The Effects of Experiential Learning on Grade Four Children's Knowledge of Marine Ecology, Their Attitudes towards the Ocean, and Their Stances towards Marine Resource Issues

by

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ABSTRACT

This study examined Grade 4 students' knowledge of marine ecology, their attitude towards the seashore and ocean, and their stances (preservationist, conservationist, exploitive) towards marine resource issues before and after a classroom instructional unit. Students' pre-instructional and post-instructional questionnaires, drawings and writing were collected and analyzed. Prior to instruction, the students knowledge level was low, however their ocean attitudes were positive and they were predominately preservationist and conservationist in their stances. The instructional unit was developed using a constructivist perspective with an emphasis on experiential learning and included field trips to the seashore and the investigation of a local marine resource issue (Pacific salmon stock depletion). A significant increase in knowledge and positive attitude was evident after instruction. As well, students' stances toward marine resource issues were less polarized. The results of the research have implications and recommendations for future research as well as for curricular development and program planning regarding environmental education in general and marine studies in particular.

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CHAPTER 1: AN OVERVIEW OF THE STUDY

Introduction

> *And then, as never on land, he knows the truth that his world is a water world, a planet dominated by its covering mantle of ocean, in which the continents are but transient intrusions of land above the surface of the all encircling sea.*
>
> Rachel Carson

Our earth is truly dominated by the sea. The oceans cover seventy-one per cent of the earth's surface and contain ninety-seven per cent of its waters. The human constructs of maps separate the seas into sections and boundaries, when in fact there exists but one large interconnecting ocean system constantly mixed by winds, tides, currents, and waves (Coulombe, 1992). This ocean system is home to more than 200,000 species of plants and animals ranging from the microscopic to the gigantic. In fact, it is estimated that nine out of every ten organisms on Earth live in the ocean (Sobel, 1989). Oceans help regulate climate and provide more oxygen than rain forests. Economically, oceans provide over 200 million jobs in the marine fishing industry and seafood is the main source of animal protein for nearly half of the five billion people on Earth (Canadian Wildlife Federation, 1996).

For Canada, a nation bordered by three oceans and consisting of one of the longest and most diverse marine coastlines in the world, the ocean is of particular importance. The waters off Canada's coasts are among the most resource-rich in the world containing huge reserves of oil, natural gas and minerals as well as valuable fish stocks. Canada has relied upon the ocean to serve as a water highway to transport and receive goods from around the world (Snively, 1989).

British Columbia has 27 040 kilometres of marine coastline including islands, headlands, inlets and bays. Thus, educators living in the coastal

city of Victoria have a vast resource at their doorsteps, for within short distances lie the wonders, the beauty, and the constant lure of the Pacific Ocean. Even in the most urban areas of the city, teachers can offer their students rich and powerful experiences through the study of marine ecology. By involving students in aesthetic and instructional marine ecology activities on local beaches, teachers can provide opportunities for their students to develop scientific skills and knowledge. More importantly, teachers can help their students learn to appreciate and develop a sense of stewardship towards the ocean ecosystem (Brody and Koch, 1989; Goodwin and Schaddt, 1978; Snively, 1989).

Most children living in the Greater Victoria area have likely visited the beaches in their local areas for recreational purposes. Some may have had educational experiences within interpretative programs either through schools or community groups. However, many have not had the chance to develop an awareness and appreciation for beach ecosystems. Therefore, it would seem that increased knowledge of marine ecology could lead to an understanding of the complex connections and relationships that exist in such places as tide pools and rocky shores, and in turn, enhance the development of positive attitudes towards the ocean. Moreover, these attitudes could assist children in the formation of opinions about the wise use of natural resources and in the long term assist them in becoming informed and responsible global citizens.

Context and Rationale

Examine each question in terms of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.

Aldo Leopold

Generally elementary school children do not have a well developed sense of ecological communities, especially the connections with and between communities, nor do they have a deep appreciation or understanding of their own natural communities. On many occasions, it had been observed by the author, that young children often show disregard for living organisms and their habitats. However, according to a study by Kellert (1985) children who have direct contact with animals rather than just studying about them are more appreciative and knowledgeable, and show concern towards the animals.

Unfortunately, humankind is faced with a multitude of ecological crises. Young children are keenly aware of and are able to describe many environmental issues (Brody & Koch, 1989). In classroom discussions, the researcher had observed that young children use words such as pollution, ozone layer, and endangered species. They are able to describe instances that illustrate these topics such as local oil spills, the need to use sunscreen to block out ultraviolet rays from the sun, or name dwindling numbers of certain marine mammals.

Children must learn basic ecological principles and concepts to be able to think critically about environmental issues. McClaren (1988), in his description of elements of environmental literacy, states that children need

to develop the ability to think about systems and move from awareness to knowledge to positive action. Ecological principles and concepts are important organisers for experience in the environment and provide insights into critically thinking about environmental issues. Children need to understand biological and geological cycles, food and energy relationships, and concepts such as adaptation and biodiversity.

It is this knowledge of ecological concepts that will assist children in developing the attitudes that result in making informed decisions about environmental issues. A positive relationship that existed between attitudes and knowledge was illustrated in a study completed by Fortner and Teates (1980) wherein they examined particular experiences that were related to students' marine knowledge and attitudes. Moreover, Jaus (1994) discovered in his study that even minimal amounts of instruction in environmental education is effective in producing highly positive attitudes and that it is possible for these attitudes to be retained over time.

Another important consideration for environmental educators in the development of attitudes and knowledge among children, is the importance of direct experience. By interacting with, and observing organisms within their ecological communities children will increase their awareness and understanding, and thus enhance their cognitive performance (Orion & Hofstein,1994). Studies of knowledge scores from student questionnaires relating to marine education (Walter & Lein, 1985) revealed that the highest scores were attained by those students who were taken on field trips to either the ocean or an aquatic area and that these students had a very positive attitude towards marine environments.

Experiential learning will also assist children to understand how ecological communities are connected to each other and to human populations. By observing plants and animals in their natural habitats, children can begin to understand biodiversity, interdependence, and the

before and after that instruction. Because the Snively and Sheppy questionnaires had been used with grade 5 and 9 students, the researcher also wished to determine if they could be used successfully with a younger group of children (grade 4).

Moreover, the researcher chose to examine pre-instructional and post-instructional student drawings of the seashore and their descriptive writings related to their seashore field trips. These students' drawings and writing would add a further dimension in assessing the changes in knowledge and understanding.

To provide a framework for interpretation, it was crucial that the researcher had clear definitions of attitude, knowledge, and stance. Therefore, for the purposes of this study, an attitude was defined as a favourable or unfavourable feeling towards objects, persons, groups or any other identifiable aspects of the ocean and seashore environment (Koballa, 1988; Shrigley, Koballa, & Simpson, 1988). Knowledge was defined as scientific information that these students possess in the areas of physical oceanography, ocean ecology, and human effects on the ocean (Snively & Sheppy, 1991). Stances were defined as the opinions that these Grade four students had towards a variety of coastal marine issues and represented an appropriate course of action to take in a given resource conflict situation, including conservationist, exploitive or preservationist (Snively and Sheppy, 1991).

After the study was completed, all data gathered (questionnaires, drawings, writing) and analyzed, the researcher used the information to address her research questions.

Method

Site and Participants. This study involved one class (n=26) of Grade Four students at Lampson St. School in Victoria, B.C. The school is located in the municipality of Esquimalt, which has a population of 18,000. The school and all students in its catchment area are within walking distance of a beach. Lampson St. School has a population of 302 students and is a Class One Inner City School meaning that many families receive a great deal of government economic and social support. Many of the children attending Lampson St. School have limited background experiences and the school as a whole has a higher than average percentage of students with learning difficulties. This particular Grade Four class (n=26) had three special needs students, two of which were non-readers. Of the remaining students (n=23) six were below grade level and 17 were considered to be average or above average Grade 4 students. As well, for six of these children, English was their second language. The site for this research study was chosen based on the researcher's and participant's familiarity with the school and community.

Esquimalt is one of the six municipalities of the city of Victoria, a mid-sized coastal city, with an area population of 300,000 people. Ocean based industries play only a small part in the economy of the city and other resource-based industries are not highly visible. Victoria is the administrative centre of the province of British Columbia. It contains a naval base and other military facilities located in Esquimalt, and is a major Canadian retirement and recreational community.

Research Questionnaires

Four questionnaires developed for grades 5 and 9 students and

described by Snively and Sheppy (1991) were used to collect the data in this study. The researcher modified two of the questionnaires to make them more appropriate to Grade Four students. This was the first time the Ocean Attitudes, Ocean Life, and Ocean Opinions questionnaires were used as described in the research phases of this study.

