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## **Cultural Beliefs and Values, and Instructional Metaphors in the Science Classroom**

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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 'Yalıis. For a fuller description of 'Yalıis, 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**

|     | <b>DAN</b>      | <b>LUKE</b>        | <b>JIMMY</b>   | <b>MARY</b>        |
|-----|-----------------|--------------------|----------------|--------------------|
| 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):

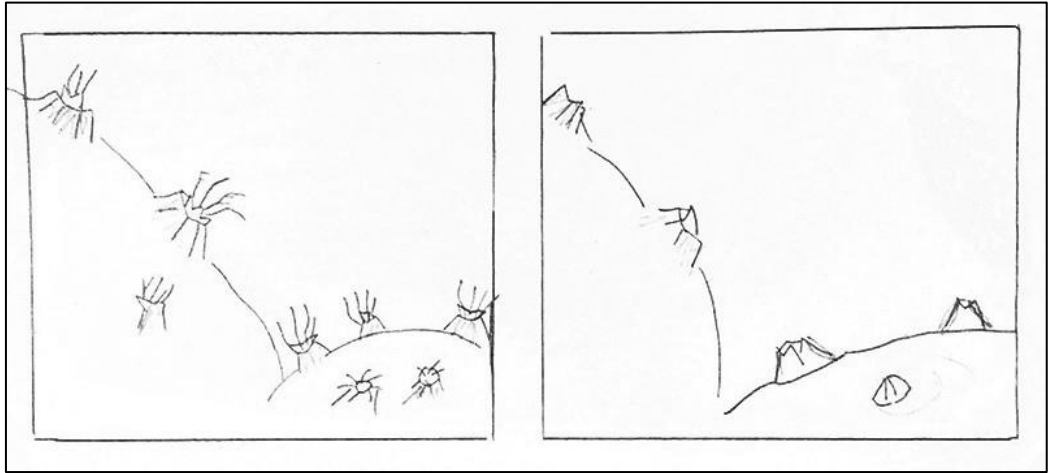


Figure 5.1 ▲ Dan's barnacles at high and low tide. Photo by Gloria Snively (1982).

**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 'Yālis 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.

|           |  |           |  |
|-----------|--|-----------|--|
| <b>1.</b> | ling cod<br>ratfish<br>whisker cod<br>perch<br>rock cod<br>trout   | <b>4.</b> | shell crab (Dungeness)<br>bullheads<br>eels<br>crabs   |
|           | <ul style="list-style-type: none"> <li>- they're all under water, they don't go deep in the sea</li> <li>- close to the seashore, just a little way out</li> <li>- you catch them from a line on the beach or a little boat</li> </ul> |           | <ul style="list-style-type: none"> <li>- when the tide goes down</li> <li>- they're all under the rocks at low tide</li> </ul>     |
| <b>2.</b> | seagulls<br>eagles<br>crows  | <b>5.</b> | barnacles<br>rocks   |
|           | <ul style="list-style-type: none"> <li>- they all fly</li> <li>- dive into the water to get fish</li> </ul>  |           | <ul style="list-style-type: none"> <li>- at the bottom of the sea</li> <li>- you can see them when the tide goes down</li> </ul>   |
| <b>3.</b> | flounders<br>red snapper<br>dogfish<br>sockeye salmon<br>pink salmon<br>hump salmon<br>black bass  | <b>6.</b> | killer whales<br>dolphins<br>seals   |
|           | <ul style="list-style-type: none"> <li>- they all go deep out in the sea</li> <li>- you catch them in nets in the seiners</li> </ul>   |           | <ul style="list-style-type: none"> <li>- they swim together</li> <li>- they eat fish</li> <li>- some people catch seals</li> </ul> |

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, Tłililáwikw 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 ‘Yalıis, 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 ‘Yalıis. 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 ‘Yá’lis 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’wala 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* (Wallas & 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:

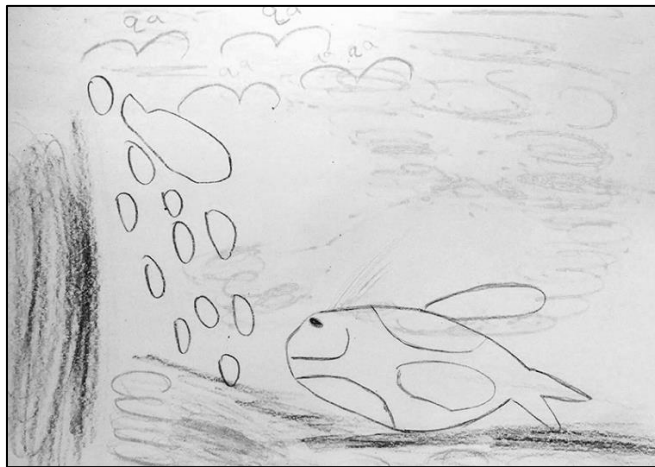


Figure 5.3 ▲ "The seashore is a happy song." Drawing by Luke. Photo by Gloria Snively (1982).

