history of systematic colonial oppression, the Kwakwaka'wakw peoples continue to practice many traditional customs and ceremonies and have a strong presence with their 'Namgis Band Office, 'Namgis Traditional Big House, and U'mista Cultural Centre with its potlatch collection.

In 1978, I published a book entitled, *Exploring the Seashore in British Columbia, Washington, and Oregon*, and over a period of several years had conducted a number of workshops, talks and beach walks with several isolated communities and schools (both Indigenous and non-Indigenous) along the BC Northwest coast. I was invited by the teachers and principal of the Alert Bay Elementary School to conduct a beach walk and a teaching workshop. This invitation provided a welcomed entry for conducting my research into students' orientations towards the seashore. In addition to giving teacher workshops and beach walks, I gave seashore talks and walks open to the community: Elders, knowledge keepers,

parents and interested residents—thus, at least to some extent, providing a two-way gift-giving relationship between myself and the ‘Yalis community.

The Alert Bay Elementary School was selected based on three criteria: (1) the presence of both Indigenous and non-Indigenous students, (2) the presence of a seagoing peoples and students born and raised in a community surrounded by the seashore, and (3) the willingness of the school, Elders and ‘Namgis Band to participate. It was expected that the presence of both Indigenous and non-Indigenous students living in a coastal community would uncover a wide range of orientations towards the seashore and, also, would provide a rich mix of metaphor responses imbedded in sensory-based experiences on the one hand, and social and cultural experiences on the other. Four Kwakwaka’wakw cultural teachers offered dance and Kwak’wala language classes, and Kwakwaka’wakw history, legends, art and fishnet mending were a regular part of the curriculum. The Grade 6 teacher was new to ‘Yalis, having moved from the Prairie Provinces, and was in his second year of teaching.

The metaphor interviews worked effectively to enable the identification of the different orientations used by the students (scientific, spiritual, utilitarian, aesthetic, and recreation). Although all the students exhibited several orientations when describing the seashore, some used one orientation predominantly, and some showed a greater mix of orientations. Within the class, six students were selected for intensive study: the student with a preferred scientific orientation (Dan), the student with a preferred spiritual orientation (Luke), the student with a preferred utilitarian orientation (Jimmy), the student with a preferred aesthetic orientation (Mary), the student with a preferred recreational orientation (Anna), and a student with no preferred orientation (Sharon). Only a few students held beliefs that were consistent with accepted science ideas; most held beliefs that were quite different. For most students, there was a reasonably strong relationship between their orientations and the nature of their beliefs about specific seashore relationships. Luke, Jimmy, Dan and Mary are First Nations; Sharon is of European ancestry; and Anna is of Filipino ancestry, and moved to ‘Ya?lis from the Philippines.

The Use of Metaphor Interviews to Uncover Meaning

For several years, Beck (1978, 1982) explored the use of metaphor as an indicator of cultural values in an anthropological setting. Beck emphasized the values of people towards family relationships and the concept of ethnicity, paying less attention to the implications of values for specific beliefs and practices.

In attempting to use metaphor interviews, I had to solve three problems as the interviews had to be designed to: (a) explore the students’ orientations to the seashore, (b) explore the students’ beliefs about specific seashore relationships, and (c) be appropriate to the language development of young children.

During Phase I (from May 1980 through October 1981), I conducted a series of five small pilot studies with Grades 2, 3, 4, 5 and 6 students in three different coastal communities in BC to sharpen the research questions and develop a research method. The problem was not one of extending or adapting some existing metaphor interview questions, but of developing a unique set of metaphor questions in which the analysis of the students’ orientations in an instructional setting was the central purpose.

In talking to various students and Elders in ‘Yalis, and by exploring the community and noting its special features, I was able to construct metaphor questions grounded in the physical and cultural backgrounds of the students. For example, the metaphors “pot-luck dinner” and “potlatch” were seen to be better utilitarian metaphors than the metaphors “dinner” or “supper.” The metaphor “cannery” was seen to be a better utilitarian metaphor than “factory,” since a fish cannery was an integral part of everyday life in ‘Yalis. The metaphors “totem pole” and “legend” were viewed as appropriate spiritual metaphors from a traditional Indigenous viewpoint, and the metaphor “church” was viewed as an appropriate metaphor for Christian spirituality, and so on.

The Metaphor Formats

In developing the metaphor interviews, the basic interview techniques described by Beck were followed, but ideas from Lakoff and Johnson's (1980) book, *Metaphors We Live By*, were incorporated to construct the interview questions. Following Lakoff and Johnson (1980), the very systematicity that allowed the students to comprehend one aspect of a concept in terms of another will necessarily hide other aspects of the concept. For example, in the "seashore is a playground" metaphor, the students were encouraged to focus on the recreational aspects of the seashore concept, and encouraged not to focus on aspects of the other orientations of the seashore. The interview questions were designed to highlight and hide a range of orientations towards the seashore: e.g., the image "painting" was selected to highlight an aesthetic orientation, a "community" to highlight a scientific orientation, a "church" to highlight a spiritual orientation, a "factory" to highlight a utilitarian orientation, and a "playground" to highlight a recreational orientation. For example, the first set of interviews asked each respondent to explore the following question:

If the seashore were one or more of the following, which one or ones would it be:

factory	church	painting
playground	community	gift

WHY?

At every point, the students were asked to explain "WHY?" they had selected a particular metaphor over others. THE QUESTION "WHY?" WAS ESSENTIAL, as this procedure generated the most interesting and useful information. Although the actual type of metaphor chosen was noted, and for some students did yield some interesting patterns, the "WHY?" query was the key to the technique's success since it indicated the respondent's reasoning for choosing a particular metaphor.

The metaphor formats contained three additional types of questions that depended on metaphorical thinking. The second set of questions asked each respondent to explore fifteen different seashore animals, objects, events, and conditions. For example:

If a clam were one or more of the following, which one or ones would it be:

vacuum cleaner	legend	potlatch
necklace	dance	

WHY?

OR

If the sun were one or more of the following, which one or ones would it be:

jewel	factory	furnace
lamp	gift	

WHY?

Responses were intended to reveal each student's reasoning towards selected animals, objects, events, and conditions at the seashore.

The third set of questions asked each student to explore twelve different imaginary questions. For example:

If you were a bird, would you be a:

raven	seagull	eagle
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WHY?

This interview set generated some of the most imaginative and useful material. The students found the metaphor questions in this interview the easiest to elaborate. They appeared to enjoy discussing their metaphor choices, possibly because of the single metaphor construction, and because the questions resembled the children's play at the seashore, wherein they "become" a bird, or a fish, or a boat.

In the fourth set of questions each respondent was asked to explore nine metaphoric dyads. Each dyad contained two types of questions that depended on metaphorical thinking. The metaphors were chosen to represent contrasting relationships: storyteller is to a story, character is to a story, or listener is to a story. The respondents were asked to decide which of the three pre-selected images was best suited to symbolize his or her own relationship to the seashore. For example:

I am to the seashore, as a:

Storyteller is to a story	Character is to a story	Listener is to a story
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WHY?

In addition, the students were asked to indicate directionality. If the students' relationship to the seashore was like a storyteller to a story, which element of the dyad would the respondents call the storyteller and which the story, and WHY? Some students found the metaphor questions in this interview too difficult to understand, possibly because of the double metaphor. Nonetheless, all of the students gave some explanation for their choices. Altogether, there were 124 possible metaphor responses (Snively, 1986).

They were also asked to generate their own metaphors for the seashore. One might think that metaphors generated by the students would be more revealing than those generated by the researcher, but this advantage was counter-balanced by the difficulty many students had thinking of metaphors for themselves.

Finally, at the conclusion of selected metaphor questions, students were asked to choose the metaphor response that best described how he or she viewed the seashore. It was hoped that by comparing the students' preferred responses (their first, second, and third choice responses), and by noting their own metaphors for the seashore, that a distinction could be made between the students' preferred orientations prior to instruction, and the effect of instruction on the students' preferred orientations after instruction.

Identifying the Students' Orientations

During Phase II (April, May, and June 1982), I collected interview data on all the students in a Grade 6 class in 'Yalis. By looking for patterns in the students' metaphor responses during the pilot studies, I identified five different orientations or dimensions in the students' answers. The five orientations listed in the Table 4.1 below were those identified to be most useful in thinking about the responses students gave to my questions about the seashore. The phrases beside each orientation are not complete descriptions, but illustrate some of the broader ideas associated with the orientation:

Table 4.1 Students' Orientations to the Seashore (Snively, 1986, p. 57)	
Utilitarian	Humans are the benefactors, directors, producers, developers, and controllers. They harness nature for their own practical and necessary use.
Aesthetic	Humans are the admirers, reflectors, imitators, lovers, and protectors. Humans are aware of the beauty or ugliness in nature. Pertaining to artistic interpretation of nature: art, music, poetry, drama, dance, etc.
Scientific	Humans are the observers, identifiers, quantifiers, predictors, theoreticians, experimenters, and controllers. Humans and nature are interconnected and dependent on one another for survival.
Spiritual	Humans are aware of the sacred, or moral, or spiritual, or supernatural aspects of nature. Humans are part of nature, and nature runs itself. Humans may help and protect nature, and the plants, animals, objects, and events in nature may even help humans. Of, or pertaining to, an organized religion, or an ability to "indwell" or "become" part of another living or non-living thing.
Recreational	Humans are aware of nature as a source of refreshment for their own bodies and minds; for exercise, relaxation, entertainment, exploration, and enjoyment.

Table 4.2 A typical student response within each of the five orientations	
Utilitarian	
Jimmy	The seashore is a factory. It's got crabs, fish for canning.
Scientific	
Dan	The seashore is a town. All the animals that live at the seashore. They all grow up there. The rocks being for the animals to hide under.
Aesthetic	
Mary	The seashore is a painting. It just looks like a painting an artist would paint.
Spiritual	
Luke	The seashore is a legend. There's a legend about this man who became wild and he could do things that animals could do.
Recreational	
Mary	The seashore is a playground. You don't have to work. Do what you want. Could be a lot of fun; looking for animals, crabs, finding shells. It's peaceful.

A certain consistency in the reasons students gave could be seen to persist across their particular choices of metaphor. For example, "The seashore is a painting" metaphor frequently resulted in an aesthetic response. "The seashore is a factory" metaphor frequently results in a utilitarian response. On the other extreme, a certain consistency in the orientations students preferred could be seen to persist across their choices of metaphors. For example, the students with a preferred aesthetic orientation tended to stress the aesthetic aspects of the seashore regardless of the type of metaphor image selected and the students with a preferred utilitarian orientation tended to stress the utilitarian aspects of the seashore regardless of the type of metaphor image selected. Notice how three different students stressed different orientations for the metaphor, "The seashore is a gift":

Table 4.3 Student responses to <i>The seashore is a gift</i> metaphor	
Scientific	
Dan	The seashore is a gift. Because of the many things that live there.
Aesthetic	
Mary	The seashore is a gift. We can enjoy the water. The way it looks pretty.
Recreational	
Jimmy	The seashore is a gift. Because children can play on it, swim in the water, and throw rocks.

Some students, more than others, responded to a particular metaphor with a complex concept of the seashore. For example, notice how one student stressed a range of orientations for the gift metaphor:

Sharon: It was given to us to use. And we use it! We're supposed to use it properly. It's like a special gift that was given to us to use. The way the fishermen use it for fish. People use it to learn about the animals. And for fun too.

Notice the obvious utilitarian aspects: "We use it.... The way the fishermen use it for fish." There are recreational aspects as well: "And for fun too." Also, notice the scientific or intellectual aspects: "People use it to learn about the animals." Perhaps there is even a concern for conservation: "We're supposed to use it properly." Overall, there are subtle spiritual or moral aspects that may not be immediately obvious: "It was given to us to use. We're supposed to use it properly. It's like a special gift that was given to us to use." Hence, a student's response depends upon the complexity of thought the metaphor stimulates and upon other characteristics of the students' thinking.

The metaphor "the seashore is a playground" used in the interviews, illustrates how an attempt was made to comprehend and represent the students' orientations to the seashore. "Seashore" as a metaphor shows a focus of thinking formed from very different childhood experiences: growing up in a large, coastal urban centre such as Vancouver versus growing up in a small, isolated coastal community in British Columbia. Similarly, the word "playground" has very different kinds of experiential basis to a child whose only space for recreation is a city street or access to a large vacant lot, versus a purpose-built adventure playground, versus a child who has the freedom to explore a forested coastline. The concept of playground enters the child's experience in many different ways and so gives rise to many different metaphor responses.

Metaphor interviews have a kind of ambiguity in the context of an experience. Students were asked to compare two terms: the term "seashore" of which something is being asserted, and the term "painting," used metaphorically to form the basis of the comparison. Words have a range of meanings; some may have new or original meanings while others may have familiar meanings. The force of the metaphor depends on the respondent's uncertainty as he or she waivers between the two meanings. Students' responses should be viewed as the meaning, either consciously or unconsciously, that they give to the metaphor. Their emerging responses depend on the complexity of thought the metaphor stimulates and upon multiple characteristics of the student's thought.

Two students' interpretation of the term "playground" may be based on two different kinds of experiences:

Jimmy: The seashore is a playground. All the kids play on the beach. You find crabs, make stuff, teeter-totter, make masks from wood, make sticks to hold fish.

Dan: The seashore is a playground. I play at the beach a lot; catching animals, looking at them. I fly my kite

Some of the experiential basis for Jimmy's metaphor response is obvious. For example, "All the kids play on the beach ... teeter totter" is an obvious statement of the recreational aspects of the seashore. "You find crabs, make stuff, make sticks to hold fish" is an obvious statement of the utilitarian aspects of the seashore. Additional insights into Jimmy's preferred utilitarian orientation came from the school staff:

Jimmy was raised in the traditional First Nations ways. He respects his grandfather. He watches his grandfather work: fishing, setting nets, setting out crab pots, driving the boat. (Home School Coordinator)

While some of the experiential basis of Jimmy's metaphor responses is obvious, some are not obvious. The statement "making masks from wood" is an implicit statement about the aesthetic or spiritual aspects of the seashore that is grounded in cultural experience. Stronger corroborating evidence comes from other examples of attaching spiritual significance to the seashore. For illustration, during the field study phase, the following data were collected from the Kwakwaka'wakw language and culture teachers:

Jimmy is First Nations living with his very traditional Native grandparents. The grandfather dances a lot in the big house. Jimmy was a good dancer in the primary grades.

Jimmy's reference to "making masks from wood" is most likely a statement about the spiritual aspects of dancing in the big house and attending potlatches. This datum suggests that some metaphor responses can only be categorized and adequately represented when additional information concerning the student's social and cultural background is taken into consideration.

There is another reason why it was important to categorize students' metaphors in terms of entire domains of experience. Jimmy's reference to "you find crabs" is very different from Dan's reference to "catching animals and looking at them." At first, the two statements appear similar in their experiential basis. However, important experiential differences become clearer when additional information is taken into consideration. For example, Jimmy makes numerous references to "finding crabs," "catching fish," "checking his crab traps," "eating them," and "making a lot of money." By sharp contrast, Dan makes numerous references to "finding crabs," "catching animals," looking at them," "learning about them from books," and "letting them go." Also, when asked to draw a picture of a crab at high tide and at low tide, Jimmy was the only student to draw an edible crab (Dungeness crab), while Dan drew the common purple shore crab. Jimmy's reference to "finding crabs" is most likely a statement about the utilitarian aspects of an experience, while Dan's reference to "catching animals and looking at them" is most likely a statement about the scientific aspects of an experience. The experiential basis of Dan's preferred scientific orientation can be understood from interviews with him:

I would be a park naturalist or a marine biologist, but only if I didn't have to move away from Alert Bay. I want to fish in the summer and do films, and draw pictures, and study and do Lansdowne books, but do it with sea animals. [Fenwick Lansdowne was a renowned BC wildlife artist.]

This is important, because many times clues to a student's own understanding of a reference were found when it was related to similar references in the student's entire set of metaphor responses, and to interviews with the students and with Elders and school officials in the community of 'Yalis.

The Students' Orientations Towards the Seashore Prior to Instruction

The metaphor interviews enabled me to identify the different orientations towards the seashore. While all the students exhibited several orientations when describing the seashore, some of them used one orientation predominantly, while others showed a greater mix of orientations. I focus in some detail on four students (Dan, Luke, Jimmy, and Mary). To begin, I describe the students' preferred orientations only. At a later point I describe the entire set of orientations for the selected students.

DAN

Dan's pre-instructional interviews pointed towards a preferred scientific orientation, as evidenced by the great proportion of responses reflecting an understanding of beach ecology. For example, he correctly identified numerous predator-prey relationships. For example:

A barnacle is a fisherman. It comes out and collects plankton from the water.
A starfish is a can opener. It can open clams, mussels, and many other shellfish.
A seagull is a robber. It steals food from little crows and peregrine babies.

Dan identified at least three different habitats—under rocks, in mud, in tidal pools:

A tidal pool is a hotel. It acts like a house for crabs, eels, bullheads, and snails, as well as many other animals.

Dan was one of the few students to express an awareness of the sun as the source of energy:

The sun is a factory. It makes all living things grow

Several of Dan's metaphor responses stressed a concern for the care and preservation of living things:

The seashore is a blackberry bush. When I pick blackberries, I pick them from on and under the bushes and put them in buckets. On the seashore, I pick up animals and put them in buckets. Usually I just look at them. Then, after a while I let them go once again.

Compared to the other students, Dan expressed the greatest awareness of seashore relationships and, in addition, expressed an understanding of the seashore that was generally consistent with Western Science ideas.

LUKE

The results of Luke's pre-instructional metaphor interviews pointed to a preferred spiritual orientation to the seashore, with numerous references reflecting the spiritual beliefs of the Kwakwaka'wakw peoples of 'Yalis:

I would be a listener to a story. I would listen to what happened a long, long time ago, about the Killer Whale, the Thunderbird, the Raven. My Uncle would be the storyteller.

I would be a raven. If I were Gwa'wina I could soar and catch killer whales. Only ravens and thunderbirds can catch the killer whale. Raven played tricks on its cousins and brothers.

The tide is a song. When I go down to the beach, I sit there and listen to what it might be saying—maybe the spirit of my ancestors might be in the tide or the waves.

The tide is a legend. The wolves looked after the tide long before anyone was born.

The seashore is a legend. There's a legend about this man who became wild and he went down to the beach every day and he ate mussels, clams, and abalone. One day one of his brothers went down to the beach. He saw his brother and went to tell his parents. They couldn't catch him. But he was wild and he lived in a tree stump. He was wild and he could do things that the animals could do.

When asked what animal, object, or event at the seashore he would most like to be Luke replied:

The Thunderbird. The Thunderbird can make thunder and lightning from its eyes. The Thunderbird is the ruler of the sky.

Luke's metaphor responses reflect the traditional stories of his people: stories about "The Wild Man in the Woods" who "could do things the animals could do," and "Thunderbird" the "ruler of the sky," and "Raven" who "played tricks on its cousins and brothers." The spirits of Luke's ancestors can be reborn and be in the tide or the waves. These spiritual stories portray an awareness of all animals as fellow creatures. Humans are not separated from nature, but are connected:

The seashore would be a gift for me because it's my meditation place. I go and smell the salty air, the sea breeze and seagulls doing their squawking ... it's like looking at the rocks with the mussels and the barnacles, and it's the whole circle of life ... without the seashore, I wouldn't have some of the foods that I eat today.

To some extent, it would appear that Luke is aware of the interconnectedness and the interrelationships of all life, "It's the whole circle of life." For Indigenous peoples, the journey towards harmony and balance begins with the sacred circle.

In addition, Luke is aware of pollution and the need for the care and preservation of the seashore:

I am a mechanic and the seashore would be the car. I am always picking up trash here and there.... I'm looking after the seashore, so I'd be the mechanic ... it looks after me and my kin when my people go to sea and go clam digging and digging for crabs. So, we look after each other.

In keeping with a traditional Indigenous spiritual orientation, there is a reciprocal relationship between humans and nature. Humans learn to live in harmony with the land and ocean; nurturing and protecting nature just as nature nurtures and protects them.

MARY

The results of Mary's pre-instructional metaphor interviews pointed towards a preferred aesthetic orientation to the seashore. Several metaphor responses expressed an awareness of the beauty in nature:

The seashore is a painting. It looks like a painting an artist would paint.
A cobblestone is a totem pole. It has different shapes and colours. The way it looks is pretty.
I would be the curtain; the seashore could be the lace. It decorates. The beach decorates 'Yalis up.

Several of Mary's responses made connections to music and dance:

The tide is music. It sways. I like the way it sways. It looks like it's dancing.
A seagull is a dance. The way it moves. It makes all that noise like music you dance to.

Interestingly, connections were made between Mary's own physical beauty, social relationships, and making jewelry:

I would be a sunny day. Everybody would like me. I would be big and bright.
I would be a polished beach pebble. It's shiny, not too big and beautiful.
The seashore is a jewel. Looking for shells on the beach, making things from the shells, like jewelry.

Rather than having an aesthetic orientation focused on the arts, Mary's aesthetic orientation was more broadly focused on the "pretty" aspects of the seashore and included social relationships and concepts of personal "beauty" and "prettiness."

JIMMY

The results of Jimmy's pre-instructional metaphor interviews pointed towards a preferred utilitarian orientation to the seashore. Jimmy's utilitarian orientation was almost wholly associated with commercial fishing:

I am the driver and the seashore is the car. I drive a seine boat and go fishing.
I would be a high tide. I would go check my fish net up the river for steelhead or sockeye or dogfish. I go up once a week and check my crab traps too.

When asked which animal, object or event Jimmy would most like to be, Jimmy said:

A crab. You could eat them. Boil them and eat them.

And he said:

A clam is a potlatch. When they have a potlatch feast, they make clam soup.
The seashore is a factory. It's got lots of animals.... You can sell them to people for meat.

It is interesting to notice how Jimmy's affinity with commercial fishing was so strong that he consistently turned even aesthetic images into utilitarian responses. For example:

I would be a bead to a necklace. You put beads on a necklace. You put the nets and the skiff on the ropes and tie them to the seine. You put the skiff on the back of the seine.

In all these metaphor responses attention is paid to fishing, crabbing, clamming, eating, and to selling fish and making money.

ANNA

The results of Anna's metaphor interviews pointed towards a preferred recreational orientation to the seashore, followed by an aesthetic and utilitarian orientation of considerably less proportion. For the sake of brevity, I will elaborate Anna's recreational orientation only:

The seashore is a playground. To me it's like playing. It's like a big playground with little pools and sand. We play in sand, in big pools and on the nice smooth logs.

I would be a sunny day. People like the sun. It's nice. You could go swimming, sailing, and surfing. You can get a suntan.

I would be a uniform and the seashore would be a hockey team.... A hockey player plays hockey, has a uniform and feels real close together.... I feel real close to the sea. Ever since I was old enough to go to the sea, I've been going there off and on: having fun, making sandcastles, playing on the beach, digging clams, playing Frisbee. We play tag down at the shallow end.

I would be the flower. The seashore would be the blackberry bush. Like as the flowers turn into fruit, I turn into the older generation, and I'm still going to the seashore when I die.... I'm thinking how I love the beach. It's my favorite place to play.

In all these metaphor responses, notice the attention paid to swimming, sailing, sun tanning, surfing, and having picnics at the seashore.

Sets of Orientations

In studying the patterns of the students' orientations, it is important to understand how all of the students relied on several orientations to describe the seashore. Where there were several orientations, there tended to be two or more orientations represented in each metaphor. These are exemplified in Dan's and Luke's sets of orientations.

DAN

In addition to a preferred scientific orientation to the seashore, Dan exhibited a spiritual orientation. Although Dan made no direct references to spirituality—traditional Indigenous legends or stories or any organized religion such as Christianity—it became clear that Dan's metaphor responses express an individualistic spiritual orientation based on a deep reverence for nature. He made numerous references to the amount of time spent at the seashore:

I would be a uniform to a hockey team because I'm on the beach a lot of the time. A uniform is always on the team players.

I would be a leaf to a tree ... and I could be bark to a tree because I'm there all the time.

Interestingly, numerous responses expressed a unique tendency to “indwell” or become part of nature:

I would be all of them: the flower, the fruit, the thorn to a blackberry bush. I'm always down at the seashore and I seem to be part of it ... I always think about the seashore, even when I'm not there.

I would be the curtain and the seashore would be the stitches. The seashore would hold us all together. I wouldn't be able to do everything without the seashore. It's just part of me. It's like my arms to me.

Several references were made to being the least in nature:

I couldn't be the root to a tree. I'm not really the base of the seashore.

A character to a story. I see myself within the story rather than telling it. Occasionally you could be listening—sitting there watching ... maybe you're learning something...the little animals and communities within it. I think humans and myself would just be another minor player within the whole seashore story... I'm trying to think of the words for how miniscule you are ... just being a drop in the bucket. I mean all of the events that happen on the seashore—any one event is almost as insignificant as you are in the whole picture. 'Cause you go down there one day and the bear rolls over a rock and a couple of crabs get squashed or

something. And you say, oh well or Wow! But it happens every day. You're just sort of a little fleeting moment in time.

Other responses stressed the inability of humans to control or to own the seashore:

I would be the deckhand and the seashore would be the fishing boat. I wouldn't be the captain or the owner because I couldn't really run the seashore, or be the boss of the sea.... There isn't a captain. The seashore is everybody's.

There is a sense of unity with nature that transcends a physical presence. Dan's relationship to the seashore can be seen as rooted in his view of himself as part of nature, not the most complex or important, but just another species sharing this world. And finally, in all these metaphor responses, it is important to notice the integration of emotion, feelings, intellectual reflection, and the humble servant or helper: "I'm sort of like part of the seashore" and "I always think about the seashore, even when I'm not there."

Dan also used an aesthetic orientation towards the seashore. Several metaphor responses expressed an appreciation of the beauty in nature:

A starfish is a flower. It sort of looks like one, the shape and colour.... Some of them are pretty.
I'd mostly be the lace to a curtain.... The seashore decorates all my life and makes it nice.
I would be the killer whale. The way it looks. How it moves ... easy ... slow. How it can move fast. And its speed for catching fish and catching seals and sea lions.

A recreational orientation was also evident:

The seashore is a playground. I play at the beach a lot: catching animals, looking at them. I fly my kite.
The seashore is a gift because of the many things that live there ... it's nice to play by and enjoy.
I would be all of them: a door, a window, a roof to a house. They're always there. I'm at the seashore a lot of the time. I'm playing, and I might go out in my boat.

Only three metaphor responses suggested a utilitarian response:

I could only be the deckhand to a fishing boat.... A deckhand's there when its fishing time.
I could be a fishing boat. I could catch fish. I could catch cod and halibut.
A clam is a potlatch. You can eat it.

Clearly, the proportion of scientific responses indicate that Dan brought to his curricular experiences a preferred scientific orientation towards the seashore, although several orientations were evident, including spiritual, recreational, and aesthetic. A utilitarian orientation was almost lacking.

The Relationship between the Students' Orientations and their Social and Cultural Background

To gain some idea of what it means for the students' orientations to be grounded in their previous experiences, I explored the relationships between the students' set of orientations and their physical, social, and cultural environments. Data included interviews with teachers, the school principal, culture teachers and Elders in 'Yalis. For continuity, I continue the biographies of Dan and Luke. For comparison, I have provided a brief account of the social and cultural backgrounds of Jimmy and Mary.

DAN

As discussed earlier, Dan had a preferred scientific orientation to the seashore. To understand the basis of Dan's preferred scientific orientation, data were gathered in an interview with the primary school teachers:

Dan goes duck hunting with his dad, then identifies ducks in books. His dad has a library on his fishing boat. They identify whatever animals they don't know.

Further information was gathered in an interview with the principal:

Dan's interest in science was developed primarily at home, particularly from William, his dad. Dan was definitely taught to be observant. William would constantly stop along the beach to say, 'look at this' or 'look at that'.

Such sensory-imbedded experiences at the seashore would account, at least in part, for Dan's keen awareness of the subtle aspects of seashore relationships. More data collected in the interviews with the teachers provide insights into Dan's family and school backgrounds:

Dan learned to read by reading factual science books: machines, how to fix things, identifying animals, dinosaurs, and whales. He spent a lot of time in the science centre.

Last, I had been hearing stories about a unique salmon enhancement project in 'Yalis. Since the project had been organized by Dan's father, I asked Dan if he would give me a more detailed description. Dan seemed especially delighted to talk about the project, and eager to show off its independence from the government:

It was my dad and fifty guys. It had nothing to do with the government. Everybody's going broke. The fishing isn't good. Some people are losing their boats. The creeks are ruined for spawning because of the logging.

The flooding caused sand and gravel to wash away the salmon eggs. My dad got everyone to volunteer their time and money. One boat was anchored in the bay. Every boat that came in gave two fish per catch. We paid for a helicopter to fly eggs from a fish hatchery to the spawning grounds.... I was the only kid that helped. We cleaned up the creek ourselves.... I helped catch the fish and milk the eggs. We put in 100,000,000 eggs. We estimate about 3% will come back. Next year we plan to put in a hatchery right at the river. Raise the eggs till they get eyes. We did it ourselves rather than through the government because it was cheaper.

Those people from Vancouver shouldn't log around the rivers. All those people fight over who's going to log what. They want to log the Nimpkish Valley. Ruin the creeks for spawning so the salmon eggs wash away. Ruin everything. Everybody's concerned. I can't do anything right now, but when I get older I will.

Notice the utilitarian and Western scientific orientation: Dan uses modern conservation and management practices used by the Department of Fisheries and Oceans, Canada to complement old traditional ways of sustaining the salmon fishery. Modern enhancement practices are similar to traditional practices where knowledge keepers and Elders successfully governed their traditional fisheries for thousands of years. This is because the Kwakwaka'wakw (as with other tribes along the coast and in the interior of BC) followed strict fishing practices based on respect for the salmon. If streams were depleted, juvenile salmon (or herring or trout) were packed into bentwood boxes or cedar baskets, transported on foot or by canoe, and the stream or lake enhanced.

The metaphor interviews also showed that Dan had a significant aesthetic orientation to the seashore: "The seashore decorates my life and makes it nice." The following from the school principal provides some understanding of the possible grounding of Dan's aesthetic orientation:

Dan's grandfather is First Nations from 'Yalis who married a Finnish woman from Sointula. Dan's father is a very successful fisherman. He fishes about four months a year. During the winter months there's a lot of free time for arts and crafts, music and reading.... An enviable lifestyle.

The mother is a very talented artist who does mostly watercolour. She excels as a homemaker—needlecraft and jewelry work. Her watercolours and jewelry are sold in the art store. Dan's dad is a craftsman, makes beautiful mandolins and guitars, as well as silver work.

Additional data were obtained from Dan:

Every Friday night ten or fifteen people come over. Mom plays the autoharp and dad plays the mandolin. I play saxophone, also guitar, mandolin, and ukulele. We sing a lot too.

I draw more than anything I've ever done: boats, lots of animals, cars, over and over again. Now I'm drawing scenery—a few boats together or a close up of one just ahead of the other.

Considering that Dan had a lot of free time, and that the arts were encouraged at home by both parents, it is not surprising that he exhibited aesthetic and recreational orientations to the seashore.

Recall that many of Dan's metaphor responses express a spiritual orientation towards the seashore, even though no responses suggested a traditional Indigenous spirituality, or Christianity, or any other organized religious affiliation. To find possible reasons for the absence of direct references to Indigenous spiritual stories and legends or to organized religious beliefs (the Christian Church), I interviewed the school principal:

When the first fish of the season is caught, William always has a ceremony. They drop anchor and go into a bay. It is in ways like the traditional salmon ceremony that thanks the salmon for returning. It's not really a spiritual thing—not like traditional beliefs. It's simply an appreciation. They have a picnic and relax. All the other fishermen think it's strange. They're competitive and always in a hurry to get out there and there's William having a picnic.

Although the family appears not to practice traditional Indigenous customs as interpreted by the school principal, it is interesting to compare their "appreciation ceremony" to the traditional practices of the Kwakwaka'wakw peoples: the "Salmon Dance," the "Prayer to the Salmon," and the "First Salmon Ceremony." In my conversations with Elders and community members it is important to understand that traditionally the Kwakwaka'wakw welcomed the first salmon by having a feast for at least four days. Musgam'dzi, (Kaleb Child), describes the first salmon ceremony:

Dances, song, ceremonies, and spiritual practices are a fundamental element of Kwakwaka'wakw worldviews even today. First salmon ceremonies are still carried out in meaningful ways to recognize and celebrate the critical importance of salmon. Our connections to the salmon resource are deeply rooted in our origin stories and our continuing cultural history, representing contexts of sustainability by making time through ceremony for initial runs of salmon upriver to spawn. This in many ways allows us to express gratitude, acknowledge our relationship to our salmon relatives, to welcome the salmon, to honour the salmon, to show profound respect, and to purposely allow a major portion of the salmon to return to their traditional territories and watersheds from which they were born (Musgam'dzi, Kaleb Child, personal communication, January 28, 2018).

Thus, the first salmon ceremony was a way to sustain the fishery for thousands of years.

Also, it is important to notice Dan's emotional feelings and respect for the seashore: "I would be all of them—a door, a window, and a roof to a house.... I'm sort of like part of the seashore, even when I'm not there." Although there are no responses that clearly reflect traditional Indigenous spiritual stories, there is an attachment and a sense of unity with nature. To say that there are no underlying spiritual structures would be failing to see the depth and complexity in

Dan's love for the seashore. Dan's belief system is grounded in a highly spiritual effort to protect and secure the human connection with nature.

Only three of Dan's metaphor responses reflect a utilitarian orientation towards the seashore: the seashore is a place where Dan can "fish for cod" and "halibut" and "eat small clams." At first the surprisingly infrequent mention of the more utilitarian aspects of the seashore appears to contradict Dan's love of commercial fishing. For example, when asked what he most wanted to be when he grows up, Dan replied:

A fisherman because my father is a fisherman. My grandfather was the best fisherman on the coast.

To gain further insight into the possible reasons for this apparent contradiction, I sought additional data from the school principal:

Dan's parents aren't into competitive fishing. William has good fishing skills and good management skills. Catching a lot of fish and making a lot of money isn't as critical. He consumes and conserves. His boat is more relaxed.

This data suggests that the problems of catching a large number of fish and of meeting financial obligations are not immediately obvious in a home where the father is a "very successful fisherman" and a "good manager." It is also interesting to note Dan's second choice if he couldn't be a fisherman when he grows up:

I would be a park naturalist or a marine biologist, but only if I didn't have to leave Alert Bay [Yalis]. I want to go live in the wilderness.... I want to go there and feed the animals, and study and do Lansdowne books, but do it about sea animals.

The data also suggests that Dan was more aware of the utilitarian aspects of the seashore than his metaphor responses seem to suggest. As Dan's family lived a "relaxed" lifestyle and was financially stable, there was little need for Dan to worry about utilitarian matters. I inferred that Dan, as an adult, would likely express his relationship to the seashore in a more utilitarian and activist way: "I can't do anything right now [the destruction of salmon habitat], but when I get older I will." As a Grade 6 student, Dan simply didn't demonstrate much use of the utilitarian orientation when describing his relationship to the seashore.

LUKE

Remember that Luke's initial metaphor responses suggested a preferred spiritual orientation to the seashore, expressed by numerous references to the spiritual beliefs of the traditional Kwakwaka'wakw peoples of Yalis. The following data collected in interviews with the culture teachers provide insight into Luke's particular spiritual orientation:

Luke takes traditional Native dancing, Kwak'waka language, and traditional art in school. He is very interested in the Kwakwaka'wakw culture ... a good listener. He visits the Elders regularly and listens to our spiritual stories. He dances a lot in the big house. Luke will be a wise man someday.

Further information was gathered in an interview with the school principal:

Luke lives with his Granny. His Granny is very traditional Kwakwaka'wakw, but also attends the Pentecostal Church here in 'Yalis. His great uncle Billy is a well-known First Nations artist. The Granny has a very strong influence on Luke. Luke doesn't go out and fish on the seiners.

And finally, upon returning to 'Yalis six months later to complete the long-term interviews, stories were told about a potlatch that Luke's Granny had given over the summer. Luke described the potlatch:

I danced two dances all by myself. It was the first time. I danced the Hamatsa, a dance about the return of the chief's son. It's the story of the 'Wild Man in the Woods.' He was lost in the woods. The people tried to catch him, but he jumped over them. They made a cage for him.

We had a big potluck dinner. It was really good: baked salmon, barbecued salmon, clam chowder, homemade buns. Mmm! My Granny gave away pillows, laundry baskets, homemade clothes, homemade shawls, homemade cushions, homemade dolls. I saved up my money and had a potlatch at the same time. I gave out toys: necklaces, squirt guns, dolls, magnifying glasses, quarters, nickels, dimes, and key chains.

Luke's involvement in the First Nations cultural program at school and the fact that traditional spiritual beliefs are encouraged at home by his Granny and his uncle help explain why Luke would understand and experience the seashore through the oral traditions of his people. This telling and retelling of the spiritual stories, and the watching and enacting of his ancestors' encounters with supernatural beings would account, at least in part, for Luke's preferred spiritual orientation to the seashore.

Recollect also, that Luke had an aesthetic orientation to the seashore. To provide some idea of the possible grounding of Luke's particular aesthetic orientation, I include information that was gathered in interviews with Luke:

When I grow up I would most like to be a carver; carve totem poles and talking sticks. If the chief wants to talk he has to hold the talking stick. I would carve a stick with eagles, bears, and frogs. I would also be a painter and paint First Nations designs or be a silversmith and make First Nations designs on bracelets, necklaces, and rings.

The fact that First Nations art is clearly encouraged at school, in the home by Luke's Granny, and that Luke's great uncle is a well-known Kwakwaka'wakw artist suggests why Luke demonstrated an aesthetic orientation to the seashore. In addition, Luke had both a utilitarian and a recreational orientation to the seashore based on traditional Kwakwaka'wakw experiences: attending potlatches, eating barbequed salmon, baked salmon, and clam chowder; and recalling traditional stories such as "the Wild Man of the Woods who came down to the beach every day and ate clams, mussels and abalone."

The legends and ceremonial dances of the Kwakwaka'wakw involve the marine and freshwater animals that are common along the coast and in local rivers and streams. The stories portray the ocean as offering a seasonal abundance of food. Thus, there was also a strong relationship between Luke's utilitarian orientation and his awareness of seashore phenomena. For example, Luke's participation in gathering, preparing, and eating seafood contributed to a good awareness of seashore life:

Sometimes I go to Gilford Island with my Uncle to dig clams. Sometimes my mom (Luke calls his Granny Mom) makes clam chowder. Sometimes we make fish chowder. My mom puts in seaweed, usually the black kind.... My mom knows a lady who eats sea urchins. She breaks off the spines and puts them in the freezer to keep. Then she thaws them out, cracks them open and eats the insides. She eats snails and chitons too.

What is important to this research is that Luke's spiritual, utilitarian, and aesthetic orientations are important dimensions of the traditional way of life in 'Yalis, and contributed to a general awareness of certain seashore plants, animals, and phenomena which he considered of significance: killer whales, eagles, ravens, salmon, clams, abalone, seaweeds, tides, and so forth. Additionally, Luke's particular spiritual orientation allowed him to believe in the existence of supernatural animals or beings, such as the Thunderbird and the Wild Man of the Woods.

Luke's spiritual orientation is also grounded in the Pentecostal Church whose doctrines are fundamental in character. The following data were collected in an informal conversation with Luke as I was driving him to his Granny's house to get his science project. When we passed the ferry dock, Luke laughed and said:

When Jesus Christ comes to 'Yalis he won't have to use the ferry dock because he'll float down on a great white cloud. He'll wear a big crown with lots of jewels on his head, and there will be angels all around with silver wings.

Recall that Luke lives with his First Nations Granny who was described by the school principal as "very traditional," but also attends the Pentecostal Church. Because the beliefs of the Pentecostal Church seem divorced from the spiritual beliefs of the traditional beliefs of the Kwakwaka'wakw peoples, the blending of the two might seem strange. But if one examines many of the stories of the two belief systems, one finds there are certain common characteristics. Look at the metaphors involved in the ceremonies, the masks, the dances, and the legends of the Kwakwaka'wakw, and the metaphors, parables, and miracles of the Bible. While no pre-instructional metaphor response illuminated Christian beliefs, which seems surprising given the above conversation, Luke's belief system embodies an integration of spiritual ideas about humans, animals, and all of creation.

The Case of Mary: The Student with a Preferred Aesthetic Orientation

In this section, I will only describe the relationship between Mary's preferred aesthetic orientation to the seashore, and her social and cultural background. To account for Mary's preferred aesthetic orientation, the following information was gathered in an interview with the principal:

Mary's mom is a non-First Nations who married a full status Kwakwaka'wakw. The First Nations Granny [Mary's dad's mother] had strong cultural ties. But the marriage failed, and the mom re-married a non-First Nations. Mary hasn't had much contact with the First Nations family for some time.

Interviews with the primary teacher provided the following insights:

Mary was always interested in arts and crafts.... Just look at Mary ... a very pretty girl with long black hair. She has two sisters and a very feminine mother. As a little girl Mary drew lots of princess pictures; girls in long beautiful gowns and with very expensive jewelry.

This data provides insights into Mary's usage of jewelry, clothing, hair, and home metaphors to describe seashore plants and animals in the metaphor responses, and later to describe seashore organisms during instruction.

And finally, an interview with Mary revealed the following:

When I grow up I would most like to be a hair stylist. I like working with hair. A hair stylist and a cosmetician.... I like working with people and I like to help people look better.

This data, at least in part, may account for Mary's preferred aesthetic orientation towards the seashore.

JIMMY

Recall that Jimmy's initial metaphor responses strongly suggested a utilitarian orientation to the seashore that was almost wholly associated with commercial fishing. An interview with the school principal revealed the following:

Jimmy is First Nations living with his very traditional Native grandparents.... Jimmy is the man of the house.... His grandparents are aging and it's hard for his grandfather to keep up with the expenses of the fishing boat. Jimmy feels a strong responsibility to put food on the table.

Jimmy's familiarity with and ability to function as a harvester was not disrespectful to marine life or the environment. He can feed his family and take care of the animals.

Comparatively few metaphor responses reflect a spiritual or aesthetic or recreational orientation to the seashore. This seemed surprising given Jimmy's Kwakwaka'wakw ancestry and his prior experiences in 'Yalis. For example, the following information was obtained from the school counselor:

The grandfather dances a lot in the big house. Jimmy was a good dancer in the primary grades..

In an effort to account for the near absence of spiritual and aesthetic orientations, the following information was gathered from the home school coordinator:

Jimmy was raised in the traditional Kwakwaka'wakw ways. Jimmy respects and relates to his dad (grandfather). He watches his grandfather work: fishing, setting nets, setting crab pots, driving the boat ... traditional First Nations boys watch their father. They practice out of sight. Then when their skills are perfected, they can perform in front of their Elders.... At school, we expose children to testing and practicing in front of adults. To be exposed, especially in front of a woman is a dishonour. Verbal skills and writing skills are not necessary on a boat.