(1) The Ocean Background Questionnaire, contains 25 items which include questions about the frequency of students' visits to the seashore, the preferences for studying the seashore or ocean environment, their frequency of their use of the ocean for a variety of activities, and the frequency in which they engaged in learning experiences which were ocean-related. Items 5 to 25 were modified. The original questionnaire contained a 4 choice response: often, sometimes, very rarely, and never. The "very rarely" choice was omitted for use with the students in this study. It was thought that Grade 4 students would be more comfortable with three choices that were less ambiguous. (See Appendix A for the complete set of questions in the Ocean Background questionnaire)

(2) Ocean Attitudes Questionnaire is a 37 item questionnaire designed to assess students' orientations towards the ocean. Five choices are given for responses ranging from strongly disagree to strongly agree. The topics cover a variety of specific coastal issues such as wild marine mammals in captivity, removing seashells from beaches, and the commercial fishing industry. (See Appendix B for the complete set of questions in the Ocean Attitudes questionnaire)

(3) Ocean Life Questionnaire is a 30 item multiple choice questionnaire designed to assess students' scientific knowledge of the ocean and coastline. It consists of three sub-tests; Physical Oceanography (7 items), Ocean Ecology (14 items), and Human Effects on the Ocean Environment (9 items). About 1/4 of the items are directly connected to the B.C.

context. Five questions from the original 35 item questionnaire were omitted for this study. (See Appendix C for the complete set of questions in the Ocean Life questionnaire)

(4) Ocean Opinions Questionnaire is a 20 item multiple choice questionnaire in which students are asked to choose from among four options the one which best matches their opinion as to an appropriate course of action to take in a given resource conflict situation. Exploitive Stance options were written to express the point of view that immediate economic return is the prime concern in human interaction with the environment. Conservationist Stance options recognize that Canadian society depends upon the utilization of nature's resources to meet its needs and desires, but that the resources must be used carefully in order to prevent their depletion or extinction so they are maintained into the future. Preservationist Stance options were written to reflect the attitude that humans should interfere minimally or not at all with natural processes, that economic considerations should never be a factor in decision making or that humans should seek to restore the environment to some "natural" condition. The following is an example of the sort of item used:

> Some species of whales are not near extinction. What should be done about hunting these kinds of whales?
>
> A. Hunting whales should be allowed because it provides people with food, clothing and money.
>
> B. Hunting whales should not be allowed because whales are beautiful and intelligent.
>
> C. It is alright to kill a certain number of these kinds of whales as long as plenty are left.
>
> D. Hunting whales should not be allowed because whales are part of the food chain

Option A is the Exploitive option, option C the controlled use or Conservationist option, and options B and D represent the Preservationist stance. Students' responses will be scored so that each student receives an "Exploitative" score, a "Conservationist" score and a "Preservationist" score. (See Appendix D for the complete set of questions in the Ocean Opinions questionnaire)

Instructional Strategies

A constructivist view of learning guided the development of the unit on marine ecology as well as the instructional strategies for this study. This approach to learning takes into account the way children "develop their own mini-theories or personal constructs based on direct experience with the physical world and informal social interactions" (Driver and Oldham, 1986).

Therefore, the researcher sought to examine the children's prior knowledge of seashore and ocean ecology in order to provide relevant and meaningful instruction. The students were encouraged to become actively involved both individually and collectively in the learning process and learning was viewed as the way conceptions changed or became refined. Learning then becomes the product of self-organization and reorganization (Yager, 1991), and it is promoted through group interaction. Some of Yager's (1991) suggestions for organizing a science classroom wherein the constructivist model can work best that would be applicable to the goals of this particular study are:

a) use local resources (human and material) as original sources of information;

b) involve students in seeking information that can be applied in solving real-life problems;

c) extend learning beyond the class period, the classroom, and the school;

d) provide opportunities for students to perform in citizenship roles as they attempt to resolve issues they have identified.

A further emphasis was on active, process-oriented learning. Reading and writing activities need to be meaningful and conceptually integrated. Glynn and Muth (1994) suggest the use of reading activities such as newspaper articles relevant to concepts being covered, the use of trade books, and the use of a variety of textbooks as references. For writing to learn science, Glynn and Muth's (1994) authentic authoring tasks such as explanatory essays, field trip notes, journals, environmental action letters, and classroom newsletter accounts of the topics being covered, are appropriate strategies. An analysis of the student's writing can enhance the researcher's ability to trace their struggle with new concepts and the restructuring of knowledge as a result of instruction (Fellows, 1994).

The methods then applied to the delivery of the unit of study were activity based and employed resources that supported this view of learning. A brief outline of the experiential component of the unit of study is as follows:

The first field trip was a familiarisation of the site and the first place chosen for this study was a local beach located at Saxe Point Park in Esquimalt. It was within walking distance for the children involved in this study, thus providing an opportunity for repeated visits and allowing for optimum learning results (Falk, 1983). The part of this beach that was used for the direct experience has a small sandy area and an accessible rocky shore containing many tide pools even at average tide levels (i.e. not necessarily the lowest tides) wherein many marine plants and animals can be viewed in their natural habitats.

The other site was the Cowichan Bay Marine Ecology Station where the children were given further opportunity to explore the characteristics of living marine animals and plants using microscopes, in aquaria, on real time video, and through plankton collecting excursions.

A second trip was taken to Saxe Point Park after many key concepts were taught in the classroom. The children were given opportunities to apply the knowledge gained from classroom activities to a familiar seashore ecosystem.

After making the necessary preparations (permission forms, parent volunteer enlistment, discussion of behaviour expectations, park rules) the initial trip was made to the designated site and the children were encouraged to observe and explore with support from selected sensory awareness activities. *Science Inquiries at the Seashore* (Snively, 1989) provided a basis for these activities. The children were guided to observe and explore gently and unobtrusively. Opportunity was given for small and large group interaction by sharing and asking questions. The emphasis was on enjoyment, appreciation and celebrating children's natural sense of wonder.

Classroom instruction was designed to develop the key ecological concept of ocean communities. Lessons contained concepts pertaining to: ocean currents, waves and tides, seashore zonation, seashore plants and animals characteristic of each zone, predator/prey relationships, food chains and food webs, interdependence of seashore plants and animals, and marine mammals. Also, local marine issues involving waste management and potential oil spills and the impact on the local site was discussed. The issue of depleted Pacific salmon stocks as seen from many viewpoints (conservationist, commercial fishermen, biologist, government official, First Nations chief) was analyzed in depth using a role-play strategy (Canadian Wildlife Federation,1996; Snively, 1989). Teaching

activities and background information contained in curriculum resources such as *Exploring Beaches With Kids,* (Snively, In Press), *Project Wild (1990), Oceans (Mason, 1995), The Seaside Naturalist (Coulombe, 1992)* were used as well. Field guides such as *Exploring the Seashore (Snively,1978),* and *Seashores* (Zim and Ingle, 1989) were consulted to assist with identification of marine and plant animals, particularly when at the seashore. These resources were utilized to plan the unit of study and assisted the children to familiarise themselves with the vocabulary and concepts needed for each field experience. The children returned to the Saxe Point Park site for a second time and, although not part of this study, will return again in the late spring when daytime tides are at their lowest. Between the local site visits, the children went to the Cowichan Bay Marine Ecology Station as previously described, and received hands-on experiences with seashore creatures.

The children were required to keep a field log for recording descriptive and statistical information (date, time, tide levels, weather), and for sketching seashore animals, tidepools, zonation, and making observational notes. They were given time to reflect and interact with each other in small and large groups using their field logs. Classroom activities involved individual and group pursuits involving reading and writing to support active and constructive learning as well as promoting the use of scientific inquiry and problem solving skills.

Research Phases

Phase 1: Pre-instructional Activities. Prior to any instruction or discussion of the unit on ocean ecology, the children were asked to create a mental image of the seashore, perhaps one they have actually visited, and then draw a picture of that image. They were asked to include

as many marine plants and animals or other objects that could be found at the seashore. The students were also asked to make a list naming as many seashore plants and animals and/or any other objects (non-living) that could be found at the seashore. Students were allotted approximately 40 minutes for this activity. The purpose of this activity was to assess the students' awareness of the existence of seashore phenomena (plants, animals, rocks, tidepools), and begin the process of identifying their existing conceptions of a Pacific Northwest seashore community.

Phase 2: Pre-instructional Questionnaires. The Ocean Background, Ocean Attitudes, Ocean Life, and Ocean Opinions questionnaires were administered. Although each student had a questionnaire with which to refer, the statements and questions were read aloud by the researcher and the children responded on a separate answer form. An overhead diagram of seashore zones was used to accompany questions 147 and 148 of the Ocean Life questionnaire. The only further assistance the children received was clarification of vocabulary. The questionnaires were administered over a two day period.

Phase 3: Classroom Study. The planned unit of study was taught over an eight week period using the instructional strategies and resources previously outlined. The concepts were integrated into other subject areas (Language Arts, Art, Social Studies, P.E.) and not limited just to Science lessons. During all phases of the research, a journal was kept by the researcher describing the various events, student interactions, comments, general observations and reflections. Further data was garnered through pupil responses in their field notebooks and required written assignments. The curricular unit was designed to fulfil learning outcomes as prescribed by the B.C. curriculum for Science education as outlined in the Integrated Resource Packages (1995) and Environmental Concepts in the Classroom (1995).

Phase 4: Post-Instructional Questionnaires and Activities. After the unit of study was completed, the Ocean Attitudes, Ocean Life, and Ocean Opinions questionnaires were administered a second time. The children were asked to draw a second picture and compile a list of seashore plants and animals and/or any other objects (non-living) that could be found at the seashore.

Phase 5: Data Analysis. The student drawings were analyzed according to accuracy and detail in depicting a seashore environment. The pre-classroom study drawings and lists were compared to the post-classroom study drawings. The researcher examined what plants and animals were included in the drawings, how they were arranged in the pictures, and if the post-instructional drawings contained items that could be related to the students' field trip experiences. Representative samples from five students (three boys and two girls) were chosen to illustrate the changes that occurred in accuracy, detail, or conceptual understanding of a seashore community.

The lists were tallied and recorded according to number and type of responses. Categories such as living and non-living, local seashore life, ocean life, and freshwater life were used to sort the responses. The pre-instructional lists were compared to the post-instructional lists and percentages were used to illustrate the changes that took place in student responses.

A descriptive statistical analysis of the Ocean Background questionnaire provided information about how often the students had previously visited the seashore, how often the ocean was used for a variety of purposes (swimming, collecting seashells, exploring), how the students had learned about the ocean and how often they ate certain seafoods.

The pre-instructional and post-instructional Ocean Attitude, Ocean Life, and Ocean Opinions questionnaires were compared and analyzed.

Paired sample t-test were used to compare pre and post data on the Ocean Life questionnaire, the Ocean Attitude questionnaire and the Ocean Opinions questionnaire. Pearson product-moment coefficients were calculated to search for correlations among attitudes, knowledge and stances. As well, independent sample t-tests were performed to examine gender differences in attitude, knowledge and stance scores. The students' field logs as well as the researcher's journal were consulted to clarify findings and assist with data interpretation.

