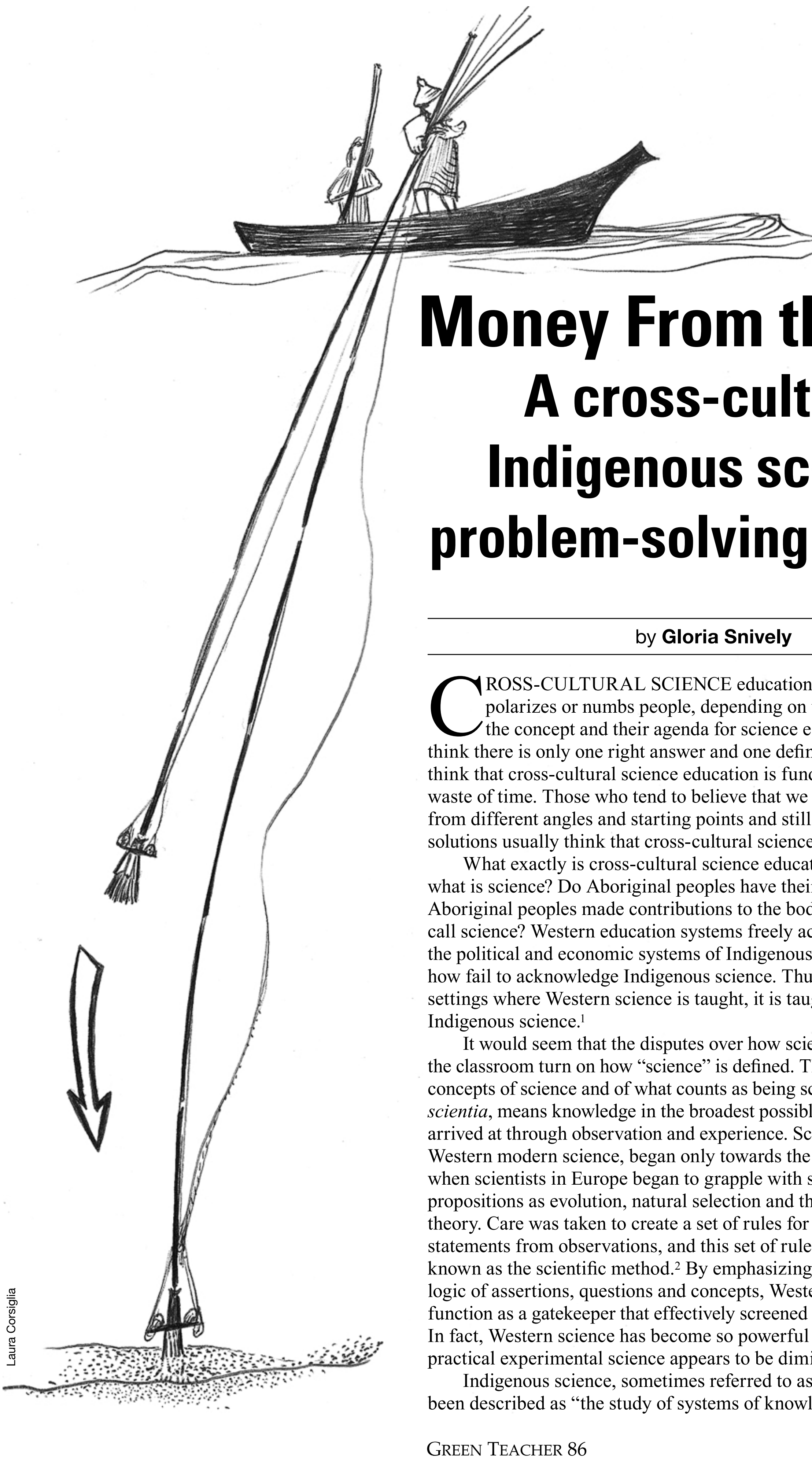


Money From the Sea:
A cross-cultural Indigenous science problem-solving activity

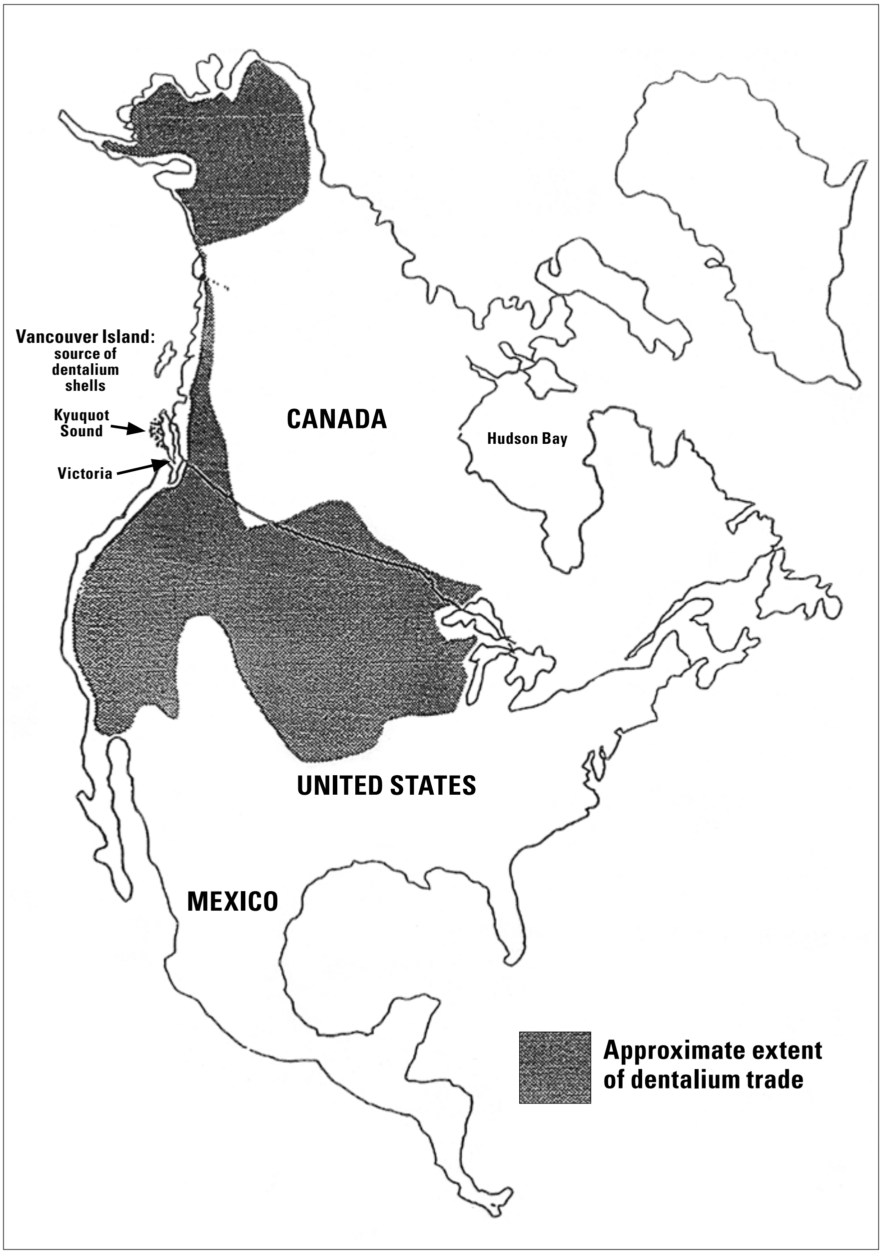
by **Gloria Snively**

CROSS-CULTURAL SCIENCE education is a topic that either polarizes or numbs people, depending on their understanding of the concept and their agenda for science education. Those who think there is only one right answer and one definition of science may think that cross-cultural science education is fundamentally flawed and a waste of time. Those who tend to believe that we can approach questions from different angles and starting points and still come up with workable solutions usually think that cross-cultural science is imperative.