Although highly speculative, the above data provides additional explanation for the near absence of obviously spiritual and aesthetic orientations. It is likely that Jimmy had both a spiritual and an aesthetic orientation steeped in traditional Indigenous ways that were of considerably more weight, but he simply preferred not to put himself forward or to share certain aspects of his thinking with outsiders. All of the above data are required to give an account, at least in part, of the interactional properties of Jimmy's orientations and beliefs about the seashore.

Coherence across Orientations

The data suggests a certain internal coherence across a student's various orientations to the seashore, and a certain external coherence between a student's various orientations and his or her physical, social, and cultural background.

External Coherence

To understand how orientations are grounded in connections with physical experience, I briefly compare and contrast the cases of Dan, Jimmy, and Anna. From discussions with the students, it became clear that: Dan interpreted the word "seashore" specifically as the inter-tidal region between the land and the sea; Jimmy frequently interpreted the word "seashore" more broadly as the offshore water and the open coast; while Anna focused partially on the seashore in 'Yalis and partially on the seashore in her native Philippine Islands. The fact that these three students interpreted the word "seashore" as a different marine environment reverberated through the metaphorical connections each chose.

In the case of Dan, there was external coherence between his particular set of orientations and the type of seashore that exists in 'Yalis. As such, Dan's scientific orientation was coherent with a type of seashore that is home to a diversity of seashore seaweeds and animals. Dan's particular recreational orientation is externally coherent with a picturesque harbor filled with fishing boats, beaches with gnarled trunks and twisted branches meeting the sea, and a continuous chain of spectacular white-capped mountains in the distance. Similarly, Dan's low utilitarian orientation is generally consistent with a type of seashore that supports comparatively few preferred edible animals. 'Yalis beaches are cobblestone set on hard rock, which support seafoods such as seaweeds, chitons, limpets, and sea urchins (the latter three not commonly eaten today); but comparatively few seafoods such as butter clams, geoduck clams, littleneck clams, oysters or Dungeness crabs which live on mixed sand, mud and gravel beaches.

In Jimmy's case, there was a certain external coherence between his particular set of orientations, and the type of physical environment that exists along the BC coastline. Jimmy frequently interpreted the word "seashore" as the offshore waters and the open ocean, and his utilitarian orientation is externally coherent with a coastline that supports a great diversity of commercial fish (sockeye salmon, chum, herring, coho, halibut, cod, flounder, etc.), as well as the wide-ranging Dungeness crab, shrimp, etc. At the other extreme, Jimmy's comparatively low recreational orientation is externally coherent with the type of lifestyle that frequently goes with commercial fishing in a very competitive fishery where losing one's boat and source of livelihood is a constant threat. Jimmy's comparatively low aesthetic orientation seems surprising given the aesthetic qualities of 'Yalis and the presence of traditional First Nations art. Despite these inconsistencies, Jimmy's orientations are externally coherent with the type of physical coastline generally.

Anna's case, on the other hand, showed a certain external coherence between her particular set of orientations and the type of physical environment that exists in the Philippines. Anna's preferred recreational orientation, which stressed swimming, sailing, surfing, playing Frisbee, picnicking, beach parties, and sun tanning, is coherent with long sandy beaches and hot tropical weather. The data suggests that Anna may have had a recreational orientation of considerably less weight had she more consistently interpreted the word "seashore" as meaning 'Yalis beaches, which are cobblestone, frequently rainy and generally cold. It seems that the students' orientations are grounded in systematic connections within their real and perceived physical environment.

Internal Coherence

Lastly, there was a general internal coherence among the various orientations shown by each student. In the case of Dan, for example, several of his orientations tended to point to his preferred scientific orientation to the seashore. For example, Dan's preferred scientific orientation is internally consistent with a father role-model who taught Dan, at an early age, to observe closely, identify organisms from a library of books in the home and on the fishing boat, and to use conservation management to help solve the problem of rapidly dwindling fish stocks. His particular spiritual orientation, which stressed a unity with nature and an ability to indwell, complemented his scientific orientation. His particular aesthetic orientation, which stressed observing closely and drawing and painting seascapes and animals like a Lansdowne artist, was consistent with his scientific orientation. His particular recreational orientation, which stressed independent exploration at the seashore, catching animals, looking at them and letting them go, was consistent with his scientific orientation. Although few responses stressed a utilitarian orientation, his interest in commercial fishing and duck hunting was coherent with his interest in science.

It seems that each student's orientations form a system of relationships grounded within his or her previous physical, social, and cultural experiences. Following Lakoff and Johnson (1980), I am proposing that the students' orientations are products of their perceptual, mental, and emotional makeup—their interactions within their physical environment (seeing, hearing, touching, observing animals, rocks, sand, and the type of seashore), and their interactions with others in their culture (in terms of family, social, cultural, economic, religious, institutions). In other words, the kind of

conceptual system the students have is a product of the way they interact with their physical, social, and cultural environments. For a more complete discussion of the internal and external coherence of the students' orientations see Snively, (1986).

In the lives of Dan, Luke, Jimmy, and Mary we can see the struggles of growing up in a small Indigenous coastal fishing community during the 1970's and 1980's. Each had been influenced directly or indirectly by the beliefs and values of their family (parents, grandparents, aunts, and uncles), the community, the big house, the Christian church, the lingering effects of the residential school, diminishing fish populations on the coast, and so forth. Each in his or her way had attempted to make sense of the world within the web of clashes between the Indigenous world and the Eurocentric world. Into this clash of beliefs and values, the students must also navigate through school science curriculum.

Several questions arise: How can teachers take into account the students' preferred orientations during classroom instruction? Can teachers design instructional metaphors to enable students with different preferred orientations to understand basic ecology concepts? Can the instruction enable students, with a preferred spiritual orientation to the seashore, to understand marine ecology concepts without replacing, in the sense of changing, the students' preferred spiritual orientation to a preferred scientific orientation? These are the issues we turn to in [chapter 5](#).

REFERENCES

Atleo, E. R. (2004). *Tsawalk: A Nuu-chah-nulth worldview*. Vancouver, BC: UBC Press.

Battiste, M. (2000). Maintaining Aboriginal identity, language, and culture in modern society. In M. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 192-208). Vancouver, BC: UBC Press.

Battiste, M. (2002). *Indigenous knowledge and pedagogy in First Nations education: A literature review with recommendations*. Ottawa, ON: National Working Group on Education and the Minister of Indian Affairs, Indian and Northern Affairs Canada (INAC).

Beck, B. (1978). The metaphor as a mediator between semantic and analogic modes of thought. *Current Anthropology*, 19(1), 83-97.

Beck, B. (1982). Root metaphor patterns. *Semiotic Inquiry*, 2, 86-97.

Blanchet-Cohen, N. (2008). Taking a stance: Child agency across the dimensions of early adolescents' environmental involvement. *Environmental Education Research*, 14(3), 257-272. <https://doi.org/10.1080/13504620802156496>

Blanchet-Cohen, N. (2010). Rainbow Warriors: Environmental Agency of Early Adolescents. In B. Stevenson & J. Dillon (Eds.), *Environmental Education: Learning, culture and agency* (pp. 31-55). Rotterdam, NLD: Sense Publishers.

Cajete, G. (2000). *Native science: Natural laws of interdependence*. Santa Fe, NM: Clear Light Publishers.

Kawagley, A. O. (1995). *A Yupiaq worldview: A pathway to ecology and spirit*. Prospect Heights, IL: Waveland Press.

Lakoff, G. & Johnson, M. (1980). *Metaphors we live by*. Chicago, IL: University of Chicago Press.

Little Bear, L. (2000). Jagged worldviews colliding. In M. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 77-85). Vancouver, BC: UBC Press.

McGregor, D. (2004). Traditional ecological knowledge and sustainable development: Towards coexistence. In M. Blaser, H. A. Feit, & G. McRae (Eds.), *In the way of development: Indigenous peoples, life projects and globalization* (pp. 72-91). New York, NY: Zed Books.

McGregor, D. (2005). Traditional ecological knowledge: An Anishnabe woman's perspective. *Atlantis*, 29(2), 103-109. Retrieved from <http://journals.msvu.ca/index.php/atlantis/article/view/1057>

Michell, H. (2007). *Nihithewak Ithiniwak, Nihithewatisiwin and science education: An exploratory narrative study examining Indigenous-based science education in K-2 classrooms from the perspective of teachers in Woodlands Cree community contexts* (Doctoral dissertation). University of Regina, Regina, SK.

Michell, H., Vizina, Y., Augustus, C., & Sawyer, J. (2008). *Learning Indigenous science from place: Research study examining Indigenous-based science perspectives in Saskatchewan First Nations and Métis community contexts*. Saskatoon, SK: Aboriginal Education Research Centre, University of Saskatchewan. Retrieved from <http://iportal.usask.ca/docs/Learningindigenousscience.pdf>

Ross, L. (2003). *The search for effective environmental education professional development in the Colquitz River watershed stewardship project* (Master's thesis). University of Victoria, Victoria, BC.

Snively, G. J. (1986). *Sea of images: A study of the relationships amongst students' orientations, beliefs, and science instruction* (Doctoral dissertation). University of British Columbia, Vancouver, BC. Retrieved from <http://hdl.handle.net/2429/27253>

Snively, G. (1987). The metaphor interview and the analyses of conceptual change. In J.D. Novak (Chair), *Proceedings conducted at the Second International Seminar of Misconceptions and Educational Strategies in Science and Mathematics*, Ithaca, NY: Cornell University.

Snively, G. (1990). Traditional Native Indian beliefs, cultural values, and science instruction. *Canadian Journal of Native Education*, 17(1), 45-59.

Tenning, A. (2010). *Metaphorical images of science: The perceptions and experiences of Aboriginal Students who are successful in senior secondary science* (Master's thesis). University of Victoria, Victoria, BC. Retrieved from <http://hdl.handle.net/1828/2758>

Chapter 5 - Cultural Beliefs and Values, and Instructional Metaphors in the Science Classroom

GLORIA SNIVELY

Researchers in science education have been hesitant to study the relationship between students' beliefs and values about science concepts and their social and cultural backgrounds. Scant research has focused on the relationship between the beliefs of Indigenous students about science concepts and their experiences during science instruction. It is likely that if different prior knowledge exists as a result of cultural and personal beliefs and theories, then different groups will likely have different prior knowledge and alternative conceptions (Aikenhead, 2006; Aikenhead & Michell, 2011; Barnhardt, 2006, 2008; Battiste, 2002; Cobern, 1996; 2000; Kawagley, et.al, 1998; Snively, 1990, 2016; Snively & Williams, 2008).

In considering the possible interactions between students' views and science instruction, researchers have generally addressed the notion of constructed meaning by analyzing student's cognitive beliefs (their factual knowledge, reasoning, and remembering capacity) about a narrow set of science concepts. However, an important additional consideration that may determine whether a given student accepts, understands or rejects a given concept is the set of values and emotions that they bring to the instructional setting. When a Western scientific view is presented in the classroom setting, the students' collection of prior knowledge, values, and emotions serves as the initial set of interpretive categories, and it is the potential match between these existing cognitive commitments and the new information which determine how the student will respond to the instructional input (Aikenhead, 1996, 2006; Aikenhead & Jegede, 1999; Aikenhead & Michell, 2011; Snively, 1990, 2016; Snively & Corsiglia, 2001; Snively & Williams, 2008).

As described in [chapter 4](#), one way of attempting to capture some of the complex interplay between cognition and affect is by the construct of an orientation (Snively, 1986, 1987, 1990). In this study, "an orientation means a tendency for an individual to understand and experience the world through an interpretive framework, embodying a coherent set of beliefs and values" (Snively, 1986, p. ii). These orientations are thought to be deeply rooted aspects of our conceptual system and not easily assessable with normal probing techniques such as pencil and paper tests or even conventional interview techniques.

Variations in the students' orientations may influence their understanding of and acceptance of new science concepts. There may be conflicts between the students' prior orientations and the instruction as presented. If a student interprets science concepts as being in harmony with his or her own orientations, then learning these concepts may be a fairly straightforward task. But if a conflict exists between the orientations and beliefs held by the student and those presented by the instruction, then learning the science concepts may be quite difficult. The fact that students bring to the classroom prior orientations suggests also that teachers need to take the students' orientations into account and incorporate these into the instructional process.

The study involved a class of 20 Grade 6 students, and placed special attention on six of those students, each with a different set of orientations to the seashore: the student with a preferred scientific orientation (Dan), a student with a preferred spiritual orientation (Luke), one with a preferred aesthetic orientation (May), another with a preferred utilitarian orientation (Jimmy), a student with a preferred recreational orientation (Anna), and finally, a student with no preferred orientation (Sharon). [Chapter 4](#) describes the six students in some detail, their preferred orientations to the seashore prior to instruction, and how interviews conducted with Elders and community officials aided in the analysis of the students' orientations.

This chapter describes in some detail the interactions between the students' preferred orientation, their beliefs about seashore relationships before and after instruction, and the use of instructional metaphors to teach an ecological view

of the seashore. It was hoped that the interaction between the students' orientations and the school science instruction would result in an increased understanding of specific ecological concepts that would persist for a significant time after instruction. Importantly, it was hoped that for the participants of Indigenous ancestry, the instruction would honour their lived experiences and not diminish their cultural identity.

Strategy for Instruction and Research Methodology

The 1982 study (Snively, 1986, 1990) involved the collection and analysis, by metaphor and literal interviews, of students' orientations and beliefs before and after instruction, as well as interviews conducted six months later. Although all the students exhibited several orientations when describing the seashore, some used one orientation predominantly, and some showed a greater mix of orientations. The participants consisted of a class of Grade 6 students in the community of 'Yalis. For a fuller description of 'Yalis, Alert Bay Elementary School and the class of students, see [chapter 4](#).

The primary purpose of instruction was to introduce a basic set of ecological concepts focused around specific seashore relationships (tidal cycle, habitat, predator-prey, food chains, food webs, interconnections, interdependence, adaptation, community (or ecosystem), pollution, preservation, etc.). Because ecological concepts and environmental ethics share many analogous characteristics with Indigenous concepts and ways of knowing nature, it was hoped that the instruction would be effective. In order to increase the students' understanding of beach ecology, the teacher attempted to use instructional metaphors that were sensitive to the students' orientations prior to instruction. A second purpose of instruction was to enhance the students' ability to view the seashore from a variety of different orientations. Thus, there was on-going interaction between the teacher and myself to design and put into use instructional metaphors and metaphorical activities to meet the dual purposes of instruction.

I made use of triangulated and accumulative data gathering techniques. As much as possible, I had to understand the total situation in order to interpret the students' metaphor responses. For instance, the analysis of data depended on an understanding of the respondents' physical, social, and cultural experience, the curriculum as presented, and so on. I used metaphor interviews; open-ended literal interviews; analysis of student drawings; class observations; and interviews with Elders, culture teachers and individuals in the school and community to describe several aspects of the same phenomena, make comparisons, formulate new questions, and construct meaningful propositions. As such, the data gathering technique was intimate and the product consequential for the community and for those involved.

The second section of this chapter begins with a description of the students' beliefs about specific seashore relationships (marine ecology concepts) prior to instruction, and describes the relationship between the students' beliefs and their preferred orientation to the seashore. The third section describes the instructional strategies that were used to increase the students' understanding of beach ecology. The fourth section provides a detailed description of two cases: Luke, the student with a preferred spiritual orientation to the seashore; and Mary, the student with a preferred aesthetic orientation to the seashore. It describes how the teacher attempted to increase their knowledge of specific science concepts by using instructional metaphors reflective of their preferred orientations. The fifth section describes the students' beliefs about seashore relationships after instruction, and the sixth section describes the students' orientations after instruction.

Students' Awareness of Seashore Phenomena

One way of attempting to understand the nature of the students' beliefs about seashore relationships prior to instruction was to document their awareness of seashore phenomena. The first part of the literal interviews asked

each student to list all the plants, animals, objects, and events connected with the seashore. As the students listed phenomena, I wrote their responses onto 2 X 4 cm cards. Table 5.1 compares the responses of four students.

Table 5.1 The students' awareness of seashore phenomena

	DAN	LUKE	JIMMY	MARY
1.	bullheads (e)	rocks	crabs	crabs
2.	crabs	eels (d)	eels (d)	seaweed
3.	seaweed	crabs	bullheads (e)	rocks
4.	barnacles	seaweed	shellfish	kelp
5.	sea urchins	kelp	perch	eels (d)
6.	big rocks	fish	ratfish	sand
7.	eels	killer whale	whisker cod	water
8.	clay	logs	flounder	logs
9.	seaweed bugs	water	black bass	starfish
10.	water	old bikes	red snapper	barnacles
11.	kelp	machine parts	rock cod	flower animals (c)
12.	logs	little shells	trout	mussels
13.	seagulls	starfish	ling cod	seashore snails
14.	crows	Chinese hats (a)	killer whale	bugs (p)
15.	pools of water	barnacles	sockeye salmon	shells
16.	rock cod	Chinese slipper(b)	pink salmon	glass (p)
17.	clams	eagles (p)	hump salmon	
18.	otters	seagulls	dolphins	
19.	killer whale	crows	seals	
20.	mice	pigeons	seagulls	
21.	rats	clams	crows	
22.	ducks	salmon	eagles	
23.	geese	halibut	rocks	
24.	pintails	herring	barnacles (p)	
25.	mallard	cod (p)		
26.	salmon			
27.	red snapper			
28.	ling cod			
29.	skiff			
30.	eel eggs			
31.	fish eggs			
32.	scallops			
33.	abalone			

34.	sea cucumbers			
35.	snails			
36.	small rocks (p)			

- a) Chinese hat (limpet)
- b) Chinese slipper (different species of limpet)
- c) Flower animals (sea anemones)
- d) Eels (blennies, an elongated fish)
- e) Bullheads (tidepool sculpins)
- p) Researcher's probe; e.g., can you think of anything else at the seashore? In the water? In the air? On the beach?

All the students began by listing the more common and obvious seashore organisms that inhabit the tidal pools and under-rock habitats of the upper tide zone: barnacles, crabs, and seaweeds. Dan had an exceptional awareness of the existence of seashore phenomena and listed organisms that are common in the lower tide zones and sub-tidally such as scallops, sea urchins, sea anemones, and abalone. By comparison, Luke had a good awareness of intertidal organisms, while Jimmy and Mary did not appear to be very aware of even some of the more common and obvious seashore organisms. Interestingly, Jimmy began by listing intertidal organisms, but rapidly listed a large number of commercial fish that live in nearshore and offshore waters: flounder, red snapper, halibut, ling cod, black bass, pink salmon, sockeye salmon, hump salmon, as well as wide-ranging mammals, such as seals, killer whales, dolphins, and birds that often accompany fishing boats (eagles and seagulls).

A second way of documenting the students' awareness of seashore phenomena was to analyze the students' metaphor responses. In Dan's case, there was a strong relationship between his preferred scientific orientation to the seashore and his exceptional awareness of seashore phenomena, as revealed in some of his metaphor responses (see [chapter 4](#)). Luke, on the other hand showed a strong relationship between his preferred spiritual orientation and his general awareness of seashore phenomena. To see this, look at the marine phenomena involved in some of Luke's metaphor responses:

The seashore is a legend. There is a legend about this man who became wild and he went down to the beach every day and he ate mussels, clams, and abalone. I would be a listener to a story. I would listen to what happened a long, long time ago, about the Killer Whale, the Thunderbird, the Raven.

The tide is a legend. The wolves looked after the tide long before anyone was born.

A clam is a dance. You could use the shells in a dance called the Kwi Kwi.

I would be Raven. If I were Gwa'wina (Raven) I would soar to catch the killer whales. Only ravens and thunderbirds can catch the killer whale.

The legends and ceremonial dances of the Kwakwaka'wakw peoples involve the marine and freshwater animals that are common along the coast and in local rivers and streams. The stories portray the ocean as offering a seasonal abundance of food. Thus, there was also a strong relationship between Luke's utilitarian orientation and his awareness of seashore phenomena. For example, Luke's participation in gathering, preparing, and eating seafood contributed to a good awareness of seashore life:

Sometimes I go to Gilford Island with my Uncle to dig clams. Sometimes my mom [Luke calls his granny Mom] makes clam chowder. Sometimes we make fish chowder. My mom puts in seaweed, usually the black kind.... My mom knows a lady who eats sea urchins. She breaks off the spines and puts them in the freezer to keep. Then she thaws them out, cracks them open and eats the insides. She eats snails and chitons too.

What is important to this research is that Luke's spiritual, utilitarian, and aesthetic orientations contributed to a general awareness of seashore animals, objects, and events (e.g., killer whales, eagles, ravens, salmon, clams, abalone, tides, etc.) which he considered had spiritual, utilitarian, or aesthetic significance. Additionally, Luke's particular spiritual orientation allowed him to believe in the existence of supernatural animals or beings: the "Thunderbird" and the "Wild Man in the Woods."

Students' Beliefs about Specific Seashore Relationships

Another way to understand the nature of the students' beliefs about seashore relationships prior to instruction was to document their beliefs about specific seashore concepts (habitat, predator-prey, tidal cycle, food chain, zonation, community, etc.).

Prior to instruction, only a few students held beliefs that were consistent with marine science concepts; most held beliefs that were quite different. Most students held a reasonably strong relationship between their orientations and the nature of their beliefs about specific seashore relationships. I begin with a general summary of the students' beliefs prior to instruction. This data is taken from both the metaphor and literal interviews.

For this set of interviews, I asked the students to draw pictures of six common seashore animals (barnacles, clams, sea stars, shore crabs, sea anemones, and seagulls) at high tide and at low tide (or when out of seawater), and to answer my questions about seashore relationships. At a later point I will provide a more detailed analysis of the relationship between the individual students' beliefs and their preferred orientations. For the sake of brevity, I provide examples of the students' beliefs about barnacles only.

Dan's Beliefs about Seashore Relationships

In the case of Dan, there was a strong relationship between his preferred scientific orientation to the seashore, and his beliefs about specific seashore relationship. A great many interview responses (both metaphorical and literal) revealed an exceptional understanding of seashore ecology. In the pre-instructional literal interviews, Dan drew pictures of barnacles at high tide and at low tide ([Figure 5.1](#)), and answered my questions (see excerpt below):

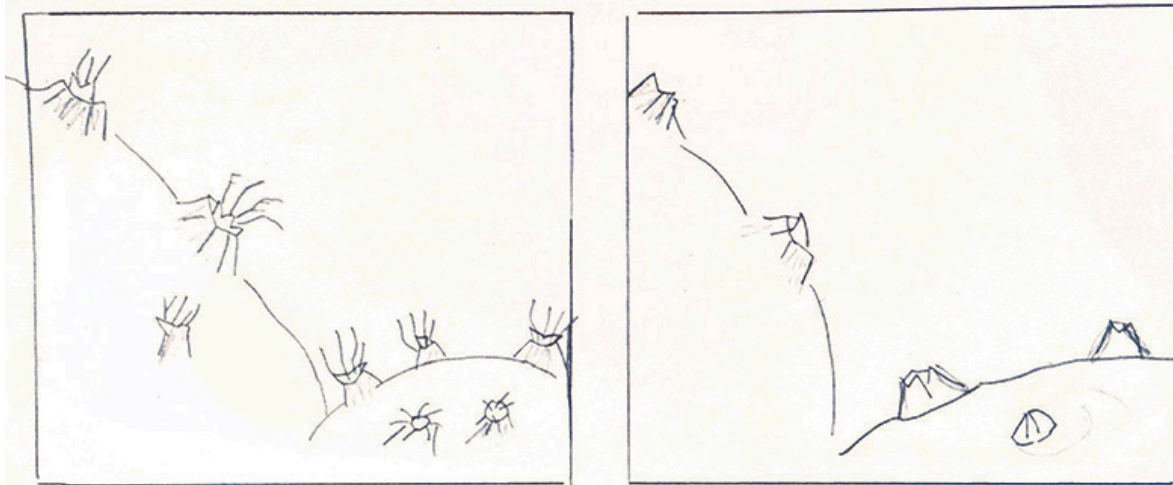


Figure 5.1 ▲ Dan's barnacles at high and low tide. Photo by Gloria Snively (1982).

Researcher: What is the difference between what barnacles do at high tide when they are covered with seawater, and at low tide?

Dan: Their little feelers are out.

R: And what are those little feelers doing?

D: Catching plankton.

R: Do you know what plankton is?

D: I forgot.... It's little baby hermit crabs. They're part of it.

R: The little baby crabs are part of the plankton?

D: They float around in the water until they get bigger and get shells.

R: So, the barnacles are catching tiny, tiny baby hermit crabs. And what are they doing with it?

D: They bring them into their shells and eat them.

R: Do they do that at low tide?

D: No. Just at high tide or when they're in a pool of water.

From the literal interviews, Dan demonstrated that he had an unusual understanding of “plankton” (tiny microscopic marine plants and animals), that barnacles begin life as tiny “baby crabs” in the plankton and grow until they settle and “get shells,” and that filter feeders such as barnacles filter plankton from seawater at high tide when they are covered with sea water and “their little feelers are out.”

Data identified in the literal interviews was often confirmed by data identified in the metaphor interviews:

A barnacle is a fisherman. It comes out and collects plankton from the water.

By comparing and contrasting data for all of the six students in this way, I was able to identify to a large extent their understanding of certain predetermined ecological concepts.

Luke's Beliefs about Seashore Relationships

There was a strong relationship between Luke's preferred spiritual orientation and his set of specific beliefs about seashore relationships as evidenced by both the metaphor and literal interview. Many of Luke's responses expressed beliefs about the seashore that resembled accepted science ideas, and many beliefs that were quite different. In an attempt to understand Luke's specific beliefs about seashore relationships, it is helpful to consider his responses to my questions about barnacles. For the sake of brevity, I include only an excerpt of Luke's interview:

Researcher: What does the barnacle do at high tide when the tide comes in and covers it?

Luke: Brings in food.

R: How does it do that?

L: It has a little mouth that takes stuff in.

R: Have you seen it moving?

L: Yes.

R: Any idea what it takes in from the water?

L: No.

R: Can you show me with your hand how that barnacles eat?

L: You can see it move, but you need a magnifying glass (moves hand by opening and closing fist).

From the literal interviews Luke demonstrated that he has observed barnacles feeding (using their cirri or jointed feeding appendages) by opening and closing his fist in rapid movement.

In addition, from the metaphor interviews, Luke demonstrated an awareness of predator-prey relationships, which amazingly included at least an awareness of microscopic plankton:

A clam is a vacuum cleaner. It opens its shell and pulls the food in real fast.

A barnacle is a fisherman. It eats the stuff in the ocean. It's really, really small. You can't see it.

Some animals recycle dead and decaying animals:

A seagull is a janitor. It eats fish guts when you throw the guts on the beach. It cleans it up.

There was an awareness of at least two different types of habitats; under rocks and in tidal pools:

The seashore is a town. The little crabs and eels live underneath the rocks. The rocks are their homes.

A tidal pool is a town. All kinds of little animals live in it, bullheads, hermit crabs, eels.

Luke was aware of the sun as an important source of energy:

If I were a sunny day, I would make the grass, trees, and flowers grow.

Several responses showed that Luke was aware of pollution and concerned for the preservation of the seashore:

I would be a thorn and the seashore would be a blackberry bush.... The blackberry bush has pretty flowers on it. If someone tried to pick the flowers, I would hurt them. The starfish and sea anemone would be the flowers. I would be a thorn and protect them.

I would be the owner to a fishing boat. The seashore would be the fishing boat. I would keep the boat going ... keep it clean. I would boss people around ... tell them to pick up garbage at the seashore and broken glass.

Although the underlying beliefs of such metaphor responses are comparatively obvious, the interpretation of the underlying beliefs of other metaphor responses is more difficult, for example:

I would be raven.... If I were Gwa'wina I could soar and catch the killer whales. Only ravens and thunderbirds

could catch the killer whale. Raven played tricks on its cousins and brothers.

In attempting to understand the beliefs inferred with this metaphor response, it is helpful to know that Raven is commonly portrayed in coastal legends as a greedy scoundrel who steals food from other animals and must be punished, while at others times Raven is portrayed as a teacher. In the story known in 'Yalis as "Crow and Raven," Raven played tricks on Lady Crow by stealing her food. One day when Lady Crow returned home and found Raven eating her clams and part of the baby seal she had just cooked, she picked up her digging stick and beat Raven with it as hard as she could. Raven flew away screaming "Gwa-gwa-gwa." It is commonly recognized among Indigenous peoples that such stories portray an implicit effort to protect and secure a common food supply by not taking too much food. Considering that Luke repeatedly expressed a concern about the conservation and preservation of the seashore in several other responses, a connection can be inferred between Luke's beliefs about the concepts of conservation and food preservation, and the Lady Crow and Raven stories.

Although some of Luke's responses expressed understandings about seashore relationships that resembled Western Science concepts, other responses expressed understandings that were quite different. Take, for example, the metaphor responses: "The tide is a legend," "The wolves looked after the tide long before anyone was born," or "If I were Gwa'wina, I would soar to catch the killer whales. Only ravens and Thunderbirds can catch the killer whale." These metaphor responses clearly indicate that Luke's understanding of the tidal cycle and locomotion did not resemble Western Science concepts. And if I had pursued the point, he likely would have had a different concept for predator-prey, food web, and food pyramid. Another major distinction arises from the realization that Luke's notion of classification is quite different from the Western scientific notion that works on a hierarchical system: from the simplest form of life to the most complex, which is humans. In Luke's system, only "ravens and Thunderbirds can catch the killer whales." Hence, Luke also had a very different concept of the phylum, and if I had pursued the point, he would have had a different concept of the origin of life, evolution and living and non-living phenomena.

In keeping with traditional spiritual stories, Luke's metaphor responses portray an implicit effort to protect and secure the human connection with nature. All animals are fellow creatures, and humans are not separate from nature but are connected with it. Luke clearly "becomes" Raven, the thorn, the high tide, and Thunderbird; and the plants, animals, rocks, water and events in nature clearly "become" human. The supernatural animals have two forms—one animal, the other human—so that animals can talk, give people advice, and aid in solving human problems.

Mary's Beliefs About Seashore Relationships

Mary appeared to have a relationship between her preferred aesthetic orientation and her beliefs about specific seashore relationships. Mary's particular aesthetic orientation, which was grounded in the "pretty" aspects of the seashore, as well as the social aspects of experience and personal beauty, may have contributed to limiting her awareness of a range of seashore relationships.

To understand Mary's specific beliefs about seashore relationships, it is helpful to consider her responses to my questions about barnacles:

Researcher: Do you have any idea what a barnacle might eat?

Mary: Flies. I don't know. No idea. It could drink the water.

R: Would it eat at high tide or low tide?

M: At low tide.

R: OK. At low tide the tide goes out, so you think it might eat at low tide?

M: Yes. It could eat at high tide too. Depends on what it eats.

R: Do you have any idea what might try to eat a barnacle?

M: No.

R: When the tide is out and the barnacles are sitting on a rock, what must the barnacle protect itself from?

M: Against humans, animals like dogs and cats.

R: Would it be very easy to eat it?

M: No.

R: When the tide is in and it's covered with seawater, would anything try to get it then?

M: No.

Obviously, Mary had little or no information about barnacles. It became clear that Mary had a very limited understanding of the concepts plankton, predator-prey, habitat, tidal cycle, desiccation, and protection, or of the relationships among them. In this case, Mary's low awareness of the existence of seashore organisms may have limited her ability to construct predator-prey relationships. From the metaphor interviews, Mary stressed concepts such as birth, growth, and family-concepts that may be associated with a young girl's view of social experience and with being neat and tidy. Unlike Dan's aesthetic orientation, which stressed observing closely, drawing the details of seashore animals, and "doing Lansdowne books, but do it with seashore animals," Mary's aesthetic orientation did not encourage close observation and exploration into the intertidal. Considering that Mary's particular aesthetic orientation was the one most preferred, it is not surprising that she would have brought to her instructional experiences many beliefs about the seashore which were more consistent with her particular aesthetic orientation, rather than with a scientific orientation.

Jimmy's Beliefs about Seashore Relationships

In Jimmy's case, a strong relationship could be seen to exist between his preferred utilitarian orientation, which stressed commercial fishing and crabbing, and his beliefs about specific seashore relationships. This relationship was so striking that it is worth elaboration. For illustration, when Jimmy was asked to organize his set of cards (seashore plants, animals, objects, and events) into categories of similar characteristics (Table 5.2), Jimmy used his considerable knowledge of the feeding behaviour and habitats of edible or commercial fish and crabs, and his knowledge of fishing methods as the major criteria for grouping.

Table 5.2 Jimmy's category system prior to instruction

<p>1. ling cod ratfish whisker cod perch rock cod trout</p>	<p>4. shell crab (Dungeness) bullheads eels crabs</p>
<p>- they're all under water, they don't go deep in the sea - close to the seashore, just a little way out - you catch them from a line on the beach or a little boat</p>	<p>- when the tide goes down - they're all under the rocks at low tide</p>
<p>2. seagulls eagles crows</p>	<p>5. barnacles rocks</p>
<p>- they all fly - dive into the water to get fish</p>	<p>- at the bottom of the sea - you can see them when the tide goes down</p>
<p>3. flounders red snapper dogfish sockeye salmon pink salmon hump salmon black bass</p>	<p>6. killer whales dolphins seals</p>
<p>- they all go deep out in the sea - you catch them in nets in the seiners</p>	<p>- they swim together - they eat fish - some people catch seals</p>

Although several boys in the class listed a large proportion of commercial fish, Jimmy was the only student who grouped animals from a general utilitarian viewpoint: habitats for catching fish and types of fishing methods. Additionally, Jimmy was the only student who generalized his knowledge of the feeding behaviour and habitats of offshore commercial fish to describe the feeding behavior and habitats of specific seashore animals. He had little knowledge of barnacles, but notice what happens when Jimmy is asked what barnacles eat:

Researcher: Any idea what barnacles eat?

Jimmy: No.

R: Do you think it does eat?

J: Yep. Those little things that float in the water.

R: Any idea of how it would eat?

J: The top of it.

R: When would it eat, at high tide or low tide?

J: Just before low tide.

R: Why would it eat just before low tide?

J: That's when all the food, all the bugs come down.

R: (pause). That's when all the fish eat. Is that what you're thinking? Is that why you think the barnacles eat just before low tide?

J: Yes

In interpreting Jimmy's incorrect assumption about barnacles feeding "just before low tide," it is helpful to know that many fish feed when the tide changes, as upwelling water renders plankton animals vulnerable. In an interview focusing on tidepool sculpins, Jimmy again used his knowledge of certain commercial fish to describe the feeding behavior of tidepool sculpins.

At first, Jimmy's low scientific orientation seems surprising given his wealth of experiences fishing. But having a general knowledge of ecological relationships related to seashore organisms is quite different from having a general knowledge of commercial fishing. In order to succeed as a commercial fisherman, you must have information of the behaviour, migration, and geographic distribution of particular fish: their feeding habits, when the adults are likely to be present in each stream, the numbers that are likely to be present, possibly their movement at sea, and so on. In other words, to be a successful fisherman, it is not necessary to know the feeding behaviour of barnacles, the life cycle of sea stars, the importance of the sun as the source of energy, or the effects of the tidal cycle on seashore plants and animals such as barnacles, sea urchins, or sea anemones.

In sum, all of the students' orientations appeared to interact with their beliefs about specific seashore relationships. The fact that Dan's beliefs are grounded in his preferred Western scientific orientation is easy to accept. The fact that Luke used a large proportion of alternate beliefs (beliefs inconsistent with Western Science) is easy to acknowledge given his preferred spiritual orientation to the seashore. The fact that both Jimmy and Mary used a large proportion of alternate beliefs to describe life at the seashore is also no accident. The data suggests that when a student is presented with new or discrepant information, the various spiritual, utilitarian, aesthetic, or recreational aspects of an experience can be used to help fill the gap; hence barnacles "feed just before low tide" or "the animals all share the same food," "they all get along," "it's peaceful most of the time." The organization of the students' beliefs is related, at least in part, to his or her particular set of orientations to the seashore.

Last, there was a certain internal coherence for all the students, among the various orientations and their awareness of seashore plants, animals, and seashore conditions. For example, in the case of Dan, several of his orientations tended to point to a preferred scientific orientation towards the seashore. For example, his particular spiritual orientation, which stressed a unity with nature and an ability to indwell, was mixed and complimented his scientific orientation. His particular recreational orientation, which stressed independent exploration at the seashore: "going out in boats," and "catching animals and looking at them" was consistent with his scientific orientation. His particular aesthetic orientation, which stressed recording information, drawing and painting seascapes and seashore animals, was consistent with his scientific orientation. Although few responses stressed a utilitarian orientation, his interest in commercial fishing and duck hunting was coherent with his interest in science.

Instructional Metaphors and Activities

In order to have more students possessing an increased knowledge of basic ecology concepts, a number of activities were planned to encourage an understanding of life at the seashore. The focus of instruction was the organism-tidal cycle relationship, which led to the concept of a community as a complex system of interrelated plants, animals, object, events, and conditions. In addition, an attempt was made to enhance the students' ability to view the seashore from a variety of different orientations through the use of instructional metaphors and activities representative of different orientations.

The Science Metaphors and Activities

To understand the different types of seashores, the students first explored their own cobblestone beach, then traveled to Gilford Island to explore a sandy beach, and visited a mudflat to discover that each type of seashore supports a different collection of habitats and a different collection of seaweeds and animals. They discovered crabs with eggs, empty crab molts, a variety of animals at different stages of development, and shorebirds scavenging amongst the rocks for edible items to eat. The students collected marine plankton using a plankton net and with the aid of microscopes observed the hordes of fascinating tiny plant and animal plankton at various stages of development: barnacle larvae, crab larvae, sea star larvae, clam larvae, fish larvae, etc.

Through directed observations the students observed the twice-daily rise and fall of the tide, how seashore organisms protect themselves from the drying effect of air, wind, and hot sun at low tide; and from predators such as big fish that patrol the seashore at high tide. The students observed how the tidal cycle affects when and how seashore animals move about and gather their food. The students observed the behaviour of common seashore animals at the seashore and in the aquarium at school. They recorded predator-prey relationships and sorted picture cards illustrating seashore organisms into food chains and food webs.

Students observed colour patterns on beaches and learned that beaches are divided into zones, or areas according to the length of time they are covered by water or exposed to air (spray zone, high tide zone, middle tide zone, low tide zone, sub-tidal). The students marked off square metre grids on dock pilings and on the beach and identified and counted populations of plants and animals to discover that the collections differed depending on the vertical location on the shore. Back in the classroom the students drew maps of zonation patterns. As the students observed, questioned, inferred, and investigated with living organisms it was hoped they would become aware of how seashore seaweeds and animals interact with one another, and with the type of shore, atmosphere, and sun in a vast network of complex relationships that constitute a community or ecosystem.

The students explored their own beach to see broken glass, tin cans, Styrofoam, and plastic bags washed ashore. From these and other observations, the students discussed the impact of humans upon seashore communities. Michael Berry, local marine biologist, visited the classroom to discuss the natural “balance and harmony” of the seashore, and related conservation and management issues.

Spiritual Metaphors and Activities

In describing the “spiritual” metaphors used in instruction, it should be acknowledged that neither the teacher nor I attempted to encourage or discourage a spiritual orientation towards the seashore. We felt that by making connections between the spiritual beliefs of the traditional First Nations peoples of ‘Yális and specific marine science concepts during certain activities, the instruction would appeal to students with a spiritual orientation.

The students were invited to the cultural language class for two half-day sessions portraying the spiritual stories, songs, and dances of the Kwakwaka’wakw peoples. To get a clearer idea of the type of instruction that occurred, I include several statements made by the four cultural teachers: ‘Mam’xu’yugwa Auntie Ethel Alfred, Gwi’molas Vera Newman, Tłililawikw Pauline Alfred, and Tidi Nelson ([Figure 5.2](#)):

Many of our people’s legends, especially about the killer whale and the wolf, come from preparing for the flood. White man calls Bible stories the gospel truth. Our stories he calls myths. They are not myths. They are spiritual stories. This is our religion.

Our dances are a gift, not a sin. They were given to us by the transformer. Our dances are important to us. We become those animals when we dance.... The Salmon Dance is important to the Kwakwaka'wakw people. We must not forget to dance the Salmon Dance.

Everything has a spirit. My grandfather told me, 'When I die, I'm going to come back as a killer whale'... Chief Henry Walker said, 'When I die, I want to be an eagle.' When he died a big eagle flew over his service. Burt Small, a great Native artist from 'Yalis, came back as a porpoise.

First Nations people made use of everything. If they wasted food, they were punished. Everything has a right to be here. Everything has a spirit. Our people believe that all animals have souls, rights, and feelings. We must respect every living thing.

During the sessions with the cultural teachers we made connections between the traditional spiritual stories and ecology concepts (inter-relatedness, interdependence, community, cycles of life, balance and harmony, and preservation). Back in the classroom the teacher read several stories from the book *Kwakiutl Legends* (Wallas & Whitaker, 1981). The students discussed the stories, made connections between the stories and the above concepts, and wrote their own legends about the seashore.



Figure 5.2 ▲ Language and culture teachers, Ada (Vera) Newman and her mother Antie Ethel Alfred. Photo by Gloria Snively (1982).

Utilitarian Metaphors and Activities

To give the students an awareness of the utilitarian aspects of the seashore a local marine biologist was invited into the classroom to discuss his attempts at culturing oysters and developing an oyster farm near 'Yalis. The students visited the docks and were invited onto a seine boat to see halibut and salmon being unloaded from the boats and see crab traps being stacked up on the deck. The students interviewed various fishermen regarding the species of fish caught, what the life of a fisherman was like, how much money fishermen made, and the state of the fishing industry. When the students visited the culture teachers, several references were made to the traditional harvest from the sea, especially salmon, but also seals, halibut, herring, abalone, scallops, clams, chitons, oolichans, shrimp, sea urchins, sea cucumbers, and a variety of seaweeds. The teacher, parents, and students prepared an elaborate seafood dinner to celebrate the annual

harvest of the sea. Throughout, connections were made to marine ecology concepts (habitat, tidal cycle, predator-prey, food chain, food web, community, pollution, destruction of habitat, the sun as a source of energy, and preservation of harvests).

Aesthetic Metaphors and Activities

To encourage an aesthetic orientation, students were encouraged to walk barefoot along the tideline and to sit at the seashore to see the colours and patterns, and listen to the sounds of nature. In the classroom they painted seascapes and explored the metaphor, “If the seashore were a musical production, what would be the instruments (violins, trumpets, piano, drums), conductor, theatre, audience?” (For an exact description of this metaphorical activity, see Snively, 1986, p. 213). At the seashore the students made beautiful sand candles decorated with driftwood and seashells. Back in the classroom they chose a seashore organism to paint. Interestingly, at first Jimmy said that he couldn’t paint a picture, but after thinking for a while he painted an exceedingly beautiful blenny (eel-like fish) in the stylized form of traditional First Nations art. This is of special interest, because of the relatively low proportion of aesthetic and traditional spiritual metaphor responses.