It was hoped that the findings and conclusions of this study would serve to heighten the awareness of not only environmental educators but science teachers in general, about the attitudes, knowledge, and opinions or stances that Grade Four students have towards beach ecological communities and issues related to marine ecosystems and the methods of assessing children this age. This would lead to implications and recommendations for curricular development and program planning regarding environmental education and particularly, marine studies.

Limitations

This study was limited by the possible bias of the researcher who administered the questionnaires, wrote the curriculum, taught the curriculum, analyzed the data and evaluated the findings. The research was conducted with one Grade Four class in School District # 61 (Greater Victoria) with children who demonstrated a wide range of academic ability. The sample size was very small and focussed. The curriculum was prepared specifically for this Grade Four class in Victoria, however it could be used and/or adapted for other classes in different districts.

The researcher came to this study with particular beliefs and values concerning the wise and careful use of all natural resources, and

specifically local resources that were being threatened by overuse and mismanagement, such as B.C. salmon stock depletion. Therefore, the children in this study may have been affected by the researcher/teacher's conservationist preferences and to some extend this influence may have extended to their choices on the post-test opinion and attitude questionnaires.

The administration and scoring of the pre and post-study questionnaires as well as the students' drawings and lists comparisons were also specific to the Grade Four class in the study. To some extent, observations of individual student interactions as they were involved in the classroom and field activities were difficult when the researcher was also the classroom teacher. However, the researcher attempted to reduce observer bias by writing descriptive observations and attempting to separate observable data from inferences and value statements. As well, the use of a teacher assistant and parent helpers afforded further partial compensation, as it allowed the researcher the focus on individual student behaviours both in the classroom and on the field trips. Furthermore, the bias in this study was counterbalanced by the collection of data from several sources and by the fact that the three questionnaires were objective assessments of the students' thinking.

Summary

Before this study was conducted, it was hoped that the researcher would determine the effects that an experientially based marine education unit would have on children's attitudes, knowledge, and stances towards a seashore ecosystem before and after instruction. This was demonstrated through the questionnaire results as well as through written and pictorial responses of the Grade 4 students throughout the study. By tracing any

changing attitudes, knowledge, and stances of the children involved in this study, the researcher hoped to determine whether or not a relationship existed between an increase in knowledge and the changes in attitude and stances toward the seashore and ocean.

The curriculum also focussed on increasing the students' awareness of different points of view on marine issues and hopefully assisted them to develop skills to become informed decision-makers in the future. It was further hoped that by conducting a pre-instructional and post-instructional study of the qualitative and quantitative data, the researcher could add new knowledge to our understanding of the study of changing attitudes, conceptions, and stances as a result of explicit instruction.

CHAPTER 2: A REVIEW OF RELATED LITERATURE

This chapter is organized around four major themes: 1) a definition of attitude for science educators and the relationship of students' attitude and knowledge; 2) values and issues as viewed in the context of marine and environmental education; 3) the constructivist approach to classroom instruction and learning; 4) experiential learning as a strategy to support positive changes in students' attitude and knowledge and enhance classroom instruction. These themes are reviewed to provide a theoretical basis for this study and to provide guidelines for classroom instruction.

Attitude and Knowledge

One of the primary considerations the researcher in this study needed to focus upon was the definition of attitude. Many constructs have evolved concerning the meaning of attitude and the researcher required a clear understanding of this term so that the analysis of the raw data collected would be consistent and unambiguous. An explicit definition of attitude is crucial to the understanding of how knowledge and attitude are related as well as the difference between values and attitudes. Furthermore, any reference to the affective domain of learning will surely address the central concept of attitude and any meaningful dialogue among researchers of student behaviour necessitates an understanding of the term.

Shrigley, Koballa, & Simpson (1988) outlined a definition of attitude for science educators. They addressed the origins of the attitude concept, how our understanding of the concept has changed over time and the subcomponents within attitude. Moreover, Shrigley et al. discussed how attitude compares and contrasts to belief, opinion and value, how the attitude trilogy (cognition, affection, conation) fit the definition, and the

major controversies that trouble the attitude concept.

Historically, attitude has evolved from describing a physical response, a motor readiness or vigilance, to a mental or cognitive response. At the turn of the century, physiologists used the term attitude to explain motor reflexes in the body, making it an observable behaviour and therefore easily measured. However, the Thomas & Znaniecki (1918) study of Polish farmers "gave attitude new prestige as a psychological concept" (Shrigley, 1988, p. 662). Later works (Fleming, 1967; Greenwald, 1968; Fishbein & Ajzen, 1975) add further descriptors of attitude which include an evaluative quality (one either likes or dislikes something), consistency "...the tendency of different individuals to behave differently in the same situation and the same individual to behave similarly in different situations..." (Kiesler, Collins, & Miller, 1969, p.8). This consistency attribute promotes the notion that attitudes can predict behaviour. A review by Schuman & Johnson (1976) suggested that the correlational consistency between attitude and behaviour is high enough to indicate that causal forces exist between attitude and behaviour. As well, attitudes are viewed by some as unobservable predispositions. Fishbein & Ajzen (1975) reported that attitudes provide us with a mental posture, a readiness to respond to experiences and situations in everyday life.

Attitudes are learned in many ways and the social influence of others is a significant factor. This influence can be direct, imagined or implied by other human beings. This leads to an important feature of attitude, that is, that attitudes are learned from experience and if attitudes are learned then they can be taught (Shrigley, Koballa, & Simpson, 1988). Learned attitudes have temporal stability (Miller & Colman, 1981), that is, they are enduring enough to be stable, but transient enough to be changed. Furthermore, attitudes have an object, whether that is an issue, an event, an abstraction, an idea, a person, or a group.

In order to solidify and clarify the definition of attitude, Shrigley, Koballa, & Simpson (1988) compare attitude to belief, opinion and value. Beliefs are factual and nonfactual cognitions (Fishbein & Ajzen, 1975), and can be divided into at least three categories: descriptive, inferential, and informational. A descriptive belief is observed directly and held with great certainty by the believer. Inferential beliefs cannot be observed directly but can be based on descriptive beliefs and informational beliefs can arise from knowledge provided by outside sources such as the media. Attitudes are organized around our beliefs and both are learned, are bidirectional (like/dislike), and have a tendency towards action. Beliefs are probably more enduring and some descriptive beliefs are observable.

When examining attitudes and values, Shrigley, Koballa, & Simpson (1988) state that the number of attitudes one person may possess can be infinite. Attitudes exist for every object, topic, concept, or human being that person encounters. This is not true for values which are "long-range moral or ethical imperatives, an end rather than a means" and from "values, moral judgments are made that are considered either right or wrong" (Shrigley, et al., 1988, p. 672). Both attitudes and values are dynamic and can be changed, although values are more complex, more persistent, and resistant to change. While attitudes are bidirectional, values are unidirectional, that is, values are favourable. A person may differ in the definition of the values of truth, beauty, or goodness, for example, but the basic value held for each of these is positive in nature.

Three traditional subconcepts of attitude have traditionally been cognition (the mental pictures of knowledge), affection (evaluation), and conation (behaviour). Each are related to attitude but in different degrees. Shrigley et al. (1988) state that this trilogy is no longer the standard bearer of the attitude definition. Changing views of cognition (a necessary setting for attitude but by no means definitive), affection, which has historically

overshadowed the importance of cognition and conation, and conation which may be replaced by behavioural intention (Fishbein & Ajzen, 1975) have led to a more serious look for more confirming data by researchers.

After deliberation over the subconcepts within attitude and the historical evolution of the interpretation of attitude, Shrigley et al. (1988) were able to illicit that an attitude is "a learned predisposition to respond consistently favourable or unfavourable toward an attitude object" (p. 66). This is the understanding of attitude for the study for which this literature review was written. The perception that attitude is a learned response, will help guide the researcher to design an instructional unit that will hopefully develop favourable student attitudes towards the seashore and ocean.

With a clear definition of attitude established, the researcher must determine whether there is a connection between increasing student knowledge of seashore and ocean ecology and developing positive attitudes towards seashore and ocean ecosystems. Several studies were examined to help the researcher develop inferences related to her research questions and to organize classroom instruction to maximize the opportunities for developing positive attitudes towards the seashore and ocean through an appropriate presentation of salient concepts.

One study, which involved almost 800 students, was undertaken by Fortner & Teates (1980). The researchers examined how much grade ten students living either near a marine coast or inland, knew about the oceanic environment and its influence on human affairs, the attitudes these students had towards some marine issues, the relationship of residential proximity to a marine coast, experiences that provided these students with oceanic information and what experiences are related to marine attitudes or knowledge. The researchers designed an instrument named The Survey of Oceanic Attitudes and Knowledge (SOAK) which indicated the current levels of marine awareness (knowledge and attitudes) and identified the

types of marine related experiences had participated.

Student performance on the knowledge section of the survey averaged 12.4 out of a possible 25 (about 49 percent) and 93 percent of the subjects expressed positive attitudes toward marine issues. The marine attitudes measured by the SOAK were composed of feelings, beliefs, and opinions. Some of the items "were probably based on an understanding of the basic concepts of earth forces and biological interrelationships" (Fortner & Teates, 1980, p. 16) while others called for opinions about government or corporate responsibility for the use of ocean resources. Seven of the attitude statements dealt with preservation of the marine environment while only one implied a personal commitment to a cause. "The attitude instrument as a whole, then, probably measured how students view humankind's relationship to the ocean, as opposed to measuring the students' depth of commitment to holding intact the natural systems involved" (Fortner & Teates, 1980, p. 16). Although the study found a "fairly strong positive relationship between attitudes and knowledge" (Fortner & Teates, 1980, p. 17) there is more required than good feelings about the ocean to make wise decisions concerning marine resource issues. As Fortner & Teates stated:

> Feeling good about the ocean, however, is hardly a reasonable basis for making rational decisions about whether coastal states should build deep-water ports to accommodate very large crude oil carriers or whether landlocked nations should have unlimited access to the resources of the high seas. The development of a marine-literate population is a necessity that transcends the development of good feelings. (p. 17)

Fortner & Teates (1980) expressed a need for " inclusion of more marine information in some form in a planned educational setting, a setting

designed to specifically increase knowledge, to heighten perceptions, or to foster positive attitudes" (p. 18).