What exactly is cross-cultural science education? For that matter, what is science? Do Aboriginal peoples have their own science, and have Aboriginal peoples made contributions to the body of knowledge that we call science? Western education systems freely acknowledge the arts and the political and economic systems of Indigenous cultures, but somehow fail to acknowledge Indigenous science. Thus, in many educational settings where Western science is taught, it is taught at the expense of Indigenous science.[1]

It would seem that the disputes over how science is to be taught in the classroom turn on how "science" is defined. There are many different concepts of science and of what counts as being scientific. The Latin root, *scientia*, means knowledge in the broadest possible sense — knowledge arrived at through observation and experience. Scientific theorizing, or Western modern science, began only towards the end of the 19th century when scientists in Europe began to grapple with such abstract theoretical propositions as evolution, natural selection and the kinetic-molecular theory. Care was taken to create a set of rules for deriving theoretical statements from observations, and this set of rules evolved and became known as the scientific method.[2] By emphasizing methodology and the logic of assertions, questions and concepts, Western science came to function as a gatekeeper that effectively screened out Indigenous science. In fact, Western science has become so powerful a gatekeeper that even practical experimental science appears to be diminished.

Indigenous science, sometimes referred to as ethnoscience, has been described as "the study of systems of knowledge developed by a



One way of engaging students in authentic cross-cultural science inquiries is to challenge them to solve a science and technology problem that would have presented itself to Indigenous people. The following activity is one of several that I use to engage students in lively discussion of the contributions that Aboriginal peoples have made to the sciences. I introduce the activity by telling the intriguing story known to west coast Aboriginal peoples and historians as "Money from the Sea."

given culture to classify the objects, activities, and events of its given universe."[3] Many would agree with Elkana that "every culture has its own science… something like its own way of thinking and/or its own worldview."[4] In this sense, Indigenous science is an interpretation of how the world works based on a particular cultural perspective. Because this knowledge is passed orally across generations of people who are long-resident in one region, it is often referred to as "traditional ecological knowledge." Such knowledge tends to be holistic, viewing the world as an interconnected whole in which humans are not more important than the rest of nature; thus, "traditional science is moral, as opposed to supposedly value free."[5]

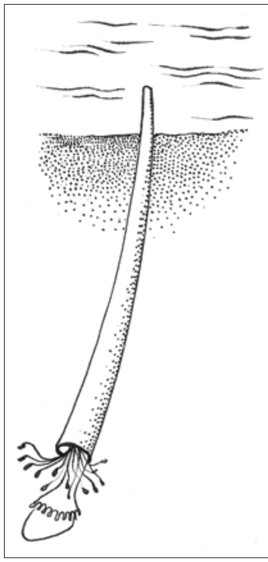
Educators wishing to incorporate Indigenous science into their teaching practice can begin by consulting elders and other Aboriginal resource persons or the burgeoning literature on Indigenous knowledge in the areas of natural and earth sciences, medicine, agriculture, aquaculture, navigation, architecture, engineering and political science.[6]

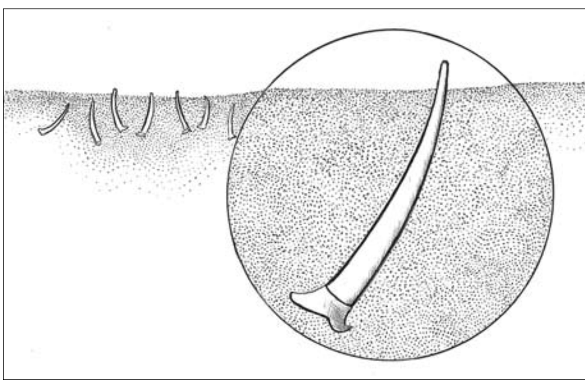
Dentalium shell money story

For 2,500 years, until the early 20th century, North American Aboriginal peoples used the dazzling white shell of a marine mollusk as currency. *Dentalium pretiosum* is a 5- to 7.5-centimeter-long mollusk of the class *Scaphopoda*, a group also known as tusk shells because of their slightly curved, conical shape. Dentalia inhabit coarse, clean sand on the surface of the seabed in areas of deep water, and are often found in association with sand dollars and the purple olive snail (*Olivella biplicata*). As predators, they use their streamlined shape and muscular foot to move surprisingly quickly in pursuit of tiny single-celled prey called forminifera. Aboriginal peoples used many substances as trade goods, but dentalia were the only shells to become currency. Harvested from deep waters off the coast of Vancouver Island, they were beautiful, scarce, portable and not easily counterfeited.