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.  
 Its 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:

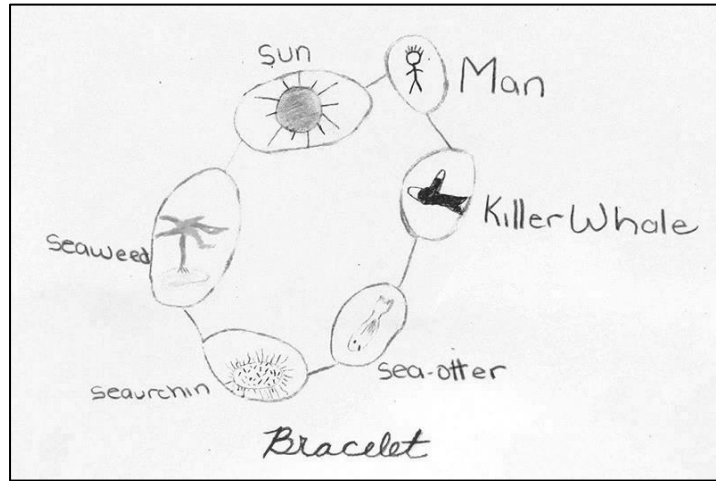


Figure 5.4 ▲ “The seashore is a bracelet.” Drawing by Mary. Photo by Gloria Snively (1982).

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 interconnections.

## **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:

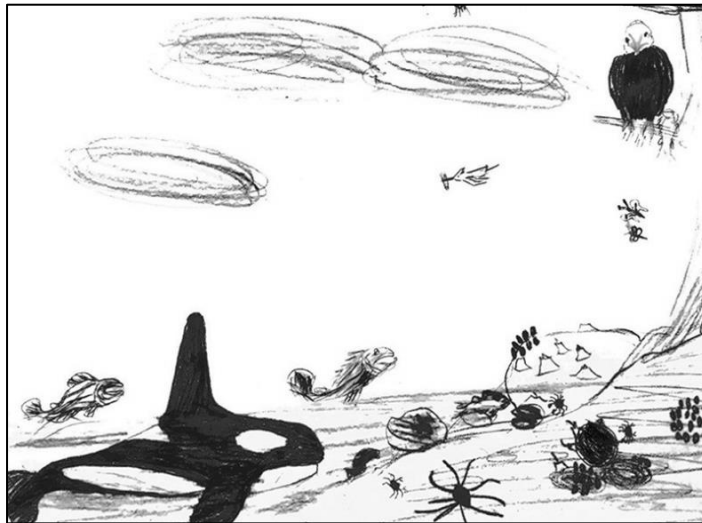
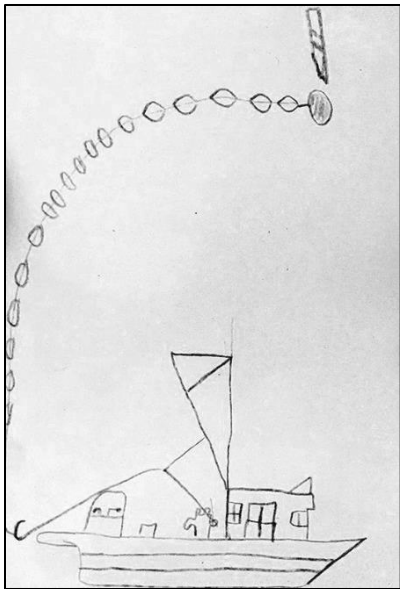


Figure 5.5 ▲ "The seashore is a neighborhood." Drawing by Dan. Photo by Gloria Snively (1982).

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:



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.

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).

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 ‘Yális 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 Kwakwáka’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 ‘Yális 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 ‘Yalis, 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 Kwak’wala 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 ‘Yalis 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.

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