If the setting to which Fortner & Teates (1980) refer is addressed in an educational context, would attitudes toward the environment change? Jaus (1982, 1984) in two studies provides evidence that even "minimal amounts of instruction in environmental education is effective in producing highly positive attitudes towards the environment..." (1984, p. 36). Jaus had observed that much of the research completed concerning the connection between attitude and knowledge in environmental education, involved secondary students. Because many attitudes are established and fixed by the time a student reaches high school, the proposal was made that instruction in environmental education take place in the elementary and/or middle school (Knapp, 1972). For this reason, Jaus choose to carry out his research with grade three and grade five children.

In the first study, Jaus (1982) used two grade five classes, one the experimental group and the other the control group. The experimental group received instruction in environmental education consisting of 15 lessons on 15 consecutive days. The topics covered were the Earth's resources, air pollution, water pollution, noise pollution, conservation of the biotic and abiotic environment, and the balance of nature. The control group did not receive any specific instruction in environmental education during this time period.

At the end of the treatment period, both the experimental group and the control group were administered a questionnaire designed by the investigator to measure their attitudes towards the environment. The students in this study were not asked to respond to the questions on the basis of any kind of personal commitment but rather respond to whether they thought grade five students should be aware of or know the concept inherent in each statement on the questionnaire. Jaus (1982) perceived this

would be more subtle and result in a more valid index of the students' attitude towards the environment. The group of grade five students who had received instruction in environmental education received a mean score of 89.31 and the control group of students had a mean score of 69.52. This indicated that the experimental group had significantly more positive attitudes towards the environment than did the control group.

In order to alleviate the concern that these results may have occurred even without instructional intervention, the instructional unit was taught to the control group and the attitude questionnaire was administered a second time to the control group. The second administration mean score was 89.11 and when this was compared to the experimental groups results, no significance difference was found. The 69.52 pretest score of the control group did indicate that at the grade five level, some positive attitudes towards the environment have been developed without the benefit of formal instruction. However, Jaus (1982) states, "the question teachers, science educators, and environmentalists must be concerned with is: Should we be satisfied with slightly positive attitudes toward the environment or should we provide instruction that produces strongly positive attitudes?" (p. 692).

Another question remains. Will positive attitudes that have been developed through instruction be retained over time? Jaus (1984) addressed this question when he chose two classes of grade three students, one an experimental group, the other a control group. Two hours of instruction in environmental education was provided for the experimental group after which an attitudinal questionnaire designed by the researcher was administered to both groups. As in Jaus's previous study, the experimental group had significantly more positive attitudes towards the environment when compared with the control group. These same two groups were tested again as grade five students and the experimental group remained significantly more positive than the grade five control group.

"The results of this study provide rather strong evidence that even two hours of instructions time devoted to the affective outcomes of environmental education augment children's attitudes toward the environment in a very positive way" (Jaus, 1984, p.36). However, Jaus does admit that even though teaching children about the environment is indeed worthwhile, there are no guarantees that such cognitive teachings will lead to positive affective outcomes and that the research remains inconsistent.

In another study by Armstrong & Impara (1991), the impact of an environmental education curriculum, *Naturescope*, was evaluated on the participants' knowledge and attitudes concerning the environment. The authors of this study point out that when considering environmental education curricula it is hoped that the individuals exposed to these materials will exhibit positive attitudes about the subjects studies. "These attitudes may be a function of exposure to the program or may have already existed. What is critical is that the program itself not result in negative attitudes" (p.36).

The design of Armstrong & Impara's study (1991) included experimental and control groups of grades 5 and 7 students who received both pretest and post test measures of knowledge as well as a pretest/posttest attitude measure. Both groups participated in the study and served as control groups for each other. Each group was pretested on two issues, exposed to the materials, and post tested on their issue and on the issue for which they served as a control group. The attitude measure was administered to a pure control group of six classes that had had no exposure to the *Naturescope* materials. The authors had earlier observed that the testing order could affect attitude scores: "students who took a knowledge test followed by an attitude measure scored lower on the attitude measure than those who took the tests in reverse order" (p. 37).

Armstrong & Impara (1991) did not expect tremendous differences in knowledge and attitudes under the naturalistic setting of their study. However, the authors of this study found that when evaluating the effect of an environmental topic on environmental attitudes, the theme of the topic must be considered. "Some topics are value sensitive and can be expected to affect attitudes more than topics that are less value sensitive" (p. 40) and as an example they cited a comparison between the study of endangered species and at the other extreme, the weather, both of which receive considerable media discussion. Weather, as a rule, is not presented from an attitude-altering perspective. Overall, Armstrong & Impara (1991) found that the classes in their study did exhibit positive attitudes following exposure to the *Naturescope* program.

Although there does appear to be a relationship between knowledge and attitudes in environmental education, their reciprocal impacts need to be determined. Higher knowledge scores have been associated with more positive attitudes (Fortner & Teates, 1980) and that intervention programs can increase knowledge and attitudes (Jaus, 1982, 1984; Armstrong & Impara, 1992) but does a more positive affect encourage learning and how does existing knowledge relate to knowledge acquisition? The relationship between knowledge and attitude is indeed a complex one. "Therefore, it is important to examine how each influences the other and how both are related to active participation in environmental concerns. One factor alone is apparently not enough to inspire environmentally responsible behaviour; both motivation and knowledge of what needs to be done are necessary" (Zimmerman, 1996, p.43).

Issues, Values and Stances

The desired goal of environmental education is responsible human behaviour (Disinger & Monroe, 1994; McLaren, 1992;) and the consideration of the factors that influence this behaviour will assist the educator in encouraging students. Another factor, besides knowledge and attitude as was previously discussed, is locus of control (Newhouse, 1990). "Locus of control is an individual's perception of his or her ability to bring about change through his or her behaviour" (Hines et al. 1987 from Newhouse, 1990, p. 26). An individual with an external locus of control cannot bring about change because they attribute change to chance or an outside power such as the government or God. People with an internal locus of control believe that they can effect change through their individual actions. It is easy to see how an individual can feel helpless and ineffectual when contemplating the environmental problems which face humankind today. However, Newhouse contends that the feelings of lack of control can be reduced by promoting an internal locus. Teachers can be highly influential by "giving children a say in matters that will affect them and by encouraging them to make their own decisions and critically evaluate the opinions of others" (p.27). When considering an environmental program that will foster the development of an internal locus, Newhouse offers some general guidelines:

> First, the program must be appropriate for the level of knowledge, attitude, and moral development of the individual...One of the central components must be...information about how ecosystems naturally function and the problems that are threatening the well-being of all life...Coupled with this should be information about action strategies, which may be best transmitted through the

> use of a respected role mode. Such information should explain both sides of environmental issues, encourage people toward direct contact with the natural environment, and stimulate a sense of personal responsibility and personal control. (p.31)

The study of environmental issues should then be a crucial component of a sound environmental education program. When students are given the opportunity to think about and discuss environmental problems, they draw upon knowledge and attitudes derived from both social and natural sciences (Brody, 1994). In a study conducted by Brody (1994) it was realized that there are a number of critical concepts for understanding ecological crises. Brody's team of researchers employed concept maps and interviews to identify conceptions related to environmental problems which selected students in grades 4, 8 and 11 could or could not be expected to possess. The concepts were organized into four categories: geological, physical and chemical, ecology, and natural resources. Children in grade four were found the be "primarily sensors in their approach to the world" (p. 430), that is, they had to see feel, or smell ecological problems for them to exist. Brody recommended that the concepts children learn be related to current ecological crises and that they be engaged in real-life issues to "reinforce the notion that scientific facts must be accumulated and analyzed in social and cultural contexts in order to make valid value judgments" (p.432). The curricula developed should stress "the interrelationship of all life and the factors which affect live on the planet earth. In order to preserve our very complex and fragile ecosystems we need a general populace knowledgeable in the area of both natural and social sciences and how they interact in today's world" (p 432).

Furthermore, Brody & Koch (1989), in an assessment of grades four, eight and elevens' knowledge related to marine science and natural resource issues, recommended that a sound marine science curriculum present a balance between the "integration of broad marine science, natural resource, and decision making concepts coupled to relevant environmental issues" (p. 26). Brody & Koch felt that "intelligent decisions concerning the management of the marine environment depend upon a fundamental knowledge of marine ecosystems applied to real-life events" (p. 26).

As well, Brody (1996) in another assessment of grades four, eight, and elevens' knowledge related to Oregon's marine resources, addressed ways in how educators could improve instruction in meaningful ways. According to Brody, children must learn to understand science in the context of the environment, society and the future of the human race and that the "logical step is to continue to (a) identify relevant real-world events that can help form the focus of instruction, (b) conceptually analyse science knowledge related to those events, and (c) determine students' existing understanding" (p.27) thus emphasizing the importance of connecting learners to the real world.