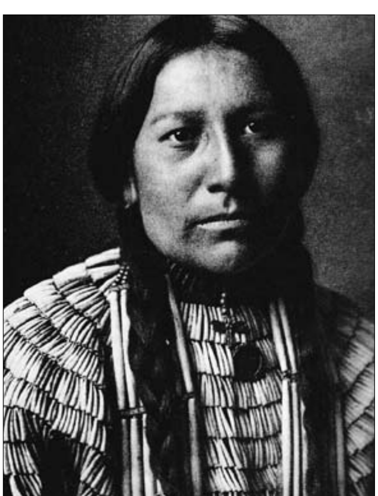
In 1778 Captain James Cook of the British Royal Navy visited the village of Yuquot ("Friendly Cove") on Nootka Island off the west coast of Vancouver Island. The island's fur trading potential led the British East India Company to set up a trading post at Yuquot, which became a focal point for English, Spanish and American traders and explorers. Trade between Euroamericans and Aboriginal peoples was initially conducted under the watchful eye of a powerful chief named Maquinna who acted as middleman, purchasing sea otter pelts using dentalia as currency, and reselling the pelts to white traders in exchange for other goods. Once the white traders realized that shells were used as money, they began trading directly with dentalia harvesters among the Nuu-Cha-Nulth and Kwakwaka'wkw people. The center of the fur trade subsequently moved to Nahwitti, a Kwakwaka'wkw village on the northern tip of Vancouver Island,[7] and dentalium shell money became a currency of cross-cultural trade. It was used throughout Alaska, down the Pacific coast as far south as Baja California, and across the prairies of the United States and southern Canada to the

Until the early 20th century, dentalia, also known as tusk shells, were harvested from the seabed off Vancouver Island and used as currency by Aboriginal peoples of the Pacific Northwest. The mollusk's muscular foot and streamlined shell allows it to burrow into sandy bottom sediments.





Illustrations: Laura Corsiglia



Edward S. Curtis

Oglala Sioux woman photographed in 1908 wearing a dress adorned with dentalium shells.

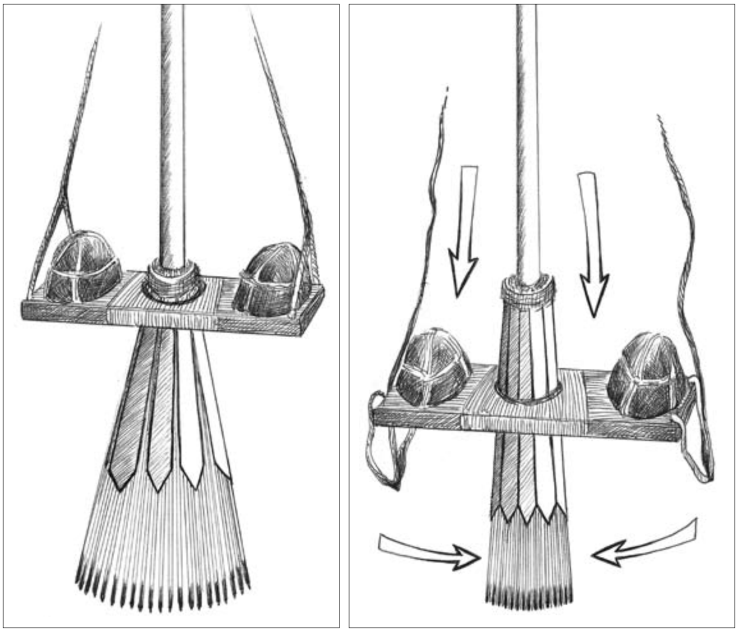
Great Lakes. The shell money was called *hy'kwa* in Chinook Jargon, a trade language spoken as a *lingua franca* in the Pacific Northwest during 19th and early 20th centuries.