The Recreational Metaphors and Activities

To encourage a recreational orientation, the students listed all the activities they enjoy doing at the seashore: “playing,” “swimming,” “boating,” “sailing,” “sun tanning,” “hiking,” “picnicking,” looking in tidal pools,” “building sand castles,” “making jewelry from found seashells,” etc. While the major focus of instruction was to increase the students’ knowledge of seashore relationships (basic ecology) and thereby increase their willingness to view the seashore from a “science” perspective, the students nevertheless were encouraged to view the seashore through a range of orientations. It was felt that by learning to appreciate the ocean from a scientific, aesthetic, utilitarian, recreational, and spiritual orientation, they could see more holistic patterns and develop a deeper appreciation for the seashore (and ocean), and take an active part to ensure that the BC Coast (and planet) remains beautiful and rich with species and resources.

Many of the activities developed for the ‘Yalis study are described in more detail in a book by Snively, *Once Upon a Seashore: A Curriculum for Grades K-6* (2001).

The Relationship between Instruction and the Students’ Orientations and Beliefs

In the following section I focus in some detail on the cases of Luke and Mary, and describe how the teacher and I collaborated in an attempt to “enter” the students’ orientations and use of metaphor in order to increase their knowledge of specific marine science concepts.

The Case of Luke: The Student with a Preferred Spiritual Orientation

To take into account Luke’s particular spiritual orientation, connections were sought between his pre-instructional spiritual responses and the science concepts of interest. Recall that Luke appeared at least to have an awareness of the phenomenon that scientists call a tidal cycle and his awareness was grounded to a large extent in the spiritual aspects

of an experience at the seashore, “The wolves looked after the tide long before anyone was born” and “I would be a high tide. If it’s summer, sometimes the water goes out too far. I would be kind. I would put food higher on the beach.” My intended sensitivity towards Luke’s understanding is very difficult to achieve in the context of written and oral English language. Luke was learning his traditional Kwak’waka language from the language and culture teachers at school and most likely from his granny, but was not fluent. When bilingual Elders talk to students in both their language and in English, and the student talks to a researcher in English, his words can unintentionally force him into a Eurocentric point of view. Because Luke is speaking English, his words are a translation of what he means (his ideas of the event understood from an Indigenous spiritual perspective) into English. I can only wonder what is lost in translation.

The Western scientific concept of the tidal cycle is that the tides are caused by the gravitational pull of the sun and moon on the earth’s ocean, and the spinning motion of the earth’s rotation. Both Western Science and Indigenous knowledge systems understand that tides are predictable. Luke’s ancestors did not need to know about the gravitational pull of the sun and moon on the earth’s ocean to predict the tides, but no doubt through observation and experience over the millennia acquired an intimate knowledge of local place-based tidal cycles and currents over the seasons, and knew when and where to collect mussels, clams, and abalone.

After reading a book of *Kwakiutl Legends* (Wallis & Whitaker, 1981), it was found that Luke’s reference to “the wolf having control of the tides” was similar in tone to the story known locally as “Turning the Tide.” The following version is condensed from the book:

It was winter and the people were hungry because there was no food. The wolf had control of the tides. He always kept it at the high water mark. The deer pretended he was dead and stole the wolf’s tail. The deer held the wolf’s tail over a fire until the wolf promised to let the tide go out so the people could get mussels. But the people were hungry. They wanted clams. So, the deer stole the wolf’s tail again and held it over a fire. This time the wolf let the tide out further, and the people could get clams. From that day on the wolf let the tide out twice a day. Every six hours it changed. After that there was plenty of food in the village.

This story expresses a spiritual, emotional, and subjective relationship between the motion of the tide and the location of specific plants, animals, and habitats on the shore (mussels and clams). The Western scientific non-spiritual, unemotional notion of zonation can be interpreted as similar in an analogous way: mussels live most abundantly in the high tide zone, clams in the middle and low tide zone, and abalone in the low tide zone, but mostly sub-tidally, and so on.

To develop teaching strategies that would appeal to Luke’s particular spiritual orientation, the students were invited to the cultural language class for two half-day sessions portraying the spiritual stories, songs and dances of the Kwakwaka’wakw peoples. Then the teacher read the story “Turning the Tide” to the class and discussed the connection between the story and the scientific concepts of tidal cycle, habitat, and zonation. Finally, during class sessions with Elders and the cultural teachers, the connection was reinforced.

The Relationship between Instruction and Luke’s Beliefs About Science Concepts

To see a relationship between Luke’s emerging understanding about the concept of zonation and this type of instruction, a comparison is provided of his pre- and post-instructional responses, looking for evidence of change. In pre-instructional interviews, Luke did not appear to be aware of the concept of zonation, but in the post-instructional responses, the concept of zonation is clear:

A tidal pool is a painting. All the different colours: black, white, blue, orange, and purple. The different sections or parts of the seashore would be like a painting. The different places and the different parts of the tidepool. The different zones of the tidepool look like a painting.

The seashore is a cannery. Because of all the animals looking for food. They all have different sections to look for food. At the seashore, the fish have a section to look for food, the barnacles have a section to look for plankton, and it's the same with crabs and other animals. A cannery has different sections where you wash the fish, cut the fish up, and then you put them in cans, then you put the lids on them.

In “A tidal pool is a painting” response, Luke expressed an awareness that different collections of plants and animals seen from a distance appear as distinct colour patterns on a shore: “All the different colours—black and white, blue, orange and purple.” The different collections of plants and animals occupy different types of habitats or zones on the beach: “The different sections or parts of the seashore ... the different parts of the tide pool.” In “The seashore is a cannery” metaphor, Luke was aware of animals living together in different tidal zones, and importantly, connected different predator-prey relationships to the various tidal zones: “They all have different sections where to look for food—the barnacles have a section to look for plankton, and it's the same with crabs and other animals.”

On the basis of these and other metaphor responses, I believe Luke made a connection between the spiritual story, “Turning the Tide” and the concept of zonation. The fact that he repeated the concept of zonation more than any other student in both the post-instructional and metaphor responses and again six months later, suggests a connection between Luke's emerging understanding of zonation, his particular spiritual orientation, and the type of instruction that occurred.

The results of both literal and metaphor interviews showed that after instruction, Luke clearly had a greater understanding of “accepted” science ideas, and a decreased proportion of responses that were quite different. First, a number of concepts that were present in the pre-instructional interviews were more elaborated after instruction: diversity of organisms, tidal cycle, locomotion, habitat, plankton, predator-prey, protection, recycle, energy from the sun, pollution, and preservation. There was an understanding of concepts not identified in the pre-instruction interviews: types of seashores, desiccation, adaptation, zonation, food chain, interdependence, and community.

Also, many of Luke's metaphor responses continued to express a spiritual view of the seashore, as expressed in the following poignant examples of traditional beliefs:

I would be a raven. It's bigger than the eagle and flies faster. It's stronger. It can talk. If you really listen they talk. They tell you things; what's going to happen to you or your family.

I would be a salmon. You could let people catch you. I was fishing off my Uncle Jimmy's boat. This salmon came up and just bit my hook. He never struggled when I pulled him in.

Again, the supernatural animals have two forms—one animal, the other human—so that animals can talk, give people advice and aid in solving human problems. Clearly, after instruction, Luke continued to have many beliefs about seashore relationships consistent with a spiritual view of the seashore and many beliefs consistent with an ecological view of the seashore.

The fact that Luke was willing to give back a majority of science responses in both the post-instructional interviews and in interviews six months after instruction raises an important question. What is the potential effect of an increase in knowledge of science concepts on the students' preferred orientations? Or, in different words, did the instruction change Luke's orientations from a preferred spiritual orientation towards the seashore to a preferred scientific orientation?

Answers were obtained from an analysis of the students' metaphor choices in the pre- post- and long-term metaphor interviews. The results of Luke's preferred metaphor choices clearly indicate that, after the instruction, he continued to prefer a spiritual orientation, as evidenced by his first, second, and third choice metaphor responses. Such data suggests that even after instruction, and in spite of his more scientific responses, the spiritual aspects of the seashore continued to play an important role in Luke's thinking.

And finally, when asked to generate a metaphor for the seashore and draw a picture of his choice, Luke provided the metaphor, "The seashore is a happy song." He drew a picture (Figure 5.3) and gave the description below:



Figure 5.3 ▲ "The seashore is a happy song." Drawing by Luke. Photo by Gloria Snively (1982).

All the sounds at the seashore make a happy song. All the different sounds make nature's music. The killer whale when he blows his water out, it makes a squeaking noise. The rocks falling on the water ... splaaaaaassh! The sand moving makes sounds like a sponge washing the bathtub ... rough! The yellow is the wind going wooooooosh! And the wind growls and crashes against the cliff.

For Luke the response suggests aesthetic, recreational, and spiritual orientations—recall in [chapter 4](#) that the Kwakwaka'wakw refer to Alert Bay as the “Home of the Killer Whale.”

In sum, a careful analysis of Luke's metaphor and literal interviews revealed that his increased awareness of seashore phenomena and his increased understanding of some of the ecological relationships associated with these phenomena enabled him to provide richer and more diverse explanations in his metaphor responses. It would seem reasonable to claim that instruction had served to increase Luke's ability to see the seashore from several points of view. In particular, this increased knowledge and understanding meant that he could adopt a Western scientific orientation in explaining the seashore. Given the school context of this study and the focus of instruction, these results are not totally unexpected. The fact that Luke's knowledge appeared to be relatively stable six months after instruction does imply that it was firmly integrated into his cognitive system and hence the instructional techniques can be judged to be effective.

The Case of Mary: The Student with a Preferred Aesthetic Orientation

To give some idea of the interaction between Mary's preferred aesthetic orientation, her beliefs about seashore relationships after instruction, and the instructional input—the introduction of the concept of food chain into Mary's belief system is documented in some detail. The introduction of the concept of food chain was chosen because after instruction Mary repeated the concept more than any other student and because it illustrates the use of an aesthetic metaphor to teach an ecological view of the seashore.

To take advantage of Mary's particular aesthetic orientation during instruction, an attempt was made to enter into Mary's thinking. This proved far more difficult than what had been anticipated. Various teachers and community members were interviewed looking for evidence of an artistic background in the home or in Mary's early school experiences. However, sufficient formal data could not be found to account for a special talent or interest in the fine arts: e.g., painting, sculpture, carving, drama, or dance. This was puzzling. How could Mary, who had a preferred aesthetics orientation to the seashore, not have an artistic background? Although her teachers thought she was interested in arts and crafts, as was the case with many students, she did not appear to be exceptionally artistic or to have a strong interest.

Finally, during the later stages of instruction, a pattern began to emerge in the types of metaphors Mary generated during her classroom experiences with living seashore plants and animals. Notice Mary's personal metaphors:

A sea anemone reminds me of a dress with lots of ruffles.
It's eye (copepod under a microscope) looks like a red ruby.
Ooooooooooh! That looks like neat curls (chain diatoms).

Some seaweed looks like feathers. Like feathers on a hat.

To gain further insights into Mary's particular aesthetic orientation, an analysis of her pre-instructional metaphor interviews was conducted, looking for preferred metaphor choices and particular types of images.

(first choice) The seashore is a playground. Seems quiet, peaceful to find seashells and things.

(third choice) The seashore is a jewel. Looking for shells on the beach, making things from the shells, like jewelry.

As evidenced from the metaphors generated during classroom instruction and from the choices and explanations from the metaphor interviews, Mary clearly preferred jewelry, clothing, and cosmetic metaphors to describe the seashore. Rather than having an aesthetic orientation fixed on the arts, Mary's more broadly focused aesthetic orientation stressed the human body, social relationships, and concepts of "peace," "beauty," and "prettiness." This increased understanding of Mary's particular aesthetic orientation allowed the teacher and myself to work collaboratively in attempting to take into account Mary's specific metaphor preferences to increase her knowledge of seashore relationships. Hence, an instructional strategy was designed wherein the teacher explored with the class the instructional metaphor:

If the food chain were a necklace, what would be the

- beads
- string
- lock

Why?

What would happen if the string broke?

As a follow-up, the students used picture cards to develop predator-prey relationships, food chains, and food webs, and they constructed a food web bulletin board.

In the post-instructional interviews, Mary chose the following metaphors:

(first choice) The seashore is a family. All of the animals all over the seashore seem like one big family living together. Some of the animals are related, or they look alike.

(second choice) The seashore is a necklace. It seems like a necklace because of the food chain. If one latch falls off, the rest of the necklace just falls right apart, or breaks in half.

In addition, all the students were asked to generate two or three personal metaphors for the seashore and to illustrate a favorite metaphor with a drawing. Mary chose “necklace” as her first choice. When informed she could not use necklace because it had been used as an instructional metaphor, Mary thought a while, then chose “bracelet.” She drew the picture below (Figure 5.4), and gave the following response:

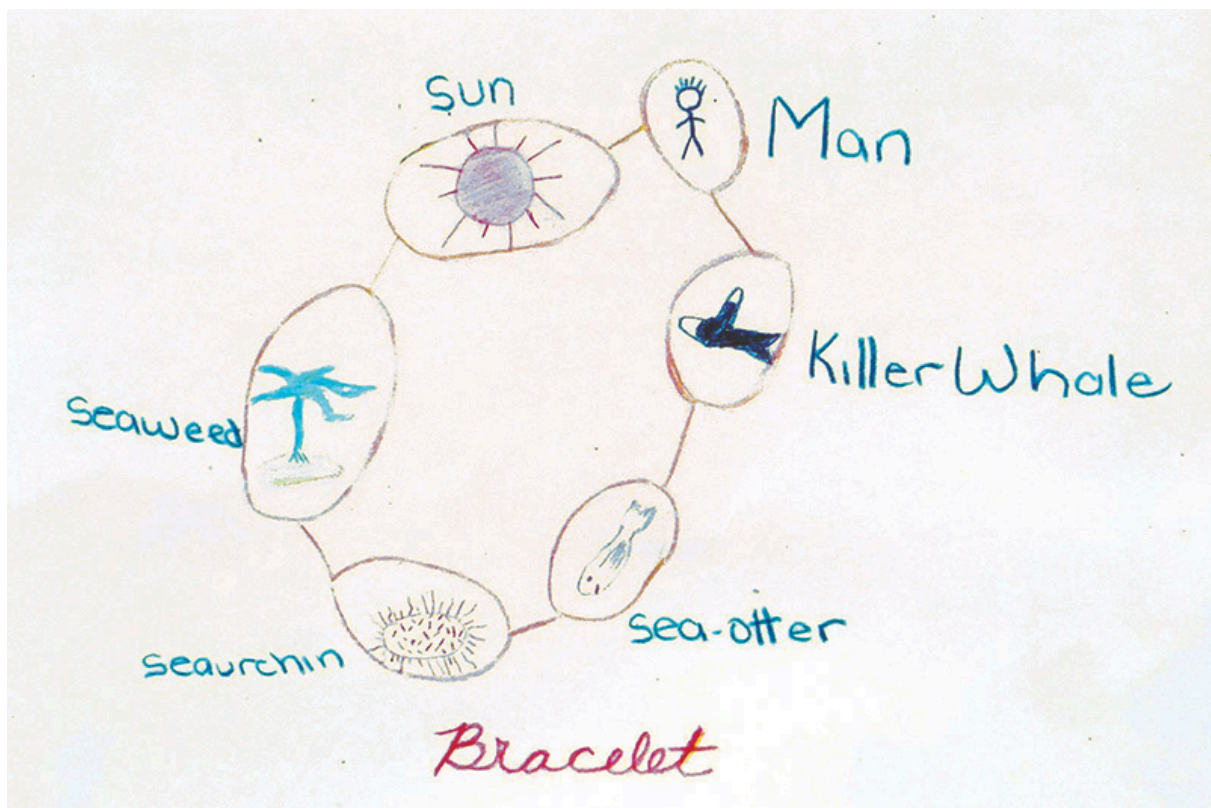


Figure 5.4 ▲ “The seashore is a bracelet.” Drawing by Mary. Photo by Gloria Snively (1982).

The seashore is a bracelet. The seashore is long like a bracelet. The seashore would be the string. All the crabs, starfish, seaweeds, sea urchins, sea otters and killer whales would be all the beads, and the sun would

be the lock. The sun is the most important part.

Quite unlike Mary's pre-instructional interviews, which stressed the peaceful and quiet aspects of the seashore, Mary's post-instructional interviews stressed the ecological aspects of the seashore (e.g., "If one latch falls off, the rest of the necklace falls right apart.") and an understanding of the sun as the source of energy: "The sun would be the lock. The most important part."

In several post-instructional responses, the concepts of food chain and interdependence were abundantly clear. For example:

The seashore is a patchwork quilt. If one piece goes missing the whole thing falls apart, meaning the food chain.... Like, if clams were to disappear, lots of other animals would suffer from it, gradually something would disappear.

I'd be a curtain and the seashore would be the stitches. It holds me together. It's like the food chain. The food chain is all hooked together. Without the stitches everything would fall apart and die. The stitches are all hooked together.

On the basis of the above responses (and several other metaphor responses), there appears to be a connection between the instructional metaphor, "The food chain is a necklace" and the successful introduction of the concept of food chain into Mary's belief system. The fact that Mary, more than any other student, wove the concept of food chain into more metaphor responses suggests a meaningful interaction between Mary's particular aesthetic orientation and the necklace metaphor. It would seem connections such as this one can be used to teach about abstract science concepts such as food chain, food energy flow and inter-connections.

Students' Beliefs about Seashore Relationships After Instruction

For the sake of brevity, I provide a general summary of the students' beliefs about seashore relationships after instruction. This data is taken from both the metaphor and literal interviews.

The results of the post-instructional interviews show that all of the students expressed a much greater awareness of seashore phenomena, as evidenced by a greatly expanded list of seashore plants, animals, objects, and events than in the pre-instructional interviews. To varying degrees all of the students used a more elaborated scientific vocabulary to describe the seashore: "energy," "predator-prey," "habitat," "food chain," "zonation," and "community." Also, all the students used a greater repertoire of explicit terminology: "tube feet," "siphon," "tentacle," "camouflage," "carnivore," "herbivore," "scavenger," "plant plankton," "animal plankton," "larvae," "high tide zone," "low tide zone."

After instruction, all the students expressed a more elaborated knowledge of concepts such as habitat and predator-prey by identifying and describing many more examples in their metaphor and literal interviews. In addition, a number of new understandings were identified in the post-instructional interviews that were not identified prior to instruction. For example, more students expressed awareness that animals recycle the remains and wastes of other animals; that

seashores can be rocky, sandy, or muddy; and the sun as a source of energy for plants. Most students expressed a new awareness of zonation and the effect of the tide on the arrangement of plants and animals on the shore. For most students there was a new awareness of the complex relationships among the concepts tidal cycle, desiccation, habitat, adaptation to habitat, and protection. Several students expressed a new awareness of the complex relationship of predator-prey, food chain, and interdependence.

For some students there was a marked decrease of beliefs inconsistent with science ideas. For example, Mary no longer exclusively stressed the “peaceful” and “cooperative” aspects of the seashore, and no longer constructed predator-prey relationships from common household pets such as dogs and cats, but correctly identified several predator-prey relationships.

It would appear that the primary purpose of instruction, which was to increase the students’ knowledge of specific marine science concepts, was achieved.

Students’ Orientations after Instruction

After instruction, all of the students showed a shift towards more responses consistent with a scientific orientation towards the seashore. Not surprisingly, Dan continued to have the greatest number and proportion of responses consistent with a scientific view of the seashore. When asked to generate a metaphor for the seashore and draw a picture, Dan gave the metaphor, “community.” I said he couldn’t choose community because it had been used as an instructional metaphor. When he chose “town” as his second choice, I said he couldn’t use town for the same reason. Dan thought for a long time, then chose “neighbourhood.” He drew the picture ([Figure 5.5](#)), and gave the following description:



Figure 5.5 ▲ “The seashore is a neighborhood.” Drawing by Dan. Photo by Gloria Snively (1982).

They're all on the seashore or close to the seashore. They're all part of my life. It's like the seashore sort of covers my mind. I always think about the killer whale and eagle as being near the shore, not far away. The purple shore crab, swimming crab [Dungeness], sculpin, eel [blenny], purple starfish, kingfisher, butterflies, and dragonflies all live close to the shore near my house. The different tide zones might be like different streets in a neighborhood. All the many different animals just make my life so much neater. Sometimes I see me as part of the seashore. I don't know if I'm part of their life, but they're part of my life.

In the neighborhood response, Dan relates the concept of community to the concepts tidal cycle, zonation, and interdependence. The fact that Dan chose the neighborhood metaphor seems no small coincidence, since Dan had a preferred scientific orientation in both the pre-instructional and post-instructional interviews. It suggests a reasonably strong interaction between instructional input and Dan's emerging understanding of the seashore as a complex ecological community.

For most students, there was an increase in the proportion of responses consistent with a scientific orientation, and a decrease in the over-all proportion of aesthetic, utilitarian, spiritual, or recreational orientations (Mary, Jimmy, Luke). In the case of Jimmy, an increase in knowledge of ecological relationships resulted in a shift from a preferred utilitarian orientation to a preferred scientific orientation, as evidenced by the over-all proportion of scientific responses. However, additional data leads me to believe otherwise. When I asked Jimmy to invent a metaphor for the seashore and draw a picture, Jimmy couldn't think of a single metaphor. I rephrased the question and gave examples of metaphors. Jimmy simply couldn't invent a metaphor for the seashore. I then asked Jimmy if he could draw a picture of the seashore. Jimmy said he couldn't draw a picture of the seashore, but he could draw a picture of a fishing boat. Jimmy drew the picture below ([Figure 5.6](#)), showing an aerial view of a purse seine fishing boat and gave the following response:

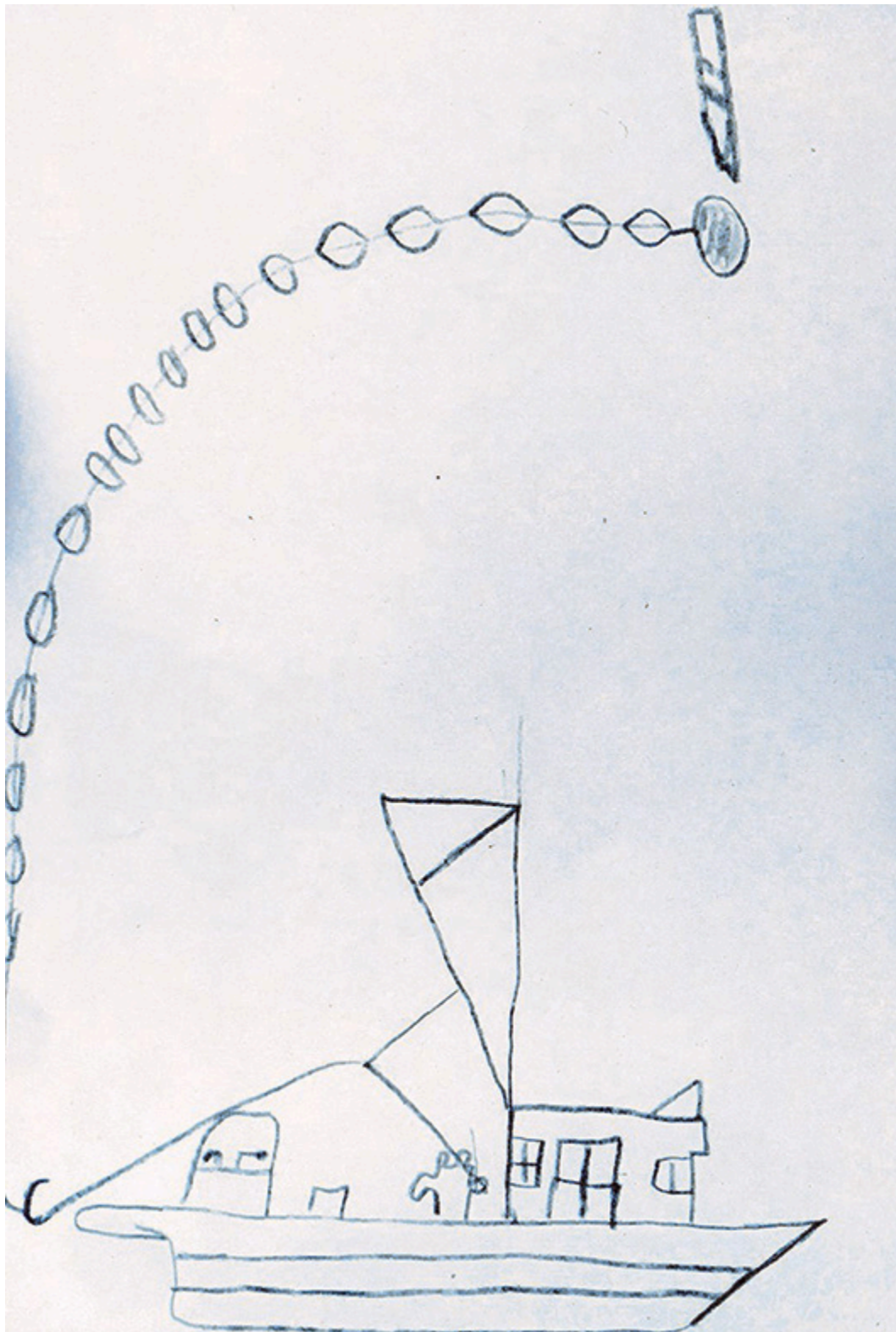


Figure 5.6 ▲ “Fishing on a seiner with my dad.” Aerial drawing of a purse seiner boat. The skiff is dragging the net to close the purse. Drawing by Jimmy. Photo by Gloria Snively (1982).

There would be salmon, killer whales, and fishing boats. I'd be on a seine boat with my dad, my mom, and Richard, Wooly, and Burt. My dad would be the captain. My mom would be cooking. Wooly and Burt would be in the skiff and I'd be running the drum. My dad would say, 'Let it go!' Then I'd hit this thing on the side that makes the skiff let go. Burt and Wooly would throw this round thing that lets the net go out. Then we just sit and wait and my dad drives the seiner around to close the net. Then, when my dad stops the propeller, I pull the winch and drum it in.

In this case, an increase in knowledge of ecological concepts allowed Jimmy to select choices that he could explain in terms of information that he obtained from instruction. Although this increased knowledge allowed Jimmy to view the seashore from more of a scientific orientation after instruction, it is clear that a strong (and most likely preferred) utilitarian orientation was still present.

After instruction, some students mentioned the traditional spiritual stories of 'Yalis for the first time. For example:

Mary: A clam is a legend. There is a story to the clam. There is a legend.

Dan: The seashore is a legend. If you look at the rocks or cliffs around seashores, you can see how the land has changed. You can see what happened long ago. What the earth's crust was like, or fossils.... There's a lot of legends associated with the sea in the Kwakwaka'wakw legends.

What this means is that students continued to use a variety of orientations to the seashore, and for some students there is evidence of willingness to use new orientations. They can begin to understand the interdependence of organisms both upon each other and upon natural phenomena (tides, nature of the beach, interdependence, etc.). Hence, one can say that their ability to use a scientific orientation to describe the seashore has been enhanced. However, finding that many of the students continued to use other orientations, and in some cases, to use new orientations, is important in that it provides evidence that the second objective was also achieved. Students were able and willing to view the seashore from multiple orientations.

The Long-term Interviews

To determine the stability of the students' orientations and beliefs over time, I returned to 'Yalis six months after instruction to conduct the long-term interviews. All of the students continued to express a greater proportion of

responses about seashore relationships consistent with “accepted” science ideas, but there was a decrease when compared with the post-instructional interviews. As well, there was a decrease in the use of scientific vocabulary. Mary continued to express an explicit understanding of food chain and Luke continued to express an explicit understanding of zonation. Despite losses, all of the students continued to show stability in their use of a scientific framework to understand and experience the relationships associated with beach ecology. This is important because it provides evidence that the instructional strategies were effective.

Diversity of Orientations and Science Instruction

Knowledge of the students’ orientations gave insights into the effectiveness of the strategies of instruction. The typology of orientations was useful in accounting for those beliefs which were retained, and which disappeared, the connections among beliefs, and changes in beliefs as a result of instruction. The finding that a three-week instructional unit brought about changes in the students’ beliefs about specific seashore relationships suggests the relative fluidity of certain beliefs. By contrast, the instruction did little to alter the students’ metaphor preferences, suggesting the stability of the students’ orientations towards the seashore generally, and especially their preferred orientations.

Closely related to the findings that some beliefs are more connected to an orientation than other beliefs, are the findings that students showed an increased proportion of scientific beliefs for different reasons. Dan had a preferred scientific orientation prior to instruction, and showed an increased number of scientific responses after instruction. This finding is consistent with research indicating that people generally seem to prefer beliefs that are congruent with their own value systems (Cobern, 1996, 2000). The finding that Jimmy stressed the concept habitat and predator-prey may be congruent with his particular utilitarian orientation—knowledge of habitat and predator-prey enable a good fisherman to locate and harvest his catch. But what about Mary and Luke? Mary’s set of orientations did not strongly conflict with a scientific view of the seashore. She simply didn’t have knowledge of beach ecology or even an awareness of the existence of many marine organisms. Hence, it was a comparatively simple task to increase Mary’s knowledge of beach ecology and increase the proportion of scientific responses. In the case of Luke, a shift to a predominant proportion of responses consistent with a scientific view of the seashore was interpreted as an increase in knowledge of science concepts, but he continued to prefer a spiritual view of the seashore as evidenced by his first-choice metaphor responses. It seems quite likely that had the situation been more threatening to this orientation, Luke may have rejected many science concepts presented during instruction. However, in this study the instruction took into account the students’ orientations and this rejection was not observed.

The results of this study help explain why some students reject science as it is currently taught in schools. Students with a spiritual orientation would reject certain Western Science claims altogether: for example, many biologists portray the “lower animals” as incapable of feeling pain or of having emotions. Recall that Luke believes in supernatural animals that can talk and give people advice. Luke’s family crest is the killer whale, which means that after death Luke’s relatives can “become” a killer whale or a Thunderbird. Given such fundamental differences in beliefs and values, it seems likely that many of the students would simply recognize a difference in values and reject the science concept outright. Or worse, they may feel frustrated and angry, fail to grasp the intended meaning of the concept, and interpret the concept quite inappropriately.

In the case of Luke, a major distinction arises from the fact that his notion of the classification system is quite different from the Western scientific method that works on a hierarchical system, from the simplest form of life to the most complex, which is humans. In Luke’s system, “Only ravens and Thunderbirds can catch the killer whale. The Thunderbird is the ruler of the sky.” Hence, Luke had a very different concept of the phylum; and if I had pursued the point, he would have had different concepts about the origin of life and evolution. Although it was not the focus of the study, the class

could have explored Western Science taxonomy and compared the phylum with traditional spiritual views. The intent would be to have all the students understand both perspectives, and to be successful in school science.

This is important, as educators need to know that it is possible to teach Western scientific concepts to Indigenous students who hold a traditional spiritual view of the world without changing—in the sense of replacing—the students' preferred spiritual orientation. We can increase a students' scientific knowledge so that it can be utilized in appropriate situations. It makes sense to talk about increasing Indigenous students' knowledge about science concepts so they can be successful in school, but we need to be careful about changing students' culturally grounded beliefs and values. What are the ethics involved?

This analysis is consistent with the work of Cobern (2000) who posits that a *belief* is what one holds as true and lives by, while to *understand* something does not require a commitment to believe it. For teachers, this is important. By focusing on understandings, we are not burdened with the issue of making someone believe a scientific idea, which can be interpreted as indoctrination. Thus, in the context of teaching, Aikenhead and Michell (2011) postulate that when comparing different perspectives, there is a distinction between understanding and believing:

An Indigenous student can understand Darwin's theory of natural selection without dismissing his or her belief in an Indigenous creation story. Similarly, a non-Indigenous student can understand Indigenous spirituality without believing it or dismissing his or her religious beliefs.... Such a classroom environment often resolves the fear that some parents have with Indigenous ideas, and it usually makes Indigenous students feel more included and less alienated in the classroom. The fact is, Modern Western Science and Indigenous Science share common ground and they do co-exist, and this should be emphasized in school science. Teaching students to believe Indigenous spirituality is the role of families, communities, and Elders (p. 135).

By exploring both systems, students would better realize the context in how theories regarding evolution or creation evolve, or how classification systems are designed, and the purpose for developing them.

Sometimes an existing orientation may act as a barrier; at other times it may form a bridge to new ideas. It seems likely that in order for students to make sense of the new ideas they encounter during instruction, they must reinterpret or reconstruct the new knowledge they encounter in their own way. Exploring differences in orientations is similar in many respects to exploring differences in worldviews, which is consistent with current cross-cultural approaches to teaching and learning in science (Aikenhead, 2006; Aikenhead & Michell, 2011; Barnhardt, 2006, 2008; Cajete, 1999; Cobern, 2000; Gay, 2000; Kawagley, et al., 1998; Lewthwaite, McMillan, Renaud, Hainnu & MacDonald, 2010; Little Bear, 2000; Snively & Corsiglia, 2001; Snively & Williams, 2008; Williams & Snively, 2016). Instruction should always recognize that there are many interpretations of natural phenomena, just as there are many interpretations of religion, politics, economics, art, recreation, and politics. Therefore, we teach that there are many different ways that we can see patterns in seashore life.

The research reported here provides some examples, but not prescriptions, about how this might occur. It should be part of science teaching that students be given the opportunity to reinterpret new information in light of their own perspectives or orientations. Students should be given opportunities to identify and articulate their own orientations with others in small group situations. In this way students are encouraged to present their own ideas, have a personal interest in the discussion, and focus on the relevant issues. Students need to know that what they have to say is important, no matter how far the content deviates from the science concepts as perceived by the teacher or school curriculum. This allows opportunities to meet individual student needs and interest, as well as promote feelings of self-worth.

Thus, science-teaching strategies cannot be the same for each school or classroom. The strategies must be modified to take into account the social and cultural qualities of the community. In some classroom situations, the teacher might

avoid certain conflicting beliefs and values altogether; in others the teacher might encourage the students to explore conflicting beliefs and values. But always the teacher encourages the students to allow for the possibility of different beliefs and values, and for respectful communication.

To negotiate meaning with others, students with different orientations must become aware of differences in meaning in their own background and when these differences are important. Metaphorical imagery can be useful in creating rapport and in attempting to communicate the nature of experiences that the students have not shared (Snively, 1986, 1990). This strategy consists in large measure of the ability to bend your own view and adjust the way you categorize your experiences. When conflicts occur during instruction, or when the teacher or person of authority transmits a fixed proposition by means of force, meaning is almost never communicated. Students need to slowly figure out what they have in common, what is safe to talk about and question, and how they can communicate personal experiences to create a shared vision. With enough flexibility, some mutual understanding might be achieved. Through discussion that is student initiated and loosely guided, it may be possible to teach each group that certain kinds of ideas and/or behaviour, previously considered annoying, can be interpreted as reasonable given a different set of orientations.

If schools are to do justice to Indigenous students, they must not represent a culture that ignores and denigrates the Indigenous culture. Oral traditions must be respected and viewed by the teacher as a distinctive intellectual tradition, not simply as myths and legends. The spiritual stories and heritage of the Indigenous community should become part of the school science experience. Each tradition generates different theories about the natural world, each developed in a different cultural tradition, and each is passed on differently; so we want students to distinguish between Western scientific theories and Indigenous theories of the same phenomena.

The research described here fits with more recent research into cross-cultural science education. Elder Marshall's two-eyed seeing metaphor encourages science and Indigenous perspectives to circulate together in school classrooms. Students learn the best of both ways of knowing, doing, and being; but students keep track of what idea or process is associated with which cultural understanding (Bartlett, Marshall, Marshall, & Iwama, 2012; Bartlett, Marshall, & Marshall (2012). This means that Luke and others could hold tightly to their original ideas, and *add* to them the scientific ideas. This is not being inconsistent, because the two knowing systems coexist; they do not compete. Instruction in two-way knowing is about choice. Such thinking underlies cross-cultural approaches to science teaching referred to as "walking in both worlds," (Battiste, 2002; Cajete, 1999) "two-way learning;" (Fleer, 1997) "both world," (Lewthwaite, et al., 2010) and "border crossing" (Aikenhead, 1996).

What became apparent in this study is that many factors operate to influence what students recognize as significant outcomes of their involvement with a learning task. What makes science teaching difficult is the fact that any one factor may be sufficient to prevent students from learning Western Science concepts. The research described here suggests that educators in all subject areas need to explore this frontier.

The Metaphor Interview as a Research Tool

The students' metaphor responses express the particular qualities of experience. What are the particular qualities of Dan's scientific mode of inquiry and his intimate relationship to the seashore? What are the particular qualities of Mary's enjoyment of the peaceful and pretty aspects of the seashore? What are the particular qualities of Jimmy's utilitarian relationship and his overriding interest in harvesting crabs, clams, and commercial fishing? What are the particular qualities of Luke's relationship to the supernatural animals and events in nature? In revealing these expressive qualities through metaphor interviews, educators have the opportunity to participate vicariously in the lives of students and acquire an empathetic understanding of these situations that are important in the lives of their students.

Metaphor interviews enable researchers to examine aspects of the cognitive system that are often masked by more conventional approaches. In addition to probing for beliefs, the metaphor interviews probed what the respondents thought was desirable and how they felt. The metaphor interviews did more than probe for single beliefs or single values or single emotions. By asking the respondents to project responses onto metaphors in an imaginative way, the respondents 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 formation of the students' response. One of the more useful features of the metaphor interview is that it allowed an analysis of "preferred" beliefs and "preferred" orientations. It allowed an analysis of the relationship between the students' beliefs about the seashore, their preferred orientations, and the type of instruction that occurred.

Some students may have more ability than others in responding to metaphor questions about particular aspects of reality. Metaphor interviews need to be developed for students with different metaphorical abilities and experiences. To do this, the abilities, and preferences to express ideas in metaphorical fashion need to be explored for students of different ages, psycho-motor abilities, sexes, and social and cultural groups. For example, as revealed in this study (and in the pilot studies), a single metaphor questions such as: "I would be an eagle, a raven or seagull" appealed to students of all ages, especially to primary school children. Whereas a double metaphor question: "I am to the seashore as a driver is to a car, a passenger is to a car, a mechanic is to a car," seemed to be difficult for students under Grade 5. Metaphors that might work for one Indigenous group, might not work for another.

The development of a sensitive metaphor interview and the analysis of responses depends on an understanding of the respondent's physical, social and cultural experience, the curriculum as presented, and so on. For instance, in this study, the analysis required knowledge of the social and cultural milieu of 'Yális, as well as the traditional Kwakwaka'wakw culture, fishing methods and the state of commercial fishing along the British Columbia coastline. The study also required a general knowledge of the participants' families—the values and beliefs of parents and grandparents, and in some cases a general understanding of the family's economic situation. It was important to work with an appreciation of the experience that the Kwakwaka'wakw have endured for more than 150 years. Generations of community members were subjected to a Eurocentric government; the residential school; church; health and law enforcement; banning the potlatch and taking away or "stealing" ceremonial masks; strict punishment for speaking the Kwakwaka'wakw language; the effects of seriously depleted fisheries; as well as environmental, lands and fisheries officials who made their presence and authority felt in countless aspects of community life.

I have attempted to present a true account of the stories of the 'Yális students and Elders. It is my hope that their stories may be helpful to curriculum developers and teachers who are developing an awareness of the complex issues involved in teaching science in communities of both Indigenous and non-Indigenous students.

The questions arise: Will the students' preferred orientations endure into adulthood? What life experiences, aspirations and career opportunities will the participants have as adults? These are the questions explored in [chapter 6](#).

Questions for Discussion

1. What is the effect of conventional science instruction (i.e., based on promoting a Western scientific framework), on students' orientations? Do such orientations persist after instruction?
2. To what extent should teachers value one orientation over another? Should science educators attempt to change students' orientations, for example, from a spiritual orientation to a scientific orientation? What are the ethics involved?
3. Traditional spiritual stories do not directly explain our relationship (our place) in the web of relationships of all life.

How effective are spiritual stories and legends in teaching an environmental ethic? Explore the stories of Raven and Coyote.

4. Religion and spirituality can be compatible, but they are not synonymous. When a teacher makes students aware of Indigenous spiritual examples (e.g., creation stories), is the teacher bringing religion into the classroom? What teaching strategies might take into account students' spiritual orientations (traditional Indigenous, Christian, Islamic, Hindu)?
5. In a small group explore the statement: When teaching science in a cross-cultural setting, *understanding*, but not necessarily *believing*, is the teaching objective.
6. In a small group explore the question: To what extent is the true story of residential schools and Eurocentric assimilative practice included in school curriculum? To what extent have individuals in the group engaged in a journey of truth and reconciliation?
7. Develop two cross-cultural lesson plans on one of the following topics: living and non-living, the classification system, the theory of evolution. Share your lesson plans with a group of teachers.

REFERENCES

- Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education*, 27(1), 1-52. <https://doi.org/10.1080/03057269608560077>
- Aikenhead, G.S. (2006). Cross-cultural science teaching: Rekindling traditions for Aboriginal students. In Y. Kanu (Ed.), *Curriculum as cultural practice: Postcolonial imaginations* (pp. 223-248). Toronto, ON: University of Toronto Press.
- Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching*, 36(3), 269-287. Retrieved from [http://onlinelibrary.wiley.com/doi/10.1002/\(SICI\)1098-2736\(199903\)36:3%3C269::AID-TEA3%3E3.0.CO;2-T](http://onlinelibrary.wiley.com/doi/10.1002/(SICI)1098-2736(199903)36:3%3C269::AID-TEA3%3E3.0.CO;2-T)
- Aikenhead, G. & Michell, H. (2011). *Bridging cultures: Indigenous and scientific ways of knowing nature*. Toronto, ON: Pearson Canada.
- Barnhardt, R. (2006). *Teaching/learning across cultures: Strategies for success*. Retrieved from <http://ankn.uaf.edu/curriculum/Articles/RayBarnhardt/TLAC.html>
- Barnhardt, R. (2008). Creating a place for Indigenous knowledge in education: The Alaska Native Knowledge Network. In D. A. Gruenewald & G. A. Smith (Eds.), *Place based education in the global age: Local diversity* (pp. 113-133). New York, NY: Lawrence Erlbaum.
- Bartlett, C., Marshall, M., & Marshall, A. (2012). Two-eyed seeing and other lessons learned within a co-learning journey of bringing together indigenous and mainstream knowledges and ways of knowing. *Journal of Environmental Studies and Sciences*, 2(4), 331-340. <https://doi.org/10.1007/s13412-012-0086-8>.
- Bartlett, C., Marshall, M., Marshall, A., & Iwama, M. (2012). Integrative science and two-eyed seeing: Enriching the discussion framework for healthy communities. In L.K. Hallstrom, N.P. Guehstorff, & M.W. Parkes (Eds.),

Ecosystems, society, and health: Pathways through diversity, convergence, and integration (pp. 280-326). Montreal, PQ: McGill Queen's University Press. Retrieved from [http://www.integrativescience.ca/uploads/articles/2012-Bartlett-Marshall-Iwama-Integrative-Science-Two-Eyed-Seeing-enriching-discussion-framework\(authors-draft\).pdf](http://www.integrativescience.ca/uploads/articles/2012-Bartlett-Marshall-Iwama-Integrative-Science-Two-Eyed-Seeing-enriching-discussion-framework(authors-draft).pdf)

Battiste, M. (2002). *Indigenous knowledge and pedagogy in First Nations education: A literature review with recommendations*. Ottawa, ON: National Working Group on Education and the Minister of Indian Affairs, Indian and Northern Affairs Canada (INAC).