In a study by Ramsey & Hungerford (1989), the instructional effects of a formal environmental education methodology, issue investigation, and action training on middle school children was investigated. A program was developed that focusses on the development of responsible environmental behaviour and identified components related to this behaviour. These included:

1. knowledge of environmental issues;
2. beliefs concerning environmental issues;
3. values related to the environment;
4. individual and group locus of control;
5. environmental sensitivity;

6. knowledge of, and skills in, environmental action strategies;
7. and knowledge of ecological concepts. (p. 29)

The study involved eight grade seven classes, four experimental and four control groups. Traditional pretest and post test designs were employed. It was found by the investigators that issue investigation and action training directed at environmental issue analysis promoted responsible environmental behaviour among the experimental group of grade seven students and these students tended to use remediative environmental behaviours more frequently than students who did not receive this training. The program that was developed for this study also promoted the specific knowledge, skills, and beliefs critical to responsible environmental behaviour as well as significantly supported both individual and group locus of control. "Overall, it would seem that issue investigation and action training is an effective instructional strategy tending to foster independent environmental behaviour...[and]...issue investigation and action training promotes the cognitive and affective variables that were indicated by previous research to be significant predictors of responsible environmental behaviour" (Ramsey and Hungerford, 1989, p. 33).

Environmental educators, in their quest for providing the foundations of learning and experiences that will ultimately result in responsible environmental behaviour, need also to be aware of the types of attitudes that their students may possess. Kellert (1986) investigated children's attitudes towards animals using a previously developed typology of nine attitude types. These were naturalistic, which is an interest and affection for wildlife and the outdoors; ecologistic, a concern for the environment as a system; humanistic, a strong affection for individual animals, principally pets; moralistic, a concern for the right and wrong treatment of animals with strong opposition to cruelty; scientistic, an interest in the physical

attributes and biological functioning of animals; aesthetic, interest in the artistic and symbolic characteristics of animals; utilitarian, a concern for the practical and material value of animals or their habitats; dominionistic, interested in the mastery and control of animals typically in sporting situations; and negativistic, an active avoidance of animals due to indifference, dislike or fear. Survey scales were developed to measure each of the attitudes, although it proved impossible to obtain an adequate aesthetic scale. The relative occurrences of each attitude scale was assessed.

The most common attitude type according to Kellert's scales was the humanistic. In general the children in this study showed strong emotional attachments to animals with a tendency toward anthropomorphism. The second and third most frequent attitudes were the naturalistic and negativistic and the fourth was the moralistic with 70 % of the children objecting to hunting wild animals for their fur and 91% opposed to trophy hunting. The utilitarian attitude was fifth with the dominionistic attitude being relatively uncommon. The least frequently occurring attitudes were the ecologistic and scientistic. "These latter attitudes emphasize an intellectual perspective of animals, suggesting conceptual understandings of animals as somewhat uncommon among children" (Kellert, 1985, p. 33).

Significant differences among varying age groups were observed by Kellert (1985). "Younger children consistently placed the needs of people over animals and expressed minimal concern for the rights and protection of animals" (p.33) as well as expressed far less interest in wildlife. Younger children, those in the six to ten year age range, were "substantially less knowledgeable and informed about animals and the natural environment..." (p.33). A dramatic decrease in negativistic, utilitarian, and dominionistic attitudes and the corresponding increase in ecological, naturalistic, and moralistic attitudes was graphically illustrated

in the grade two to grade eleven children in this study. This rather contravenes the notion that small children have a natural affinity for living creatures when in reality "young children were the most exploitive, unfeeling, and uninformed of all children in their attitudes toward animals" (p. 33).

Kellert (1985) concluded that the "transition from second to fifth grade would be the most opportune time for emphasizing affective/emotional concerns for animals"...while the "interval between fifth and eighth grades"...offers the most promising possibilities for developing cognitive and factual understanding of animals" (p.38).

Another study that addressed attitude types was Bateson & Wolthers' (1988) paper concerning the effects of attitudes of primary children and the *Salmonids in the Classroom* curriculum program. Bateson & Wolthers stated that "the primary classroom message, of care, protection and appreciation, is probably more important to the child than the economic message, and is probably a good place to start the child's education about the environment" (p.9). The authors found that students who participated in the salmonid program became more fond of salmon and might be described as "pro-lifers for salmon" (p.18) even to the extend of rejecting the use of salmon for a resource. The students develop attitudes that would encourage future preservation (as opposed to conservation) of the salmon resource. "Preservation is one very important aspect of environmental education, but preservation techniques and programs are often implemented to the detriment of other aspects of the environment" (p. 18). Bateson and Wolthers (1988) label the attitude developed by children involved in the salmonid program as protectionist and feel that the many students do not seem to have a sense of the importance of the environment that is tied to the salmon's survival. Viewing salmon as an important component of the total environment needs to emphasized and clarified thus

not excluding other organisms including humans. Part of addressing the total picture should include resource issues. "The salmonid resource is at risk, and the issues for the salmonid resource problem should be dealt with at the early stages of a child's life" (p. 20). Furthermore, "we cannot expect students to meaningfully deal with environmental and economic issues surrounding the salmonid resource when they are older if we refuse to deal with the fundamental issues when their attitudes were being formed" (p. 20).

Perhaps the most confusing term in science education research, according to Shrigley, Koballa, & Simpson (1988) is opinion. It was felt that although more cognitive in nature than attitude, opinions lack evaluation, and are not a predisposition to act. Because belief and attitude have precise definitions, Shrigley et al. state there is little need for opinion as a research construct. However, further studies have viewed opinion as a valid and meaningful term.

Snively & Sheppy (1990) investigated student opinions in their study. Three categories, that they termed "stances" (p. 4), were used to describe a particular opinion or set of beliefs and values a student had to an appropriate course of action to take in a given resource conflict situation. These stances were referred to as the exploitative, the conservationist, and the preservationist stances, and Snively & Sheppy (1990) developed an ocean opinions questionnaire that would examine the way in which students responded to a variety of marine issue topics. This questionnaire was used with grade five and grade nine students in three different communities in British Columbia (Victoria, Campbell River, Williams Lake). Responses that were considered exploitative would be ones that expressed "the point of view that immediate economic return is the prime concern in human interactions with the environment" (p.4); a preservationist stance reflected the attitude that humans should interfere

very little or not at all with natural processes and "that economic considerations should never be a factor in decision making or that humans should seek to restore the environment to some natural condition" (p.4); a conservationist stance recognizes that people depend upon natural resources to meet needs and desires but that these resources must be used carefully to guard against depletion so they are perpetuated into the future. Just under one third (32.9%) of the children involved in Snively & Sheppy's study made choices that were preservationist, over one-half (51.9%) were conservationist, and only (14.9%) made exploitative choices. The questions offered choices that represented differing degrees within the same stance and more students chose the option nearer the preservationist end of the scale 11 out of 14 times. "The investigators interpret these data to mean that most students in elementary and junior secondary school favour careful use of the ocean environment with a substantial minority feeling that we should change it only minimally, if at all" (p.12).

A further consideration to make when attempting to interpret children's beliefs and attitudes is to explore the values that underlie children's thinking about the world. Snively (1983,1986,1987) used the construct of "orientation" to examine the relationships among students attitudes towards the seashore, their beliefs about specific ecological relationships, and their experience during science instruction. In Snively's study, which took place in a small coastal town in British Columbia with both Native and non-Native community members, orientation was defined as "a tendency for an individual to understand and experience the world through an interpretive framework, embodying a coherent set of beliefs and values" (p. 343). Snively identified six different orientations (scientific, aesthetic, utilitarian, spiritual, recreational, and health and safety) as well as several beliefs about seashore relationships and used these orientations to catagorize pupil responses.

Snively (1983, 1986, 1987) used the metaphor interview technique to gather student responses before and after instruction which focussed on ecological concepts pertaining to seashore relationships. During pre-instructional interviews, it was discovered that some students used one orientation predominately, only a few students held beliefs that were consistent with accepted science ideas and most students had strong associations between their orientations and the nature of their beliefs about seashore relationships. The post-instructional interviews revealed an increase in student knowledge about the seashore and a decrease of beliefs inconsistent with accepted science concepts. Although the cognitive gains remained constant over a six month period, many of the students still used orientations that they demonstrated prior to instruction providing evidence that these students orientations are deep-set conceptual structures and not easily changed. Snively's findings and methods are important considerations for researchers who wish to pursue a wholistic approach to understanding personal perceptions, feelings and value preferences.

Further to the notion of orientations, are the influences that a child's social and cultural background have on their beliefs and values. According to Snively (1990), a researcher needs to be cognizant of the dominant factors that may predispose a child's orientation towards a particular scientific concept.

Snively's study (1990) presented a wide range of orientations towards seashore ecology. Interviews before and after instruction illustrated that an increase in knowledge did not necessarily change the beliefs the students had about the seashore but provided a vehicle for richer and more diverse explanations of those beliefs and orientations. Snively found that this study helped explain why some students who tenaciously cling to a particular orientation that may be a result of social or cultural influences, reject science as it is taught in school. Another important

finding was "it is possible to increase a student's knowledge without altering substantially his or her preferred orientation" (p.54). This implies that science educators can present an authentic view of science set in a social and cultural context by using concrete and real situations relevant to the learner.

A Constructivist's View of Learning and Teaching

Learning has often been viewed as a passive act, an absorption of knowledge. However, current perspectives suggest that learning is an active process in which the learner is engaged in constructing meaning, whether from text dialogue or physical experiences (Osborne & Wittrock, 1983). This constructivist perspective is becoming a dominant paradigm in the field of cognitive psychology, one wherein "learners respond to their sensory experiences by building or constructing in their minds, schemas or cognitive structures which constitute the meaning and understanding of their world" (Saunders, 1992. P.136). These mental reconstructions are often not in accord with those of scientists or those given in textbooks and have been described as misconceptions or alternative conceptions (Viennot, 1979; White & Tisher, 1986). When analyzing how learning evolves within a constructivist framework, there are key factors that are emphasized. According to Driver & Bell (1986):

1. Learning outcomes depend not only on the learning environment but also on the knowledge of the learner.
2. Learning involves the construction of meanings. Meanings constructed by students from what they see or hear may or may not be those intended. Construction of a meaning is influenced to a large extent by our existing knowledge.