In addition to their use as currency, the pearly white dentalium shells also served as decorative wealth: they were fashioned into necklaces, bracelets and hair adornments, and decorated the clothing of both men and women. "It was said that if a woman owned a dentalium necklace she could marry any man in the village. If she owned an entire shell dress, she could marry all the men in the village."[8]

It is generally agreed that the best dentalium shells were those harvested by the Ehattesaht and Quatsino people from shell beds off the west coast of Vancouver Island. These beds lay deep underwater — too deep for divers to hold their breath, too dark for them to see, and too cold to sustain a diving operation — so the Quatsino people designed specialized gear to harvest the money shells. Historical records indicate that a spear-like device with a very long handle and a bottom end resembling a "great, stiff broom" was used to pluck live dentalia from the seabed. Three of these implements still exist in museums in Victoria, British Columbia, and Seattle, Washington.[9]

Some scholars have thought it unlikely that dentalia could have been harvested live, arguing that the broom would be too difficult to handle and that the organisms burrow too deep in the sediment. In 1991, Phil Nuytten, a deep-sea engineer and inventor of a robotic diving suit called the "Newt Suit," resolved to fabricate a dentalium broom and find out for himself. "What I came up with," Nuytten stated, "was a generic device — a hybrid based on various old descriptions and my own knowledge of how tools work underwater."[10] Nuytten enlisted the help of Kwakiutl master carver John Livingston, who built the implement from local materials:

> He made the broom from a hundred sharpened yew splints, scorched to increase their hardness. He



Illustrations: Laura Corsiglia

Left: Phil Nuytten's dentalia-harvesting broom outfitted with a weightboard. Right: Loosening the ropes lowers the weightboard, an action that partially closes the broom head for grasping the shells.

Courtesy of Phil Nuytten, Nuytco Research Limited

Scientist and expedition leader Phil Nuytten is lowered overboard from a winch to land on the sea bottom where he observed the dentalium broom at work.

> then sheathed the bundle in thin slats of springy yellow cedar.
>
> Attached to a 70-foot-long handle made in sections, the head would be lowered from the surface and jabbed into the bottom. A board, weighted down by rocks and operated by a separate line, would then be eased over the outer slats, thus trapping whatever had been pinched between the inner splints.[11]

In Kyuquot Sound near Friendly Cove, Nuytten looked for the underwater shell beds in his high-tech eight-foot mini submarine — after Native scuba divers had pointed him toward the site. To test the harvesting implement, he then donned his Newt Suit and was lowered overboard by a winch to land on the dentalium beds below. Once Nuytten was in a good viewing location, John Livingston lowered the broom over the shell beds and pushed it about ten centimeters down into the sand and sediment. According to Nuytten, "When he lifted it up — jackpot!" The broom worked like a charm.[12]

Since the first expedition in 1991, Nuytten has continued his research and refined his design. Although various historical accounts and drawings show two rocks lashed above the broom end and used as weights,[13] in the final analysis he deemed the weight board unnecessary. "The craftsmen who built the original broom now housed in the museum was of the same opinion, although he likely reached it a century before us," stated Nuytten.[14]

Strategies for changing thinking

To introduce students to the story of dentalium shell money and to excite their interest in a problem-solving activity, I developed a short PowerPoint presentation. We began by looking at a 1908 photograph of the shell dress of an Oglala Sioux woman and discussing how clothing adorned with dentalium shells could signify an individual's or family's wealth. Students were then shown a map of the routes of the North American dentalium shell trade. They marveled at the extent of the trade and wondered how it happened that a shell became a currency. Finally, we looked at 1991 photographs of Phil Nuytten's mini-submarine and of Nuytten in his deep-sea diving suit being lowered from a ship.

The photographs served to heighten the students' curiosity. I asked: If it takes a mini-submarine for modern scientists to locate dentalium beds, and a pressurized deep-sea diving suit to harvest a few shells, how could Native divers have harvested large quantities of them? It was clear that Native harvesters must have invented a tool, a trap, or some combination of a trap and strategy to harvest the shells. But what implement, and from what materials? To make the problem more intriguing, I informed the class that dentalium shells had not been harvested for over 100 years; hence, the traditional knowledge required to harvest the shells appeared to be lost.