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

Coburn, W. W. (1996). Worldview theory and conceptual change in science education. *Science Education*, 80(5), 579-610. [https://doi.org/10.1002/\(SICI\)1098-237X\(199609\)80:5<579::AID-SCE5>3.0.CO;2-8](https://doi.org/10.1002/(SICI)1098-237X(199609)80:5<579::AID-SCE5>3.0.CO;2-8)

Coburn, W. (2000). *Everyday thoughts about nature: A worldview investigation of important concepts students use to make sense of nature with specific attention to science*. Contemporary trends and issues in science education, Vol. 9. Boston, MA: Kluwer Academic Publishers. <https://doi.org/10.1007/978-94-011-4171-0>

Fleer, M. (1997). A cross-cultural study of rural Australian Aboriginal children's understandings of night and day. *Research in Science Education*, 27(1), 101-116. <https://doi.org/10.1007/bf02463035>

Gay, G. (2000). *Culturally responsive teaching: Theory, research and practice*. New York, NY: Teachers College Press.

Kawagley, A. O., Norris-Tull, D., & Norris-Tull, R. A. (1998). The Indigenous worldview of Yupiaq culture: Its scientific nature and relevance to the practice and teaching of science. *Journal of Research in Science Teaching*, 35(2), 133-144. [https://doi.org/10.1002/\(SICI\)1098-2736\(199802\)35:2<133::AID-TEA4>3.0.CO;2-T](https://doi.org/10.1002/(SICI)1098-2736(199802)35:2<133::AID-TEA4>3.0.CO;2-T)

Lewthwaite, B., McMillan, B., Renaud, R., Hainnu, R., & MacDonald, C. (2010). Combining the views of "both worlds": Science education in Nunavut Piqusiit Tamainik Katisugit. *Canadian Journal of Educational Administration and Policy*, 98, 1-71. Retrieved from https://www.umanitoba.ca/publications/cjeap/pdf_files/lewthwaiteetal.pdf

Little Bear, L. (2000). Jagged worldviews colliding. In M. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 77-85). Vancouver, BC: UBC Press.

Snively, G. J. (1986). *Sea of images: A study of the relationships amongst students' orientations, beliefs, and science instruction* (Doctoral dissertation). University of British Columbia, Vancouver, BC. Retrieved from <http://hdl.handle.net/2429/27253>

Snively, G. (1987). The metaphor interview and the analyses of conceptual change. In J.D. Novak (Chair), *Proceedings conducted at the Second International Seminar of Misconceptions and Educational Strategies in Science and Mathematics*, Ithaca, NY: Cornell University.

Snively, G. (1990). Traditional Native Indian beliefs, cultural values, and science instruction. *Canadian Journal of Native Education*, 17(1), 45-59.

Snively, G. (2001). *Once Upon a Seashore: A Curriculum for Grades K-6*. Victoria, BC: Kingfisher Press.

Snively, G. (2016). When uncles become killer whales: Bridging Indigenous science with Westerns science and worldviews. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1 (pp. 129-146). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Snively, G., & Corsiglia, J. (2001). Discovering Indigenous science: Implications for science education. *Science Education*, 85(1), 6-34. [https://doi.org/10.1002/1098-237X\(200101\)85:1<6::AID-SCE3>3.0.CO;2-R](https://doi.org/10.1002/1098-237X(200101)85:1<6::AID-SCE3>3.0.CO;2-R)

Snively, G., & Williams, L. (2008). Coming to know: Weaving Aboriginal and Western science knowledge, language, and literacy into the science classroom. *Educational Studies in Language and Literature*, 8(1), 109-133.

Snively, G., & Williams, L. (2016). Creating change: Instructional strategies, teacher education, teaching science in rural Aboriginal and urban multicultural schools (pp. 53-72). In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1. Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Wallas, J. & Whitaker, P. (1981). *Kwakiutl legends*. Surrey, BC: Hancock House Publications.

Williams, L. & G. Snively. (2016). "Coming to know": A framework for Indigenous science education. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1 (pp. 129-146). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Chapter 6 - Significant Life Experiences and Long-term Orientations to the Seashore

GLORIA SNIVELY

Why do some people take the view that all of creation is connected and sacred and therefore should be respected and protected, or the view that humans are the experimenters, dominators, and controllers of the seashore? While others see the seashore as an ecological system of interconnected plants, animals, water, etc., that should be preserved for the sustainability of the planet. Why do some people take the view that humans can harvest the seashore for their own benefit even at the expense of environmental degradation, or that nature is to be admired and protected for its integrity and beauty? Yet others see nature as primarily a source of recreation, relaxation, and enjoyment?

Some of the above phrases are more reflective of a Eurocentric worldview, while others are more reflective of an Indigenous worldview. Some phrases are reflective of an Indigenous spiritual orientation, while others reflect a Christian orientation. Some phrases reflect a Western scientific orientation, while others reflect a utilitarian or aesthetic or recreational orientation. The way we view the world is a product of the sum total of our life experiences.

A question one might consider regarding the 'Yalis study, is why do the students (and adult participants) view the seashore differently? What significant life experiences in their teenage and adult years contributed to the creation of different orientations? How stable are orientations over the long term? What life triggering events would provide an impetus for some of the participants to re-evaluate their career choices?

As described in [chapter 4](#), in 1982 I interviewed a class of Grade 6 students in 'Yalis, located on the North Coast of Vancouver Island, British Columbia, using metaphor interviews to describe the students' orientations to the seashore. The metaphor interviews enabled the identification of six students: the student with a preferred science orientation to the seashore (Dan), the student with a preferred spiritual orientation to the seashore (Luke), the student with a preferred aesthetic orientation (Mary), the student with a preferred utilitarian orientation (Jimmy), the student with a preferred recreational orientation (Anna), and the student with no preferred orientation to the seashore, but a combination of several strong orientations (Sharon). Because orientations were thought to be deeply rooted aspects of our conceptual system, it was assumed that there would be a certain stability of orientations over time (Snively, 1986, 1987, 1990).

In 2001, nineteen years after the Grade 6 study, I located and interviewed five of the six participants in an attempt to describe and analyze their adult orientations to the seashore. The intent of the longitudinal study was not to determine their long-term recall of science instruction and the retention of marine ecology concepts, but to describe the stability of the participants' orientations to the seashore into adulthood. In addition, the adults were asked questions related to personal aspirations, life experiences, and career choices. I wanted to know if there would be a relationship between their childhood career aspirations and their adult career choices.

In this chapter, I focus on the adult orientations of Dan, Luke, Mary, Jimmy, and Anna. Sharon, a student of European ancestry, moved away from 'Yalis shortly after the 1982 study, and I was not able to locate anyone who knew where she or her family had moved.

Significant Life Experiences

When adults are asked to reflect and comment on the path taken to reach their current place in life, the response often involves the recounting of an important life experience that had special meaning. This type of incident is referred

to as a “significant life experience” (Tanner, 1980; Chawla, 1998, 2001). Similarly, “critical incidents are life events that have a great impact on a person and that appear important to an outsider” (Shuman & Ham, 1997, p. 29). “The phrase ‘formative experience’ is also used to describe an experience that had a profound effect on a person’s life direction. “Chance encounters with other people may also affect a person’s life path” (Ottnad, 2002, p. 10). These unexpected experiences can act as catalysts that alter the course of one’s life.

As we shall see from the analysis of the ‘Yalis study, a myriad of additional factors described in this research as “external life-altering circumstances,” such as seriously declining salmon populations, the state of the local economy, pressures of supporting a family, a university education, the Christian church, and cultural changes in the community can also affect one’s adult orientations and choice of career.

Methodology

In 2001, I travelled to ‘Yalis to interview and tape-record the adult participants using the same metaphor questions that I employed in the 1982 study. I transcribed the tapes and analyzed the metaphor responses to identify their adult orientations. I then interviewed the adults again to determine if they agreed with my interpretation of both their 1982 and 2001 orientations. This was the first time that the construct of orientations had been described to the participants. In addition, I asked questions related to their career choices, life experiences, and personal aspirations.

When I visited ‘Yalis in 2001, the community had changed a considerable extent. Most notable were far fewer commercial fishing boats in the harbour, especially the very large seiners. The salmon and herring fishery had both experienced serious decline. One of the big, old fish cannery buildings along the waterfront had been torn down and in its place a boardwalk constructed. A second cannery on the reserve is still there and used as a fishnet loft where fishermen make, repair and store nets; and where the Elders and knowledge holders fast freeze elk, fish and other food products to distribute throughout the community. The beautiful new band-operated T’lialagi’lakw School is decorated with First Nations art, carvings, and photography. Although the old brick Anglican St. Michael’s Residential School building still stood, many Elders and community members discussed the possibility of tearing down the building as it was a reminder of “a very dark time” (it was demolished in February 2015). The old ‘Namgis Traditional Big House that served as the social and cultural centre for the community burned down in 1997, the work of an arsonist, and was replaced in 1999 by a new Big House with ornately carved and painted red cedar poles and figures ([Figure 6.1](#)).



Figure 6.1 ▲ Front of 'Namgis Big House, Alert Bay. Photo by A. Davey. CC-BY 2.0. <https://www.flickr.com/photos/adavey/4666465323>

The new Big House, considered one of the largest and most impressive structures of its type on the West Coast, continues to host important ceremonial events—marriages, burials, and winter ceremonies complete with elaborate regalia, ancient dances, songs, and stories (Figures 6.2, 6.3, and 6.4).



Figure 6.2 ▲ Natalya Child–Tlakwetlgenaxw, and Kiara Child–Tlakvagila’ogwa ‘Salmon Twin Dancers’, Kwakiutl Bighouse, Tsaxis, Fort Rupert, BC. Photo by J.R. Rardon (2013).



Figure 6.3 ▲ Mark Isaac, Hoylikala Dancer, 'Yq̓lis (Alert Bay) Bighouse. Photo by Sharon Eva Grainger (2018).



Figure 6.4 ▲ After the potlatch ban was lifted, the Kwakwaka'wakw could hold potlatches as formerly. The T'sasala Cultural Group sing and dance in the big house, and tell their stories. Traditional Kwakwaka'wakw dances are performed by the T'sasala Dance group. Photo courtesy of the Province of British Columbia. CC-BY-NC-ND 2.0. <https://www.flickr.com/photos/bcgovphotos/15333772433/>

The U'mista Cultural Centre continued to work towards the preservation and celebration of the traditional Kwakwaka'wakw culture (Figure 6.5 and Figure 6.6).



Figure 6.5 ▲ The mandate of the U'mista Cultural Society is to ensure the survival of all aspects of the cultural heritage of the Kwakwaka'wakw. U'mista Cultural Centre entrance. Photo by Brian Burger. CC-BY 2.0. <https://www.flickr.com/photos/wirelizard/27005400726/>



Figure 6.6 ▲ U'mista Cultural Centre [back of building]. Photo by Roger Meike. CC-BY-NC-ND 2.0. <https://www.flickr.com/photos/rogermeike/3913708749/>

The heritage buildings, 'Umista Cultural Centre, Big House, impressive totem poles, cultural events and whale tours encourage a growing tourist industry. Despite an often-difficult history with government, residential schools, fisheries, and church issues, the 'Yalis community continued its history of both Indigenous and “pioneer” or European and Asian newcomers living side by side in relative harmony.

Adult Orientations to the Seashore

Luke's Adult Orientations

For the longitudinal study I traveled to the metropolitan city of Vancouver to interview Luke. The results of Luke's metaphor interviews show that he continued to prefer a spiritual orientation to the seashore, as evidenced by the greatest proportion of his responses reflecting the spiritual beliefs of the traditional Kwakwaka'wakw peoples, followed by a mix of aesthetic and utilitarian orientations. For example, when asked to choose his favorite metaphors from the entire set of metaphor questions, Luke chose “painting” and “garden” and offered the following responses:

A garden. On the spiritual aspect, I would say garden because I listen to the wind blowing by the sea breeze. I listen to the seagulls and the waves splashing on the shore ... and I try to hear whether they are trying to communicate.... Especially recently in January, I lost my grandfather, and he composed a song about the seagulls. So, when I see a seagull, I think of him and it's like it's his spirit in the seagull watching over me.

It would be a painting. I don't draw as much as I used to, but every now and then I pick up a piece of paper and doodle on it. So, painting ... a lot of traditional artwork—birds and whales.... I have some prints put away right now and I'll study them and try and make my own designs.

Of all the metaphors that show a relationship to the seashore, which one would be Luke more than any other?

I would have to say the listener is to a story. I would be a listener and the seashore would be the story. It was difficult for me growing up and I had to excel at so many things. So yes, I'm a listener. I had to excel in education. I had to excel at Kwak'wala, my Native language. Learning the dances—we had our dance class, learning our dances, the songs, what song belonged to what dance, what village the song and dance came from. So, it was quite tedious for me.... Looking back today, it was my own doing because I am what is considered a white Native because I am not as dark as the rest of my family. So, to prove that I was a member of my village I had to push myself to learn the ways of my village. But looking back today, it was mostly my doing. To a degree, I am glad I did when I look at the closeness I have with my family....

And then I learned to live in the big city. Its rush here and there, but still, you have to take time and smell the roses, or smell the exhaust....

I was taught at a very early age to accept people for what they are, and we all have our talents. So, when I realized that this is my family I didn't really have to push myself so hard to prove myself as an Alert Bay Native descendent [sic].

If there is one metaphor that is you more than any other, which one would be your favorite—the one that really encompasses Luke?

I'd have to say town...'cause I came to realize it's not just me you know. We all have something to learn from each other ... like I've learned from other cultures.... I hope I was a blessing to someone else ... to teach something to someone else and so I would have to say town.

Could I just ask if you were to teach something to somebody else, what would you want to teach?

That two different cultures can harmonize with each other you know. It's like what I just said. I know more

about you. You know more about me, and it's just harmony with each other.

When I told Luke that I had interpreted both his Grade 6 and adult metaphor responses as having a preferred spiritual orientation to the seashore that stressed the traditional spiritual beliefs of the Kwakwaka'wakw, Luke smiled and said, "Yep, that's me!" When I said that I had to a much lesser extent interpreted responses that reflected Christian spiritual beliefs, Luke again smiled and said, "Yep, that's me too!"

When I asked Luke about his work history and aspirations, he explained that he was attending a Bible College that is associated with the Foursquare Church in Vancouver and run by a former pastor. The Bible College has a Native Studies program that is geared for First Nations peoples who want to help other First Nations peoples. During his spare time Luke works at *Mission Possible*, an outreach program for street people. Luke explained:

I spend a lot of time on the streets in Vancouver and I talk to people down on skid road. We all know who we are, but skid road people have forgotten who they are. I talk to these people to help them remember who they are, these First Nations people who are the forgotten people.

I asked Luke to explain his reasoning for integrating the First Nations spiritual stories and beliefs with Christian beliefs. He explained:

It has something to do with Christ being the same as the Great Creator. It has something to do with the way Native people pray and the way the church prays. We recognize the Great Creator who the church calls God and we recognize the Great Spirit who the church recognizes as the Holy Spirit or the Spirit of God. And we recognize that we are not evolved creatures, as evolutionists perceive. And the Great Spirit gives us our knowledge and our wisdom.

In attempting to understand how Luke's spiritual orientation is grounded in both Indigenous spiritual beliefs and Christian beliefs it is important to recall that Luke was raised by his Granny in 'Yalis. The school principal described the Granny as "a very traditional Native," who "attends the Pentecostal Church in 'Yalis" and "has a very strong influence on Luke." Thus, it is not surprising that Luke's spiritual orientation would be grounded in both traditional First Nations beliefs and fundamentalist Christian beliefs, and that these beliefs persisted into adulthood.

Mary's Adult Orientations

For the longitudinal study, I interviewed Mary in 'Yalis. Mary's long-term metaphor responses show a significant proportion of responses reflecting a scientific orientation, followed closely by a mix of recreational, spiritual, and aesthetic orientations. For example, when asked to choose her favorite metaphor choice, Mary chose family and necklace:

The family. Having to live with one another and trying to do it successfully. You know, everything having to live together, everything being dependent on everything else—like you would your family members.

The necklace. You know a necklace is a perfect circle or an oval when you wear it, and if you took something out of the necklace, then it wouldn't be complete. You'd be missing something—it wouldn't work.... It would be broken—the chain would be broken.

Of all the metaphors that show a relationship to the seashore, which one would be Mary more than any other?

The bead to a necklace. A bead is just a part of a necklace—a part of a perfect circle. It's a part of the circle of life. And if you take a bead out, it affects the rest of the necklace—it changes it—it falls apart.

After describing my analysis of Mary's Grade 6 orientations, and her preferred aesthetic orientation she was quick to say, "That's me, definitely yes, there's a connection."

When I described how I was inferring spiritual responses in the 2001 metaphor interviews that appeared to reflect a First Nations spiritual orientation, and that I had not seen a spiritual orientation in the 1982 data, Mary did not hesitate to reply:

Yes, that's correct. When I was a young girl the only time I felt Native was when I was with my Native grandparents. It's been only the last three-years that I feel more Native. Once I started teaching school and had my own kids I've been going more to Native activities. I've been working at the First Nations House. I have more of a thirst for it, wanting to find out more. Yes, it's been a definite change. Even in the last little while, my dad and uncles and lots of people, they're trying to connect more with their culture.

Recall in [chapter 4](#) that Mary's Kwakwaka'wakw dad and non-First Nations mother divorced, so Mary was raised by her mother. Thus it is not surprising that the only time Mary felt Indigenous while growing up was when she was with her Kwakwaka'wakw grandparents. But 19 years later, Mary had become a part-time cultural teacher at a nearby elementary school and wanted to teach her students and her own children more about the Kwakwaka'wakw culture, "so they can be proud of who they are."

At first, I inferred that Mary chose the necklace metaphor to stress the concepts of the food chain and its interdependencies, as in the post-instructional Grade 6 interviews. However, it was explained to me by the Elders that the phrase "circle of life" is commonly used by First Nations peoples to describe ideas associated with natural cycles such as seasonal changes; life cycles (birth, growth, and death); balance and harmony; reciprocity; and our human relationship to nature. It seems likely that Mary's recent acknowledgement of the traditional First Nations culture enabled her to stress concepts consistent with both Western Science (ecology concepts) and Indigenous Science—the traditional knowledge and wisdom of First Nations peoples. Nevertheless, the fact that Mary continued to use "necklace" and "jewelry" metaphors to stress concepts associated with the circle of life, inter-connections and interdependence is undeniably striking.

Jimmy's Adult Orientations

In order to interview Jimmy, I traveled to Campbell River, a coastal town located 195 kilometres south of 'Yalis, at the southernmost part of the Kwakwaka'wakw traditional territory. Jimmy's long-term metaphor interviews showed that he continued to have a preferred utilitarian orientation as evidenced by the greatest proportion of utilitarian responses, followed closely by a large proportion of responses consistent with a scientific orientation, and a smaller proportion of responses reflecting aesthetic and spiritual orientations. For example:

The seashore is a jewel. We get food from the seashore: clams and crabs, and other shellfish. A jewel because people make their living clam digging for money and some guys do pretty good on that.

Of all of the metaphors we just talked about...which one of those is the one you would say is mostly Jimmy?

A fishing boat. You can catch fish and put other people to work. It's a nice thing to do. I enjoy doing it.... I just like being out on the water and catching fish for commercial and food fishing to eat.... I've done it all my life and probably will do it for the rest of my life.

If you were anything that you wanted to be at the seashore, what would you most want to be?

A salmon. A sockeye or a nice fish, there's 3-4 different runs of them. Some runs are small and some of them are big. Some runs are early summer, and some are late summer. The Stuart run is usually the small run—the Adams is late. This year is the Stuart run, next year is the Adam one and it will be the big fish.

Importantly, some responses made connections to utilitarian, spiritual and ethical considerations, for example:

I'd be the deckhand and the seashore would be the boat. The deckhand because you could help the shore by cleaning it up and looking after it, so you can keep the water clean and not let it get polluted. And then you won't be able to get any resources from it anymore.... We make our living off it, so we got to look after it, or it ain't going to keep looking after you.

The above metaphor response makes reference to pollution, stewardship, and a traditional spiritual reciprocal relationship with the seashore, "we got to look after it, or it ain't going to keep looking after you."

Several responses expressed an aesthetic and spiritual orientation, for example:

I'd be a raven because it goes back into my culture and its one of our Native masks—so the raven, and there's lots of legends around it. It's like a spiritual bird and it's basically birds in our culture.

When I told Jimmy that I had interpreted both his 1982 and 2001 metaphor responses as having a preferred utilitarian orientation to the seashore, he grinned and said, “Yep, that’s me, definitely all the way.” When asked about his job history and aspirations, Jimmy explained that he had continued to work over the entire nineteen years since Grade 6 as a commercial fisherman. At the time of the interview, he was working as an engineer on his father-in-law’s boat. I asked him to tell me what it had been like being a fisherman over the past several years:

It's been pretty tough. In the last three years we've gone fishing with the seine boat about 5 times. And there's been no fish when they let us fish and tough for guys that own the boats, and own nets and everything. A lot of Native fishermen have lost their licenses. I'm hoping that next year the salmon runs will pick up and the remaining boats are going to do quite well.

Did you say you have a herring license?

Yeah, my father had one, but somebody's got it and won't give it back. Somebody else has it and has had it for four or five years now and my dad never got a cent from it. We're looking into going to Fisheries and trying to get it back.

So, your boat sits in the dock the whole rest of the year?

Yeah, so you see how it's tough on guys who pay moorage. You're looking at probably \$1500.00 a month. That's just for the boat, and then you have to store all your nets and stuff in the net loft and that's another two or three thousand dollars a year. And to lease a license it could cost up to \$200,000.00 just for the season. So, it's not cheap now to stay in the business.

Yes, it's obviously pretty tough. So how do you plan to survive?

The guys that are left are banking on the fishing picking up. There's lots of herring now. That's a good sign.... One of the older Native guys, he had to sell most of his boats, but he said, 'never give up cause the fish will always be around.' So I fish for other guys commercially and for my own family. We get sockeye for canning and go get chums in the fall for smoking.

Remarkably, in spite of the near collapse of salmon and herring fisheries in the 1980's and 1990's, Jimmy had successfully pursued his childhood dream of becoming a commercial fisherman. Interestingly, Jimmy's increased proportion of science responses reflect an increased knowledge of the ecology of marine organisms and habitats, and is consistent with the type of knowledge that might be expected of a successful commercial fisherman.

Dan's Adult Orientations

To interview Dan I travelled to 'Yalis. The results of Dan's longitudinal interviews showed that he continued to have a preferred scientific orientation to the seashore, as evidenced by the greatest proportion of science responses, followed closely by a recreational orientation, and then a smaller proportion of aesthetic, spiritual, and utilitarian orientations. For example:

A barnacle is a fisherman because they reach out with their little rods and they cast out and grab whatever they find.... They're grabbing plankton—small marine life. We're looking at them under the microscopes out at the farm. Some of them get into the fish and bother the fish. I think they're baby prawns and crabs, and mussels.

The sun would have to be the factory. Because about 99 percent of all life on the planet comes from the sun—from the photosynthesis that it creates, unless we're talking about the little upwelling creatures out in the ocean that we don't know a whole lot about. But you know that the sun is what provides for everything here.

Seaweed is a garden. It's sort of like your lower plant life.

A clam is a vacuum cleaner. What are they called? Bivalved mollusks?... They suck in water. They're getting the same things as the barnacles and I really don't know how many different species reproduce by the same way.

When asked to respond to the relational metaphor questions, he said:

I guess I could be a thorn for the blackberry bush. If the seashore or the bush ever required defense, that's what a thorn is all about, to keep the blackberry bush intact. If I had the opportunity or if the need arose, I would be defending the seashore on its behalf. So, I could see myself more as involved there, protecting it. If there were environmental concerns locally that might be destroying the seashore, I would be certainly concerned and feeling like I would want to defend it in that respect which is the biggest issue in our land these days—preserving what we had here—seems to be the way everybody's thinking around here.

Dan's metaphor responses show that he continued to have an understanding of the concepts habitat, plankton, life cycle, photosynthesis, conservation, taxonomy (the terms "species" and "bivalved mollusks"), and an awareness of a Western scientific framework of classification; e.g., the reference to "the lower animals."

In addition, two of Dan's recreational responses reveal important aspects of a rapidly changing lifestyle for 'Yalis students:

The seashore is a gift. You know I really enjoyed growing up living on the seashore. It was the best childhood experiences. When I was a kid it was entertaining...and you're learning and participating down there. We were always playing games and we weren't playing with each other there, we were sort of getting along on the beach, turning over rocks and just having a good time. I mean I look at the kids now and its video games. It's a nightmare. In 'Yalis where everybody should be down on the beach like we were when I was a kid, but it doesn't happen. One of the big things in my life was playing on the beach between 6 years and 15.... Most kids today expect to be entertained.

The seashore is a dance. You just sit around and watch what's happening.... Yesterday I was watching some bears on the beach. It was quite a performance watching them dig around and get mad and look around.... It was fun to watch. They were digging and a rock fell. The bear ran away, and then he turned back to doing what he was doing. There was a couple of us sitting watching him, chuckling away at it while we were having coffee.

Such metaphor responses provide a stark contrast between how Dan experienced the seashore during the 1970's and early 1980's as a form of entertainment, the learning he received out on the land, and how as an adult he sees how the youth are unable to entertain themselves. Video games serve as a major form of entertainment instead.

When I described my interpretation of Dan's preferred scientific orientation in both the 1982 and 2001 studies, Dan readily agreed that he viewed the world from a [Western] scientific perspective, and so did his Dad. When asked about his job history and aspirations, Dan revealed that he had tried commercial fishing for several years, but couldn't make a go of it because of rapidly declining fish populations and the cost of owning a commercial seiner. Then he worked for a few years delivering supplies to fish farms. Finally, with the help of his dad, he saved enough money to purchase a barge, "a really big barge!" He hires himself out to fishers and boaters who have capsized or need to be towed, or who need something hauled a long distance across the water. He makes good money supplying fish farms with nets, feed and equipment. He would rather be a commercial fisherman, but said:

Given the choices with the lack of fish and all, I feel pretty successful. I'm on the water and I enjoy cruising around. I cruise along and look at pretty nice beaches.... I see lots of animals ... and I really enjoy myself.

It's interesting to note the different attitudes of Dan and Jimmy towards salmon fish farms and managing the wild fish stocks. Jimmy is strongly opposed to fish farms because our West Coast farms raise Atlantic salmon, a species that is not indigenous to BC. Atlantic salmon pollute the water around fish farm pens and are known to escape in such large numbers that they are breeding in our BC rivers and competing with our wild Pacific salmon for food and habitat. By sharp contrast, Dan views the wild stocks as "so endangered that they will become extinct over the long term." Like his father, he sees fish farms as "the way of the future." What is interesting about the two opposing viewpoints is that Jimmy takes a utilitarian and traditional spiritual view towards conserving the wild salmon for future food and job opportunities that is consistent with the stand taken by the 'Namgis Band Council in 'Yalis. By contrast, Dan views fish farms (a Western scientific form of production and management) as the solution to the problem.

Anna's Adult Orientations

I travelled to Burnaby, BC, located in the greater Vancouver metropolitan area, to interview Anna who was living in an apartment complex and taking courses in teacher education at Simon Fraser University.

Recall that Anna had moved to 'Yalis from the Philippines in Grade 3. Anna's long-term metaphor interviews show that there was a shift from a preferred recreational orientation to the seashore to a preferred spiritual orientation to the seashore. Anna's spiritual orientation was followed closely by a recreation orientation, and then a mix of scientific, aesthetic, and utilitarian responses. For example, several responses made reference to Christian beliefs, as well as being peaceful and reflective:

I would be a sunflower sea star.... I think I'd like to teach how much we are affected by the seashore.... It can be a place where you can do some reflection. A place for solace. For me, I'm a Christian and I just find the whole seashore as majestic, and whenever I get that feeling I am so thankful for it.

The seashore is a gift. It's beautiful, it's a gift because it keeps on giving.... We take from it peace just by looking at it or just by being there.

The seashore is a legend. You have stories to tell. One important story to me is feeling peace at sea.... If you concentrate on yourself and just the sea and the sand around you, you sometimes feel like there's nobody else there.... The tides are kind of faint and reflective.... The feeling can be profound.... Problems that I may have had to deal with during the week are no longer there.

Anna's spiritual orientation was followed closely by a recreational orientation:

The seashore is a painting. I would love one day to be able to snorkel so that I could enjoy those tropical fish that are so bright.

I would be a sandy beach. There can be different types of sand ... and that can signify different emotions. If you go down to the Caribbean the sand could be white.... Other sand is a little bit brown.

I would be a sailboat. One of the things that I love to do is sail even though I haven't done it much.... It symbolizes freedom...people come to see tourist attractions ... like Haystack Rock on the Oregon coast.

Several responses reflected an aesthetic orientation:

The seashore is a gift. It's beautiful.

The seashore is a painting. At first glance, it may just seem like one colour, but when you get close up there are so many colours and so many hues it's just amazing.

I would be a fish. A rainbow fish.... Although I value inner beauty more than outer beauty, I would still like people to see me as beautiful all over.

Three responses reflected a scientific orientation:

I would be a sandy beach. There are different types of sand depending on northern hemisphere or southern hemisphere or tropics vs. Vancouver.

The seashore is a jewel. You have to treat it properly. You can have an oil spill, but eventually there will be a renewal and that's as long as you clean it up ... the sea has the capacity to eventually build up the life that was destroyed.

Only two responses reflected a utilitarian orientation:

The seashore is a gift. It's a gift because it keeps on giving. We take food from it.

The seashore is a garden. If you treat it properly it will bloom. If you don't treat it properly it will start to deteriorate.

When I told Anna that I interpreted her adult metaphor interviews as having a preferred spiritual orientation followed very closely by a recreational orientation, and that I had not observed a spiritual orientation in her grade 6 metaphor interviews, she did not hesitate to reply:

That's right. I am definitely more spiritual now ... more religious.... When I was in high school my best friend got killed in a car accident. It was terrible. I had a very hard time.... It was then that I started to regularly go to church. It was my pastor who helped me a lot to get through that really difficult time. Ever since that time I've been very active in my church, but I hadn't been active before.

Anna was the only participant who showed a changed set of preferred orientations, from a clearly preferred recreational orientation in Grade 6 to a preferred spiritual orientation 19 years later. Anna's adult spiritual orientation stressed "reflection," "feeling peace at sea," being "thankful for being Christian," while her recreational orientation stressed travel and tourist attractions to faraway places such as Oregon and the Caribbean. It would appear that in the case of Anna, a significant life experience, such as the death of a best friend in high school and a compassionate pastor, had a profound effect on her life direction and triggered a major shift in her adult orientations.

Significant Life Experiences and Orientations

When the adults were asked to reflect and comment on the path taken to reach their current place in life, their responses often involved the recounting of an important life experience that had special meaning. Perhaps the clearest example of a "significant life experience" (Tanner, 1980; Chawla, 1998, 2001) and a "chance encounter with another person" (Ottstad, 2002) triggering a change in orientations can be seen in the case of Anna. It would appear that the

death of a best friend in high school and a compassionate pastor held special meaning for Anna and prompted a change in preferred orientations, from a preferred recreational orientation to a preferred spiritual orientation.

In the 'Yalis study, it was not so much a “significant life experience” or “chance encounter with another person,” but a combination of multiple “life-altering circumstances” that resulted in a change in orientations or a change in career choices for some of the adults. Dan’s childhood first career choice was to become a commercial fisherman, but this career choice was impacted by seriously diminished salmon runs, the rising cost of purchasing and maintaining a commercial fishing boat, and eventually by the economic responsibilities of raising a family. Even then Dan tried unsuccessfully to pursue commercial fishing for several years before purchasing a large barge and tugboat to deliver food and equipment to fish farms and to assist boaters in need of help—a choice that is consistent with his preferred scientific orientation to the seashore. Nevertheless, in keeping with his childhood dream of never leaving 'Yalis, he was able to find a means of income that enabled him to live in his beloved home territory, “out on the ocean,” “cruising along,” “looking at pretty nice beaches,” and “really enjoying” himself.

It would seem that Jimmy’s childhood dream of owning his own fishing boat would prove to be not financially viable, but Jimmy tenaciously followed his dream and was one of the very few remaining fishermen earning a living out on the ocean by working on his father-in-law’s commercial seine boat, a childhood career choice consistent with his preferred utilitarian orientation. What is interesting is that both Dan and Jimmy tried their hand at commercial fishing, indicating that the goal of becoming commercial fishermen was firmly ingrained into their career aspirations in Grade 6.

Mary’s childhood career aspiration was to become a “hair stylist and a cosmetician,” which was consistent with her Grade 6 preferred aesthetic orientation. Instead, becoming a culture teacher at a nearby elementary school, parenting her own children, having more contact with her First Nations family combined with a resurgence of traditional ceremonies, art and culture in 'Yalis, and pride in being First Nations in recent years has held special meaning for Mary. It became more acceptable and desirable to view the seashore from a spiritual orientation based on the traditional beliefs and values of the Kwakwaka'wakw peoples.

Thus, it is clear, that in addition to “critical incidents” and “chance encounters with significant individuals,” a myriad of “external life-altering circumstances” such as the economy, the near collapse of salmon populations, the loss of natural resources, the state of the environment, pressures of supporting a family, a university education, the Christian church, and cultural change in the community also affected the adults’ orientations to the seashore, as well as their choice of career.

The Categorizing of Orientations to the Seashore

There may be additional orientations that have yet to be identified. For illustration, in 1984 I gave a workshop on the metaphor interview at the University of Hawaii, attended by adult science and social studies teachers and university professors from the Pacific Rim countries. Not surprisingly, a large proportion of the participants’ metaphor responses reflected international and political aspects of the seashore:

The seashore is a painting. Like a mosaic of many nations and cultures trading with one another.

The seashore is a battleground. It’s a battleground to fight wars and for power—like the war in the Pacific, Pearl Harbour, World War I and World War II.

The above metaphor responses represent a political orientation to the seashore. A political orientation had not been encountered from the five pilot studies, and hence I did not include metaphor questions such as, “The seashore is a courtroom” or “The ocean is a judge” to highlight a political orientation in the ‘Yalis study. Importantly, a political orientation was likely not a significant component of these young students’ conceptual system and especially not for First Nations students grounded in their traditional culture. Since the Grade 6 students wove their own preferred orientation into the great majority of metaphor choices, a politically minded student would have woven the political aspects of experience into his or her metaphor responses, at least in part, had such a student been present.

Just as there may be orientations to the seashore not yet identified, there may be aspects of metaphor responses in future research projects that at first appear to be orientations, but fall short of the definition of an orientation defined in [chapter 4](#). For example, during the five 1982 pilot studies, I identified several metaphor responses that led me to include a health and safety orientation to the seashore. Hence, I included metaphor questions such as, “the seashore is a battleground,” “the seashore is a pin cushion,” “a barnacle is a thumb tack.” The following illustrates a typical response:

The seashore is a pin cushion. There’s the barnacles and sea urchins that could poke you if you were to fall on them.

I would be a lock to a necklace. A lock could pinch, just like a crab could pinch. Like that clam closing on my fingers or how that big red crab can cut you open with its pinchers.

The seashore is a battleground. Like the eel [blenny] that can give you an electric shock.

Looking back, I would not include a health and safety orientation in future research related to seashore orientations. The participants’ responses reflect a painful or fearful relationship with the seashore based on experience and certain knowledge (or misinformation), but their responses do not reflect the values component of an individual, social group, or culture. Many of the students’ ideas and fears were addressed during instruction. For example, the “eel” is really a harmless elongated fish called a blenny that looks like an electric eel, but is incapable of delivering an electric shock. Blennies can be picked up by the hands and when viewed in a classroom aquarium, is often a favourite entertainer. After instruction there were far fewer health and safety responses, and these responses were almost absent in the long-term adult interviews.

Inferring Indigenous Orientations to the Seashore

When describing the orientations of Indigenous populations, it is important to acknowledge the holistic nature of Indigenous worldviews. All things are related and interconnected. Thus, concepts of wholeness, spirituality, reciprocity, self-knowledge, and how people relate to others and to nature are a necessary aspect of attempting to infer an Indigenous scientific, spiritual, utilitarian, aesthetic or recreational orientation. It is crucial to consider that because Indigenous peoples come from diverse backgrounds and home-places, there is no single Indigenous worldview. Nevertheless, there is a shared worldview in which humans are inextricably connected to the natural world (Cajete, 2000). Similarly, orientations are broad intellectual and emotional commitments, and must be inferred in light of the person’s life history, family dynamics, culture, and home place.

Table 4.1 in [chapter 4](#) represents the five orientations as described in the 1982 study, and attempts to take into account the orientations of both First Nations and non-First Nations students. After completing the longitudinal study, I felt that

an attempt should be made to describe the orientations of the First Nations peoples of ‘Yalis more clearly (see Table 6.1 chart below).

Kwakwaka’wakw Orientations to the Seashore

Table 6.1 presents an attempt to describe the orientations of the Kwakwaka’wakw culture towards the seashore. The orientations represent a synthesis of the participants’ (both student and adult) metaphor responses, communications with Elders and community leaders, as well as readings on Northwest Coast First Nations culture. There are no clear boundaries between orientations, for example, the spiritual aspects of an experience are an integral and inter-related aspect of each orientation:

Table 6.1 Kwakwaka’wakw Orientations to the Seashore	
Scientific	A body of knowledge, experience, observation, experimentation, practice and belief. All things are related and interconnected at all times. All of creation is sacred, and should be respected and protected. Indigenous Science, rather than just being knowledge, is a way of life and is the actual living of that life in a good way.
Spiritual	Everything of Mother Earth possesses a spirit. That spirit is conscious and has awareness—the wind, rocks, plants, animals, etc. Nature has a voice. Humans cannot place themselves before or above other life forms. The winter ceremonies are a time of individual spiritual and cultural renewal.
Utilitarian	Humans can harvest nature for their practical use (berries, root vegetables, cedar planks, salmon, clams, seaweeds, bear, deer, moose, etc.). Humans have a reciprocal relationship with nature—they can harvest nature for their own use, but if the person behaves in a way that harms nature, then their negative way of being can turn on them. Respect is expressed in words of gratitude, and must be shown towards the natural world—the plant or animal before, during and after harvesting.
Aesthetics	Artistic expression can be seen in crests bearing art forms such as totem poles, house fronts, ceremonial robes, headdresses, masks, bentwood boxes, basketry, and textiles. Items made from cedar, for example, represent sacred objects believed to contain the life force of the living tree. Art forms often display inherited rights and kinship, and rights to names, songs, dances, and crests. A carving “comes alive” through the life-giving power in the carver’s hands. The gift of carving ability can be recognized even in childhood. Stories, crests, songs, dances, and names can function as deeds to tribal and family territories and associated rights.
Recreational	Singing, drumming, art, storytelling, games, canoe journeys and feasting are forms of relaxation, enjoyment and recreation that are an integral part of healthy community preservation.

In the study, analysis of the participants’ metaphor responses depended on a general understanding of the physical, economic, social, and cultural environment of ‘Yalis as well as the traditional First Nations culture. As the researcher, I needed to have a general knowledge of the potlatches, ceremonial dances, and customs, as well as a close collaboration with Elders and knowledge holders. The participants’ orientations have a high degree of validity, as exemplified by the fact that all of them readily agreed to my inferred interpretation of their preferred orientations, by variously responding, “Yep, that’s me!”

When working with Indigenous orientations, the holistic and inter-related quality of Indigenous knowledge systems gradually emerge; most Indigenous peoples know this, most non-Indigenous researchers do not. Researchers should always recognize that just as there are many interpretations of natural phenomena, there are as many different ways that humans can see patterns in seashore life. It is intended that researchers attempting to explore the construct of orientations with Indigenous communities will need to modify the above descriptions according to the experiences of respondents, the interpretations of Elders, knowledge holders, and the community.

Metaphor Interviews and Orientations

The metaphor interview is one possible assessment tool that takes into account the linguistic and socio-cultural background of the child—a method that may be used in large urban centres, rural settings and isolated coastal fishing, as well as Indigenous and non-Indigenous communities. Metaphor interviews can be modified to explore orientations towards the forest, lake, mountain, prairie or city. They can be linked to a sampling strategy to provide important qualitative data that is holistic and episodic, and be used in cross-cultural studies. Acknowledging the holistic nature of orientations suggests that the analysis of data is not a simple statistical coding schedule that can be picked up in a 30-minute training session. Additionally, a coding schedule seems unlikely because it would require an understanding of complex situations and careful examination of the contributions of context to the respondent's metaphor responses.

The typology of orientations consisting of scientific, aesthetic, spiritual, utilitarian, and recreational contributed insights over and above those to be obtained by studying only beliefs about seashore relationships. In the overall study, as described in chapters 4, 5, and 6, the typology was useful in four ways: (1) in identifying the students' pre-instructional orientations to the seashore, (2) in developing instructional metaphors that were interesting and appealing to students with different preferred orientations, (3) in assessing the effectiveness of instruction, and (4) in accounting in large part for the respondents' adult orientations, behaviors, career choices, and personal aspirations.

The discourse of students struggling to increase their understanding of seashore relationships and the discourse of adults revealing their current relationships to the seashore, has the potential to add rich descriptions and humanistic understanding to both qualitative and quantitative research. The respondents' metaphor responses shed light on the person's recall of an event, which could be different from someone else's recollection. Metaphor interviews provide a window into the respondent's unique memory of what was significant and meaningful to them; and a connecting place for the respondents' feelings and emotions to be entered into the research data.

The use of metaphor interviews to describe orientations rests on data collected through a small interview sample, the need for more extensive research is obvious. As such it suggests that researchers, curriculum developers and teachers in all subject areas need to explore this emerging research frontier.

Reflections

The lives of Dan, Luke, Jimmy, and Mary reflect the struggles of growing up as a First Nations person, living in a small coastal fishing community during the 1970's and 1980's. Each in his or her own way was influenced directly or indirectly by the beliefs and values of their family (parents, grandparents, aunties, and uncles), the community, the Christian church, the devastating ripple effect of parents who were taken from their homes and attended the residential school, and the beliefs and values of the traditional Kwakwaka'wakw culture.

When I conducted the initial study in 1982, salmon, halibut, herring, cod, oolichans, as well as clams, scallops, crab, and shrimp (although declining) were still relatively abundant. It seemed that almost every boy in 'Yalis wanted to be a commercial fisherman when he grew up. During the 1980's and 1990's we can see how the young adults in this study, in particular Jimmy and Dan, were faced with significantly diminished salmon returns, as well as seriously diminished halibut, herring, and oolichan runs. The decline of traditional harvests affected the ability of the community to offer the usual wide assortment of abundant traditional foods, and to give away precious oolichan grease during the winter feasts.