3. The construction of meaning is a continuous and active process.
4. Meanings, once constructed are evaluated and can be accepted or rejected.
5. Learners have the final responsibility for their learning.
6. There are patterns in the types of meanings students construct due to shared experiences with the physical world through natural language. (p. 453-454)

When learning is viewed through constructivist lenses, the focus of teaching becomes that of changing misconceptions or alternative conceptions. The teacher's role changes from a transmitter of knowledge to a facilitator of conceptual change by encouraging students to actively engage in the personal construction of knowledge. The design of curriculum then becomes a vehicle which will encourage children to change their ideas in useful and intended ways and engage them in activities which will help them construct ideas for themselves.

Driver & Oldham (1986) developed a curriculum sequence which embodied the constructivist theory of learning. The sequence comprised five stages: orientation, elicitation, restructuring, application and review. The orientation phase was designed to give pupils a purpose and motivate them for learning a topic. The elicitation phase made student ideas explicit. Some of the activities suggested for achieving this were group discussion, designing posters, or writing. The restructuring phase involved interchange of ideas which may lead to disagreement and challenges or an "an explicit attempt may be made by the teacher to promote conceptual conflict through the use of disconfirming or 'surprise' demonstration" (p. 118). Students can develop an appreciation for a range of ideas that will explain or describe the same phenomenon. During this restructuring stage the

students may begin to feel dissatisfied with their conceptions and be open to change. In the application phase, the students are given many opportunities to use their ideas in a variety of familiar and unfamiliar situations which assist in extending, consolidation, or reinforcing new concepts. In the final review stage, students are invited to reflect back on how their ideas may have changed. They may have been given an opportunity to monitor their learning through the use of a journal thus encouraging the development of metacognitive strategies.

Besides following the general structure outlined above, Driver (1987) further suggests ways in establishing an appropriate learning environment. Attention needs to be directed to the learning tasks which should be meaningful to the students. "If schemes are to be developed, the context in which this is done may be important in maintaining attention and facilitating later applicability of the conceptions" (p. 101). The learning environment itself needs to be non-threatening, supportive and encouraging, if students are to test new ways of thinking. Small group work will enable students to represent their ideas more readily and maximize the opportunities for discussion. As well, an emphasis on metacognition will help student reflect on their own learning and begin to appreciate what is involved in the process of conceptual change.

Driver (1987) also describes several teaching manoeuvres for promoting conceptual change that had been employed in the Children's Learning in Science Project based at the University of Leeds. Research was undertaken into the learning of science by 10 - 15 year old students in classroom settings. Depending on the nature of the students' prior knowledge, some of strategies used in this research project were: (a) broadening the range of the application of a conception, that is, extending or using students' prior knowledge as a resource; (b) differentiating the conception by clarifying and refining ill defined conceptions; (c) building

experiential bridges to new conceptions and in the case of younger children, through practical experiences; (d) unpacking a conceptual problem by dealing with related conceptions; (e) using a different model or analogy; (f) progressively shaping the conception through testing, adapting, changing; (g) constructing an alternative conception particularly in the case where a student's prior ideas are incommensurate with scientific conceptions (p.103-104).

Many researchers have suggested similar instructional strategies as Driver (1987) that support the constructivist perspective and enhance meaningful learning. Saunders (1992) outlines four instructional features that he feels are relatively easy to implement in science classrooms. First, Saunders (1992) advocates the use of direct sensory experiences in the form of hands on laboratory activities. By using the investigative or inquiry approach as a opposed to what Saunders calls the "cookbook" approach to laboratory wherein the design and the procedure of an experiment has been thought out by someone else other than the learner. In the investigative approach, active cognitive involvement is achieved by allowing the student to participate in the design of the investigation as well as making observations and predictions. "Consequently, in the investigative or inquiry lab, the learner is much more likely to be immersed in an environment rich with opportunities that evoke disequilibration and hence give rise to the potential for cognitive restructuring" (p. 139).

A second instructional feature Saunders (1992) proposes is that a constructivist classroom should provide students with opportunities for active cognitive involvement. Such activities as thinking out loud, developing alternative explanations, interpreting data, participating in cognitive conflict are a few of the strategies cited. Saunders (1992) also mentions the value of students working in small groups. "Small group work tend to stimulate a higher lever of cognitive activity among a larger

number of students than does listening to lectures and thus provides expanded opportunities for cognitive restructuring" (p.140).

The fourth recommendation Saunders (1992) outlines is that tests or exams with which students are ultimately faced be structured as to effectively stimulate students' higher thinking skills. Many commercial tests place a heavy emphasis on lower-level knowledge and the "more frequent use of quiz and test questions which tap higher-level cognitive abilities is a very important aspect of learning environments which help ensure that students will be more actively involved in meaningful learning" (p. 140).

Another research study by Watson & Konicek (1990) involving teaching for conceptual change outlines the problems and obstacles encountered as well as the strategies used by a grade four classroom teacher. The researchers state that changing one's way of thinking, substituting one theory for another, is not an easy task for either adults or children. Several barriers stand in the way and "among schoolchildren the strongest of these obstacles is likely to be stubbornness, the refusal to admit one's theory may be wrong" (p.682). Young children are often not given the chance to express their opinions and experiment with new ways of thinking. Therefore, they cling tenaciously to their old ideas and find it hard to assimilate new ones. Another barrier is language and the researchers cautions teachers seeking conceptual change to monitor new vocabulary. New and difficult words may confuse and frighten children causing them to be wary of new ways of interpretation. Perception can also block conceptual change. Children are taught to believe what they see, yet in science many concepts cannot be observed directly. Preliminary experience with existing ideas must be the precursor or an enlightened view is less likely to evolve. Another important obstacle to conceptual change is the developmental stage of the student involved and attention needs to

focus on the age of the child and choosing activities suited to their thinking and reasoning ability. "Children will modify their experiments to accommodate their beliefs long before they will change their beliefs to fit the evidence" (p. 683). Finally, science itself has critical barriers to understanding for children and adults alike. Teachers need to cognizant of the fact that teaching for conceptual change can be a lengthy process.

With the above barriers to conceptual change in mind, Watson & Konicek (1990) cite how teachers can actively promote new thinking patterns. First, relevance must be stressed and new concepts must be linked to the child's everyday life. Secondly, children should be asked to make predictions and not function as passive observers. Reflective thinking in journal writing gives pupils a chance to adjust their realm of knowledge. Thirdly, consistent thinking should be stressed. Teachers need to tactfully draw attention the inconsistencies in children's thinking and examine how two contradictory statements could be true. "The development of logical, consistent thought is thus a by-product of teaching aimed at conceptual change, and developing an orderly view of the world can prevent the compartmentalization of knowledge that occurs when students think that nature works one way at home and another way at school" (p.684).

Yager (1991) proposes that many teachers intuitively use many procedures that illustrate the constructivist learning model. Examples of these strategies are: using student ideas to guide lessons and plan units, accepting and encouraging student initiation of ideas, encouraging use of alternative sources for information, using open-ended questions and encouraging students to elaborate on and explain their thinking, encouraging students to test their own ideas, encouraging students to challenge each other's conceptualisation and ideas, using cooperative learning strategies, allowing time for reflection and analysis, and

encouraging self-analysis and reformulation of ideas in light of new experiences and evidence (p.56). Yager also offers ten points to characterize a science classroom where the constructivist model can work best (p. 56). All of these suggestions revolve around providing the optimum learning environment, child-centered learning by involving students in seeking information that can be applied to real-life situations, use of local resources, and extending learning beyond the classroom.

The strategies that have been outlined above represent approaches to a broad spectrum of science conceptions. When applying constructivist views of learning and teaching to environmental education, Ballantyne & Packer (1996) state a "constructive approach to environmental education would help students to become aware of their own and alternative conceptions of the environment and environmental education" (p.29). The way an individual interacts with their world would be explored and inconsistencies between aspects of environmental knowledge, attitudes, and behaviour would be challenged. Students would then be encouraged to make informed decisions and commitments within their frameworks of understanding.

Ballantyne & Packer (1996) maintain that a balanced environmental program address the three dimensions of knowledge, attitudes/values and behaviour and that a range of strategies be employed that would be applied to all these three dimensions. The researchers caution that the procedures they suggest should not be viewed in isolation but rather applied to all dimensions in an integrated manner.

The constructivist approach in the environmental knowledge domain can be utilized using the strategy of group-learning according to Ballantyne & Packer (1996). Group-learning allows the learner to become cognizance of another person's perspective and extends, clarifies, and challenges their cognitive development. "The process of inducing cognitive conflict in the

learner by presenting alternative conceptions or incompatible knowledge in an interpersonal context is the basis for many group-learning strategies" (p.30). Environmental educators need to be aware of their students' current and alternative environmental conceptions thus optimizing such techniques as small group projects, role playing or task assignments. Scenarios that are structured and designed to confront students with new knowledge that would encourage them to examine their existing conceptions would challenge them to reevaluate their understanding and response to environmental issues.

Approaches to environmental education, as has been previously established in this review, must recognize the interdependence of the cognitive and affective domains. Ballantyne & Packer (1996) state that it "is important that strategies that address the affective dimension are given adequate attention, for this dimension is likely to be particularly salient in regard to an individuals' level of commitment and the choices that are made when alternative or conflicting actions are supported by different attitudes or values" (p. 30). Direct experience with environmental object and/or issues is crucial to the development of positive environmental attitudes (Newhouse, 1990). A strategy to enhance the effectiveness of direct exposure, particularly when participating in outdoor experiences, is the use of personal journals (Ballantyne & Packer, 1996). "Such an approach enables students to become aware of and explore their feelings toward the environment, reflect on their own and society's interrelationship with the environment, and reevaluate their conceptions of why particular environmental issues are important" (p. 30). As well as personal journals, Ballantyne & Packer (1996) suggest the use of narratives, that is, encouraging students to tell their own stories of real-life environmental conflict and choice. Through story-telling, conflicts can be identified and appraised and students receive the opportunity to become responsible for

their own stances. And included within personal journals and story-telling, traditional values-education techniques may also be applied within a constructivist framework. These value-education techniques can help students become aware of, explore, and clarify their own value systems.