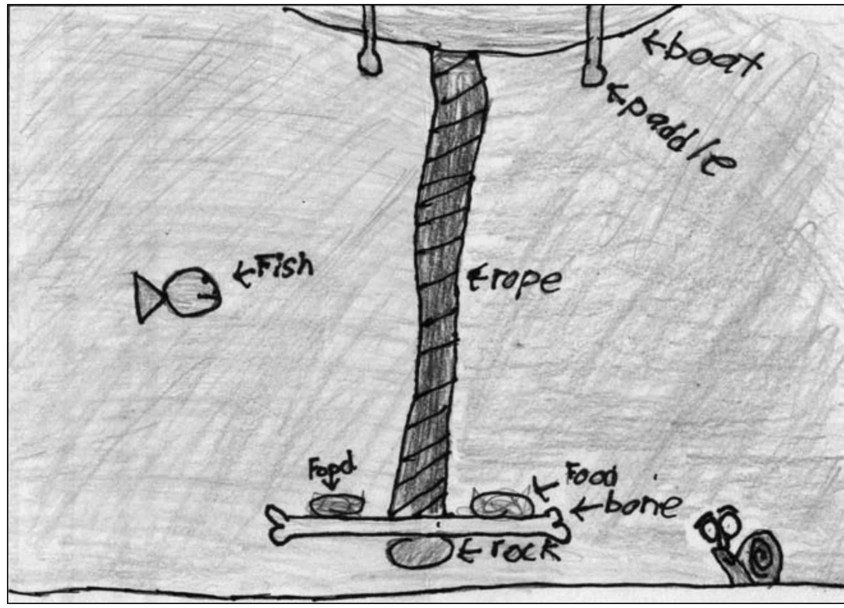
I then challenged the class to invent a means of harvesting dentalium shells — an implement and/or a technique for collecting or grabbing the mollusks. What knowledge would the Quatsino have needed to solve the problem? A Grade 5/6 class to whom this problem was presented brainstormed the following questions as I wrote them on the blackboard:

How deep are the dentalia?
What do dentalia eat?
What are their predators?
Do they come out of their shells?
How do they protect themselves?
Will hermit crabs live inside their shells?
Can dentalia be attracted to bait?
How do they move? Do they stick to rocks or dig?

Grade 11/12 students asked similar questions, and added the following ones:

Do dentalia rise to the surface to feed?
Do they live in sand or on rocks?
Would weather conditions such as storms make it impossible to harvest?
Would the tides or time of year affect harvesting?
Would the life cycle of dentalia be important to harvesters?

In addition, I asked the students to brainstorm what materials would have been available to the Native harvesters for developing their technologies. The Grade 5/6 students posited rocks, cedar trees, shells, hides and bark. The Grade 11/12 students added obsidian, bones, ropes made from cedar strips or kelp, the power of water, and flotation devices made from seal stomachs.



When challenged to design a dentalium-harvesting implement or technique, students came up with a variety of practical and fantastical strategies.

The students discussed possible answers to their questions, as well as how the Quatsino might have answered these questions. The students then worked in groups of three to five to design and draw a dentalium shell-harvesting implement. Each group was provided with large flipchart paper and colored pencils for representing pictorially the invented implements and harvesting techniques or strategies.

The groups took turns presenting their drawings and ideas to the class, each describing their implement, the materials it was made from, and how their implement and/or strategy worked. I encouraged the class to ask questions of the presenters, to critically explore practical considerations and to address the question, "Would the implement work?" Most students were skeptical that their newly invented designs would actually work.

I then showed the students the second half of the PowerPoint presentation, which introduced the Quatsino broom. We looked at sketches of the dentalia and discussed the organism's adaptation to coarse sandy bottom sediments: the long thin shells are streamlined for burrowing rapidly into sand with piston-like strokes of the mollusk's muscular foot. I then showed sketches of the dentalium broom and explained how the broom worked: its handle was made in segments, and the harvesters would lower the broom head by adding these extensions one at a time. Students marveled at the ingenious implement and the problem-solving skills of the Indigenous harvesters. Our paper-and-pencil drawings had only begun to solve the numerous problems that would have been addressed as the broom was designed, tested and modified over hundreds and thousands of years.