Although important Chiefs, Elders, and knowledge holders struggled, often successfully, for many decades to keep the traditional culture alive, it was nevertheless a community in which many members largely felt shame for having lost

their language and sometimes even for identifying as First Nations. In the words of Donna Cranmer (2016), principal of Wagalus Elementary School in Fort Rupert:

There are Kwakwaka'wakw who have had the benefit of the old people who continued to practice their ways during the dark years when our cultural ceremonies and ways of doing things were outlawed by the government of Canada. There are Kwakwaka'wakw whose old people rejected their culture when the government created laws that made the practice of our way of life illegal. With the introduction of the English language and Western ways of thinking, a breakdown in language and cultural traditions has occurred. In some families, many traditional teachings are not taught to the young. (p. 181)

Importantly, during those “dark years” people did not stop holding secret potlatches, practicing their culture and giving witness to family dances, songs, titles and stories. Thus, it is not surprising that Luke has a preferred spiritual orientation based on traditional Indigenous beliefs mixed with Christian beliefs, or that Mary’s set of orientations did not include a spiritual orientation based on the Kwakwaka'wakw culture during her childhood years.

It raises the question, of why Mary did not show any spiritual beliefs based on traditional Kwakwaka'wakw teachings in grade 6, and then a significant proportion of traditional spiritual beliefs as an adult? It becomes important to understand that there has been a resurgence of the traditional Kwakwaka'wakw culture over the past several decades. This resurgence was led by Chiefs and Elders, and often spearheaded by a new generation of young knowledge holders who worked hard to continue the potlatch and the giving of gifts. Significant efforts were made to teach the Kwakwala language and traditional customs and values in the school and by holding community feasts and ceremonies. After the potlatch ban was lifted people could freely and openly hold potlatches, tell their stories, sing and dance in the big house, and feel pride in the Kwakwaka'wakw culture.

As a Eurocentric newcomer, I can only imagine the deep cultural and economic loss that the Kwakwaka'wakw continue to endure with regard to significantly diminished salmon and other fish runs. According to the traditional creation story, it was salmon runs that gave birth to the Kwakwaka'wakw, and the reason why they call themselves “the salmon people.” The Nimpkish watershed is the largest on Vancouver Island and sustained the community for thousands of years. Legend has it that the river was placed there by the Creator to support salmon runs, “for as long as the days shall dawn on the world.” Yet, in spite of great pressures from European settlers to give up their traditional life-ways, the Kwakwaka'wakw have to a large extent retained their traditional ways and have remained close to the land and ocean.

It is my hope that this research might foster a better understanding of the trials and triumphs of the Kwakwaka'wakw, and of Indigenous peoples generally. The metaphor responses express the adult participants’ particular qualities of experience: Jimmy and Dan’s struggles to fulfill their childhood dreams of becoming a commercial fisherman during a time of seriously diminished fish returns; Mary’s newfound spiritual orientation based on traditional Kwakwaka'wakw teachings; and Luke’s ability to merge Christian beliefs with the traditional spiritual beliefs of the Kwakwaka'wakw.

In 'Yalis, the First Nations students (Kindergarten through Grade 7) are currently taught by, primarily First Nations teachers. Three of the five teachers at Alert Bay School (the public school) and all of the teachers at the T'lisalagi'lakw School (the band-operated school) are First Nations. From Grade 8 onwards, the Alert Bay students catch the ferry to Port McNeil and are bussed to North Island Secondary School. At present, in most First Nations communities in BC, First Nations students are still taught by non-First Nations teachers. Clearly, all teachers need to be aware of the community, the culture and to some extent the biographies and histories of the students and families where they teach and live. This understanding is critical to our efforts to reformulate our teaching objectives in ways that will benefit First Nations students and their communities. I am hopeful that research involving metaphor interviews and the construct of orientations has the potential to help us all (both Indigenous and non-Indigenous teachers) develop curricula and programs that are culturally appropriate, challenging, and beneficial to students of diverse cultural backgrounds. It is time for each of us to engage in a personal and professional journey of truth and reconciliation. If we travel this journey together, the possibilities are greater than we can imagine.

DISCUSSION QUESTIONS

1. In a small group explore the relationships between students' orientations and their social and cultural background. For example:
 - Explore how a utilitarian orientation for a student of Eurocentric background might be different for a student of Indigenous background.
 - Within the category of a scientific orientation to the seashore, explore similarities and differences between a Western Scientific orientation and an Indigenous Science orientation.
 - Within the category of a recreational or aesthetic orientation to the seashore, explore potential similarities and differences between a person of Eurocentric ancestry and a person of Indigenous ancestry.
2. With regard to orientations, how might individuals from within a Eurocentric background differ? How might individuals from within an Indigenous background differ?
3. How might knowledge of Indigenous orientations affect curriculum and program development?

REFERENCES

- Burger, J., Gochfeld, J., Jeitner, C., & Pittfield, T. (2012). Activity patterns and perception of goods, services, and eco-cultural attributes by ethnicity and gender for Native Americans and Caucasians. *International Journal of Sport Management and Tourism*, 9, (34-51).
- Cajete, G. (2000). *Native science: Natural laws of interdependence*. Santa Fe, NM: Clear Light Publishers.
- Chawla, L. (1998). Significant life experiences revisited: A review of research on sources of environmental sensitivity, *Environmental Education Research*, 4(4), pp. 369-382. <https://doi.org/10.1080/00958969809599114>
- Chawla, L. (2001). Significant life experiences: Revisited once again. Response to Vol. 5 (4) 'Five critical commentaries on significant life experiences research in environmental education'. *Journal of Environmental Education*, 7(4), 451-461. <https://doi.org/10.1080/13504620120081313>
- Cranmer, D. (2016). Dzaxwan (oolichan fish): Stories my Elders told me. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1. Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>
- Krkošek, M., Ford, J. S., Morton, A., Lele, S., Myers, R. A. & Lewis, M. A., (2007). Declining wild salmon populations in relation to parasites from farm salmon. *Science*, 318, 1772-1775. <https://doi.org/10.1126/science.1148744>

Ottstad, K. E. (2002). Significant life experiences that have inspired environmental education in British Columbia. (Masters thesis). University of Victoria, Victoria, BC. Retrieved from <https://dspace.library.uvic.ca//handle/1828/10560>

Shuman, D. & Ham, S. (1997). Toward a theory of commitment to environmental education teaching. *Journal of Environmental Education*, 7(2), 25-32. <https://doi.org/10.1080/00958964.1997.9942820>

Stevenson, K. T., Peterson, M. N., Carrier, S. J., Strnad, R. L., Bondell, H. D., Kirby-Hathaway, T. & Moore, S. E. (2014). Role of significant life experiences in building environmental knowledge and behavior among middle school students, *The Journal of Environmental Education*, 45:3, 163-177. <http://dx.doi.org/10.1080/00958964.2014.901935>

Tanner, T. (1980). Significant life experiences: A new research area in environmental education, *Journal of Environmental Education*, 11(4), pp. 20-24.

PART III
CULTURALLY APPROPRIATE CURRICULUM
PROJECTS



Blessings. Artwork by Una-Ann (2018).

The Elder gently cradles the hand of the child, as she speaks softly sharing the stories of her ancestors. She remembers the first Salmon Ceremony when the bones were returned to the river, in hope of abundance the following year. She shares how important it is to care for the Salmon. How many ways it is prepared and the nourishment it provides. Saying prayers and counting her blessings she is grateful that the salmon once again have returned to provide for her family.

Chapter 7 - Cross-Cultural Marine Science: Culturally Inclusive Curriculum for All Learners

DAVID ASHURST, RICHARD KOOL, AND GLORIA SNIVELY

One of the many challenges facing British Columbia (BC) high school science educators is balancing their teaching strategies to effectively engage all students, while meeting the learning outcomes set by the BC Ministry of Education within the allotted school calendar year. In achieving this balance, pressure is often greatest for educators at the senior levels where students are completing their credits for graduation and facing important final exams. Unfortunately, it is at these senior levels that the highest dropout rate for all students, regardless of culture, is evident (Aikenhead & Michell, 2011; BC Ministry of Education, 2004, 2016a, 2016c; Snively & Williams, 2016).

Currently, one of the largest “at risk” groups are students who identify themselves as Indigenous, a term collectively referring to First Nations, Métis, and Inuit in Canada (BC Ministry of Education, 2016b). Historically, few Indigenous students continue with either math or science into senior secondary education courses that are required for acceptance in post-secondary college or university (Ministry of Education, Province of British Columbia, 2006; Snively & Williams, 2006). However, when Indigenous students do participate in these upper level math and science courses, they tend to not only pass, but achieve high test scores (Ministry of Education, Province of British Columbia, 2006, 2009, 2016c).

Possessing an understanding of science is important for all students, as they are the future decision makers in their communities. Utilizing ecological and environmental science to encourage Indigenous students to develop a scientific understanding of their environment may be an effective method to encourage their participation in senior science courses. Environmental educators often try to connect humans to their environment through local culture and the interrelationships between human and natural communities (Smith & Williams, 1999). Unlike conventional science education methods which tend to detach humans from the environment, an environmental education program encourages students to develop an affinity to one’s land and place, and engages them to gain an understanding through direct contact with their environment (Louv, 2006; McKeon, 2012; Williams & Snively, 2016). It is the ecological connections and respect developed through environmental education that can provide the backbone for a different kind of scientific inquiry and understanding through which students can make informed community decisions (Kesler, 2015; Roczen, Kaiser, Bogner & Wilson, 2014; Sobel, 1995; Wilson, 1997).

The Cross-Cultural Science Classroom

The authors feel that it is important that the science curriculum reflects the diversity found in our multicultural communities. Unfortunately, most science classrooms and curricula have lacked contributions from any culture outside the dominant Western culture. Aikenhead (1997) recognizes “science” as a subculture of Western culture and that teaching Western Science (WS) only is a form of cultural transmission. The perspectives inherent in WS include cultural facets such as man’s ability to understand the natural world through study and to disseminate the information. Scientific knowledge is pursued for a variety of reasons: “pure” science may be done for its own sake, while “applied” science is often done for a particular purpose—to solve a particular problem, to create a particular innovation—and is often of direct benefit to the discoverer/creator and their sponsors. New knowledge is found through the scientific method and is judged valid when results are predictable, uniform and repeatable (Aikenhead & Ogawa, 2007). Therefore, in educating students in WS, teachers have been presenting a privileged view of Western culture, regardless of students’ cultural background (Aikenhead, 2006). In teaching WS exclusively, educators have marginalized the validity of non-Western cultures’ valuable contributions to other ways of knowing about the world (Cobern & Aikenhead, 1997).

Aikenhead and Jegede (1999) have noted that K-12 school science has its own “culture,” which is not the home culture of most Indigenous students. A cross-cultural education encourages all students to acknowledge this difference and enables students to maintain their own culture, gain awareness of other cultures, and can encourage the extraction of teachings they feel are relevant to their lives. However, at this time, due to the nature of upper level science courses, it is important that students are able to understand WS concepts for exam purposes and to gain entry into university. A key approach to cross-cultural science education is the incorporation of Indigenous Science (IS), which is the knowledge of Indigenous cultures worldwide, developed over time within a cultural framework for understanding one’s world, which tends to connect community, environment, and technology (Ogawa, 1995; Snively & Corsiglia, 2001). Hatcher, Bartlett, A. Marshall, and M. Marshall (2009) refer to the learning of both Western and Indigenous Science—taking advantages of the strengths of each way of knowing—as “Integrative Science” and “Two-Eyed Seeing” (p. 149). For a more complete discussion about how the terms of Western Science and Indigenous Science are used, refer to [Chapter 1](#). Although BC’s new science curriculum (2016b), encourages the recognition and incorporation of IS into science courses it is not, at present, fully integrated into the learning outcome in the high school science curricula.

Traditional Ecological Knowledge and Wisdom

One strategy that educators may use to increase Indigenous student participation in the sciences is through the exploration of a subset of IS known as Traditional Ecological Knowledge and Wisdom (TEKW). Even though the concept of TEKW has various definitions, the overriding principle involves an extensive body of knowledge and practices of various cultures acquired through long-term interdependence with the environment, which is passed down through generations (e.g., Berkes, 1993, 2012; Berkes, Mathias, Kislalioglu, & Fast, 2001; Martin, Roy, Diemont, & Ferguson, 2010; Snively & Corsiglia, 2001). “Traditional wisdom may be thought of as an aspect of IS that focuses on balancing human needs with environmental requirements” and begins with an understanding that “all life forms be respected as conscious, intrinsically invaluable, and interdependent” (Snively & Corsiglia, 2016, p. 92).

TEKW presents a worldview that encourages an understanding of interdependence, long-term resource management, ecological connections, survival skills, culture, and respect that has been recognized as an important source of knowledge by the Government of Canada and others around the world (Berkes, 2012; Johnson, 1992; Pearce, Ford, Willox & Smit, 2015). Introducing all students to TEKW presents them with an alternative cultural view of knowledge and encourages students to respect both their own and other perspectives of science, as well as complementing many cross-curricular aspects, such as First Nations studies, multiculturalism, anti-racism, and environmental education (BC Ministry of Education, 1996, 2016b). Additionally, the new BC science curriculum identifies the importance of local knowledge and a place-based approach to science for all students (BC Ministry of Education, 2016b), through promoting a sense of place within the students’ communities that may be vital to successful Indigenous education (Kawagley & Barnhardt, 1999).

Including TEKW in the science classroom may also promote learning benefits for all students. TEKW, in addition to a WS curriculum, can present students with hands-on, tangible ways of knowing, as well as offering opportunities to engage abstract thinking skills. Including TEKW can also help students, whose prior conceptions do not fall into the realm of Western Science, feel more included. These students need not only be Indigenous students, whose cultural and community views of science and sources of knowledge may differ from WS, but may be students of any culture whose perspectives vary from a Eurocentric (WS) background (Snively & Corsiglia, 2001). A cross-cultural approach to science as proposed by Yamada, a Japanese historian of Oriental sciences, as translated and quoted by Ogawa (1995) states: “every society and culture has its own science, and its function is sustaining its mother society or culture” (p. 585). Understanding that science, and thus science education, is part of all cultures, whether implicitly or explicitly recognized, Western science is just one form of the many sciences developed in cultures around the world (Elkana, 1981). In this context, both WS and TEKW could be presented not only for comparison, but also for co-existence,

reinforcement, and inclusion into students' overall worldviews, without forcing students to either build a separate Western scientific worldview, or replace existing aspects of their worldview (Aikenhead, 2001; Aikenhead & Michell, 2011).

Purpose

The purpose of this research and curriculum project was to develop and evaluate a locally based, cross-cultural secondary school marine science program through two cultural perspectives: Indigenous Science and Western Science. The Indigenous Science perspective involved an introduction to concepts and examples of the TEKW of the First Nations peoples of the British Columbia (BC) coast, including the Coast and Straits Salish whom are locally represented in Sooke, BC, on southern Vancouver Island, by the T'Sou-ke, Scia'new, and Pacheedaht. This IS perspective was paired with senior high school level WS and WS field techniques.

Our study focused on the broad question, "Can Western Science and Indigenous Science be taught together in an effective cross-cultural program in which students learn, enjoy, and understand alternative views of science?" In order to answer this question, we examined the knowledge and personal opinions of students before and after a marine science program of studies. Specifically, the study was designed to investigate:

- students' knowledge and beliefs about WS concepts of local marine ecology and oceanography, such as habitat, the tidal cycle, food energy flow, nutrient cycles, adaptation, zonation, human impacts, environmental monitoring, and resource management,
- student familiarity with local First Nations' culture and the concepts of IS and TEKW, such as names of local First Nations communities, First Nations stories, and use of natural resources for food, tools, and medicine,
- the extent that students recognized the applicability of science, both Indigenous and Western, as part of their daily life,
- students' personal opinions regarding their prior science and learning experiences,
- students' knowledge of ecological topics such as resource use and human impacts on the environment, as well as perceptions of cultural influences upon science, and
- how the students' knowledge and opinions changed after implementation of the program of studies.

Location and Participants

This study involved the Environmental Studies 11/12 class at Edward Milne Community School (EMCS) in the municipality of Sooke BC, during the fall of 2007. The 19 student participants consisted of eight students of Indigenous ancestry (four males and four females) and 11 of non-Indigenous ancestry (six males and five females) enrolled in the class. The Environmental Studies course, offered as a locally developed course by Sooke teachers, Megan Bondurant and Mike Bobbit, would satisfy student requirements for their Science 11 credit toward graduation, and was a popular option for students due to its local, experiential and hands-on nature, and the use of frequent field trips to natural environments. Due to the nature of Sooke School District's proximity with First Nations communities, a number of students in the Sooke community have had exposure to the knowledge of First Nations Elders since primary school. Additionally, some of these students had taken First Nations 12, which examined the history of the First Nations in BC and Canada.

EMCS is located close to the Sooke River, which empties into the salty waters of the Sooke Basin. Behind the school are extensive trails through the nearby coastal temperate rainforest. Numerous parks are within easy driving distance,

including beautiful East Sooke Park with its windswept rocky coast, rain forest, and sheltered coves. The school has an open design including a full-size grey whale skeleton in the common area (Figure 7.1), and incorporates many carvings and art into the design, reflecting the local T'Sou-ke, Scia'new and Pacheedaht First Nations' influence (Figure 7.2 and Figure 7.3). Local First Nations culture is reflected in the student population of EMCS, where First Nations students come from any of the three local Nations. A population of approximately 700 students from grade 9-12, come from Sooke as well as from as far away as Port Renfrew, 80 km to the west.



Figure 7.1 ▲ Gray whale skeleton on display in the common area of EMCS. Photo by Megan Bondurant (2017).



Figure 7.2 ▲ Totem pole carved for the entrance to EMCS by T'Sou-ke Master Carver Fred Peters (1996). Photo by Megan Bondurant (2017).



Figure 7.3 ▲ Carved bench for students outside EMCS by T'Sou-ke Master Carver Fred Peters (1996). Photo by Megan Bondurant (2017).

Dave Ashurst was introduced to the class as the temporary teacher/researcher. Although not from the Sooke community, he had previously spent time at EMCS as a temporary teacher and teacher on call. He was familiar with the community and school culture, as well as the class that would be part of the study. As part of his introduction to the class, he explained his own cultural background of European descent and growing up in nearby Victoria, and that, although the class would be learning about Indigenous Science and Traditional Knowledge, he did not have any Indigenous heritage. However, he explained that he had a long history of marine and environmental education, as well as more recent experiences along the coast learning about TEKW from Elders and knowledge holders.

Research Method

The design of the study included the development and application of questionnaire instruments that sought to assess the knowledge and opinions of students, both before and after instruction of the cross-cultural marine science program. Information from a pre-instructional questionnaire provided the authors a baseline quantitative and qualitative assessment of the students' existing conceptions, beliefs, and opinions about a number of topics to be addressed in this program, including students' prior personal educational experiences and understandings in science and ecology, such as marine ecology, oceanography and resource uses, in addition to students' understandings and beliefs of local First Nations culture and TEKW.

The questionnaire (Ashurst, 2009) was based on a standardized questionnaire originally developed by Snively & Sheppy (1991), which had been adapted and shown to be effective in later research projects (e.g., Cummins, 1997; Halls, 2002). For this project, the questionnaire was completed online and targeted students' knowledge level; background; the local geography, resources, and historical aspects relevant to the District of Sooke; and addressed local ecological features such as the Sooke Basin, the rocky shorelines and coastal temperate rainforest. Other aspects of the questionnaire explored students' familiarity with local native plant and animal life, Indigenous communities, such as T'Sou-ke and Esquimalt, and locally important resources, such as fishing and logging.

Comprised of three parts, the questionnaire included a Likert-style section that explored feelings and beliefs using ratings from one (strongly disagree) to four (strongly agree). The second section explored students' knowledge levels through multiple-choice questions, covering various aspects of oceanography, ecology, coastal resources, human impacts and TEK. Then, in the final section students were asked to sketch their local seashore, including drawing and identifying as many organisms as possible, and they were invited to respond to an open-ended questionnaire about how they would approach a scientific marine resource study in their local area.

Effectiveness of the program curriculum was examined through the application of a post-instructional questionnaire, which was administered a week following Ashurst's cross-cultural marine science program. The questionnaire re-examined students' opinions on specific topics, and elicited statements describing their feelings toward the program. In addition, the open-ended question on designing a marine study in their locality was re-administered to examine differences in how students acquired and applied their knowledge during the program. Results were assessed and compared statistically to the pre-test results to determine the effectiveness of the program.

Cross-cultural Marine Science Program

A marine science program of three weeks duration was developed in which both WS and TEKW were explored, along with outdoor experiences and cross-cultural learning about various ways of understanding nature. Implementation of the marine science program was designed to coincide with low tides and good weather conditions during the spring and early summer months.

This program included sessions taught in the classroom (used to present background knowledge and field trip logistics) and during field trips (included several outdoor excursions). In school, classes lasted approximately an hour, while there was an opportunity, twice each week, to take advantage of a double block and lunch hour time slots for field trips lasting two to three hours. Classroom instructional material included presentations by Archer, as well as discussions and group activities exploring various aspects of marine science. The goals of the program incorporated:

- A place-based focus on education,
- An experiential education,
- A cross-cultural exploration of science, focusing on WS and IS,
- Learning about First Nations culture and understanding the importance of TEKW,
- Learning about and practicing various WS methods and techniques used to study the coastal environment,
- Understanding specific WS concepts of marine ecology and oceanography.

Overall, this program focused on the recognition of science as culturally diverse, with hands-on practice in the students' own communities. This locally specific environmental and ecological education is what Woodhouse and Knapp (2000) refer to as "place-based education" (p. 2), where students' experiences in nature and their community will lead to educated choices that support cultural and ecological sustainability. Finally, a culturally respectful approach to this program aimed to affect the student's knowledge, while respecting their beliefs.

Curriculum Explorations

Indigenous Science Concepts

Introducing students to both IS and TEKW was an important aspect of the program. Students were encouraged to recognize that school-based WS is just one of many perspectives on how we can come to understand the world around us. In recognizing how ways of knowing depends on cultural background, students explored the purpose of “science” and how science is influenced by culture.

First Nations’ stories were used to explore concepts in IS and TEKW. Stories present a powerful and integral form of cultural transmission of science and related knowledge. Coastal First Nations stories, such as “Salmon Boy” and “Octopus and Raven,” adapted from the BC coastal Haida and Nuu-chah-nulth nations, respectively were read to students (Caduto & Bruchac, 1991). Guided group discussions were utilized to explore the ecological, cultural, and moral aspects of these stories. “Salmon Boy,” for example, emphasized the importance of respecting one’s natural resources in the same manner one would respect a close relative. This respect, and the careful behaviours around salmon, emphasize how these particular cultures acknowledge that humans are not separate from nature, but are entwined within, and must therefore show proper respect for their environment. Additionally, the tradition of returning the remains of salmon to the river in the same story illustrates the importance of nutrient cycling in the forest, as well as keeping the village clean. In the “Octopus and Raven,” children learn from their Elders through respectful observation and learn that one should always be aware of the tidal rhythms when at the seashore.

Students also examined various “creation” and “flood” stories from several cultures around the world, including Salish, Mayan, Judeo-Christian, Greco-Roman, Japanese, Sumerian, and others, and compared these with each other, as well as WS evidence regarding past events. Students were encouraged to recognize that, in addition to entertainment and moral lessons, some of these “stories” can be seen as a potential source of historical environmental data in a region, especially when corroborated with other sources such as archaeological and geological data. An important aspect of the program was to show how TEKW, including resource use and sustainability, could be used either on its own or complementary to WS.

One example of braiding together TEKW and WS was exploring concepts related to the tidal cycle. Stories connected with the tides such as “Raven and the Man Who Sat on the Tides,” which was adapted from the northern coastal Tlingit (McWilliams, 1996), and “Octopus and Raven” (Caduto & Bruchac, 1991), were read by Ashurst to the class. After reading a story, a guided discussion explored their allegorical nature. For example, “The Man Who Sits on the Tides,” who is engrained in habitual behaviours without understanding why, is influenced by Raven who works to change the behaviour of the man from constantly sitting, encouraging the man to regularly stand, releasing the waters he sits upon and creating the tides. Important life lessons about tidal cycles and how knowledge of the tides affected and still affect people’s daily lives in transportation and resource extraction were acknowledged. In these stories, the tides are important for access to food in the tidal zone, but not paying attention to the tidal cycle could prove fatal as Raven found out in “Octopus and Raven” (Caduto & Bruchac, 1991). In the next stage of the instructional program, the students learned to connect the tidal concepts to WS through a study of the cycles of the moon, its gravitational effects upon the oceans, and the intertidal zonation of marine life.

The purpose of blending IS and in particular, the wisdom aspects of TEKW, with WS was to encourage mutual respect for the applicability of both perspectives. It was felt that if both views were taught independently, students might perceive these perspectives as being in contrast instead of appreciating them as complementary perspectives. Although not used in this instructional program and research study, it should be noted that inviting Elders to share locally specific, First Nations stories would have been an even more appropriate approach. However, trying to involve Elders may prove a

challenge for educators needing to plan ahead, and possibly placing too much demand on time from local First Nations communities. Additionally, educators need to be aware that utilizing First Nations culture in the classroom may involve understanding certain protocols. For example, specific First Nations families own the intellectual property of the stories, and unless given express permission by the community, it is not appropriate to re-tell these stories.

Marine Ecology and Resources

Marine ecology concepts and processes were explored in the classroom utilizing presentations and activities, which focused on local coastal life. One of the first aspects addressed was to understand and brainstorm the various biotic (living) and abiotic (non-living) factors that influence the lives of marine organisms. These factors were examined with reference to adaptations of life in different intertidal zones and built upon the prior cross-cultural tidal lesson.

In teaching a cross-cultural, ecological program, it is important to acknowledge that although WS and IS have similarities, they do have differences. In their respective ecological worldviews, WS classifies ecological factors into “living” (biotic), and “non-living” (abiotic) components. These biotic components include organisms from the six kingdoms of life recognized by WS biologists (e.g., Cavalier-Smith, 1998, Ruggiero et al., 2015). Abiotic components include environmental factors such as oxygen, water, sunlight, various nutrients and space. However, within the Indigenous worldview (IS) of coastal BC First Nations, as described by Snively (2016), the rocks, trees, fish, streams, sun, and moon, all have consciousness and have the ability to teach lessons to each other and people within this system— all the components of the ecosphere are equally important (Snively & Williams, 2008; Williams & Snively, 2016). Utilizing both of these worldviews can help students of all cultures understand their place within the environment. “Time and again the stories have said that all of the living and nonliving parts of the Earth are one and that people are a part of that wholeness. Today, ecological science agrees” (Caduto & Bruchac, 1988, p. 5).

Thus, the intent of instruction was to provide both Indigenous and non-Indigenous students an understanding of the western scientific concepts of classification and ecosphere, not to replace their existing cultural beliefs. High school examinations test students’ understanding of Western Science concepts, such as their understanding of “living” and non-living,” not their beliefs about living and non-living. The instruction was designed to enable students to negotiate between the science being taught in the classroom and their life-world culture. As Aikenhead and Michell (2011) further clarify, “An Indigenous student can understand Darwin’s theory of natural selection without dismissing his or her belief in an Indigenous creation story. Similarly, a non-Indigenous student can understand indigenous spirituality without believing it or dismissing his or her own religious beliefs” (p. 135).

Students explored the intertidal environment, became familiar with tidal cycles and tide zones, and identified a great diversity of marine organisms, utilizing both scientific (Latin binomials) and local names. Back in the classroom, students worked in groups to sort a large set of marine organism pictures and arrows cards into food chains and food webs, using the arrows to show the directional cycle of food energy flow through the ecosystem from the sun, through primary producers (phytoplankton), to higher consumers and predators (seals, sea lions, orca), and back through detritivores and decomposers.

Students were introduced to a survey of intertidal marine organisms and to the WS method of classifying organisms into phyla. Students identified and then classified organisms from the survey into their scientific and local common names. Students worked with identification guides so that they would be able to utilize these effectively during field excursions. Additionally, Indigenous classification systems were discussed, such as classification by utilitarian uses (food berries, medicinal plants) or general morphological classifications (seaweeds, trees, shrubs, grasses). Indigenous classification systems may differ in purpose from WS classification and naming systems in that IS may include articulating relationships between organisms and humans, or between the organisms and their ecological niche. WS often lacks

the contextualization in the classification of organisms as WS sees the relationships between organisms as based upon genetic relationships, and, although very accurate in separating species and showing evolutionary relationships, this approach offers no information on how humans might use the organism or any information about its ecology.

One example comparing classification and naming systems can be seen in the Bigleaf Maple (*Acer macrophyllum*), where the common name and scientific names describes the large leaves (*macrophyllum*) and connects it to the maple family (*Acer*). A number of coastal First Nations languages refer to the Bigleaf Maple as what can be translated to “paddle tree,” referring to the common use of the wood for making lightweight canoe paddles, among other tools (Pojar & MacKinnon, 1994). As noted by Snively (2016), “Both classification systems are valid, depending on the context and purpose for which they were constructed, and thus, both should be presented to students in the science classroom” (p. 140). Through perceiving classification with a cross-cultural lens, the various purposes of each system can be recognized, and students can gain an understanding of the utility of varying classification systems.

Students were also introduced to coastal resource management concepts and issues. Western exploitationist and expansionist resource use was compared to long-established Indigenous practices of long-term resource management. Effects of modern fisheries and timber industries were discussed in terms of over-harvesting and water quality degradation. Traditional BC coastal marine resources, such as clams, crabs, sea urchins and a variety of fish species were discussed, in addition to the traditional technology and techniques involved in this harvesting, such as weirs, bentwood hooks and the bull kelp fishing line (Figure 7.4). Modern small-scale traditional resource use, such as the various ways herring are used by Sooke First Nations (Figure 7.5) (Moss, 2016), was introduced into the discussion, showing how IS is still applicable to modern resource management.



Figure 7.4 ▲ First Nations halibut fishing rig replication using traditional materials including bull kelp (line), cedar bark (twine) and Douglas fir (hook) made by David Ashurst. Photo by David Ashurst (2009).

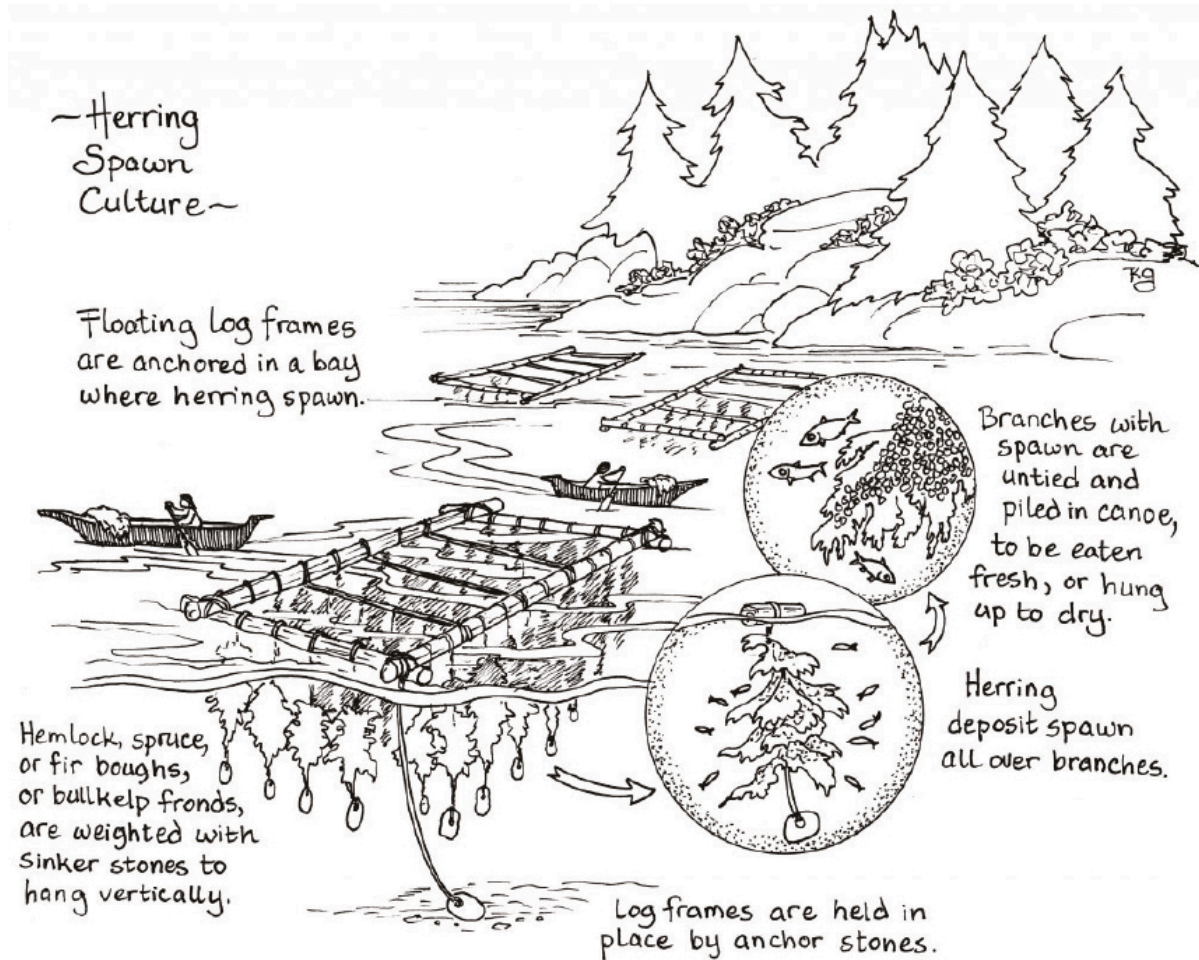


Figure 7.5 ▲ For hundreds and possibly thousands of years, Indigenous fisherman have anchored floating log frames in quiet bays, allowing the herring to deposit their eggs all over tree branches or kelp hung down from the log frames. Illustration by Karen Gillmore (Snively & Williams, 2016, p. 119).

Monitoring the coastal environment

Ashurst felt that introducing students to methods of environmental data collection and research was important and was intended to engage students in the field where they could use modern scientific equipment to collect and analyze data. Students used various techniques in assessing coastal environmental health:

- pH, temperature, salinity, and turbidity (particles suspended in the water column) were ascertained to assess water quality,
- biological quadrat studies and plankton tows helped students to assess biotic conditions.

Students explored how the data collected from these WS techniques could be complemented by IS and how the use of multiple cultural perspectives in science can lead to comprehensive, effective monitoring, and management of our coast.

Field Explorations

An important aspect in developing the EMCS environmental program was the focus on outdoor and experiential learning; the class went on several excursions, each lasting between two to four hours, resulting in approximately half of the instructional time being out of the classroom. In addition to encouraging close observation, questioning and analysis of their surroundings, the field trips were intended to create a sense of wonder and appreciation for the natural environment and diversity of life where the students lived. Informal explorations of the local coastal environment involved many casual teaching moments as students examined and questioned various aspects of the cultural environment, including a First Nations petroglyph located in East Sooke Park ([Figure 7.6](#)).



Figure 7.6 ▲ Petroglyph of seal or sea lion at East Sooke Park. Photo by David Ashurst (2008).

Most field trips had specific purposes, such as practicing skills in environmental sampling and data recording where students utilized scientific equipment. Students learned to use a GPS (a global radio-navigation system) for recording locations. Water quality was analyzed using Secchi disks, refractometers, and hydrometers. Biodiversity was analyzed using plankton nets and quadrats. A detailed study in intertidal mapping of the local seashore was used as a culminating project ([Figures 7.7, 7.8, 7.9, 7.10, 7.11](#) and [7.12](#)). These WS methodologies introduced students to how a marine ecosystem

may be monitored for changes, including the collection of baseline data to utilize as a reference point for comparisons with future conditions.

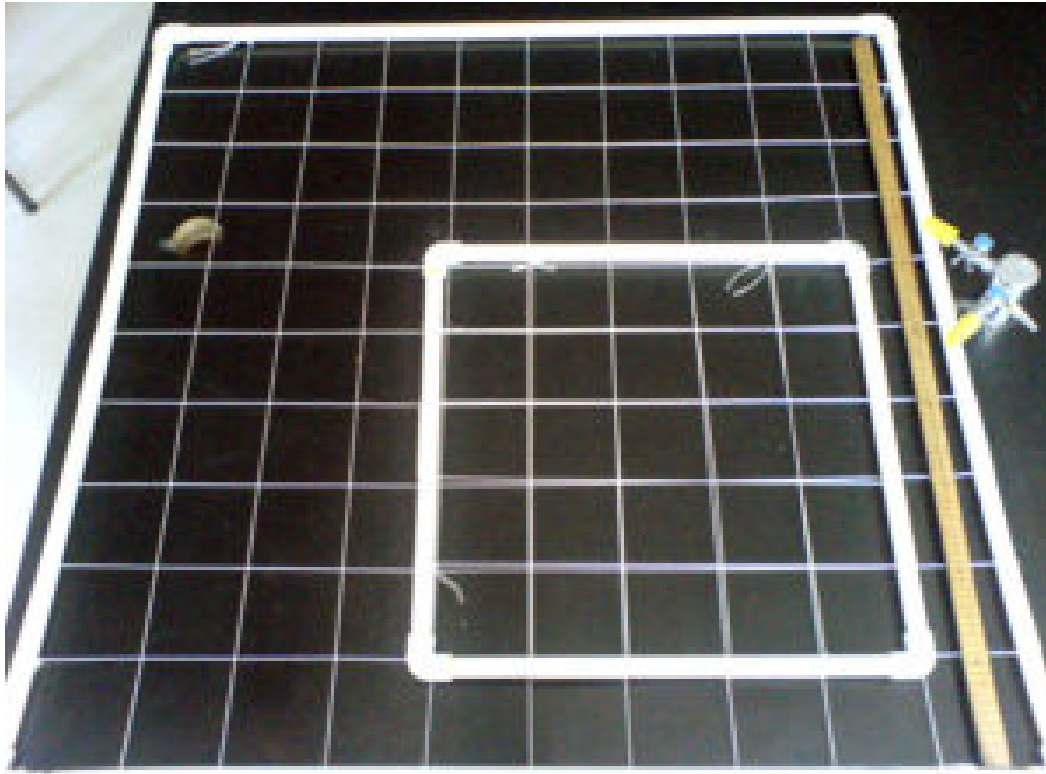


Figure 77 ▲ Two quadrats (1m x 1m and 0.5m x 0.5m) used for student sampling in the intertidal zone. Photo by David Ashurst (2009).



Figure 7.8 ▲ Students using a 1m x 1m quadrat to explore intertidal life on Whiffin Spit near Sooke. Photo by David Ashurst (2009).



Figure 7.9 ▲ Small plankton net. Photo by David Ashurst (2017).

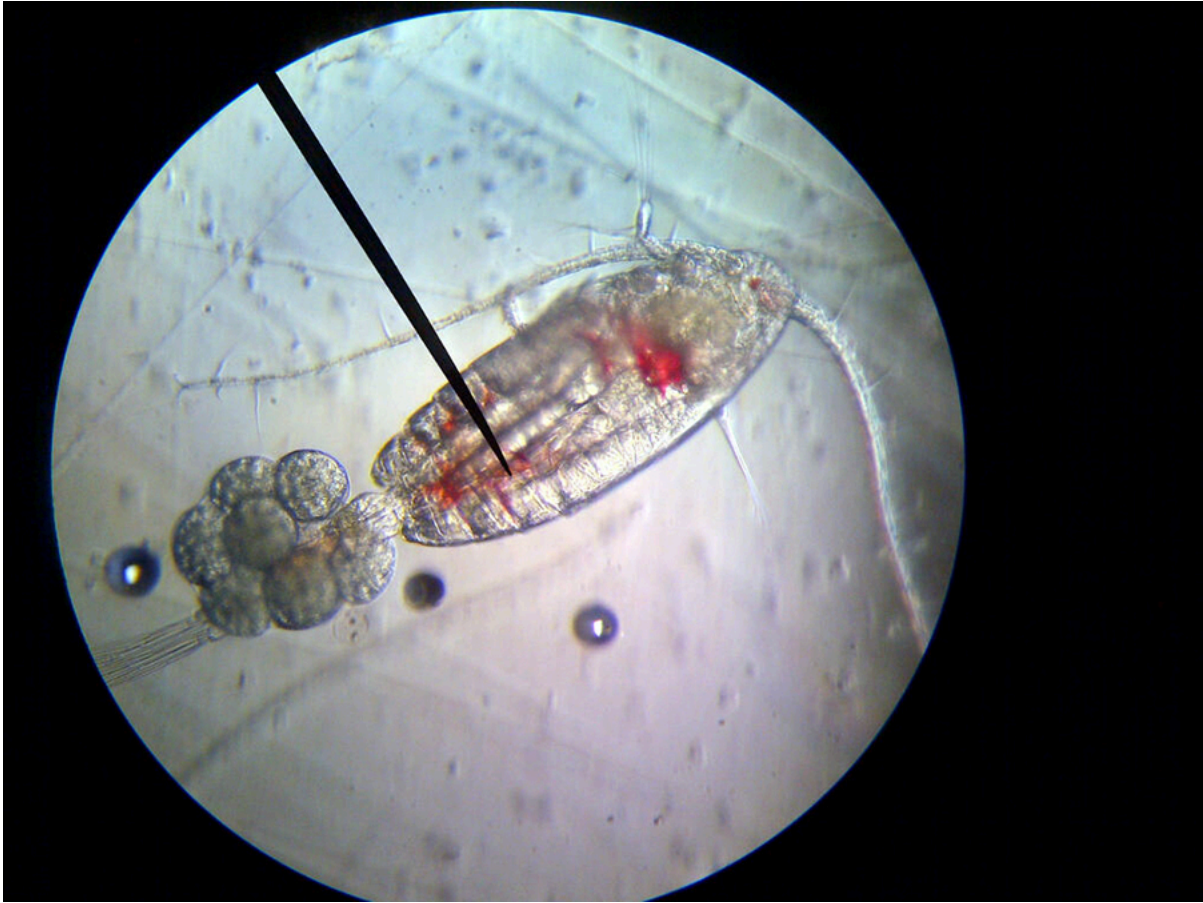


Figure 7.10 ▲ Copepod caught in plankton net as viewed with a microscope. Photo by David Ashurst (2012).



Figure 7.11▲ Students working along an intertidal transect. Photo by David Ashurst (2017).

Results

Pre-Instructional Knowledge and Opinions

Western Marine Science. In addressing the effectiveness of the instructional program, it was important to understand the students' prior knowledge and beliefs about local marine ecology and oceanography concepts such as tidal cycle, adaptation, ecological energy flow, habitat, habitat loss, human impacts, and environmental and resource management. Prior to instruction, these students did not have a strong understanding (<50% correct) in many areas of basic ecology and oceanography, as evidenced through questions that focused on local seashores (Figure 7.12). The low knowledge levels in these areas is consistent with a similar study of grade 4 students by Cummins and Snively (2000) and may indicate that these subjects are not being adequately addressed in many elementary or middle school classrooms (complete findings for this research, including statistical details, can be found in Ashurst, 2009).