The third dimension which Ballantyne & Packer (1996) state must be included in a comprehensive and effectual environmental education program is the action or behavioural dimension. Issue investigation, wherein students choose an issue of personal interest based upon real-life situations, investigate that issue in depth and develop an action plan as well as implement it, is a recognised approach (Hungerford & Volk, 1990) that can bring about change or development of student conceptions. Alternatively, the extended case study can be employed. This method proceeds similarly, with students focussing on an issue predetermined by the teacher (Ballantyne & Packer, 1996).

All the above strategies (Driver & Oldham, 1986; Driver, 1987; Saunders, 1992; Watson & Konicek; Yager, 1991; Ballantyne & Packer, 1996) developed within a constructivist perspective are by no means definitive or comprehensive. Rather, these approaches represent a cross-section of constructivist approaches that will assist this researcher in designing a meaningful science and environmental curriculum, appropriate to the age and ability of the students involved in her study. If curricula takes into consideration the existing knowledge of students and directly addresses student misconceptions it will then indeed be a more meaningful learning experience for the student. Environmental issues involve students in real-life topics that connects scientific knowledge to the realm of the learner and science education does not become rote memorization of meaningless facts from a textbook. "Environmental studies should stress the inter-relationship of all life and the factors which effect life on earth. To preserve this very complex and fragile system we need a general

populace knowledgeable in the area of science and natural resources" (Brody, 1987, p. 80).

Experiential Learning

Responsible citizenship is one of the ultimate goals of environmental education. Developing experiences for children that will prepare them in becoming critical thinkers and wise decision makers must include an experiential component. A review by Backman & Crompton (1984/1985) suggest that the outdoors may be effective in stimulating critical thinking, increasing problem-solving skills, and developing concepts rather than rote memory. Environmental educators who strive to make curricula meaningful to their students will undoubtedly include field trips as an integral part of their programs. In this section, support for these claims as well as guidelines for maximizing positive learning outcomes of a field trip will be addressed.

An enormous amount of literature has been published about field trips in science education (Orion & Hofstein, 1991). One such study is that of Lisowski & Disinger (1991) whose research focussed on students' conceptions of ecological concepts and the influence of field instruction strategies. Three separate experiential marine science field programs were evaluated and students were tested before and after school-sponsored 7-day instructional excursions. Lisowski & Disinger found that "(1) prior knowledge is a significant predictor of post test scores; (2) gains in conceptual understanding are positively related to instructional emphasis; and (3) field-based programs in the sciences are effective in assisting students' understanding and retention of selected ecological concepts" (p. 23).

In a report by Milton, Cleveland & Bennett-Gates (1995) on a

park/school program developed by the Urban Resources Initiative at the Yale School of Forestry and Environmental Studies in cooperation with school teachers and urban park rangers, field studies were conducted involving 46 grade five students. These students were introduced to natural resources and the development of social skills in a neighbourhood park. The program succeeded in its aims of increasing ecological knowledge as well as an indication that responsible environmental behaviour can lead to positive attitudes, a sense of responsibility, and a feeling of personal efficacy.

In another study, Walter & Lein (1985) sought to find out how much Canadians knew about their marine heritage, their attitudes towards marine resources and how they learned about oceans and marine ecosystems. A national survey involving approximately 4000 students and 200 teachers from across Canada elicited many significant responses. In general, the students surveyed were concerned about marine issue and showed respect toward it. When examining student experience with and knowledge of marine environments, students frequently reported that their most important source of information was the school. Highest knowledge scores were attained by students who claimed that they learned most about oceans from television and direct experiences with the sea. "However, those students that were taught about the sea in school and were taken on field trips to either the ocean or an aquatic environment did show higher knowledge levels" (p. 197).

The value of field trips is well recognized by science and environmental educators, however more important factors lie in the design of the field trip experience. Preparation for the field trip is of prime importance in order for student learning to be maximized (Gross & Pizzini, 1979; Orion & Hofstein, 1994). The field trip itself should not be an isolated event but connected to learning that both precedes the experience

and follows it (Farmer & Wott; 1995; Orion & Hofstein, 1994).

The choice of place and the length of time spent in one place has a direct influence on the effectiveness of a field trip. Falk (1983) examined aspects of field trip environments and found that environmental novelty was an interesting and consistently important variable. Generally, children in the 10 -12 age range were ready for day long trips to stimulating environments such as outdoor centres and museums. However, younger children may not be as receptive unless more than one trip is planned to the same place. "A first visit can emphasize activities that will familiarize students with the setting, while later visits can focus on more conceptual material" (p.141).

The length of time spent in the outdoors does seem to have an effect on developing positive environmental attitudes. Shepard & Speelman (1985/1986), in a study involving campers attending an outdoor education program as part of their camping experience, found that the resident programs of five days in length seemed to have had a more positive effect. Also, campers from urban areas needed an initial period of acclimatization involving sensory awareness activities utilizing the natural surroundings.

Orion and Hofstein (1994) encapsulated the factors that impact on trips to natural environments. Learning efficiency might be influenced by three main sources: (a) the place of the field trip within the curriculum (placing the field trip in the earlier stages of the unit of study as a means of concretization); the extent of the students' novelty or familiarity of the place while on the field trip (adequate preparation); and the design of the field trip program (learning materials, structure, teaching and learning strategies). In their study, Orion and Hofstein found that three student characteristics before the trip were of significance and described what is termed "novelty space". These factors are (a) level and type of knowledge and skills of the students involved; (b) familiarity with the field trip area,

and (c) psychological preparation. "Preparation which deals with the three novelty factors can reduce the novelty space to minimum, thus facilitating meaningful learning during the field trip" (p. 1117). Practical concrete activities that can aid classroom preparation include: working with materials the children will meet in the field; simulation of phenomena and processes involved; slides, films and/or maps of the area to be visited; detailed information about the event such as purpose, length of time, expected weather conditions, difficulties to be encountered, etc.

Field trips are an important and well-used component of many curricula and a very critical aspect of a sound environmental education program. If used with adequate preparation of both educator and student, a field trip can be an incredibly valuable method of enhancing student learning.

Summary

This review was organized to include a variety of aspects concerning: (a) the relationships between attitude and knowledge in student learning; (b) values and issues as viewed in the context of marine and environmental education; (c) the constructivist approach to classroom instruction and learning and; (d) experiential learning as a strategy to support positive changes in students' attitude and knowledge and enhance classroom instruction. The knowledge the researcher assimilated by reading relevant literature maximised the chances of providing for her students a rich learning experience that will develop the intended increase in knowledge of seashore ecology, awareness of local marine issues, and the development of enduring positive attitudes towards seashore and ocean communities. The author is cognizant of the wealth of theoretical knowledge and numerous recommendations and implications contained in the areas that

were targeted in this literature review and felt it was necessary to explore the four themes to gain a global perspective. This holistic view is crucial to effectively address the research questions in the author's study and offers a spectrum of strategies to utilize in curriculum construction. This review also reaffirms the author's beliefs in the importance of environmental education as an integral part of every school's curriculum and the development of positive attitudes in children based on meaningful knowledge about their world.

CHAPTER 3: THE STUDENTS' KNOWLEDGE AND BELIEFS PRIOR TO CLASSROOM INSTRUCTION

Qualitative data representing students' conceptions of a seashore community and quantitative data pertaining to students' background, knowledge, attitudes, and stances were compiled and analysed prior to a unit of instruction on selected aspects of seashore and ocean ecology. This chapter will outline the pre-instructional findings of the samples collected of students' drawings and their lists of seashore items as well as present a descriptive review of results obtained from the four pretest questionnaires: (a) Ocean Background Information; (b) Ocean Attitudes; (c) Ocean Life; and (d) Ocean Opinions.

Students' Drawings and Lists

A constructivist view to learning and teaching maintains that a learner's prior knowledge is the most important ingredient in the process of meaningful learning (Ausubel, 1968). Therefore, assessing prior knowledge of a seashore community can identify student conceptions and assist the educator in planning explicit instruction and will address the misconceptions or alternate conceptions currently held by those students concerning the indigenous seashore plants and animals of the Pacific Northwest coastal regions.

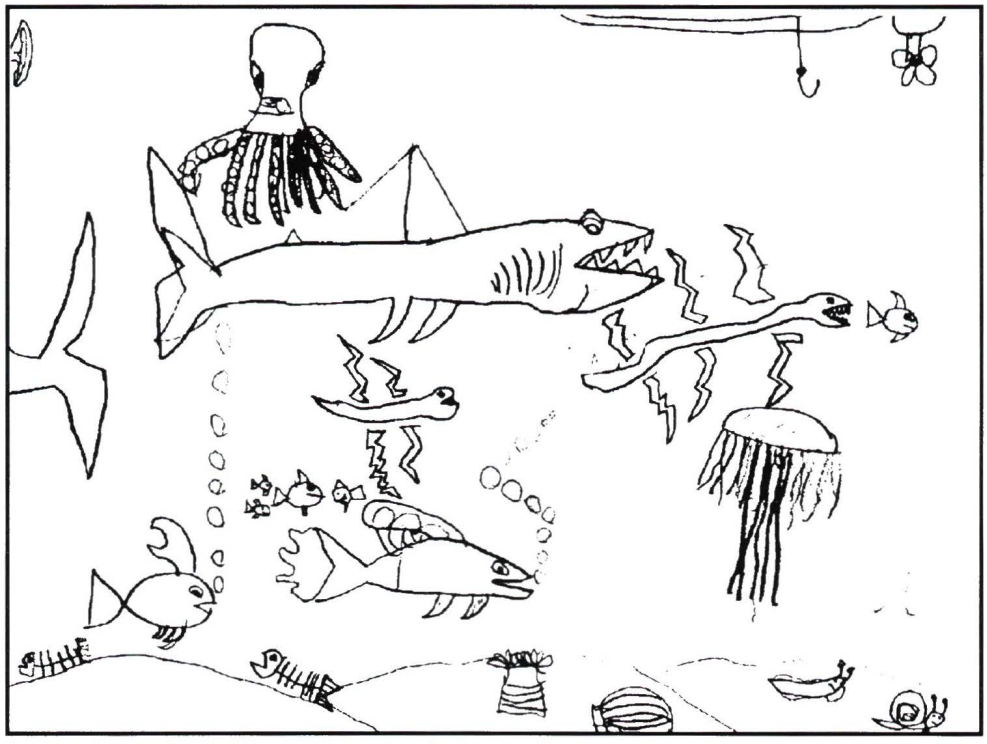
Although twenty-six children were part of the study, only twenty-one student drawings were collected before the instructional treatment and were examined for specific details about seashore communities. Drawings from the children who were not present for both the pre-instructional and post-instructional sessions were not used in order to maintain consistency with the comparisons. However, the unused drawings were similar to those reported and contained no unusual characteristics. The children had been