I asked the students whether, in the process of attempting to invent a dentalium harvester, they had been engaged in science. That is, had they asked questions, inferred, predicted, observed, communicated, built models, adapted, and interpreted information? The students were sure that they had engaged in science because the exercise had been an attempt to solve a difficult problem.

I then invited the students to consider these questions: Did Indigenous people engage in science when they developed the dentalium broom? To what extent had they made observations, asked questions, predicted, inferred, speculated, theorized, interpreted, invented and built models? To what extent were the originators of the broom required to understand the tides, ocean currents, adaptations of dentalia, qualities of materials, buoyancy, water pressure, and so on? The students agreed that although the broom was likely developed without knowledge of all of these concepts, the quest to solve the shell-harvesting problem was not haphazard. It was a systematic series of investigations conducted over a long period of time and involving a complex set of science-related concepts and processes. As it turns out, the Quatsino didn't need to understand the dentalium life cycle; but they did need to have an intimate knowledge of the type of substrate dentalia live in, the properties of available materials, tides and currents, and which organisms are indicators of the presence of dentalia (e.g., sand dollars and the purple olive snail). We discussed the likelihood that the Quatsino built and tested numerous models of the dentalium broom before perfecting its technology. We also considered the similarity between attempting to build an implement that works in an unseen environment (in this case the deep, dark seabed) and the way scientists build models to represent and understand what we cannot see.

Conclusions

I have conducted similar workshops with pre-service teachers, practicing teachers and graduate students. The result is always a celebration of drawings and strategies ranging from fairly skilled cedar baskets operated with a cedar rope, to variously fashioned nets or hooks designed to capture dentalia in the water column, to a variety of baskets, traps, scoops, rakes, snares and shovels designed to catch dentalia on the seabed. There are also fantastical ideas, such as a hollow cedar tree trunk through which the dentalia are coaxed to the surface with bait, a hollow tree through which a person climbs down to the bottom to pick up dentalia, a collection of hermit crabs that pick up the shells, and a trained shell-collecting octopus. (This activity is guaranteed to produce gales of laughter.) Not once has a student or teacher invented an implement similar to the one described in the historical journals.

Clearly, the introduction of Aboriginal examples adds interest, excitement and authenticity to the science classroom. Similar science and technology activities could be developed around such topics as fishing equipment (the halibut hook), dugout canoe, weir, fish wheel, tanning hides and cedar bent boxes. Students might also explore how Aboriginal people in different regions have dealt with the same concept or process. Even small differences in environment can result in surprisingly different ways of tanning hides, harvesting fish or making a canoe.

Cross-cultural science education is not merely throwing in an Aboriginal story, putting together a diorama of Aboriginal fishing methods, or even acknowledging the contributions Aboriginal peoples have made to medicine. Most importantly, cross-cultural science education is not anti-Western science. Its purpose is not to silence voices, but to give voice to cultures not usually heard and to recognize and celebrate all ideas and contributions. It is as concerned with how we teach as with what we teach. Instead of defining what science is, let students explore what the word “science” means to them. Encourage them to ask: Do traditional peoples have their own science? Have they made contributions to the body of knowledge we call “science”? If our ultimate goal is to have the greatest number of students derive the most benefit from our science lessons, we must plan these lessons to be inclusive. Our choice of wording, readings, experiments, classifications, resource persons and concepts can include and engage all students, or it can risk alienating students who see no depictions of people like themselves and thus receive an unintended message that science has nothing to do with them.

Much work needs to be done to create or revise science education lessons and activities to fit a cross-cultural science framework, but it is not impossible or overwhelming. If teachers can understand how the purposes of scientific activity have varied in different cultures and times, and how different cultures have developed sciences to meet their needs, then they can work towards developing innovative and culturally sensitive resource materials and teaching strategies that encourage students to broaden their understanding of the nature of science and of the relationship between science and culture.

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Notes

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