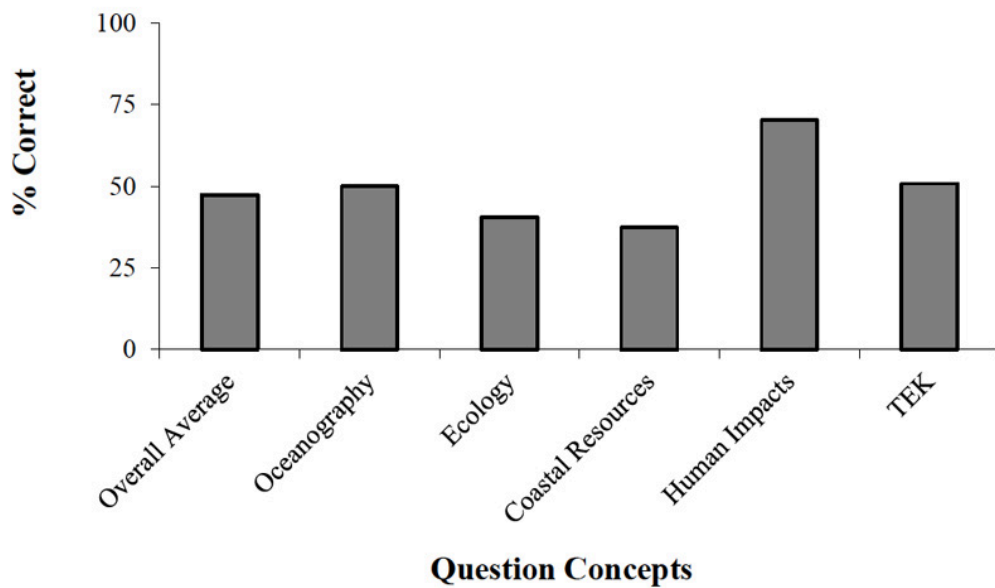


Figure 7.12 ▲ Student scores (n=16) for the “Coastal Knowledge Survey.” The overall average score and scores for questions focusing on similar concepts were compared.

Students tended to have poor recognition of specific organisms found in the intertidal zone, and classified organisms in very general groups, such as crabs, snails, and seaweeds. Additionally, the seashore sketch and the knowledge questionnaire found that almost all of the students failed to recognize specific habitats in the intertidal zone (on rocks, under rocks, in tidal pools, or in the sand or mud), the concepts of zonation (see [Figure 7.13](#)), and how seaweeds and animals adapt to survive within the intertidal zone.

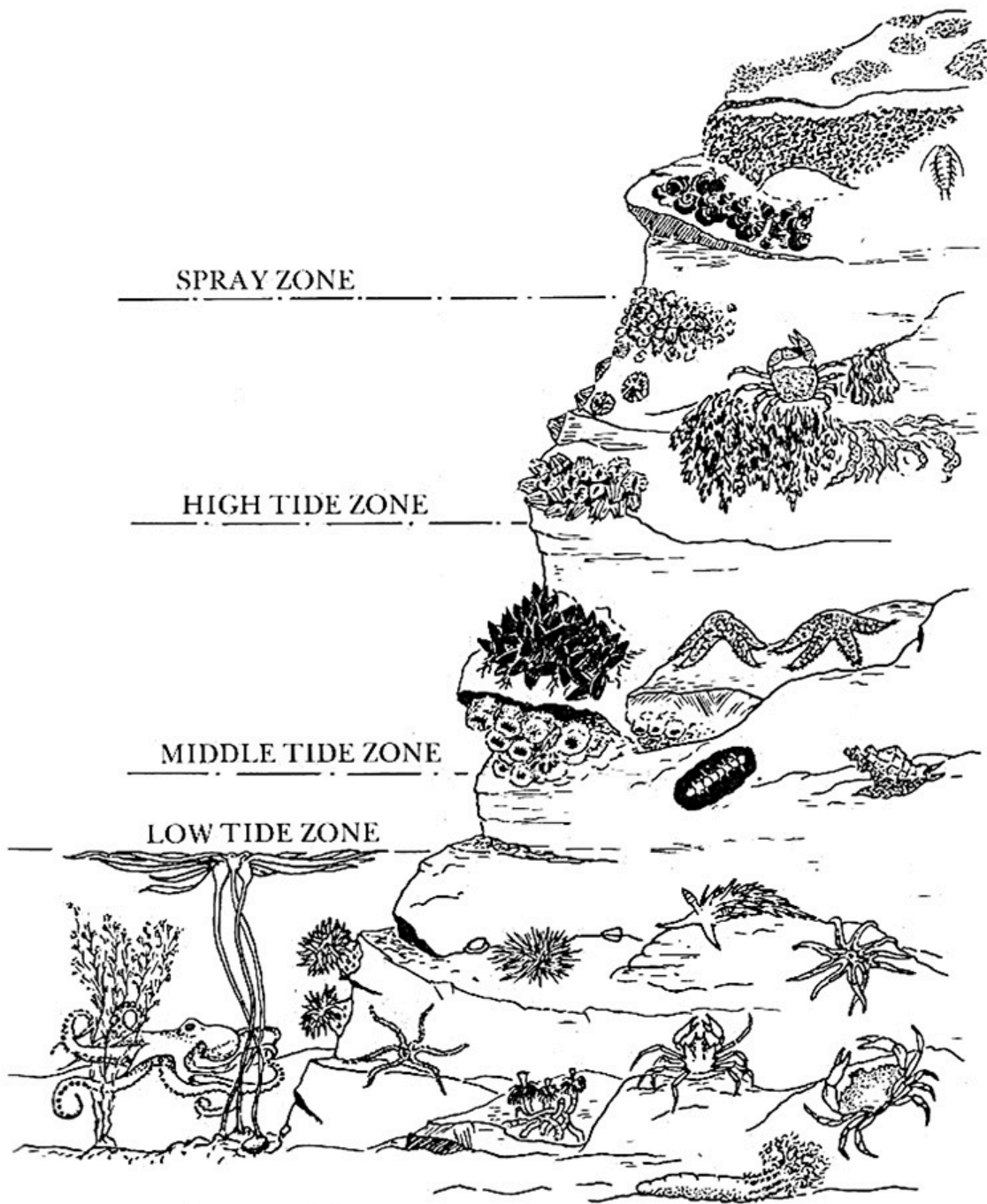


Figure 7.13 ▲ An example of rocky intertidal zonation. Image by Phillip Croft. (Snively, 1983)

Although students had previously taken high school science courses and over half of these students had completed senior science classes, almost all of the students were unable to incorporate their previous science experiences into applications of a field ecology study. Students could not identify methodologies and use of any equipment or scientific tests, such as field guides for identification, water quality tests, or use of control sites for comparison, or sampling methods. The most common student response was some form of “I don’t know.”

While students felt that they were knowledgeable in coastal resources and their impacts, the pre-instructional data suggested that this was actually an area of weak understanding. For example, many students did not understand basic resource management definitions, such as conservation and preservation. In fact, students’ understanding of resource management was shown to often be incorrect regarding their perceptions of the status of BC’s fishing industry, and the impacts of this industry and the timber industry upon coastal ecosystems.

Indigenous Culture and Indigenous Science. When Indigenous culture and concepts of TEK were explored, students appeared to have had some prior experiences with and/or knowledge of these topics (Figure 7.14). Students showed positive opinions and respect toward Indigenous cultures both pre and post instruction and recognized how stories could be used to transfer knowledge and morals. Overall, both Indigenous and non-Indigenous students had some general knowledge about Indigenous cultures, such as where food was collected and how stories were utilized, but this knowledge was not specific to the local area. Additionally, although students had awareness and some ideas about TEK, such as utilizing plants for food, medicine, and tools, they were unable to express any actual application of this knowledge in designing a research project of effects upon the coastal shoreline.

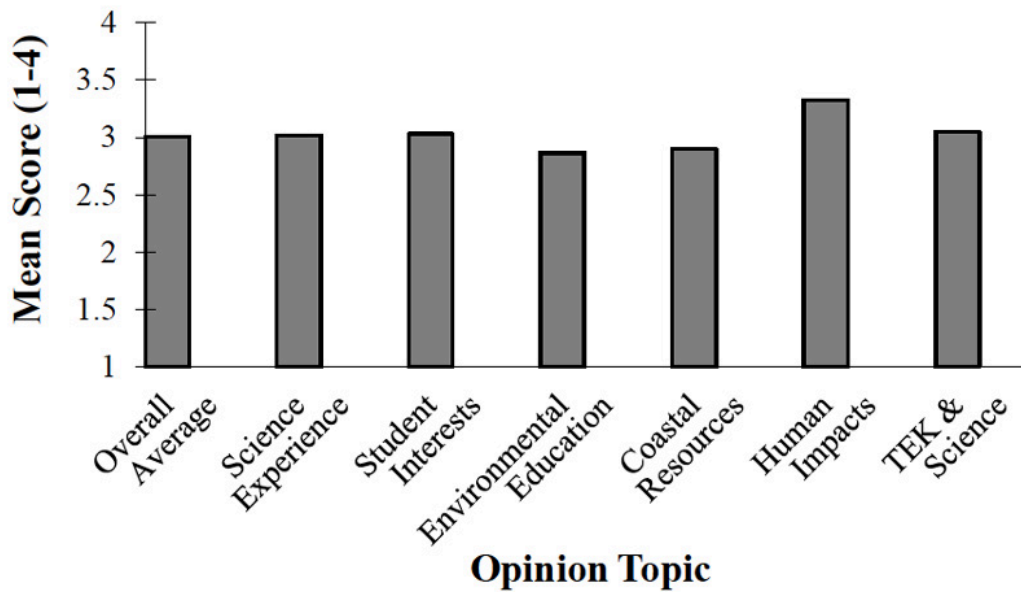


Figure 7.14 ▲ Average topic scores of responses on the pre-instructional (N=17) “Coastal Opinions” surveys. In this scale, 1 represented a negative opinion and a 4 represented the most favourable opinion.

Students’ Opinions Towards Program Goals. Prior to instruction, students’ overall opinions about concepts such as school science, IS, exploring the environment and how humans impacted the environment, were in strong, positive agreement with the goals of this program. Students enjoyed past experiences, recognized a use for science and wanted

to learn how to use scientific tools and methods in exploring their environment (Figure 7.14). The students' positive interests in exploring the marine environment (Figure 7.14), agreed with previous studies conducted by Snively and Sheppy (1991) (grades 5 and 9) and Cummins and Snively (2000) (grade four). Students also showed a respect and understanding of Indigenous culture and a basic understanding of ecological concepts prior to instruction. However, students did not have a strong sense about the cultural influences that relate to WS—they tended to see WS as a subject taught in school and disconnected from their everyday Western cultural experiences.

Pre-Instructional Comparisons. Comparing questionnaire scores between different groups (i.e., gender, cultural, and academic background), we found only three significant pre-instructional trends. Students who had taken a previous grade 11 or 12 science course scored significantly higher for recognition of species diversity in the intertidal zone than those who had not taken a senior science—which may indicate students' interest in natural science or exposure to the concept of species identification. In addition, the results also show two other statistically significant differences: Indigenous students had a lower estimation of the extent of human impacts upon the environment and lower overall scores on the knowledge questionnaire. These results and other statistical analyses can be found in Ashurst's Masters thesis (2009).

Addressing Students' Alternate Conceptions. Overall, students' pre-instructional opinions were already positive toward the goals of the program, suggesting that the educational objectives were likely to be accepted and synthesized into their understandings. Many of the students' alternate conceptions (misconceptions, incorrect understandings, and/or intuitive beliefs) were addressed through classroom and/or field activities. Examples of misunderstandings in the context of WS include:

- 15 of 16 students (94%) believed that seaweeds and kelps are vascular plants with roots and vascular tissue, or closely related to eelgrass (a vascular plant), instead of non-vascularized marine algae. This common and incorrect perception of seaweed was addressed through classroom lessons covering coastal ecology, food webs, and species identification in both the classroom and field;
- From the seashore sketch, all 12 students (100%) earned 50% or less in ecological understandings, representing the intertidal zone as a uniform habitat and did not recognize the importance of zonation in the intertidal zone, or how changes in temperature, elevation, and water cover affects species diversity and location of organisms on a shore. An intertidal survey in the field, examining living and non-living factors at various intertidal zones helped emphasize how different biological factors change due to environmental conditions;
- 13 of 16 students (81%), did not recognize that there are different species of barnacles which exploit different parts of the intertidal zone, and assumed that the size differences of populations of barnacles in different zones was due to food and water availability among the same species. Closer examination and identification of intertidal organisms in their intertidal zones helped students recognize how different species exploit different intertidal zones.

As noted previously, students indicated general group names of organisms spread throughout the intertidal zone. One of the primary purposes of the seashore field excursions was to have students examine the coastal intertidal habitat more closely and recognize the biotic and abiotic factors that affect habitat and species composition throughout their transects. Thus, the research methodology involved designing curriculum, surveying the students' prior ideas and beliefs, and modifying the instructional input to account for the students' prior conceptions.

Post-instructional Knowledge and Opinions

Western Marine Science. After instruction, we found that the marine science program induced a number of positive changes within the students' knowledge and opinions. Overall, students showed a statistically significant pattern

of increase in knowledge of all concepts explored (Figure 7.15), with only “Human Impacts” not being statistically significant. After instruction, students understood the biotic and abiotic factors resulting in intertidal zonation of organisms, recognized a greater diversity of species (25% increase score on average), and showed a large improvement in naming specific organisms (38% increase score on average). For example, proceeding from naming generic “seaweeds” to specific types, such as, bull kelp, feather boa, rockweed, and sea lettuce; and generic invertebrate groups to black chitons, keyhole limpets, acorn barnacles, periwinkles, purple shore crabs, and feather duster worms. The improved use of more specific, accepted, non-indigenous common names terminology through experiential field-based explorations was similar to the results found by Cummins and Snively (2000). Students showed a substantial increase in confidence and knowledge in understanding and applying WS methodologies after the instructional program. Prior to instruction, 62% of students were willing to attempt to describe a possible methodology for an ecological impact survey, while 76% attempted this after instruction and they were able to describe the utility and appropriateness of specific methods. Additionally, more students recognized the need to use control sites and samples for comparison with the primary study site. Examples of students utilizing proper methodologies when theoretically testing for impacts of a salmon farm include:

Sample the water from near a salmon farm and sample the water from an area of the ocean where there are no salmon farms. This will tell you the pollution created from them. (Grade 11 student)

Take samples from areas further and closer to the salmon farm and compare the data and make some conclusions from that data and compare it to older data already. (Grade 11 student)

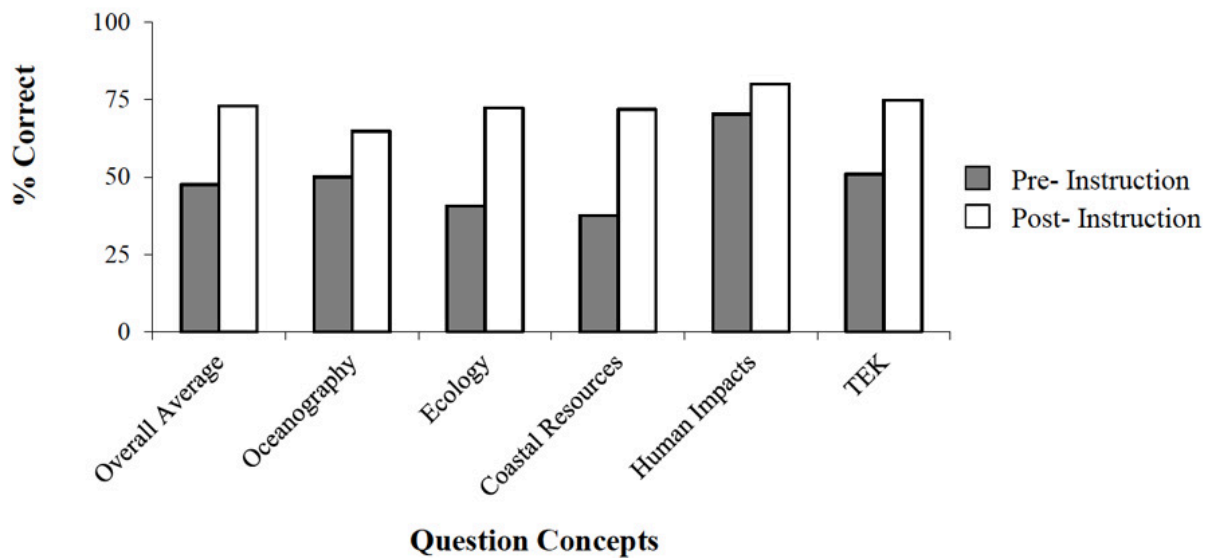


Figure 7.15. ▲ Student scores for the “Coastal Knowledge Survey.” The overall average score and scores for questions focusing on similar concepts were compared. Two tests were compared, pre-instructional (n=16) and the post-instructional (n= 15). Both tests were similar but utilized different question sets.

Indigenous Culture and Science. After instruction, students showed increased knowledge and appreciation of IS and other cultural perspectives. Students had an understanding of these concepts prior to instruction (51% average score on TEK based questions); however, after instruction they had developed a significantly more sophisticated knowledge and acceptance of other cultural views of science (Figure 7.15, Figure 7.16, see also Ashurst, 2009). In reference to IS and TEK, students had more positive opinions about the importance of First Nations stories for moral lessons, as well as its applicability to WS, including environmental and resource management. This improved appreciation was shown where students’ overall opinions in related statements moved towards the “strongly agree” end of the Likert-scale on these topics (Figure 7.16). Increased concrete knowledge and appreciation was also evident as students were able to compare and find complementary strengths between WS and TEK in ecology and resource management. When asked to design a study looking into the possible environmental effects of introducing a salmon farm into their local waters, students showed an improvement above the pre-instructional study in incorporating both WS and IS, although the improvement was greatest in the WS aspects, such as equipment and methods.

We can measure amounts of animals and population using quadrats. This way we can see [whether] populations have been affected and if food chains are the same. (Grade 11 student)

I would gather traditional knowledge from Elders and base some observations from that point ... to compare to the information from the Elders. (Grade 11 student)

I would gather traditional knowledge from Elders and base some observations from that point. Do some sort of experiments and monitor the health of the seashore animals. (Grade 11 student)

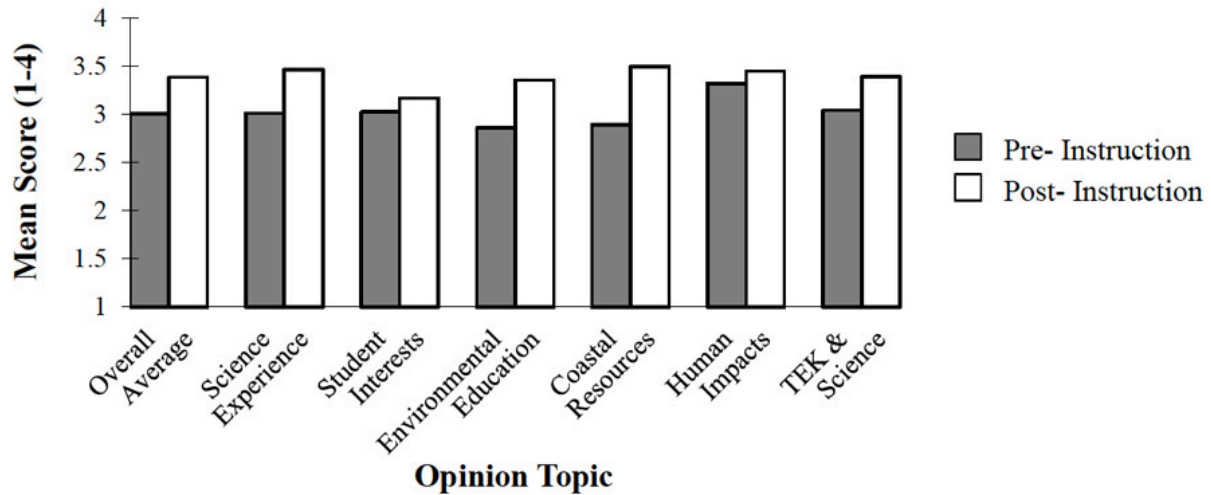


Figure 7.16 ▲ Average topic scores of responses on the pre- (N=17) and post-instructional (N=16) “Coastal Opinions” surveys. In this scale, 1 represented a negative opinion and a 4 represented the most favourable opinion.

Students’ Opinions Towards Program Goals. After instruction, students’ opinions towards the program and its goals, which were also positive before the program, became more positive after instruction. The Opinion Questionnaire showed significant increases across all categories, except “Student Interests” and “Human Impacts,” where only slight increases were evident (Figure 7.16, see also Ashurst, 2009). The little change in students’ opinions about Human Impacts, however, may be because this aspect was already very high prior to the instructional program, leaving little room to increase. Additionally, students consistently expressed that they enjoyed the hands-on experiential nature of the program, using Western scientific equipment in the field and exploring their local environment.

I enjoyed learning what tools are used for the study of the environment, and how to use them. I cannot think of a situation where I might use them, but I believe in expanding one’s knowledge in any way. (Grade 11 student)

I liked it a lot better than if we were to learn about it in the classroom. Doing our projects in [their] natural habitat is a better [way] to learn about it. (Grade 11 student)

Feelings of Environmental Empowerment. Although not a stated goal, an important finding after instruction was how students' feelings of empowerment changed positively with regard to their ability to participate in and affect change when confronted with environmental issues. Prior to instruction, students tended to recognize numerous negative human impacts upon the coast, but expressed feelings of helplessness in their ability to contribute to environmental protection. On the pre-instruction Knowledge Questionnaire, 44% of the students answered at least one question with "I don't know," where four questions had this as an option; 8 of the 16 students attempted the written response about assessing the impacts of a nearby salmon farm, and 30% of the students felt that their opinions were not valid and that they could not effectively monitor and protect the environment:

Nobody listens to kids. I don't know. (Grade 11 student)

Someone just needs to smack somebody higher in government... and do something before [it's] too late... (Grade 11 student)

Students holding opinions such as these, felt that an external force such as government and other professionals, were the only ones that could deal with problems in the community and the environment.

Importantly, after instruction, most students gained confidence in their skills and knowledge, and had the conviction that they could participate in monitoring and providing solutions to the various environmental impacts. After instruction, only one response of "I don't know" was recorded in the Knowledge Questionnaire. Supporting this gain in confidence, the number of students who attempted the written question about assessing the impacts of a salmon farm increased from 50 % (8 of 16) to 76% (13 of 17) after the program. Additionally, students expressed opinions such as:

I thought that [the program] was pretty interesting and gave me a better/different outlook on the way I looked at the marine units. I now know what I can do to help keep our oceans clean and healthy! (Grade 11 student)

This increased sense of empowerment regarding environmental issues, through confidence in skills and knowledge, agrees with other research regarding the positive effects of environmental studies programs (Smith-Sebasto, 1995).

Comparisons. After instruction, the only notable difference was that students who had taken First Nations 12 (a history course), which is an option to fulfill social studies graduation requirements in BC, showed a 20% higher score in applying TEKW in a situational example than those who didn't take First Nations 12 (Ashurst, 2009). Although TEKW is not necessarily directly addressed in First Nations 12, this difference may be because these students brought a greater knowledge of First Nations culture and were able to apply this knowledge in their responses. Other than that, there were no large differences between any results of students' questionnaires, suggesting that all students learned to a similar level regardless of gender or cultural heritage, and were successfully and equally engaged (Ashurst, 2009).

Overall, this project showed that students were able to effectively learn both WS and IS in a holistic marine science program. The cross-cultural nature of the program exposed students to other cultural views of science, and students from all cultures developed an understanding and appreciation for these perspectives. The positive results from this

program are encouraging and suggest its potential for developing ecologically literate and environmentally active members to support a sustainable future for many coastal communities.

Examples and Cases into the Science Classroom

Since this study, Ashurst has been incorporating both WS and IS approaches to co-management of resources into the science classroom. For example, the practice of utilizing WS techniques, such as Geographic Information System (GIS) mapping and ecological inventories along with TEKW has been shown to be effective in monitoring and managing resources and local effects of climate change (Reid, *et al.*, 2014; Sanderson *et al.*, 2015). In Canada, the practice of collecting traditional knowledge to support co-management with governing bodies includes work with communities within the Dene Nation for the co-management of northern wild game resources, such as documenting winter moose habitat and usage. For example, ecologists may classify an area as suitable moose habitat based on biological and environmental factors, but experienced Indigenous peoples may recognize more subtle signs, such as lack of evidence of winter usage by moose (droppings, evidence of browse), establishing that the area is not used as winter moose habitat for various reasons, such as deep snow (Johnson, 1992). He noted other examples of co-management including whaling, Pacific walrus and beluga whale management regimes in various communities of the North, from Alaska through to Quebec, and the Inuvialuit wildlife management and harvesting regimes. Both First Nations TEKW and WS have been utilized for yellow-eye rockfish management on the central coast of BC. First Nations Elders and fishermen established baseline data as to size, abundance and habitat of the historical fishery population to compare current First Nations observations with data collected by Department of Fisheries and Oceans Canada (DFO)—a method that can be used to improve the management of the stocks (Eckert, 2017). Furthermore, the DFO specifically incorporates both WS and TEKW into its Integrated Fisheries Management Plans for groundfish, salmon, shellfish, and pelagic fish (Government of Canada, 2017).

The importance of long-term, qualitative data in traditional knowledge for resource management was demonstrated on the north coast of British Columbia when the Nisgʷaʼa community recognized subtle behavioural changes of crabs which led to the discovery of environmental contamination by a nearby mine (Corsiglia & Snively, 1997; Snively & Corsiglia, 2016). Studies like this are local examples of larger scale research into the traditional observations of worldwide trends in changing resource reliability due to climate change. Savo, Lepofsky, Benner, Kohfeld, Bailey, & Lertzman (2016) present a multi-country study utilizing both local and traditional knowledge where a majority of “subsistence-oriented” communities noted changes in weather patterns and temperature, as well as changes in seasonality. Savo *et al.* (2016) found that numerous “subsistence-oriented” communities in the Arctic and sub-Arctic have noted increased temperature and decreased snow in recent times, through both lifetime and multi-generational observations. In tropical and sub-tropical biomes, the majority of these subsistence-oriented groups, including Indigenous communities, had noted sea level rise and changes to tidal patterns. Tidal and weather patterns are not the only noted changes. Inuit in Canada’s Arctic have recognized changes in animal migration and behaviour, increased numbers of mosquitos, new species arriving from southern areas and increased coastal erosion, to name a few (Savo *et al.*, 2016).

Conclusion

The experiential emphasis and local focus of this program encouraged both academically and non-academically inclined students to participate in and enjoy science in a variety of cultural forms. Even if these students choose not to continue with a Western Science education, they had, through the field-based seashore survey, the opportunity to experience how science may be used within their communities. They also had the chance to develop critical thinking skills and a

better understanding of the language and methodology of science and its relationship with culture. Students may utilize these skills and knowledge for considering issues related to how they can help reduce their community's impacts on the local environment. For students who may be more academically inclined, these explorations may have enabled them to experience how professional scientists work in the field, and how environmental science may be applied, putting theory into practice.

Encouraging student recognition of the teachings of both Western Science and Indigenous Science may shift the cultural perceptions of what science is, and who does science. The cross-cultural aspects of the program seemed to be crucial in encouraging success of both Indigenous and non-Indigenous students. Although many students already had positive views of Indigenous culture prior to instruction, the experiences seemed to help to develop a deeper and more concrete understanding about the importance of this cultural knowledge and how Traditional Ecological Knowledge and Wisdom could be important in modern ecological sciences for all students. For example, prior to instruction, students may have known that Indigenous stories held moral and environmental lessons, however after instruction, all students' experiences included direct examples of the lessons within these stories such as respect for the intertidal organisms, or an improved understanding of the tidal cycles. Indigenous students saw First Nations' stories presented along with Western Science concepts such as tidal movements, intertidal zonation, sustainability, and research methodologies. This braiding of cultures in the scope of science hopefully reinforced the relevance of their cultural perspectives and the use of Western Science, embracing "two-eyed seeing" (Hatcher, *et al.*, 2009; McKeon, 2012).

This incorporation of First Nations culture appeared effective with the Indigenous students within the program. The equality of knowledge and opinions shown by students after the program, regardless of ancestry and gender, suggests that this culturally inclusive program was equally beneficial for all learners. This cross-cultural factor is important to recognize, as most school science programs do not address issues of cultural equality in learning.

Many First Nations communities along the coast of BC still utilize their natural resources such as forests and fisheries, and these resources require monitoring and management. The majority of scientists employed to monitor these resources are non-Indigenous and often have few, if any, personal relationships with the local community. However, an important intention of the marine-focused environmental program utilized in this project was to engage Indigenous students in active, outdoor, scientific inquiry of and in their local environment. Ideally, this place-based approach to teaching can lead to students becoming educated and engaged members of their communities, making conscientious decisions that support their culture, community, and environment.

Local community management of resources has important implications for BC First Nations communities. Currently, groups such as Ecotrust Canada work with Indigenous communities to aid in mapping and understanding their local resources. Project managers, such as the researcher's brother, Chris Ashurst, who worked with various communities in efforts to identify and map cultural and natural resources, note the importance of having more Western Science trained First Nations community members who understand the principles of resource management and sustainability (personal communication, July 2004). Increased participation and success of Indigenous students in math and science allows for the possibility of increased opportunities for these students to work directly with their own communities, utilizing Western Science and Indigenous Science in resource management and scientific study. Importantly, future Indigenous professionals (biologists, geologists, and engineers) are more likely to acknowledge cultural aspects of these resources and incorporate these uses into management plans.

An important outcome of this program was that all students developed an increased environmental and cultural understanding of their local environment and feel that they have the ability to positively influence future decisions and events. As educators, we believe that it is important to teach students more than just the recognition of the numerous negative impacts that humans have upon the environment, but instead, to also nurture a feeling of personal empowerment to address such issues. The influx of negative media about global environmental issues has the potential to make students feel powerless and defeated in the face of overwhelming environmental degradation. Educators need to demonstrate to students that there is hope, that Indigenous cultures have the potential to give insight and

guidance to environmental ethics and understanding, and that individuals and groups have the potential to make positive differences in protecting and sustaining their local communities and environments.

REFERENCES

- Aikenhead, G.S. (1997). Toward a First Nations cross-cultural science and technology curriculum. *Science Education*, 81(2), 217-238. [https://doi.org/10.1002/\(SICI\)1098-237X\(199704\)81:2<217::AID-SCE6>3.0.CO;2-I](https://doi.org/10.1002/(SICI)1098-237X(199704)81:2<217::AID-SCE6>3.0.CO;2-I)
- Aikenhead, G.S. (2001). Integrating western and Aboriginal science: Cross-cultural science teaching. *Research in Science Education*, 31(3), 337-355. <https://doi.org/10.1023/A:1013151709605>
- Aikenhead, G.S. (2006). *Science education for everyday life: Evidence-based practice*. Ways of knowing in science and mathematics. New York, NY: Teachers College Press.
- Aikenhead, G.S., & Jegede, O.J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching*, 36(3), 269-287. [https://doi.org/10.1002/\(SICI\)1098-2736\(199903\)36:3<269::AID-TEA3>3.0.CO;2-T](https://doi.org/10.1002/(SICI)1098-2736(199903)36:3<269::AID-TEA3>3.0.CO;2-T)
- Aikenhead, G.S. & Michell, H. (2011). *Bridging cultures: Indigenous and scientific ways of knowing nature*. Toronto, ON: Pearson Canada.
- Aikenhead, G.S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, 2(3), 539-620. <https://doi.org/10.1007/s11422-007-9067-8>
- Ashurst, D. (2009). Promoting sense of place and culture in science: a study of the effectiveness of a cross-cultural, marine science curriculum through experiential exploration (M.A. Thesis). University of Victoria, Victoria, BC. Retrieved from <http://hdl.handle.net/1828/1688>
- Berkes, F. (1993). Traditional ecological knowledge in perspective. In J. T. Inglis (Ed.), *Traditional ecological knowledge: Concepts and cases* (pp. 1-9). Ottawa, ON: International Program on Traditional Ecological Knowledge/International Development Research Centre (IRDC) Books.
- Berkes, F. (2012). *Sacred Ecology* (3rd edition). New York, NY: Routledge.
- Berkes, F., Mathias, J., Kislalioglu, M., & Fast, H. (2001). The Canadian arctic and the Oceans Act: The development of participatory environmental research and management. *Ocean & Coastal Management*, 44(7/8), 451-469. [https://doi.org/10.1016/S0964-5691\(01\)00060-6](https://doi.org/10.1016/S0964-5691(01)00060-6)
- British Columbia Ministry of Education (1995). *Science K-7 integrated resource package*. Victoria, BC: Author.
- British Columbia Ministry of Education (1996). *Science 8-10 integrated resource package*. Victoria, BC: Author.
- British Columbia Ministry of Education. (2004). *Six-year completion rates*. Victoria, BC.
- British Columbia Ministry of Education. (2006). *Aboriginal report- 2005/06: How are we doing?* Victoria, BC: Aboriginal Enhancements Branch.
- British Columbia Ministry of Education. (2009). *Aboriginal report: How are we doing?* Retrieved from <http://www.bced.gov.bc.ca/abed/perf2008.pdf>
- British Columbia Ministry of Education. (2016a). *Six-Year Completion and Grade 12 Graduation Rates – 2015/16 Province – Public and Independent Schools Combined*. Retrieved from <http://www.bced.gov.bc.ca/reports/pdfs/graduation/prov.pdf>

British Columbia Ministry of Education. (2016b). Building Student Success – BC's New Curriculum. Retrieved from <https://curriculum.gov.bc.ca/> . Archived in Wayback Machine <https://web.archive.org/web/20160409013324/https://curriculum.gov.bc.ca/>

British Columbia Ministry of Education. (2016c). Aboriginal Report 2012/2013–2016–17. How Are We Doing? Retrieved from <http://www.bced.gov.bc.ca/reporting/systemperformance/16>. Archived at https://web.archive.org/web/20171007133336/http://www.bced.gov.bc.ca/reports/pdfs/ab_hawd/Public.pdf

Caduto, M. J., & Bruchac, J. (1988). *Keepers of the earth: Native American stories and environmental activities for children*. Golden, CO: Fulcrum Publishing.

Caduto, M. J., & Bruchac, J. (1991). *Keepers of the animals: Native American stories and wildlife activities for children and teacher's guide*. Golden, CO: Fulcrum Publishing.

Cavalier-Smith, T. (1998). A revised six-kingdom system of life. *Biological Reviews*, 73, 203–266. <https://doi.org/10.1111/j.1469-185X.1998.tb00030.x>

Coburn, W.W. & Aikenhead, G. (1997). Cultural aspects of learning science. In K. Tobin & B. Fraser (Eds.), *International handbook of science education*. Dordrecht, NLD: Kluwer Academic Publishers.

Corsiglia, J., & Snively, G. (1997). Knowing home: Nisga'a traditional knowledge and wisdom improve environmental decision-making. *Alternatives Journal*. 32(3), 22–27.

Cummins, S.A. (1997). *The effects of experiential learning on grade four children's knowledge of marine ecology, their attitudes towards the ocean, and their stances towards marine resource issues* (M.A. thesis). University of Victoria, Victoria, BC.

Cummins, S.A., & Snively, G. (2000). The effect of instruction on children's knowledge of marine ecology, attitudes toward the ocean, and stances toward marine resource issues. *Canadian Journal of Environmental Education*. 5(Spring), 305–324. Retrieved from <https://cjee.lakeheadu.ca/article/view/315>

Eckert, L. (2017). *Towards indigenous marine management: A case study of yelloweye rockfish on the central coast of British Columbia* (M.Sc. thesis), University of Victoria, Victoria, BC. Retrieved from <http://hdl.handle.net/1828/8060>

Elkana, Y. (1981). A pragmatic attempt at an anthropology of knowledge. In E. Mendelsohn & Y. Elkana (Eds.), *Science and cultures. Sociology of the sciences*, Volume 5 (pp. 1–76). Dordrecht, NLD: Reidel.

Government of Canada, Fisheries and Oceans Canada, Communications Branch (2017). Integrated Fisheries Management Plans. Retrieved from <http://www.pac.dfo-mpo.gc.ca/fm-gp/ifmp-eng.html>

Halls, S.R. (2002). *The Courtenay River estuary: Marine science curriculum development from a constructivist perspective* (M.Ed. thesis). University of Victoria, Victoria, BC.

Hatcher, A., Bartlett, C., Marshall, A., & Marshall, M. (2009). Two-eyed seeing in the classroom environment: Concepts, approaches, and challenges. *Canadian Journal of Science, Mathematics and Technology Education*, 9(3), 141–153. <https://doi.org/10.1080/14926150903118342>

Johnson, M. (Ed.). (1992). *Lore: Capturing traditional environmental knowledge*. Hay River, NWT: International Development Research Centre.

Kawagley, A. O., & Barnhardt, R. (1999). Education Indigenous to place: Western science meets Native reality. In G. A. Smith & D. R. Williams (Eds.), *Ecological education in action: On weaving education, culture, and the environment* (pp. 117–140). New York, NY: SUNY Press.

- Kesler, B. (2015). Learning naturally: An inquiry study of streams in Hawaii. *Bank Street Occasional Paper Series*, 2015 (33), 76-94. Retrieved from <http://educate.bankstreet.edu/occasional-paper-series/vol2015/iss33/8>
- Louv, R. (2006). *Last child in the woods: Saving our children from nature-deficit disorder*. Chapel Hill, NC: Algonquin Books.
- McWilliams, B. (1996). *Raven and the tides*. Retrieved from http://www.eldrbarry.net/rabb/rvn/r_tide.htm
- Martin, J., Roy, E., Diemont, S., & Ferguson, B. (2010). Traditional Ecological Knowledge (TEK): Ideas, inspiration, and designs for ecological engineering. *Ecological Engineering*, 36(2010), 839-849. <https://doi.org/10.1016/j.ecoleng.2010.04.001>
- McKeon, M. (2012). Two-eyed seeing into environmental education: Revealing its “natural” readiness to indigenize. *Canadian Journal of Environmental Education (CJEE)*, 17, 131-147. Retrieved from <https://cjee.lakeheadu.ca/article/view/1071>
- Moss, M. L. (2016). The nutritional value of Pacific herring: An ancient cultural keystone species on the Northwest Coast of North America. *Journal of Archaeological Science: Reports*, 5, 649-655. <https://doi.org/10.1016/j.jasrep.2015.08.041>
- Ogawa, M. (1995). Science education in a multiscience perspective. *Science Education*, 79(5), 583-593. <https://doi.org/10.1002/sce.3730790507>
- Pearce, T., Ford, J., Willox, A. C., & Smit, B. (2015). Inuit Traditional Ecological Knowledge (TEK), subsistence hunting and adaptation to climate change in the Canadian Arctic. *Arctic*, 68(2), 233-245. <https://doi.org/10.14430/arctic4475>
- Pojar, J., & MacKinnon A. (1994). *Plants of coastal British Columbia*. Vancouver, BC: Lone Pine Publishing.
- Reid, M. G., Hamilton, C., Reid, S. K., Trousdale, W., Hill, C., Turner, N.,...Matthews, H. D. (2014). Indigenous climate change adaptation planning using a values-focused approach: A case study with the Gitga'at Nation. *Journal of Ethnobiology*, 34(3), 401-424. <https://doi.org/10.2993/0278-0771-34.3.401>
- Roczen, N., Kaiser, F.G., Bogner, F.X., & Wilson, M. (2014). A competence model for environmental education. *Environment and Behavior*, 46(8), 972-992. <https://doi.org/10.1177/0013916513492416>
- Ruggiero, M. A., Gordon, D. P., Orrell, T. M., Bailly, N., Bourgoin, T., Brusca, R. C., . . . Kirk, P. M. (2015). A higher level classification of all living organisms. *PLoS One*, 10(4), e0119248. <https://doi.org/10.1371/journal.pone.0119248>
- Sanderson, D., Picketts, I. M., Déry, S. J., Fell, B., Baker, S., Lee-Johnson, E., & Auger, M. (2015). Climate change and water at Stelat'en First Nation, British Columbia, Canada: Insights from western science and traditional knowledge. *The Canadian Geographer/Le Géographe Canadien*, 59(2), 136-150. <https://doi.org/10.1111/cag.12142>
- Sanger, M. (1997). Sense of place and education. *Journal of Environmental Education*, 29(1), 4-7.
- Savo, V., Lepofsky, D., Benner, J. P., Kohfeld, K. E., Bailey, J., & Lertzman, K. (2016). Observations of climate change among subsistence-oriented communities around the world. *Nature Climate Change*, 6(5), 462-473. <https://doi.org/10.1038/nclimate2958>
- Smith, G. A., & Williams, D. R. (1999). Introduction: Re-engaging culture and ecology. In G. A. Smith, & D. R. Williams (Eds.), *Ecological education in action*, (pp. 1-18). Albany, NY: State University of New York Press.

Smith-Sebasto, N. (1995). The effects of an environmental studies course on selected variables related to environmentally responsible behavior. *Journal of Environmental Education*, 26(4), 31-36. <https://doi.org/10.1080/00958964.1995.9941449>

Snively, G. (1983). *Exploring the Seashore in British Columbia, Washington and Oregon*. Vancouver, BC: Gordon Soules Book Publishers.

Snively, G. (1995). Bridging traditional science and western science in the multicultural classroom. In G. Snively, & A. MacKinnon (Eds.), *Thinking globally about mathematics and science education*, (pp. 53-75). Vancouver, BC: UBC Research and Development Group.

Snively, G. (2016). When uncles become killer whales: Bridging Indigenous science with Westerns science and worldviews. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1 (pp. 129-146). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Snively, G., & Corsiglia, J. (2001). Discovering Indigenous science: Implications for science education. *Science Education*, 85(1), 6-34. [https://doi.org/10.1002/1098-237X\(200101\)85:1<6::AID-SCE3>3.0.CO;2-R](https://doi.org/10.1002/1098-237X(200101)85:1<6::AID-SCE3>3.0.CO;2-R)

Snively, G. & Corsiglia, J. (2016). Indigenous science: Proven, practical and timeless. In G. Snively & Williams, L. (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1 (pp. 86-104). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Snively, G., & Sheppy, J. (1991). The kids are saying "Save our endangered oceans." *Current: The Journal of Marine Education*, 10(2), 14-20.

Snively, G., & Williams, L. (2006). The Aboriginal knowledge and science education research project. *Canadian Journal of Native Education*, 29(2), 229-244.

Snively, G.J., & Williams, L.B. (2008). Coming to know: Weaving Aboriginal and Western science knowledge, language, and literacy into the science classroom. *Educational Studies in Language and Literature*, 8(1), 109-133.

Snively, G., & Williams, L. (Eds.). (2016). *Knowing home: Braiding Indigenous science with Western science*, Book 1. Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Snively, G., & Williams, L. (2016). Why transforming the science curriculum is necessary for Aboriginal students. In G. Snively & L. Williams (Eds.), *Knowing home: Braiding Indigenous science with Western science*, Book 1 (pp.13-34) Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Sobel, D. (1995). Beyond ecophobia: Reclaiming the heart in nature education. *Orion*, 38(4), 18-22.

Twenge, J. M., Zhang, L., & Im, C. (2004). It's beyond my control: A cross-temporal meta-analysis of increasing externality in locus of control, 1960-2002. *Personality & Social Psychology Review*, 8(3), 308-319.

Williams, L. & G. Snively. (2016). "Coming to know": A framework for Indigenous science education. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1 (pp. 129-146). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Wilson, R. (1997). *Special places for young children*. Retrieved from <http://www.bgci.org/education/article/280/>

Woodhouse, J. L., & Knapp, C. E. (2000). *Place-based curriculum and instruction: Outdoor and environmental education approaches*: ERIC Digest. ERIC Clearinghouse on Rural Education and Small Schools, 1-8. Retrieved from ERIC database. (ED448012).

Chapter 8 - Secondary School Student Researchers Use Digital Video as a Learning Tool for Retaining and Transferring Indigenous Knowledge

MUPENKIN JOHN LYALL AND TED RIECKEN

Indigenous students' use of digital video is a form of modern storytelling. It represents a conduit for traditional and cultural wisdom to traverse into the modern world. The advent of handheld film/video cameras and movie-making software allows Indigenous students the opportunity to preserve the stories and knowledge of their Elders.

Jason Ohler in his book, *Digital Storytelling in the Classroom* (2008) provides revelations about digital storytelling in education, many directly relevant to this research project. "It is the special responsibility of teachers to ensure that students use technology to serve the story and not the other way around" (Ohler, 2008, p. 6). Essentially, Ohler is saying that if you don't have a good story to tell, the technology will not make the story any better. Ohler concludes that the digital revolution enables all of us to tell our own story in our own way.

Storytelling is a traditional and effective method of learning in Indigenous communities (Cajete, 1999; Campbell, Menzies, & Peacock, 2003; Iseke & Moore, 2011; MacIvor, 1995). Manuel and Posluns (1974) believe that the production of digital videos allows the student to be the storyteller, the messenger:

Story-telling was often used among [N]ative peoples, not only for moral teaching, but for practical instruction.... One advantage of telling a story to a person rather than preaching at him directly is that the listener is free to make his own interpretation. (p. 27)

Cajete (1999) asserts that by "combining story with experience, Native Americans are able to achieve a highly effective approach to basic education" (p. 128).

There is a direct relation between the use of digital video and traditional methods and philosophies of Indigenous learning and knowledge: experiential learning, storytelling, and creativity. Cajete believes that "[e]xperiential learning is the most basic and holistic type of human learning" (p. 55). He furthers this discussion by stating, "experiencing through watching, listening, feeling and doing gives reality and meaning. Through students producing their own videos on topics of their own choice, they engage in experiential learning; they are learning by doing" (Cajete, 1999, p. 55).

The production of digital videos allows our students an avenue to communicate their personal stories. It is these stories and experiences from themselves, their Elders, and their communities, which may allow a better understanding of the world around them, one that may help bridge Indigenous and Western worldviews.

Purpose

This research project was developed as part of the Science Education Research Project (Snively, G. & Williams, L., 2016), and was an extension of a five-year participatory research project on Indigenous students' understandings of health and wellness (Riecken, T., Tanaka, M., & Scott, T., 2006). Students using digital video making as a learning tool in the documentation and reflection of Indigenous Knowledge (IK) with regard to science was the focus of the project. By working within the nexus of Indigenous cultures and the public-school system the project examined ways that digital

technologies, specifically digital video, can be used to include IK as well as Indigenous Science (IS) within the British Columbia (BC) secondary science curriculum.

Using video as a tool for students to explore ideas and concepts from their culture is a well-established practice in education (Aronowitz & Giroux, 1991; Goldfarb, 2002; Iseke & Moore, 2011; Riecken, Strong-Wilson, Conibear, Michel, & Riecken, 2005). Rather than drawing on youth cultures as distinct from the adult world, this research represents a focused application of video technology to elicit and represent Indigenous scientific knowledge.

Background to the Study

Three distinct sources were used to gather data: weekly student journals; student, staff, and community participant interviews; and the films the students produced. The project used Participatory Action Research (PAR) methodologies to draw upon the interests of the participants themselves to focus the research. Thus, students used digital video as a tool for facilitating learning, and the students selected the topics of their inquiry within the broadly defined topic of “science.” As a tool for research, PAR focuses on engaging participants in identifying research topics and finding answers to questions that are of concern to them as community members. In this project, IK and IS provided the material from which students looked for answers to questions that they identified as being of concern to them or their community. Student researchers worked with their families, community resource people, and community Elders to gain understanding of IK and IS (Lyll, 2009).

Fals-Borda (1991, pp. 8-9) identifies four techniques from PAR that can be used to establish a countervailing sense of power among groups that have been disadvantaged by their interactions with the larger dominant society: (1) collective research, (2) critical recovery of history, (3) valuing and applying folk culture, and (4) production and diffusion of new knowledge. Elements of these four techniques were woven throughout the project as it progressed.

From a learning perspective, the intention and purpose of this research investigated how the use of digital video contributed to:

- Developing a positive learning environment in the science classroom.
- Reflecting and documenting IK and IS.
- Developing students’ understanding of IK and IS.
- The development of students’ research, leadership, and technological capacities.
- A developed sense of pride and self-efficacy in the accomplishment of a completed video.
- Building language capacity and language transfer systems.
- The development of a bridge of understanding between Indigenous Science and Western Science worldviews.

Location and Participants

Participants were enrolled in the First Nations Graduation Program (FNGP), a small alternative program with approximately twenty-five students, at the Westshore Centre for Learning and Training (WCLT). The WCLT is located in Colwood (a municipality in Greater Victoria) within Sooke School District (SD 62). It is a suburban school with students coming from on or off reserve communities. The program is a cohort style, with myself and John Lyll (of the Kwakwaka'wakw First Nation) teaching, and offered to students who have usually not achieved well in a public school. The FNGP is focused on Indigenous students, although not exclusively. Lying in traditional Coast Salish territory, SD 62

is home to three First Nations: Scia'new, Pacheedaht and T'sou-ke. The Sooke School District enrolls approximately 800 Indigenous students, of which approximately 150 are from the three local nations (Sooke School District, 2008).

Created in September of 2002, the FNGP is an alternative option for school aged and adult Indigenous students continuing or returning to their schooling. Its goals are to:

- Provide a safe, caring, open and exciting community for learning,
- Integrate First Nations culture and language,
- Involve the local community through the involvement of Indigenous artists, cultural instructors, and Elders, and
- Interact and meet with the community. (FNGP, 2002)

The FNGP students were the primary participatory research group and completed a video project on the subject matter of IK and IS, submitted their journals, and completed a post-project interview. Another group of students, aged sixteen and over, registered in the Fast Forward to Graduation (FF) program, and reflected on the use of digital video as a learning tool.

Several staff participated in the research project by assisting students, facilitating the project, or were interviewed for the students' videos. In order to protect the privacy of the young participants, codes and a number were assigned to describe students. This ensured that the students who took part in the study were not identified by their real names. Students in the First Nations Graduation Program (FNGP) were assigned the code FN1 and the Fast Forward (FF) programs the code FF6. Westshore staff, including FNGP and FF staff were designated as donated staff.

Data Sources and Research Methods

Data used to answer the questions guiding this study came from a variety of sources associated with FNGP courses offered between the years 2004-2007. These included weekly student journals, interviews with students, community participants and staff, and a content analysis of the ten digital videos created by the FNCP students. Sample post interview questions included:

- What does IK mean to you?
- What does science mean to you?
- What is the topic of your class project? Why did you make a film on this topic?
- The subject of this research project is IK with regard to science, how does your topic relate to this subject?
- What does knowledge transfer mean to you?
- A sense of place to me is ...

Descriptions of the Videos

The core components of the data and the underlying principle behind this research project were the production of student videos based on IK and IS. Using a class definition of science as “a way to understand the world around us,” the videos reflected students' diverse understandings of their world through the dual lenses of science and culture. The medium of filmmaking within the parameters of PAR, where students chose the specific subject matter of their choice, produced a diverse collection of films. At times, the actual request for science knowledge to be included in the films was not followed, but the videos produced were still a good learning tool for documenting a range of IK and IS examples and cases. The ten videos submitted for the data pool are listed below in date order.

Students who had previously attended the FNPG and wanted to participate in this project produced the first two videos from 2004:

Evolution of a People, 2004

A twenty-five minute video that is a powerful look at Indigenous culture, history, and the will to survive. It examines the views of contemporary Indigenous peoples queried on their perspectives on the significance of language and culture in their histories and in modern life today. The video examines the challenges facing Indigenous cultures and the significance of language and culture for the participants' children and children yet unborn. This video broadly examines IK, its worldview, and its knowledge transfer systems.

Seafood for Life, 2004

A six-minute video on the importance of seafood for a west coast Indigenous community and its culture. The video presented many varieties of seafood as the Pacheedaht people harvested them from the tide-pools of Botanical Beach. This video primarily examined the significance of place to Indigenous Knowledge and the environment. In the opening narration, the student video-maker introduces herself and the video, as follows:

I am from Pacheedaht; we are People of the Seafoam, in Port Renfrew, BC, which is along the west coast of Vancouver Island. This video shows some of the traditional foods we have gathered from Botanical Beach, which includes mussels, slippers [chitons], rock stickers [limpets] and sea urchins. (Seafood for Life, FN 15, 2004)

The next two videos were selected for inclusion in the data gathering phase because the students in the FAST Forward and First Nations Graduation Program wanted to participate and their subject material was relevant:

Youth and the Environment, 2006

This eight-minute video presents students and staff members' personal reflections about why it is important to take care of the environment. It explores a Western Science perspective on the many challenges and perils facing the Earth and the environment today, and student and community perspectives on the need to protect the environment. Youth explored ideas and beliefs related to ecosystems, pollution, environmental issues, sustainability, the importance of place, and how all of creation is inter-connected.

Irwin Park Community Project, 2006

A twenty-five minute class documentary on a local park restoration project. This video examined the significance of place to IK and the environment, and the benefits of project based learning. The project was “designed to provide students with an alternative form of learning” (Irwin Park Community Project, 2006). The video presents numerous interviews, nature shots and documentation of the naturalization and restoration of the park, which took the form of removing invasive species such as scotch broom, and planting Indigenous trees and plants in the park. Students and community members learned from Elders, park naturalists, Langford community members and city workers through “hands on,” place-based activities about the natural environment at Irwin Park, including tree and plant classifications, and Irwin Park habitat investigations.

The significance of language to Indigenous Knowledge was examined in the next two videos:

Language, 2007

An eleven-minute video on the local Coast Salish language and its significance to Scia'new First Nations people in understanding the world around them. Indigenous Knowledge transfer through understanding the natural world is presented in the video through community participant 4:

When I was a young baby, my grandmother used to take me and speak Ditidaht to me, and she would make me understand many things ... she would take me 100 yards from our house, and she would say “Klubasha klee asi (phonetic), I want you to tell me what that tree does, and when you find out, come and tell me.” So, I learned about nature first and I got to understand the world around me.

Nuu-chah-nulth Language, 2007

A seven-minute video on the Nuu-chah-nulth language, its historical and present state, and its cultural significance to the student video-makers. The focus of the film was an interview with a fluent Nuu-chah-nulth Elder.

The following two videos focused on IK and IS and include cultural elements that are an important aspect of Traditional Ecological Knowledge (TEK):

The Moon, 2007

A five-minute video on the moon, paralleling WS and IS perspectives, with a Nuu-chah-nulth oral history of the thirteen phases (or faces) of the lunar cycle. Pairing the astronomical perspective of the lunar cycle with an Indigenous perspective adds a more holistic understanding of the moon. A FNGP student narrated Nuu-chah-nulth artist Tim Paul's analysis of the moon:

The film told of the arrival of food sources such as salmon and the size of crops, as well as weather conditions and other environmental information. Cultural knowledge was linked to the respectful interaction between humans and the environment. (Paul, 1999, p. 31)

Scia'new Cultural Event, 2007

A five-minute media arts class documentary of a cultural day hosted by the local Scia'new First Nation. This video primarily examined the significance of place to Indigenous Knowledge and the local environment. The "place" of significance in this video is Beecher Bay, a region rich in marine life and significance to the Scia'new First Nation.

Two videos on drugs and alcohol included extensive research on the effects and impact they have on the human body. The videos are a combination of "facts" presented through a WS lens and personal narratives from Indigenous youth and community members:

Drugs and Alcohol, 2007

An eight-minute video interviewing Indigenous youth on their perspectives on drugs and alcohol and its social, family, and personal impact. Interviewees tell compelling stories of hardship and courage as they attempted to overcome their personal challenges.

Pros and Cons of Marijuana Use, 2007

A six-minute video investigating the pros and cons of marijuana use for medicinal purposes and guidelines for the safe use of the drug. The video includes an interview with a medicinal marijuana user.

All films were presented publicly at the WCLT following their production. Family and friends were invited to celebrate the completion of the films and they asked questions of the student filmmakers. It was a great way to bring the community together and to witness what the filmmakers were learning from their cultural knowledge. It was evident that the students were proud of their work.

Research Findings

The purpose of this research was to investigate whether using digital video in the documentation and reflection of IK and IS was a positive learning tool. Four interwoven themes emerged through the research project: Indigenous Knowledge, learning & knowledge transfer, capacity, and sense of place and identity—providing unequivocal evidence for the utility of digital video as a positive learning tool that can be used to link IS and IS with WS in the science classroom.

Through the production of their videos, students clearly indicated how the process of choosing a topic and creating digital videos on WS and IK aided in developing a positive learning environment in the science classroom. One student commented that “It [producing videos] makes school a lot of fun, it also brings a lot of respect” (FN 12, 2007). Video making also proved a valuable tool in the archiving and reflection of IK. Students began by trying to understand, investigate, and document the world around them, and created videos to document their world. One of the teaching staff noted in an interview that, “Students can look back on, reflect on, and share with students for years to come. It is helpful to have them recorded for their future generations” (Staff 3, 2007).

The development of students’ research, leadership, and technological capacities were enhanced as they were introduced to the exciting world of research and the medium of digital video to express their findings. As one student reflects:

Research to me is a big word, but a fun word. To be able to go to different places, and meet new people, listen to their experiences, share their knowledge, collaborating with team members, and then coming out with the finished project months later, it is really amazing. My experiences at Westshore have been very meaningful to me, and I have always enjoyed doing the research for a video project. (FN 11, 2007)

Students and video participants developed a sense of pride and self-efficacy in the accomplishment of completing a digital video:

It is my work, and I am proud of it, and more than anything, I will promote it as much as I can, and if I have the opportunity to go somewhere to show it, to give them that understanding, I will. (FN 15, 2007)

Students’ videos, not only presented their understanding of Indigenous Knowledge, but presented a bridge of understanding between Indigenous and Western Science worldviews.

Throughout several students’ videos, the knowledge contained within Indigenous language was seen as a vital aspect of IK and IS. “As we separate from our language, we separate from nature” (John Powell, Kwakwa?ka??wakw artist, 2004). This statement connects Indigenous languages, a vital strand of Indigenous Knowledge, to nature. If the objective of WS is to understand systematically the world around us; then the connection of Indigenous languages to nature allows educators a pathway to appreciate the natural environment through Indigenous eyes.

The will to survive in the face of adversity forms an integral component of an Indigenous Knowledge system. This resilience and resistance comes with a price, the charge of responsibility. “It is important to do things the way they are supposed to be done, to honour those people who suffered back in those days” (Evolution of a People, community participant 17, 2004). This resilience and resistance also generated optimism amongst Indigenous peoples that ancient IK systems will continue to survive and thrive again.

It is my hope, with everybody’s interest coming back to our culture and our roots, and realizing the importance of it, we grow strong again. It might not be what it was before, but it will definitely come to a point where the government is never, ever going to get rid of us, the way we are. (Evolution of a People, community participant 15, 2004)

For the community participants, who expressed their ideas within the students' videos, the importance of children in the knowledge transfer systems of Indigenous peoples is paramount. Whereas knowledge transfer to children seems obvious in any knowledge system, the importance of children is foremost in Indigenous Knowledge. One participant expressed it this way "If we didn't honour our children, our culture would die, who we are, our very existence would cease, that's why children are the most important thing in our culture" (Evolution of a People, community participant 15, 2004).

The importance of Elders as facilitators in the knowledge transfer systems of Indigenous peoples is vital. Elders teach responsibilities and relationships among family, community, and all of creation, reinforcing intergenerational connections and identities. They are the keepers of wisdom and knowledge through continuous experiences and apprenticing with their forbearers (Little Bear, 2009; Williams & Snively, 2016) – thereby serving as an invaluable archive of knowledge. The simple notion of students asking their Elders or their grandparents questions about IK is an overwhelmingly positive outcome of this research project. Too often today, Indigenous youth seek their knowledge in mediums not congruent with Indigenous ways of knowing. Sitting with Elders is often reduced to coffee table chat, the knowledge that they possess seemingly not important in today's world. However, having students ask their Elders questions with respect to IK may assist in re-igniting that knowledge transfer system. Engaging Elders validates the knowledge that they possess.

Video is a great tool for learning. An Elder who never thought that the knowledge that they held was sacred, put it this way: "Sharing what you know is important. It lights a fire, bringing alive that Indigenous Knowledge and applying it to one's life" (FN 11, 2007).

This project employed "a learning by doing" methodology, a vital strand of an Indigenous Knowledge transfer system. Cajete asserted that "experiential learning is the most basic and holistic type of human learning" (1999, p. 55). The students were learning by doing, and they took note of that fact: "I am producing it (the video) the way I want to" (FN 10, 2007). There is a strong reciprocal relationship between sense of place, sense of identity, and Indigenous Knowledge. One participant said it very simply: "Indigenous Knowledge to me is respect of who you are, and where you come from" (FN 16, 2007).

Indigenous Knowledge includes a knowledge base and a knowledge system that forms relationships with the world around us. It is a knowledge system that demonstrates these relationships in a respectful and reciprocal manner, and one that requires us to take the responsibility to pass this knowledge on to coming generations. The lens of IK, and by extension IS, can assist all learners to understand the natural world and to form respectful, reciprocal relationships with the environment. As such, it should be explored as a complementary worldview to WS.

The use of digital video as documented in this research project produced several key outcomes. Personal capacity development occurred among students in the form of advanced computer and camera technological skills and research skills:

When we first started playing around with the computers, I didn't really know a heck of a lot about computers. And now, you can pretty much throw any program out in front of me, and I can figure it out if I need to. (FF 1, 2007)

For some students, personal capacity development occurred in the form of ownership of their learning, and this new knowledge and expertise encouraged them to want to share their videos with a bigger audience. In his video, student FF 2 expressed a lighter sentiment, although it clearly demonstrates ownership of his video:

I just hoped that everyone would enjoy it. At the presentation, everyone did enjoy it; a lot of people actually asked me for a copy of the video, everyone had a good laugh (FF 2, 2007).

Personal capacity development also came in the form of an increased sense of self-efficacy and accomplishment. In response to the interview question, “What have you learned in this project?” one student noted that “it created a sense of self-esteem and self-accomplishment, and makes you motivated to move on and do more” (FN 11, 2007). These are powerful and important outcomes for students enrolled in alternative education programs, many of whom had rarely experienced a sense of accomplishment in their previous school settings.

Indigenous community capacity development comes with the recognition that the student videos represent a kind of cultural archive. “How does video work as a tool for learning about IK?” Teacher and researcher John Lyall stated:

For one, it archives [knowledge]; that is of critical importance. I have spoken of how the Kwakwaka'wakw recorded our songs in the 1930's. Now 60-70 years later, we are still learning and using those songs in our cultural practices today. So, our ancestors had the foresight to archive it. It seems like a simple thing, but simple things are not always done.

In an era when all children are “born digital,” digital video making presents a new avenue for our youth to tell their traditional knowledge in a modern way. One staff member noted that digital video making is “Another way of expressing what they are learning” (Staff 1, 2007). One of the students said that it has “introduced a new medium, other than pen and paper. When I get to use a camera and video, it made it so much better” (FN 10, 2007).

Students are well versed in the multitude of technological devices available today, from the digital recording device used to capture the footage to the computer software used to create the videos. For many of these students, the process of creating videos mirrors the process of learning—the processes by which they acquire knowledge. In the process of expressing what they are learning, the students were offered many opportunities to examine and re-examine their footage and to ask themselves “does this sound reasonable?” (FN 11, 2007). The media arts instructor discusses the learning opportunities provided in using digital video:

You really have to stand in a neutral ground, to weigh the pros and cons about what your message is going to say. There is a continual consideration of your ideas... the students will be able to go into so many rounds living with the idea and finding ways to express these ideas to each other. It is a phenomenal way because it is very neutral. (Staff 1, 2007)

Conclusion

This research project developed a greater understanding of the significance of IK and IS for learners in a science classroom in an alternative learning program. The use of digital video was seen as a highly positive tool for students to learn and reflect about their culture and language, and how that relates to science as a way to understand the world.

From an educator’s perspective, building community capacity revolves around communities recognizing that their people may use this research project as a model for their own learning. Any videos made on Indigenous Knowledge will only add to our learning about the very cultures that Davis (2009) warns us are on the verge of extinction. The use of mobile phones and other video recording devices, with the ability to upload material to YouTube and other social media networks, broadens the availability of the material to other cultures.

By using digital video as a form of storytelling, IK was presented as a complementary worldview to WS. IK, at its root, is based in place. Through a beneficial interaction and mutual acknowledgement of the value of both knowledge systems, we can better understand the world in order to form respectful, reciprocal relationships with the environment around us.

REFERENCES

- Aronowitz, S. & Giroux, H (1991). *Postmodern education: Politics, culture and social criticism*. Minneapolis, MN: University of Minnesota Press.
- Bracsoupe, S. & Mann, H. (1999). *A Community guide to protecting Indigenous knowledge*. Retrieved from <http://publications.gc.ca/collections/Collection/R2-160-2001E.pdf>
- Cajete, G. A. (1999). *Igniting the sparkle, an Indigenous science education model*. Skyand, NC: Kivaki Press.
- Campbell, K., Menzies, C., & Peacock, B. (Eds.). (2003). *B.C. First Nation studies*. Victoria, BC: British Columbia Ministry of Education.
- Capra, F. (2008). *The science of Leonardo*. Toronto, ON: Anchor Books.
- Davis, W. (2009). *The Wayfinders: Why ancient wisdom matters in the modern world*. Toronto, ON: Anansi Press.
- Fals-Borda, O. (1991). Some basic ingredients. In O. Fals-Borda, & M.A. Rahman, (Eds.); *Action and knowledge: Breaking the monopoly with participatory action research*. New York, NY: Apex Press.
- Goldfarb, B. (2002). *Visual pedagogy: Media cultures in and beyond the classroom*. Durham, NC: Duke University Press.
- Iseke, J., & Moore, S. (2011). Community based Indigenous digital storytelling with Elders and youth. *American Indian Culture and Research Journal*, 35(4), 19-23.
- Lederman, N.G. (2001). *Understanding nature of science: the potential contributions to censorship by differing views of science*. Paper presented at ASTE International Meeting, Costa Mesa, CA: Association for Science Teacher Education.
- Little Bear, L. (2009). *Naturalizing Indigenous Knowledge: Synthesis Paper*. Saskatoon, SK: University of Saskatchewan Aboriginal Education Research Centre and First Nations and Adult Higher Education Consortium. Retrieved from http://www.afn.ca/uploads/files/education/21_2009_july_ccl-alk_leroy_littlebear_naturalizing_indigenous_knowledge-report.pdf
- Lyll, John. (2009). *The use of digital video as a learning tool for documenting and reflecting aboriginal knowledge with respect to science* (Master's thesis). University of Victoria, Victoria, BC. Retrieved from <http://hdl.handle.net/1828/1752>
- Manuel, G. & Posluns, M. (1974). *The fourth world: An Indian reality*. Don Mills, ON: Collier MacMillan Canada.
- 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, BC: UBC Press.
- Ohler, J. (2008). *Digital storytelling in the classroom, new media pathways to literacy, learning and creativity*. Thousand Oaks, CA: Corwin Press.
- Riecken, T., Strong-Wilson, T., Conibear, F., Michele, C., & Riecken, J. (2005). Connecting, speaking, listening: Toward an ethics of voice with/in participatory action research [57 paragraphs] *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 6(1). <https://doi.org/10.17169/fqs-6.1.533>
- Riecken, T., Tanaka, M., & Scott, T. (2006). First Nations youth reframing the focus: Cultural knowledge as a site for health education. *Canadian Journal of Native Education*, 29(1), 29-42.

Riecken, T., Scott, T., & Tanaka, M. (2006). Community and culture as foundations for resilience: Participatory health research with First Nations student filmmakers. *Journal of Aboriginal Health*, 3(1), 7-14. Retrieved from <https://jps.library.utoronto.ca/index.php/ijih/issue/view/1924>

Riecken, T., Conibear, F., Michel, C., Lyall, J., Scott, T., Tanaka, M.,...Strong-Wilson, T. (2006). Resistance through re-presenting culture: Aboriginal student filmmakers and a participatory action research project on health and wellness. *Canadian Journal of Education*, 29(1), 265-284. Retrieved from <http://journals.sfu.ca/cje/index.php/cje-rce/article/view/2898/0>

Snively, G., & Williams, Wanosts⁷ L. (Eds.). (2016). *Knowing home: Braiding Indigenous science with western science*, Book 1. Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Williams, L. & G. Snively. (2016). "Coming to know": A framework for Indigenous science education. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1 (pp. 129-146). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Chapter 9 - Learning from the Homeland: An Emerging Process for Indigenizing Education

W?SÁNEĆ SCHOOL BOARD AND TYE SWALLOW

SWETÁLIYE Marie Cooper was an Elder from W?SÁNEĆ, a First Nations community near Victoria, BC whose territory extends through the Saanich Peninsula and nearby Southern Gulf Islands. She was, and always will be, cherished within her W?SÁNEĆ community and throughout the greater education community because of her experience and her powerful, yet gentle welcoming way of expressing how important education is to her people. She is deeply missed and the impact she has had will continue to ripple well into the future. One of the first times I sat down with her over tea at her house, she said emphatically to me:

If you don't even know where you come from, how can you even begin to know who you are! (personal communication, February 9, 2005).

For SWETÁLIYE, it was more a statement reflecting on what her Elders had told her. My understanding is that it is a relatively new phrase, brought on and punctuated by the realities of colonialism. For me, it continues to resonate as a powerful question because it provides curriculum and program developers a lens through which to view an Indigenous perspective.

This chapter, written over the past 15 years, is a collection of W?SÁNEĆ voices spoken to me over that time. It is about a language revitalization movement in our school, and an opportunity taken to escape confining educational systems. In 2012 the W?SÁNEĆ School Board (W?SB) established a SENĆOŦEN immersion program from pre-school through to grade four. This significant work, represented by this story is, in part, about the journey of SENĆOŦENizing our school. It is hoped that by telling this story, other communities might be able to implement aspects of what we've learned into their own schools.

Assumptions, Confessions, and other Background

I am a British Columbia (BC) Ministry of Education certified, non-Indigenous male teacher and descendant of immigrants from the UK. I have also been teaching, facilitating, and working with adult learners at the Saanich Adult Education Centre (SAEC), part of the W?SÁNEĆ School Board (W?SB) for most of my educational career. The W?SB provides educational services for the four W?SÁNEĆ villages: W?JO?E?P Tsartlip, S?ÁUTW? Tsawout, BO?OĆEN Pauquachin, and W?SIKEM Tseycum. We are a band operated, nominal role funded school that provides educational services at the preschool, K-10 and adult upgrading levels for First Nations students and uses a range of BC Ministry of Education prescribed curricula. The W?SB has a long and storied history with many educational and language warriors—you'll hear from many of them later in this chapter—and it is because of people like SWETÁLIYE that our school continues to innovate meaningful and relevant educational programming for W?SÁNEĆ peoples.

From my earliest memories, I have lived within W?SÁNEĆ territory. It is my home and I care for it deeply. I am humbled, honoured and thankful to know my homeland much deeper because of all the knowledge, wisdom, and teachings I have learned from W?SÁNEĆ peoples in W?SÁNEĆ places. It has been through a method of learning from the land and working with the community that has provided me with the opportunity to approach curriculum and program development, and its implementation, from a W?SÁNEĆ perspective.

As an early career teacher, I was acutely aware that there seemed little need or reason, especially within public educational practices, for students to learn or know about their lands in ways their ancestors would have. The landscape of W̱SÁNEĆ has changed significantly since colonists arrived in the early 1800's, and this has had obvious repercussions on how people continue to relate to their homeland. From a W̱SÁNEĆ-centric educational perspective, this lack of meaningful cultural, linguistic, and ecological education has a huge effect on practice, understanding and sustainability.

The Canadian federal government's recent commitment through the Truth and Reconciliation Commission poignantly reminds us of the reasons behind the erosion of Indigenous knowledge systems. The residential school education system is perhaps the most significant example of the harm that our colonial legacy has brought onto First Nations peoples and their knowledge systems. Although much has changed, this erosion of Indigenous knowledge continues in more subtle but equally detrimental ways. For example, funding for First Nations schools is determined through the use of mandated ministry prescribed curriculum; that is the law. Education, as it is predominantly practiced in our schools, is driven from a Western or Euro-centric perspective and includes a set of inter-related assumptions. These include the assumption that an efficient way to educate all people is to use pre-existing subject areas to meet pre-set objectives in a classroom, and to assess students on meeting those objectives, all within very structured and rigid timetables and yearly schedules. I have witnessed some positive changes, but this current system of education still exerts significant colonial influence and control.

Indigenizing Education

Indigenous scholars argue that the future of Indigenous education must shift emphasis toward *indigenizing* educational systems and structures (Battiste, 2000, 2013; Cajete, 1994, 2000; Castellano, 2014; Deloria Jr. & Wildcat, 2001; Kawagley & Barnhardt, 1998; Prakash & Esteva, 1998; Simpson, 2004). The "Indigenization of Education" necessitates taking the rights of Indigenous peoples as the highest priority, and to always work from a decolonizing theoretical framework. Kawagley and Barnhardt (1998) proposed that the culture of the education system, as reflected in First Nations schools needs radical change. This can be achieved, they say, by documenting, articulating, and validating local Indigenous Knowledge (IK) systems and using those to guide the development of curricula that reflect and reinforce those same knowledge systems. Simpson (2004) suggests we must protect, foster, and revitalize Indigenous processes for the transmission of IK to younger generations. This involves strengthening the oral tradition, teaching children how to learn from the land and how to understand the knowledge of the land in its cultural time and place. Educational programs and curricula, as such, must be land-based, use traditional language and "they must provide opportunities for youth to interact with Elders and traditional knowledge holders on Indigenous terms" (p. 380). Most importantly though, she emphasizes, "Indigenous Knowledge must be lived" (p. 381). How might *education* become lived?

A Sense of Place

Place is a persistent theme in Indigenous education; scholars (Barnhardt, 2008; Cajete, 1994, 1999a, 1999b, 2000; Deloria, 1997; Deloria & Wildcat, 2001; Corsiglia & Snively, 1997; Kawagley, 1995; Kawagley & Barnhardt, 1998, 1999; Simpson, 2004, 2011, 2013; Snively & Corsiglia, 2001; Turner et al., 2000; Williams & Snively, 2016) consistently connect place with identity and sense of belonging to homeland. Cajete (2000), a Tewa scholar, links an Indigenous notion of science with a deeply internalized sense of place. He calls this, "living in relationship...people understood that all entities of nature, plants, animals, stones, trees, mountains, rivers, lakes, and a host of other living entities, embodied relationships that must be honoured" (2000, p. 178).

An education of place provides a learning situation where both IK and Western Science have a meaningful and relevant context to draw from while at the same time providing all learners a sense of belonging to place. The notion of place is integral of any peoples' worldview. How a sense of place develops, is respectfully learned or not, depends on how it is informed. Basso, in his book *Wisdom Sits in Places* (1996), prefers to use the term "sensing of places" (p. 109) because our sense of place is accrued and never stops accruing from lives spent sensing places. "Sensing of places," as the term suggests, elicits using all your senses. David Abram (1996) puts it beautifully, "to enliven your senses" and making sense of your surroundings "is to make the senses wake up to where they are" (p. 265). Intrinsically, an education of place also allows for the inclusion of the more affective, intuitive, creative, and spiritual nature of the world, and our collective place in it (Peat, 1994; Cajete, 1994, 1999a, 1999b, 2000; Williams & Snively, 2016). Inclusion of the principles of ecology and eco-literacy, as articulated by alternative educators such as Capra (1998, 2002), Orr (1994, 2002) and Peat (1994) have contributed to this understanding of a more holistic and ecologically responsive education—one very much in-line with an education of place.

Most importantly though, as Michell et al. (2008), in reviewing a concept of Indigenous Science education reminds us, while Indigenous worldviews are similar in that they are place-based, they are, by the very same token, as diverse as the places from which they emanate. Fundamental in this description is that the land and the communities are both the source and the authority of the knowledge. Science education, as with all learning, cannot be learned entirely from the written word of a textbook in a classroom; it must be lived within the local community and experienced in a place-based (non-classroom) context.

Researching a Curriculum of Place—Purpose and Methodology

The primary purpose of this research was to explore a cultural concept of a sense of place and to open up possibilities of creating a local school-based program focused on themes that emerged from conversations with Elders, knowledge holders and students. Secondly, the research was designed to explore the extent to which a *sense of place* as a construct might contribute conceptually and methodologically to a place-based curriculum development process, such that a culturally appropriate framework might be established and articulated in collaboration with First Nations communities (Swallow, 2005).

Research within a First Nations community requires that certain protocols be followed in order to maintain the respect of the people within the community (LaVeaux & Christopher, 2009). The process of building a research methodology around community input and design resembles what is known as Community Based Participatory Research (CBPR). LaVeaux and Christopher (2009) referencing Israel et al. (1998) identify several aspects of CBPR that have been successful in research with Indigenous communities. They highlight research practices that involve:

- understanding community as a unit of identity, building on strengths and resources of community,
- collaborating in all aspects of research, integrating knowledge and action for mutual benefit,
- promoting co-learning and empowerment processes that attend to social inequalities,
- a cyclical and iterative process, addressing research issues from a positive and ecological perspective, and
- disseminating findings and knowledge gained to all partners.

With the intention of openness and flexibility, the methodology unfolded as I talked with Elders and community members. SWETÁLIYE suggested we set up a local advisory committee. This group proved integral in the development of the research questions and design, interview protocols and the gathering of participants. The research was conducted in two phases. First, a feast took place, to inform community members about the research and to ask for guidance, which resulted in a gathering of Elders and other interested community members. The second phase of the research consisted of semi-structured personal interviews with Elders, language teachers and former students. Questions revolved around

an evolving understanding of a W?SÁNEĆ sense of place and notions of what this might mean in science education. Twelve people were included in the original research conversation, which provided the dialogue for synthesis into emerging themes.

What is “Knowledge of Most Worth?” A W?SÁNEĆ Perspective

The idea of researching the process of curriculum development and implementation was used in the overall framework. As such, perhaps a fundamental question for any curriculum and its purpose is to determine “what is knowledge of most worth?” (Marsh & Willis, 1995, p. v). Research into answers from this question provided convincing evidence of what W?SÁNEĆ peoples felt should be in science curriculum and illuminated what I came to identify as central aspects of a W?SÁNEĆ sense of place.

The quotes that follow provide a representation of the themes that emerged from interviews. Specific knowledge is left out, but the importance behind that knowledge comes through beautifully.

SWETÁLIYE believed fully in supporting public education for her people and how it could bridge gaps in understanding between her people and the larger society ([Figure 9.1](#)).

However, from a W?SÁNEĆ perspective, she said:

Unless we begin to educate our people fully, holistically, unless our young ones begin to find their place, to see, hear, feel and experience our territory, to learn who we are as Saanich people, then we risk losing that knowledge” (personal communication, February 9, 2005).

Mavis Henry, long-time Tsawout educator and W?SB member, reiterate the above concerns and expands on what that knowledge means to her people:

We need to understand and sustain our knowledge of the land, how we used it, that it provides gifts, and why they are considered gifts. We need to remember to respect these gifts by using them, if not then we risk losing that knowledge. We have a responsibility to remember that (personal communication, January 12, 2005).

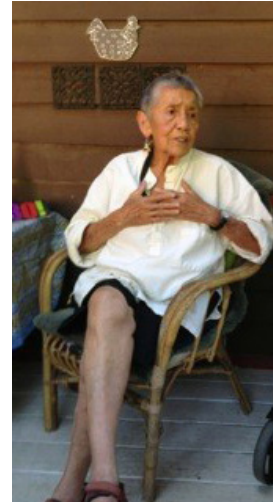


Figure 9.1
▲ SWETÁLIYE Marie Cooper was a highly respected knowledge holder and Elder. Photo by Stephanie Papiak (2014).



Figure 9.2 ▲ STOL?E? John Elliott Sr. demonstrates how to make a cedar root basket at W?EN,NÁ,NEĆ near Fulford Harbour. Photo by Terralingua (2011).

STOL?E? John Elliott Sr. is a fluent SENĆOŦEN speaker, language champion and resident Elder and teacher at the W?SB. His knowledge of his peoples' heritage and place on this land is invaluable (Figure 9.2).

He explains W?SÁNEĆ knowledge this way:

We need to maintain those things that the old people talked about, to take care of the land, respect it now and for the future. Our culture is all related to our land and our territory and within it all our teachings. We need to know who we are, what makes us W?SÁNEĆ (personal communication, February 8, 2005).

One of the pertinent findings of this research was the fact that very little, if anything, of what W?SÁNEĆ peoples indicated was of most worth, is currently prescribed in any formal public school curriculum. Former students all reported this in one way or another. Kelly Paul, a former student and W?SÁNEĆ activist expressed it this way to me:

What are we taught to value in school? I wasn't taught the importance of my culture or my language in public school. How are we to identify ourselves without our traditions? Instead, we learn to value what they [Ministry of Education] value (personal communication, January 14, 2005).

For students to find meaning and relevancy in what curriculum prescribes, knowledge of their community and culture and what they feel is of most worth must be a significant part of their whole educational experience. STOL?E? says:

The way we are teaching and learning does not fit. Students are learning in a false environment. We lived on the land and learned from it. The land was our school (personal communication, February 8, 2005).

How Does “Knowledge of Most Worth” Relate to Science Education?

When asked how science education might be able to assist students gain knowledge of what their community feels is of most worth, some participants responded by asking their own questions. Glenn Jim, Tseycum community educator, suggested:

Students need to learn the impacts and consequences of environmental actions that relate to their communities like run-off from farms and development. Our traditional gathering grounds are polluted. Why? How do we fix it? (personal communication, February 23, 2005)

Mavis Henry asks a very relevant question:

What is the science in our knowledge? Use science to approach our reasoning. Find the science in everyday life, holistic knowledge, like gathering, catching our food and preserving it. Search out ways where science helps day to day. Use science for change to reduce health risks for our people (personal communication, January 12, 2005).

Josephine Henry, a former student (now enrolled in a B.Ed program at UVic) and current SENĆOŦEN Language Revitalization Apprentice, suggests how this can be achieved in a culturally meaningful way:

We need to learn by incorporating both sides of an issue, by learning science and with an Elder. How we used the land and what it represented for us then, and how it can be used now? (personal communication, November 29, 2004)

W̱SÁNEĆ peoples' relationships within their homeland encompasses belief systems, it also captures a context of inquiry of their notion of science. It was practiced in living with their homeland. STOL?E? expresses it this way:

Our science lies in knowing our ancient connections to land. It is also where our spirituality is. I believe we bring a lot of awareness in the way we educate, the way we relate to our land and territory (personal communication, February 8, 2005).

An important question for education becomes: How can we structure educational experiences such that students have opportunity to build long lasting, culturally respectful and meaningful relationships with place and to encourage responsibility for maintaining long-term sustainable relationships? And how might incorporating science education help us investigate and express those relationships?

Regenerating Place-based Relationships

Themes that emerged in my conversations with the W̱SÁNEĆ peoples reveal knowledge associated with homeland along with significant essentials of that knowledge: Elders as knowledge carriers; the SENĆOŦEN language and place-names; W̱SÁNEĆ history, teachings, ceremony, sense of belonging and identity—they provide a cultural context to inform curriculum development. Meaningful and relevant education, including science education, suggests relearning relationships with “a sense of place”—a perspective that will provide ecologically grounded experiences, exposure, and rediscovery; this is true regardless of culture. However, most importantly this research strongly indicated that place-based experiences need to be delivered within—and for—a cultural context.

Land development has impacted the traditional territory of W̱SÁNEĆ significantly—agriculture and the inevitable pollution and the ecological degradation that results have fundamentally altered W̱SÁNEĆ people's relationships with their homeland. Fishing, hunting, and gathering food and other resources are no longer the necessity, nor are they available as they once were. As a result, ceremonial and other spiritual relationships that relate to these practical needs are inherently altered and to varying extents not practiced anymore. However, this reality does not suggest that these relationships are no longer important in today's world. Indeed, W̱SÁNEĆ people tell me that the meanings behind these traditional relationships are absolutely essential for cultural survival and sustainability. If spiritual and practical applications of culturally inherent relationships to place have been forced to change over time, can new relationships with the land be regenerated to recapture those important and essential meanings into a current context?

Place Names

Indigenous place names convey the importance of place because they have direct references to specific sites within a traditional territory. The name a place carries forms a shared body of knowledge that reaches deeply into other cultural spheres (Basso, 1996). XETXÁ?TEN Earl Claxton Jr. notes: “Our place-names are very important in identifying

our homeland because each of those places contains a history, an important meaning or a teaching. It is more than just the name of a place” (personal communication, September 22, 2004) (Figure 9.3).



Figure 9.3 ▲ XETXÁ?TEN Earl Claxton Jr. shares the story of ?ÁU,WEL?EW? to a group of students atop ?ÁU,WEL?EW? mountain. Photo by Tye Swallow (2008).

The history, teachings, and meanings referred to above represent a significant source of cultural knowledge. STOL?E? states: “These teachings provide a sense of identity as W?SÁNEĆ people. They provide a connection to place. Our people learn something from these places. They are learning and passing on important cultural values. This is W?SÁNEĆ thinking” (personal communication, February 8, 2005). Place-based experiences provide opportunities to draw from spiritual and practical applications of culture through the stories, teachings, and/or other important references to history, people, and place. Vern Jacks Jr., Tseycum, community educator, expresses it succinctly: “We need to remember; the old people left something for the young ones at these places” (personal communication, October 14, 2004).

Based on emerging themes, we approached our Elders’ cultural advisory group and discussed the creation of a pilot project. Culturally appropriate learning outcomes were established, based on the outcomes of the original research, but purposely left open to emergence. Together we determined that several cultural and ecological activities could be utilized to contextualize a program that grounds learning, on W?SÁNEĆ terms, in and from place. These outcomes revolved around educating students through traditional teachings, history, and stories with Elders; language learning and application with fluent/proficient speakers; engaging in traditional use values of the environment; ecologically informing students through field experiences; eco-cultural restoration projects in places; and outdoor recreation—all wrapped around a traditional W?SÁNEĆ year (Figure 9.4).

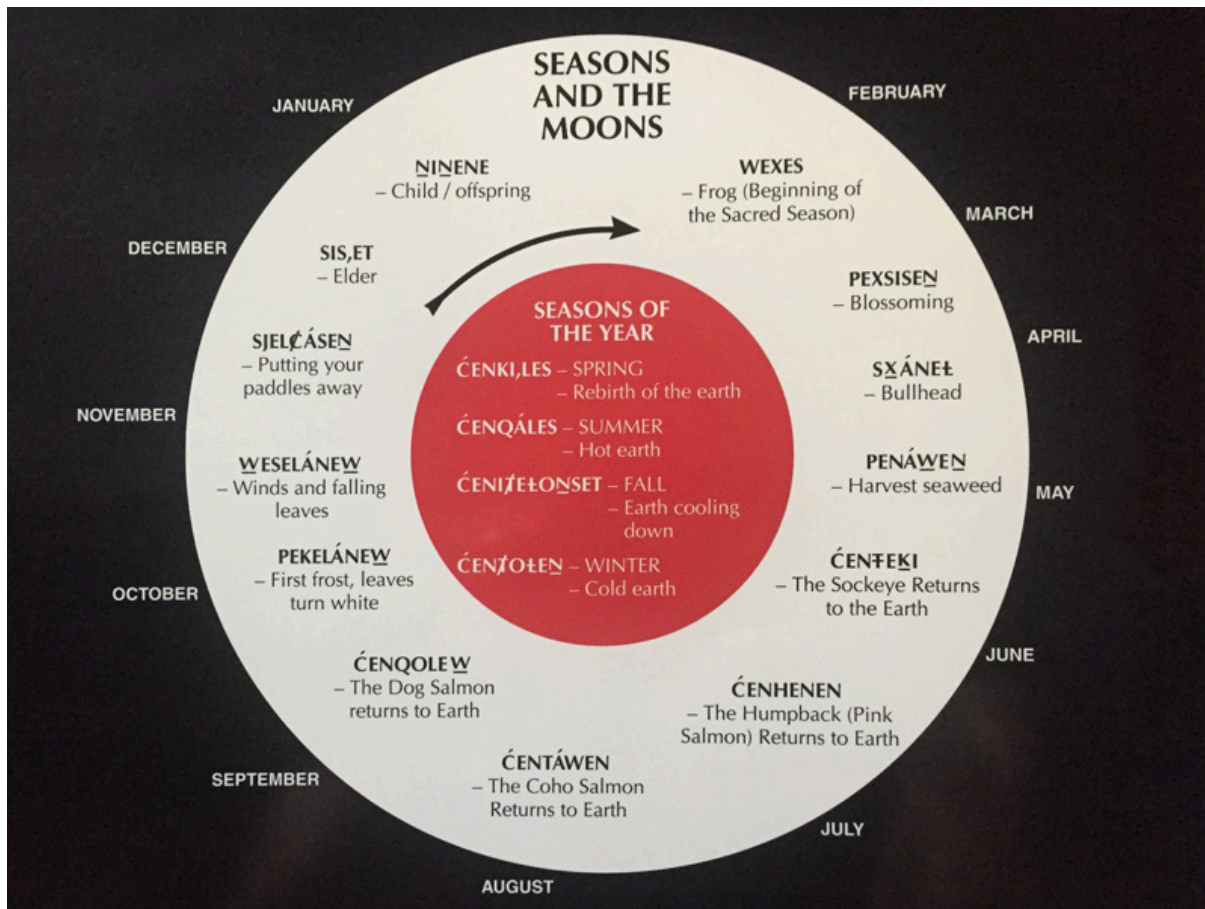


Figure 9.4 ▲ The Saanich Year (1993), back cover, is an excellent resource. A traditional W̱SÁNEĆ year is based on a lunar cycle and is an obvious place to theme place-based educational programs. Each of the 13 moons carries a name and indicates a time for seasonal harvest and/or cultural practice. Photo by Tye Swallow (2018).

ÁLE?ENE?—Learning from Homeland

ÁLE?ENE? means “homeland” in the SENĆO?EN language. *ÁLE?ENE?—Learning from Homeland* was a curriculum development research project that was created and delivered by the SAEC as an extra-curricular course in 2006. The intent of the pilot project was simply to bring people and place together and to learn from those experiences. Centred on culturally significant place-names within W̱SÁNEĆ territory, participants learn through direct experience by visiting cultural places. Most importantly, it is a living curriculum, and has since experienced several iterations as it has been left open to emergence over the years.

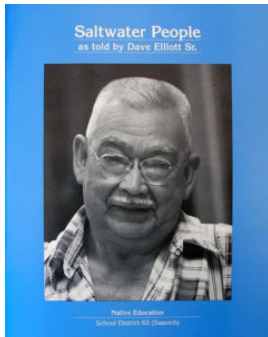


Figure 9.5
▲ The book Saltwater People contains a treasure trove of W?SÁNEĆ place-names. Photo by Janet Poth (1983).

For the first three years, the program ran in May and June, half-days Tuesday through Thursday and a full day on Fridays. This format allowed for longer-term intensive experiences in home places and out on the land for participants. Numerous other guest speakers and organizations, both from within and allies outside of the W?SÁNEĆ community, would share their work with us and many continue to collaborate with us.

We have a huge map of SENĆOFEN place-names in the hallway of our school. It was created as part of a successful Saanichton Marina court case in the 1980's in which W?SÁNEĆ Elders came together and created a place-name map, to claim the extent of their territory. *Saltwater People* (Elliott, 1990), is a wonderful and powerful collection of SENĆOFEN place names, and it offers a fascinating glimpse into a W?SÁNEĆ sense of place ([Figure 9.5](#))

We can explore and learn about literally hundreds of place names. Up to this point, many of these places have been visited by students in our program: L?ÁU,W?EL,?EW (place of refuge), S?ITC?EL (place of Blue Grouse), KENNES (whale), and PKOLS (white head) one of three places with that name that demarcate W?SÁNEĆ territory (Elliott, 1990). They all have realms of significance from the sacred to practical. Due to the physical character of the Saanich Peninsula, each place can be accessed by a variety of ways, by trail, water, and/or road. Participants can canoe, kayak, hike, or drive to each place, adding variety to the way a place can be approached and experienced. Elders and several other knowledgeable community members culturally inform learning experiences through the telling of traditional history as well as the stories and teachings associated with the place ([Figure 9.6](#)).



Figure 9.6 ▲ Ray Sam (sitting) and Earl Claxton Jr. tell stories about ?IX?E? (on Tsawout First Nation). Photo by Tye Swallow (2007).

Elders and guest speakers are provided a suggested list of questions that can be used to guide the experience:

- What does the place name mean?
- Are there stories connected to the place?
- What is its history?
- How can we interpret the place name today?

Awareness of ecological relationships naturally guides experiences. For example, in *place* we ask:

- How can we describe the ecology of the place?
- What are the SENĆOŦEN names of the plants and animals of the place?
- How might SENĆOŦEN describe these relationships?

In addition, sustainability factors are discussed and questions might include: How did the ancestors live sustainably with this place? How can we live sustainably in place again? With sustainability as the focus, we ask questions related to housing, food security, water, energy, and waste management.

Eco-cultural restoration activities that are locally meaningful to the community are conducted in an ongoing seasonal basis according to the W̱SÁNEĆ Year (Claxton & Elliott, 1993). The sites where these activities occur become important “classrooms” for schools and communities to begin reclaiming culture through reengagement. These activities take place outside the ministry mandated school year-time frame and are readily accepted by the community. There are very few places on the Saanich Peninsula where a look back in time is possible, but fortunately a few of these places have been preserved as parks and protected lands. These are truly beautiful ecosystems; they are Indigenous within W̱SÁNEĆ territory. One particular example, significant to W̱SÁNEĆ and neighbouring nations, is ḴO,EL camas lily—*Camassia leichtlinii* or *quamash*. The bulb of this perennial flower was a starch staple and trade item for many tribes in the Pacific Northwest region. Traditionally, families tended these places as gardens and harvesting was a seasonal social and cultural activity (Turner & Hebda, 2012). Currently, the ecosystems that support this plant, and many other culturally significant species, are severely threatened by land development and other invasive plant and animal species. Although ḴO,EL is not the staple it once was, there are several places, including ones with place-names, that have ḴO,EL ENE? (places of camas). We have been interacting with these places in an attempt to rebalance these ecosystems through the removal of invasive species, such as Scotch broom and gorse, English ivy, daphne, and bull thistle; we are also replanting native species, such as ḴO,EL and other perennial species, native shrubs, climax tree species ČE?Á?Ć (Garry oak), and ?O?E,I?Ć (arbutus). Several First Nations community-based leaders, academics, and allies have been working towards restoring and revitalizing these places (Beckwith, 2004; Corntassel & Bryce, 2012; Turner & Hebda, 2012; Turner, 2014a, 2014b). It is an ecosystem ripe for school/community engagement and an example of where scientific inquiry and action can be implemented.

Other more recent place-based eco-cultural restoration projects revolve around a traditional clam garden at a place called ?EMÁ?ES (Russell Island). In partnership with Parks Canada and Royal Roads University, students and community members are revitalizing this site and others through traditional practices, turning over of the beach and re-establishing the ancient rock wall. Parks Canada helps provide a host of scientists and community activists to guide scientific enquiry on how traditional activity on the beach affects changes in productivity (Grosbeck et al., 2014). Traditional cultural activities and crafts include preserving clam necklaces and rattles ([Figure 9.7](#)).



Figure 9.7 ▲ SWE?,TISIYE May Sam shares her knowledge of how to make clam necklaces, originally taught to her by her mother-in-law, to student Tiffany Joseph. Photo by Tye Swallow (2006).

Another site/classroom is ?IKEL (Figures 9.8 and 9.9)—a wetland that was an integral site for gathering medicines as well as a culturally significant plant and climax tree species called SX?ELE,I?Ć (Pacific Willow).



Figure 9.8 ▲ ?IKEL – Diploma of Indigenous Language Revitalization program students participate in a wetland restoration project at ?IKEL. Photo by Tye Swallow (2016).



Figure 9.9 ▲ XEMFOLTW? Nick Claxton working at a SX?ELE,I?Ć (Pacific Willow restoration site). Photo by Tye Swallow (2008).

Restoring traditional gathering grounds through ecological practice, while at the same time relearning the traditional practice of making nets from fibre, is another example of a meaningful educational practice ([Figure 9.10](#)).



Figure 9.10 ▲ STOL?E? John Elliott Sr. demonstrates to students how to twine willow fibres. Photo by Tye Swallow (2016).

For a more detailed description and illustration of the reef net technology, see Claxton & Elliott (1994) and Snively & Corsiglia (2016).

W?ÁĆES — “Relatives of the Deep”

A highlight and culminating activity was a multi night kayaking and canoe trip through the W?ÁĆES (relatives of the deep), part of traditional W?SÁNEĆ territory in the southern Gulf Islands ([Figure 9.11](#)). Students, guides, and guest

speakers were co-participants, and together planned a traditional route and camped overnight at W?SÁNEĆ First Nations reserves.



Figure 9.11 ▲ Students and kayak guides at W?EN,NÁ,NEĆ prepare to launch on their journey back to W?SÁNEĆ. Photo by Tye Swallow (2007).

Participants were responsible to research a particular place-name and tell their stories as we travelled. For example, we travelled from S,DÁ,YES (wind drying) referring to a happy place for wind drying salmon, to ?O,LE,ĆEN (place to leave behind), on to SXEĆOFEN (you can see where your mouth is) and finally to W?EN,NÁ,NEĆ (bay facing Saanich). Elders, community members, and children also joined us by ferry at several of these places. Elders led cultural activities that involved cedar root and bark gathering, fire building, clam digging, preparing, and smoking, as well as preparing salmon in a traditional way. Together a feast was shared (Figure 9.12). Similar multi-night canoe trips continue to this day.



Figure 9.12 ▲ After a productive day's work, students sit beside the fire as salmon and clams cook. Photo by Tye Swallow (2006).

Reflection as Assessment

All experiences are intended for participants to learn about themselves in relation to their homeland. As such, reflection is an integral component and outcome of the program. In order to facilitate personal reflection, time is provided at each place-name of cultural significance for participants to write about and share how each experience made them feel, what they learned, and what they will carry with them into the future. During our third year we published a collection of participant voices in *ÁLE?ENE?—Learning from Homeland* and other educational research essays (Saanich Indian School Board, Guilar, & Swallow, 2008). The following quotes are examples of participant reflections:

In many ways, I have reconciled with our land, our relationships, and our connection with our traditional spirit. This trip has reawakened something that has been dead for a long time. Our reconnection to land is

so vital to our existence and survival. At these places, I felt like I was being welcomed. (Rhonda Underwood, p. 278)

Part of the rediscovery I felt was my reconnection to the land. As a child, I was taught about how this land is ours, how it is alive, and how to live and take care of it. I realized how many ways I was out of balance with what I had learned about our land. My thoughts and actions were from a borrowed way of life. The reconnection to our islands was like being home, like learning a close reenactment of how people lived. Kayaking felt like a reconnection to the water, it was a great feeling. (Tracy Underwood, p. 152)

I think the way I look at my territory has changed dramatically—the way I look at plants, their SENĆOŦEN names, our environment, and their meanings. I look where I step now. I have a much greater appreciation of where I am. (P. J. Sam, p. 277)

I feel more connected to the land and the use of our territories. Seeing them made me envision our ancestors, what they did, and what my role would have been. It would be very different from today. Every place we went to had a story. Our people had a use because the name tells us that. Like our ?E?ÁĆES (islands). I know them now in our words. The SENĆOŦEN names provide more depth. I feel like I have been given a gift. I need to remember to live what I have learned. (SDEMOXELTEN Ian Sam, former Language Revitalization Apprentice and current Immersion Language Teacher, p. 278)

I have always talked about community and land. I have always had a desire to take a lead in protecting our land. This class has provided opportunity to talk with and be with people who share similar thoughts and beliefs. This group and the energy it carries will move somehow in the future. It has been an uplifting feeling. (MENEŦIYE Elisha Elliott, former Language Apprentice and current Immersion Language Teacher, p. 281)

I have been dreaming in our language. I know I have so much more to learn. I have spent my whole life here and am just beginning to learn our language. Our strength is within our traditions, language, and culture. (PI?ELÁNEW?OT Samantha Etzel, Tsawout Educator, p. 286)

This course has been like becoming W?SÁNEĆ. We have a long way to go, but I see the possibility of incorporating our philosophy and ways of harmonizing with our environment. I realize now we are way out of balance. We need to take a step back and look at things and get critical as a way of transformation. (PENÁĆ David Underwood, former Language Apprentice and current Immersion Language Teacher, p. 278)

Barriers to an Emergent Curriculum Development Process in Public Schools

Although there are always exceptions, it is easy to argue that contemporary educational systems exacerbate a fragmented and mechanistic philosophy that views knowledge as abstract and disconnected from students' lived experiences (MacQuarrie & Smith, 2009; Orr, 1994, 2002). The reality these forms of education reflect is the same "dominant worldviews [that] permeate and (re)construct human consciousness to such an extent that we scarcely question their validity" (MacQuarrie & Smith, 2009, p. 33), or their limitations. MacQuarrie and Smith (2009) suggest that this problem is insurmountable if we continue responding in ways that only tinker with existing western education systems and structures. There is no simple fix, they say, because it requires nothing less than a change in the way an educational system forces us to view the world.

While there is increasing willingness in the public-school system to use locally and more Indigenous developed curricula, there continue to be significant barriers. The fourth iteration of our *ÁLE?ENE?* program involved the creation and development of a school board authorized course for *W?SÁNEĆ* learners at the local public high school that serves the *W?SÁNEĆ* community. Even though the program received consequential support from both the *W?SB* and local school district, creating the space to implement *ÁLE?ENE?* proved to be a difficult task. Due in large part to conflicts between the two educational systems, primarily an inflexible timetable and packed student schedule, the high school students were only able to participate at 20 percent of what had been done previously. Attrition was high as students fell behind in their other “core” courses and were not permitted to participate in many events. Admittedly this was only one try, but the context and timeframe that worked so well in previous years was severely fragmented. I bring this to the reader’s attention to stress the point that public school systems tend to be extremely rigid systems. Ministry standards exist, for good and for bad depending on a position, but they limit change. By succumbing to the pressures and enforcement of this colonially inspired educational system, local First Nations communities lose significant authority to self-determine education.

Recent attempts by the BC Ministry of Education (2015/16) to redesign the K to 12 curriculum by embedding more Indigenous perspectives and resources at each grade level and subject area, is a huge step towards Indigenizing education for public school systems. From a First Nations perspective, however, where there is a greater ability to adapt and change, it is still considered tinkering only. The argument here is not to discourage attempts to do better and increase Indigenous content in our BC Ministry of Education’s *Prescribed Learning Outcomes*, but rather to emphasize that much more can be done at the community level. After all, it is not a priority of the Ministry of Education to help revitalize Indigenous languages and cultures. The argument is to encourage individual communities to not wait for change or leadership from the ministry but to make change for themselves; don’t ask for permission to take back control of education.

Rebalancing an Education System

One way to counter some of this ongoing colonial influence and further Indigenize control over education, is to use current ministry *Prescribed Learning Outcomes*, but utilizing a language immersion context through a traditional language medium like the Māori in New Zealand and the Hawaiian people have been championing for well over 30 years. This notion of control is being utilized at a few Band-Operated Schools in BC (e.g., Chief Atahm School in Chase, Mount Currie, *W?SB*). Although there are 125 band operated schools and adult centres in BC (INAC, 2013), the sad and stark reality is that almost all BC languages are critically endangered or sleeping (First Peoples’ Cultural Council, 2014). As such many communities do not yet have the language capacity to invest in this work.

Language Apprenticeships and the Importance of Adult Education—Towards *SENĆOŦEN*ization

Indigenizing the entire context (the why, when, where, what and how) in which we actually practice education needs significant transformation if it is to reflect culturally relevant ways of knowing and being. Our experience suggests we cannot fit this learning context, as it has emerged in our *ÁLE?ENE?* program, into a fixed, pre-determined educational system. It loses its flexibility and adaptability and as such, its ability to emerge in any culturally meaningful new way. In our case, the learning context was created first, *ÁLE?ENE?—Learning from Homeland*, and our timetable re-worked to facilitate its development at the adult level where following mandated curricula or an inflexible timetable is not as restricting. Assessment has been about finding ways to culturally improve and expand the program and student learning.

Program outcomes are about holistic and interconnected relationships between people, places, and an educational culture that can continue to evolve on its own terms.

It is important to note that our experience indicates that adult participants respond at a deeper level to these experiences. It has been clear from the beginning that the strength of the program, and any potential movement forward, lies within the participants who care deeply about revitalizing their languages and cultures. Community-based adult education programs can benefit significantly from partnering with universities in the development and delivery of Indigenous Language Revitalization programs such as the program at the University of Victoria. Their support, along with allies in linguistics, has been essential in realizing the outcome of Indigenization and actualizing SENĆOŦENization.

S?Á,SEN TFE SENĆOŦEN—Developing Language Capacity

In 2009, the W?SB initiated a language revitalization department—the S?Á,SEN TFE SENĆOŦEN. Up to that point in 2009, 44 community members (24 female and 20 male) aged 16 to 56 had contributed to our ÁLE?ENE? program through their participation. As such, we knew there was much interest to begin language revitalization apprenticeships; they were primed and ready to take on these important roles and were acutely aware of the critical state of their heritage language, and the declining number of proficient-fluent Elders. We began by offering paid apprenticeships for six students who had, or would commit to becoming certified teachers or early childhood educators. We funded our program through commitment from the W?SB and ongoing grant applications from organizations such as First Peoples' Cultural Council (FPCC). Apprentice tasks were to shadow our three existing Elder language teachers, spend time with other proficient Elders in weekly gatherings, help develop language curriculum and other language revitalization duties. They also participated in more traditional Mentor-Apprentice relationships (Hinton, 2002; FPCC, 2012). A challenge we continue to face and that most BC communities will need to overcome is a lack of fluent Elders. In order to counter this, we often doubled and tripled up apprentices with mentors. And, as more needs/wants became exposed, our collective jobs became to find ways to fill those needs. There are endless needs and wants in this work. The key is to prioritize and keep expanding the language capacity to accomplish that work.

In the years since we have provided paid language apprenticeships to 22 W?SÁNEĆ people of all ages and that number grows yearly as our language capacity increases. Most of that first cohort of apprentices are now BC ministry certified teachers or early childhood educators working in our school. These language *revitalists*, as we call them, now carry our place-based curriculum forward in our SENĆOŦEN LENO?ET SCUL,ÁUTW? preschool through Grade four immersion survival school—our goal is to continue providing immersion/bilingual programming up to grade 12.

ÁLE?ENE? is a core context (not content) area through which language immersion teachers teach science, social studies, math, P.E., and other language related content through the medium of SENĆOŦEN. Much like several Nature Kindergarten programs gaining support in the Greater Victoria region—another meaningful Indigenizing step—students spend extended times, several days per week learning from outdoor place-based contexts in their homeland. An overriding objective of our S?Á,SEN TFE SENĆOŦEN program continues to focus on the development of SENĆOŦEN language curriculum connected to place to be infused into the overall programs of the W?SB. SX?EDFELISIYE Renee Sampson, is a SENĆOŦEN immersion kindergarten teacher in the LENO?ET SCULÁUTW?. She has a Masters degree in Indigenous Language Revitalization and is also a former student of our ÁLE?ENE? program. When asked how she utilizes ÁLE?ENE? with her students, she says:

We focus on connecting our children, our babies, to our homeland outside the four walls of a classroom, to use our senses to really feel what our Earth encompasses. I think a reality is many of our W?SÁNEĆ children

don't play outside or even ever get dirty. Like most children these days, they're gaming inside and rarely, if ever, get dirty, play in the forest, jump in the leaves, climb the hills and mountains in our territory.

The science related PLO's in Kindergarten relate to our senses and so are very relatable to our connections to nature and our homeland. We exercise through playing outside in a natural state. We try to subtly get them to stop and take in the beautiful scenery of our forests, smell the light rain on the moss, to use their senses to feel what our ancestors would have felt, to feel the plants and trees that would have been so very important, essential to our ancestors. We sit in silence, listen with our ears, our hearts, to the birds, winds through the trees. Then we connect these feelings with the telling of our origin stories.

We use our senses to take in our surroundings, but we do it in a beautiful way that opens up deep windows into a W?SÁNEĆ way of understanding our world. When we use the names of sacred beings (plants, trees, animals, places in our territory) we give them respect. Giving them respect through prayer, honouring, acknowledgment; thanks gives it more life. Our children, they gain a deep identity.

Other science areas such as inquiry, prediction of weather, life cycles of salmon for example, these are very relatable to our Worldview. Learning the stages of a salmon and releasing them at SELE?TE?, we then complete this cycle through the catching, cutting, smoking, and tasting of our salmon. Learning the life cycle of a frog, their habitats etc., we learn those through our own words, our language that captures who we are in this world. Then we can connect those experiences in our classrooms. (May 16, 2017)

Conclusion

Towards Truth and Reconciliation through Education

Anyone who knew SWETÁLIYE understands how important the idea of *Holistic Education* was to her. In her words:

We need to begin again to understand the holistic place of our people. Our connections to our land are not just physical. It is all encompassing. Our language, place-names, our heart, our soul, our spirit, our livelihood, our way of living and being is tied up in our land. It has taken me a long time to understand fully, the impact our knowledge of our land and territory means to the holistic place of our people (personal communication, February 9, 2005).

This idea of holism and holistic education, still sits with me always. ÁLE?ENE? was ultimately about bringing people and place together, and science education can learn and give much for this “purpose” of educating. Our S?ÁSEN TFE SENĆOFEN language revitalization work has seen huge growth, but an enormous amount of work—generations of it—still remains. Our efforts suggest that curriculum and program developers at First Nations controlled schools, in collaboration with the community and in the community, explore processes for gathering and facilitating place-based knowledge education at the adult curriculum level in order to generate interest and offer the possibility of providing language revitalization apprenticeships. They can then leverage those efforts through infusion of a Language and Culture Revitalization movement in a band controlled school.

Communities need to move forward with this work—and now. It takes a growing team of dedicated people who all share a common vision, and a passion for revitalizing their heritage languages and cultures to sustain this effort. Language Revitalization involves a monumental amount of work because it is arguably an Indigenous communities' most valuable

remaining asset and it requires significant investment. If we are serious about Truth and Reconciliation; communities, schools, universities, and governments must all contribute towards this effort. It needs to be nested and cultivated at the community level. A community-controlled school is a meaningful and fruitful place to “purpose” – creating the space – for education and educating.

Emergence and transformation are themes that run deep through many W?SÁNEĆ stories and embedded within these stories is a philosophy of change and adaptation to new realities. Indeed, W?SÁNEĆ translated means “the Emerging People.” In the flood story, it is said that when the top of L?ÁU,W?EL,?EW? (Mt. Newton) became visible, someone said: “NI QENET TFE W?SÁNEĆ” (Look at what is emerging!).

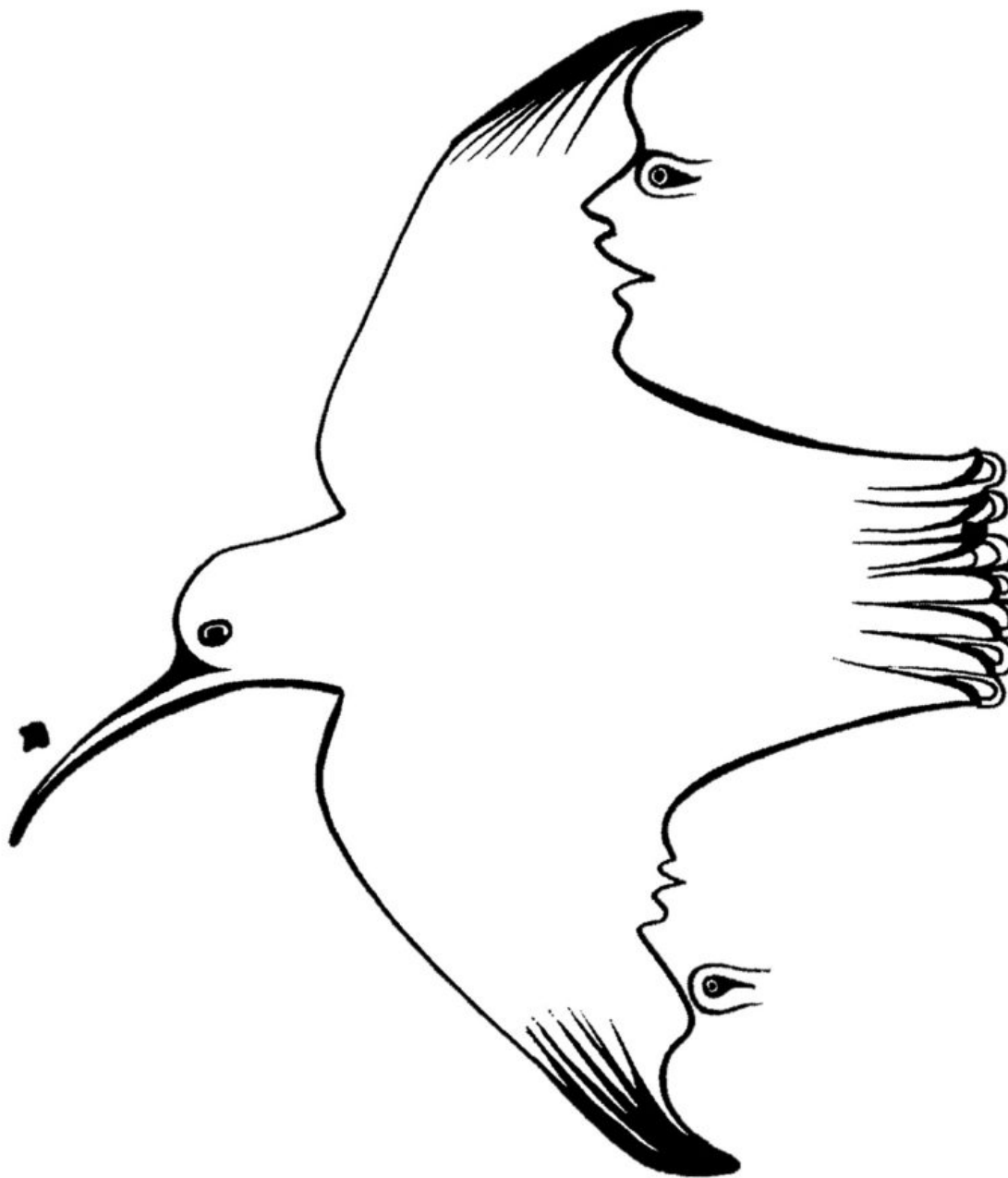
REFERENCES

- Abram, D. (1996). *The spell of the sensuous: Perception and language in a more-than human world*. New York, NY: Random House.
- Barnhardt, R. (2008). Creating a place for Indigenous knowledge in education: The Alaska Native Knowledge Network. In D. A. Gruenewald & G. A. Smith (Eds.), *Place based education in the global age: Local diversity* (pp. 113-133). New York, NY: Lawrence Erlbaum.
- Basso, K. (1996). *Wisdom sits in places: Landscape and language among the Western Apache*. Albuquerque, NM: University of New Mexico Press.
- Battiste, M. (2000). Maintaining Aboriginal identity, language, and culture in modern society. In M. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 192-208). Vancouver, BC: UBC Press.
- Battiste, M. (2013). *Decolonizing education: Nourishing the learning spirit*. Saskatoon, SK: Purich.
- Beckwith, B. (2004). “The queen root of this clime”: *Ethnoecological investigations of blue camas (camassia leichtlinii (Baker) Wats., C. quamash (Pursh) Greene; liliaceae) and its landscapes on southern Vancouver Island, British Columbia* (Doctoral dissertation). University of Victoria, Victoria, BC. Retrieved from <http://hdl.handle.net/1828/632>
- Cajete, G. (1994). *Look to the mountain: An ecology of Indigenous education* (1st ed.). Durango, CO: Kivaki Press. Retrieved from <http://files.eric.ed.gov/fulltext/ED375993.pdf>
- Cajete, G. (1999a). Reclaiming biophilia: Lessons from Indigenous peoples. In G. Smith & D. Williams (Eds.), *Ecological education in action: On weaving education, culture and the environment*. Albany, NY: State University of New York.
- Cajete, G.A. (1999b). *Igniting the sparkle: An indigenous science education model*. Skyland, NC: Kivaki Press.
- Cajete, G. (2000). *Native science: Natural laws of interdependence*. Santa Fe, NM: Clear Light Publishers.
- Capra, F. (1998). *The web of life: A new scientific understanding of living systems*. New York, NY: Anchor Books.
- Capra, F. (2002). *The hidden connections: A science for sustainable living*. New York NY: Anchor Books.
- Castellano, M.B. (2014). Indigenizing education. *Education Canada Magazine*. Retrieved from <http://www.ceaace.ca/blog/marlene-brant-castellano/2014/06/2/indigenizing-education>
- Claxton, E. & Elliott, J. (1993). *The Saanich year*. W?SÁNEĆ: Saanich Indian School Board.

- Claxton, E. & Elliott, J. (1994). *Reef net technology*. W?SÁNEĆ: Saanich Indian School Board.
- Claxton, N. X-T (2004). *ISTÁ SÍÁNEW?, ISTÁ SX?OLE–“To fish as formerly”: The Douglas Treaties and the Saanich reef net fisheries*. Victoria, BC: University of Victoria.
- Corntassel, J. & Bryce, C. (2012). Practicing sustainable self-determination: indigenous approaches to cultural restoration and revitalization. *Brown Journal of World Affairs*. 18(2), 151-162.
- Deloria, V. Jr., & Wildcat, D.R. (2001). *Power and place: Indian education in America*. Denver, CO: Fulcrum Resources.
- Elliott, D. Sr. (1990). *Saltwater people: A resource book for the Saanich Native studies program*. Saanich, BC: School District 63.
- First Peoples' Cultural Council [FPCC] (2012). *B.C.'s Master-apprentice language program handbook*. Victoria, BC: First Peoples' Cultural Council. Retrieved from http://www.fpcc.ca/files/PDF/MAP_HANDBOOK_2012.pdf
- First Peoples' Cultural Council [FPCC] (2014). *Report on the status of B.C. First Nations languages (2nd edition)*. Victoria, BC: First Peoples' Cultural Council. Retrieved from <http://www.fpcc.ca/files/pdf/language/fpcc-languagereport-141016-web.pdf>
- Groesbeck, A.S., Rowell, K., Lepofsky, D., Salomon A.K. (2014) Ancient Clam Gardens Increased Shellfish Production: Adaptive Strategies from the Past Can Inform Food Security Today. *PLoS ONE* 9(3): e91235. <https://doi.org/10.1371/journal.pone.0091235>
- Hinton, Leanne (2002). *How to keep your language alive: A commonsense approach to one-on-one language learning*. Berkeley, CA: Heyday Books.
- Kawagley, A.O. (1995). *A Yupiaq worldview: A pathway to ecology and spirit*. Prospect Heights, IL: Waveland Press.
- Kawagley, A.O., & Barnhardt, R. (1998). *Culture, chaos and complexity: Catalysts for change in Indigenous education*. Fairbanks, AK: Alaska Native Knowledge Network.
- Kawagley, A. O., & Barnhardt, R. (1999). Education Indigenous to place: Western science meets Native reality. In G. A. Smith & D. R. Williams (Eds.), *Ecological education in action: On weaving education, culture, and the environment* (pp. 117-140). New York, NY: SUNY Press.
- LaVeaux, D., & Christopher, S. (2009). Contextualizing CBPR: Key principles of CBPR meet the Indigenous research context. *Pimatisiwin: A Journal of Aboriginal and Indigenous Community Health*, 7(1), 1-25.
- MacQuarrie, J., & Smith, G. D. (2009). Placing pedagogy and curriculum within an ecological worldview. *SFU Educational Review*, 1, 30-40.
- Marsh, C., & Willis, G. (1995). *Curriculum: Alternative approaches, ongoing issues*. NJ: Prentice Hall Inc.
- Michell, H., Vizina, Y., Augustus, C., & Sawyer, J. (2008). *Learning Indigenous science from place: Research study examining Indigenous-based science perspectives in Saskatchewan First Nations and Métis community contexts*. Saskatoon, SK: Aboriginal Education Research Centre, University of Saskatchewan. Retrieved from <http://iportal.usask.ca/docs/Learningindigenousscience.pdf>
- Orr, D. W. (1994). *Earth in mind: On education, environment, and the human prospect*. Washington, DC: Island Press.
- Orr, D.W. (2002). *The nature of design: Ecology, culture, and human intention*. New York, NY: Oxford University Press.

- Peat, F. D. (1994). *Lighting the seventh fire: The spiritual ways, healing, and science of the Native American*. New York, NY: Birch Lane Press.
- Prakash, M. S., & Esteva, G. (1998). *Escaping education: Living as learning in grassroots cultures*. New York, NY: Peter Lang.
- Saanich Indian School Board, Guilar, J. & Swallow, T. (2008). *ÁLE?ENE?: Learning from place, spirit and traditional language*. *Canadian Journal of Native Studies*, 2(2), 273-293.
- Simpson, L. (2004). Anticolonial strategies for the recovery and maintenance of Indigenous knowledge. *American Indian Quarterly*, 28(3/4), 373-384. <https://doi.org/10.1353/aiq.2004.0107>
- Simpson, L. (2011). *Dancing on our turtle's back: Stories of Nishnaabeg re-creation, resurgence and a new emergence*. Winnipeg, MB: ARP Books.
- Simpson, L. (2013). *The gift is in the making: Anishinaabeg stories*. Winnipeg, MB: Highwater Press.
- Smith, L. (2012). *Decolonizing methodologies: Research and Indigenous peoples* (2nd edition). London, EN: Zed Books.
- Snively, G., & Corsiglia, J. (2001). Discovering Indigenous science: Implications for science education. *Science Education*, 85(1), 6-34. [https://doi.org/10.1002/1098-237X\(200101\)85:1<6::AID-SCE3>3.0.CO;2-R](https://doi.org/10.1002/1098-237X(200101)85:1<6::AID-SCE3>3.0.CO;2-R)
- Snively, G., & J. Corsiglia. (2016). A window into the Indigenous science of some Indigenous peoples of Northwestern North America. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1 (pp. 105-125). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>
- Swallow, T. (2005). *A sense of place: Toward a curriculum of place for W?SÁNEĆ people* (Masters thesis). University of Victoria, Victoria, BC. Retrieved from <http://hdl.handle.net/1828/819>
- Turner, N. J. (2014a). *Ancient pathways, ancestral knowledge: Ethnobotany and ecological wisdom of Indigenous peoples of northwestern North America, Volume 1: The history and practice of Indigenous plant knowledge*. Montreal, QC: McGill-Queen's University Press.
- Turner, N. J. (2014b). *Ancient pathways, ancestral knowledge: Ethnobotany and ecological wisdom of Indigenous peoples of northwestern North America, Volume 2: The place and meaning of plants in Indigenous cultures and worldviews*. Montreal, QC: McGill-Queens University Press.
- Turner, N. J., & Hebda, R.J. (2012). *Saanich ethnobotany: Culturally important plants of the WSANEC people*. Victoria, BC: Royal BC Museum
- Turner, N. J., Ignace, M. B., & Ignace, R. (2000). Traditional ecological knowledge and wisdom of Aboriginal peoples in British Columbia. *Ecological Applications* 10(5), 1275-1287. <https://doi.org/10.2307/2641283>
- Williams, L. & G. Snively. (2016). "Coming to know": A framework for Indigenous science education. In G. Snively & L. Williams (Eds.), *Knowing Home: Braiding Indigenous Science with Western Science*, Book 1 (pp. 129-146). Victoria, BC: University of Victoria. Retrieved from <https://pressbooks.bccampus.ca/knowinghome/>

Appendices



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Appendix A

The Metaphor Questions for chapter 3.

- If science was an animal, what animal would it be? Explain.
- If science was an object, what object would it be? Explain.
- If science were one or more of the following, what would it be? Why?¹

Set #1		
a car	a totem pole	a circle
a tree	a drum	

Set #2		
a puzzle	a medicine wheel	a garden
a story/legend	a court case	

Set #3		
Pyramid	a forest	a feast or potlatch
a song or dance	an experiment	

- Of all the metaphors listed above, which is your favourite metaphor for science and why? What is your second favourite metaphor? Which metaphor is your least favourite? Please explain. Please generate your own metaphor for science and explain.
- I am to science as...²

a driver is to a car	a mechanic is to a car	a passenger is to a car
an author is to a book	a reader is to a book	a character is to a book
an inmate is to a prison	a warden is to prison	a guard is to prison
a chief is to a community	a child is to a community	an elder is to a community

Which one of the following images best describes how science is taught in school? Why?³

Set #1		
a car	a boat	a garden
a forest	a factory	

1. The same question will be asked at the beginning of each set. "Why" will be asked after each question.
2. Explain your experience, role, or relationship in/with science.
3. The same question will be asked at the beginning of each set. "Why" will be asked after each question.

Set #2		
a prison	a longhouse	a computer
a carving	a tree	

Set #3		
a painting	a medicine wheel	a church
a calculator	a sport (such as hockey, basketball, etc.)	

- Of all the metaphors listed above, which is your favourite metaphor for how science is taught and why? What is your second favourite metaphor? Of the metaphors listed above, are there any that the way science is taught would not be? Please explain. Please generate your own metaphor for how science is taught and explain.
- If the way that science is taught could be changed, which one of the above metaphors best describes the way that you would like to see it taught? Why? Is there a metaphor that you would select second?

Appendix B

The metaphor questions for chapters 4, 5, and 6.

Set A: The Students' Metaphors for the Seashore

If the seashore were one or more of the following six images, which one or ones would it be? Why?

Set #1		
factory	painting	house
battleground	legend	gift

Set #2		
farm	dance	graveyard
blackberry bush	totem pole	hotel

Set #3		
cannery	necklace	town
pin cushion	playground	song

Set #4		
pot-luck dinner	patchwork quilt	family
jewel	spaceship	garden

Set B: The Students' Metaphors for the Animals, Objects and Events at the Seashore

If a barnacle were one or more of the following images, which one or ones would it be? Why?

thumb tack	fisherman	song
house	rock	

If a seagull were one or more of the following images, which one or ones would it be? Why?

spear	robber	pearl
janitor	dance	

If seaweed were one or more of the following images, which one or ones would it be? Why?

garden	banana peel	curtain
forest	patchwork quilt	

If a crab were one or more of the following images, which one or ones would it be? Why?

robot	pair of pliers	mobile house
feast	garbage collector	

If cobblestone were one or more of the following images, which one or ones would it be? Why?

umbrella	hairbrush	community
totem pole	hotel	

If a tidal pool were one or more of the following images, which one or ones would it be? Why?

painting	store	town
dance	war	

If a sea star were one or more of the following images, which one or ones would it be? Why?

spaceship	can opener	flower
robber	jewel	

If the tide were one or more of the following images, which one or ones would it be? Why?

song	mop	bowling ball
legend	gift	

If the sun were one or more of the following images, which one or ones would it be? Why?

jewel	furnace	gift
factory	lamp	

If mud were one or more of the following images, which one or ones would it be? Why?

pillow	tunnel	piano
city	pot-luck dinner	

If a clam were one or more of the following images, which one or ones would it be? Why?

dance	legend	potlatch
necklace	vacuum cleaner	

If sea water were one or more of the following images, which one or ones would it be? Why?

diamond	soup	theatre
dance	factory	

If a sea anemone were one or more of the following images, which one or ones would it be? Why?

garden	flower	mouse-trap
dress	person	

If sand were one or more of the following images, which one or ones would it be? Why?

graveyard	sandcastle	theatre
mattress	bullets	

If a sea urchin were one or more of the following images, which one or ones would it be? Why?

sun burst	spaceship	lawn mower
farmer	pin cushion	

Set C: If You Were A...

If you were a crab, would you most like to be a:

hermit crab	edible crab	purple shore crab
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If you were a starfish, would you most like to be a:

sunflower star	sun star	purple star
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If you were a rock, would you most like to be a:

boulder	sand grain	polished beach pebble
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If you were a bird, would you most like to be a:

bald eagle	raven	seagull
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If you were a fish, would you most like to be a:

sculpin	blenny	salmon
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If you were a type of seashore, would you most like to be a:

rocky shore	cobblestone beach	sandy beach
mud flat		

If you were the weather, would you most like to be a:

sunny day	rainy day	stormy day
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If you were a mammal, would you most like to be a:

seal	sea lion	killer whale
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If you were the wind, would you most like to be a:

windy day	gentle breeze	hurricane
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If you were the tide, would you most like to be a:

low tide	high tide	ebb tide
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If you were a boat, would you most like to be a:

sail boat	ferry boat	fishing boat
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If you were anything you wanted to be at the seashore, what would you most like to be? Why?

Set D: The Students' Own Relationship to the Seashore

I am to the seashore as a... and why?

Set 1	driver is to a car	passenger is to a car	mechanic is to a car
Set 2	story teller is to a story	listener is to a story	animal is to a story
Set 3	manager is to a hockey team	hockey puck is to a hockey team	uniform is to a hockey team
Set 4	leaves are to a tree	roots are to a tree	bark is to a tree
Set 5	lock is to a necklace	bead is to a necklace	string is to a necklace
Set 6	fruit is to a blackberry bush	thorn is to a blackberry bush	flower is to a blackberry bush
Set 7	owner is to a fishing boat	captain is to a fishing boat	deckhand is to a fishing boat
Set 8	window is to a house	door is to a house	roof is to a house
Set 9	cloth is to a curtain	lace is to a curtain	stitches are to a curtain

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1.0	November 30, 2018	Added to the B.C. Open Textbook Collection	
1.1	June 4, 2019	Updated the book's theme.	The styles of this book have been updated, which may affect the page numbers of the PDF and print copy.