asked to draw a picture of the seashore, one that they had preferably visited and some examples of local sites were given. As some of the children in this class had moved from inland regions of British Columbia and one child was from England, the option was given that if they had not visited a local beach they could draw one they had seen or read about. The researcher took into consideration the possibility of some children never having had visited a seashore. During the pre-instructional drawing session, the children seemed ill at ease and asked many questions such as, "Can we draw killer whales? Can we draw an ocean picture?" The researcher simply repeated the same instructions and left the decision to the children.

Of the twenty-one drawings that were examined, 14 (67%) depicted the ocean rather than the seashore. Five children's drawings that were representative of all the drawings viewed were chosen for discussion. The researcher chose two girls' and three boys' pictures. Three of the pictures (Laura, Greg, Kelly) were ocean related as opposed to the seashore and the other two (Jamie, Robbie) were chosen because they depicted only the seashore. Jamie's picture represented the same features as most of the children who drew the seashore and Robbie's picture displayed unique features that were not found in any other students' drawing. The same children's post-instructional drawings were used to compare growth in the students' knowledge of indigenous sea life as well as to find similarities between the concepts covered in the instructional unit and the items represented in each picture.

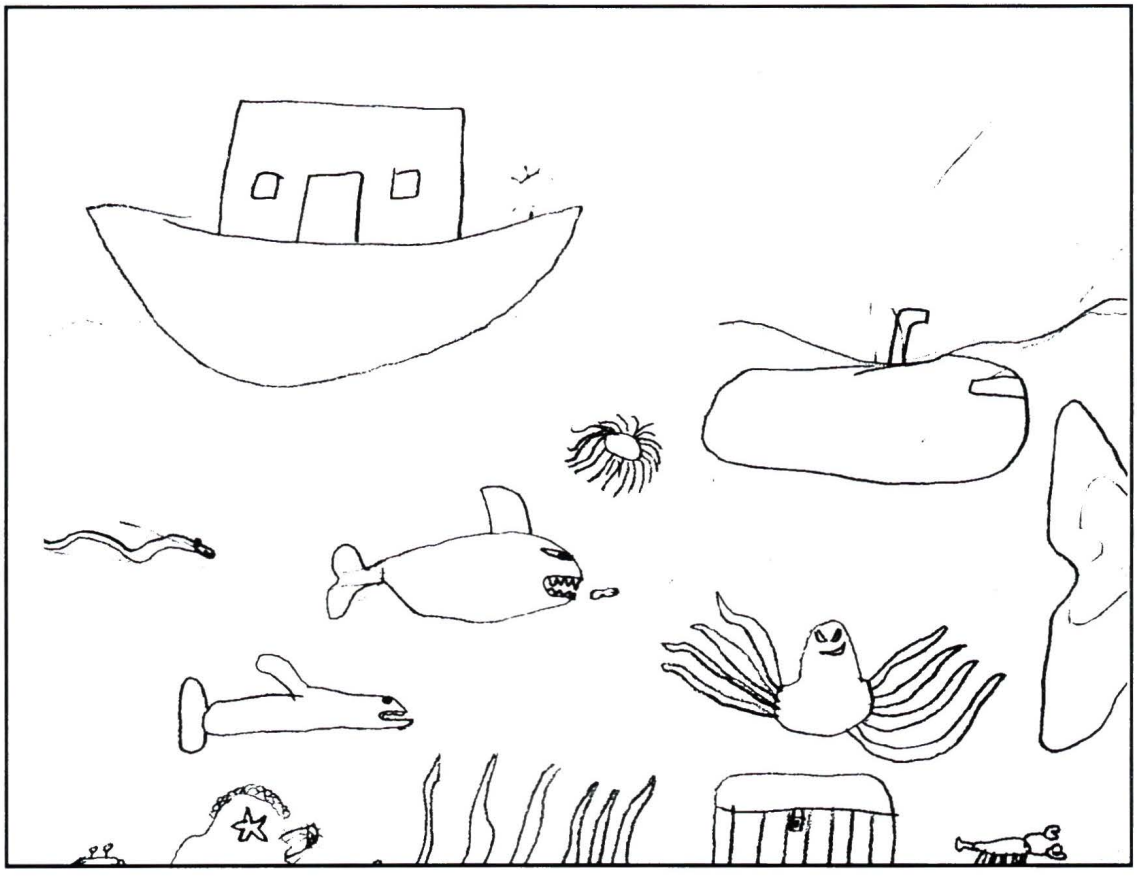
Laura's drawing, (see figure 3.1), illustrated many ocean creatures rather haphazardly and disproportionately placed in the middle of the page. The top showed the bottom of a boat with a line and hook dangling into the plethora of sharks, electric eels, and other fish or fish-like animals. The bottom of the ocean was reserved for dead fish, an anemone, and two sea snails. There was also a large floating octopus and jellyfish, but no sea plant life. Laura seemed to think that she had to choose the ocean to depict a variety of living creatures as she was one of the students who asked several times if she could draw the ocean rather than the seashore.

Figure 3.1 - Laura's Pre-instructional Drawing



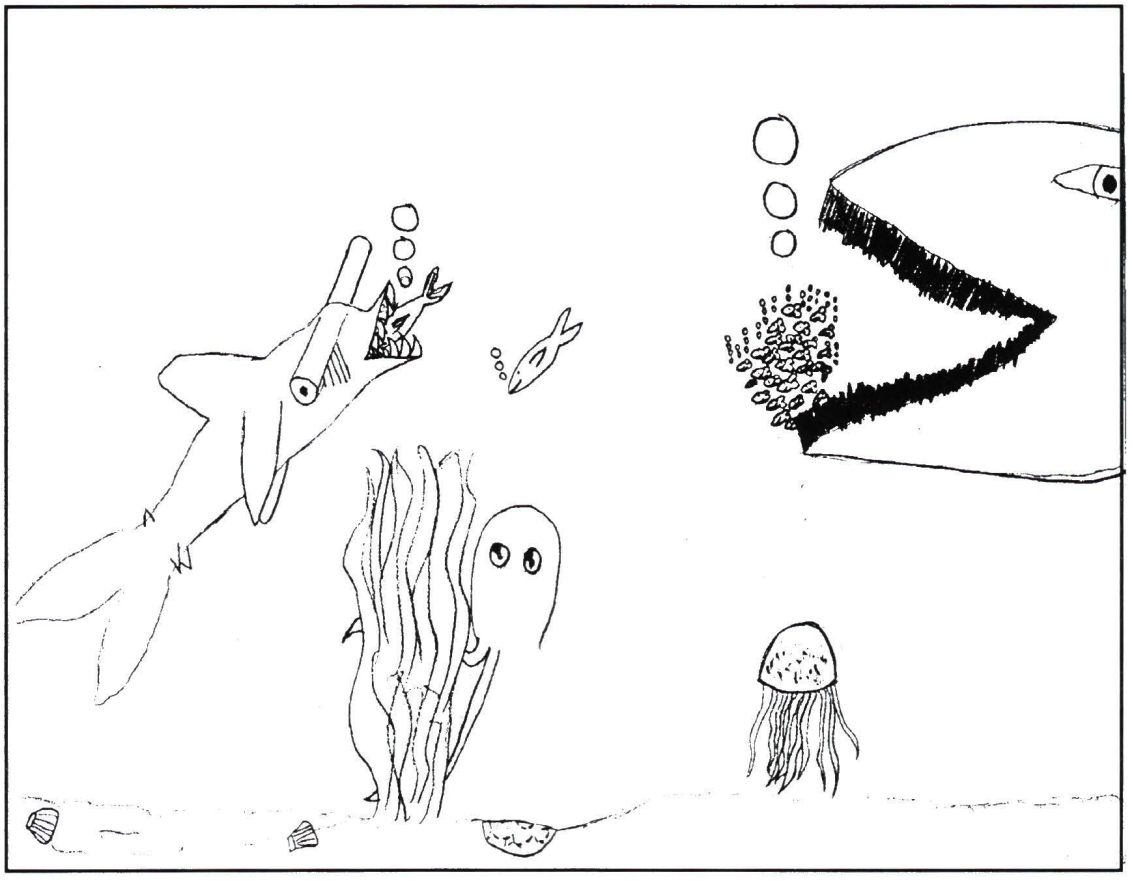
Greg's drawing (see figure 3.2) again depicted the ocean and included some whales, an octopus, and jellyfish. Greg gave his creatures human qualities by drawing angry looking eyes and mouths. The smaller creatures like crabs, lobsters and sea stars were on the bottom of the ocean floor along with some plant-like structures. Greg also included a boat, submarine and treasure chest, but no people. This seemed to hint of a human usage of the ocean environment.

Figure 3.2 - Greg's Pre-instructional Drawing



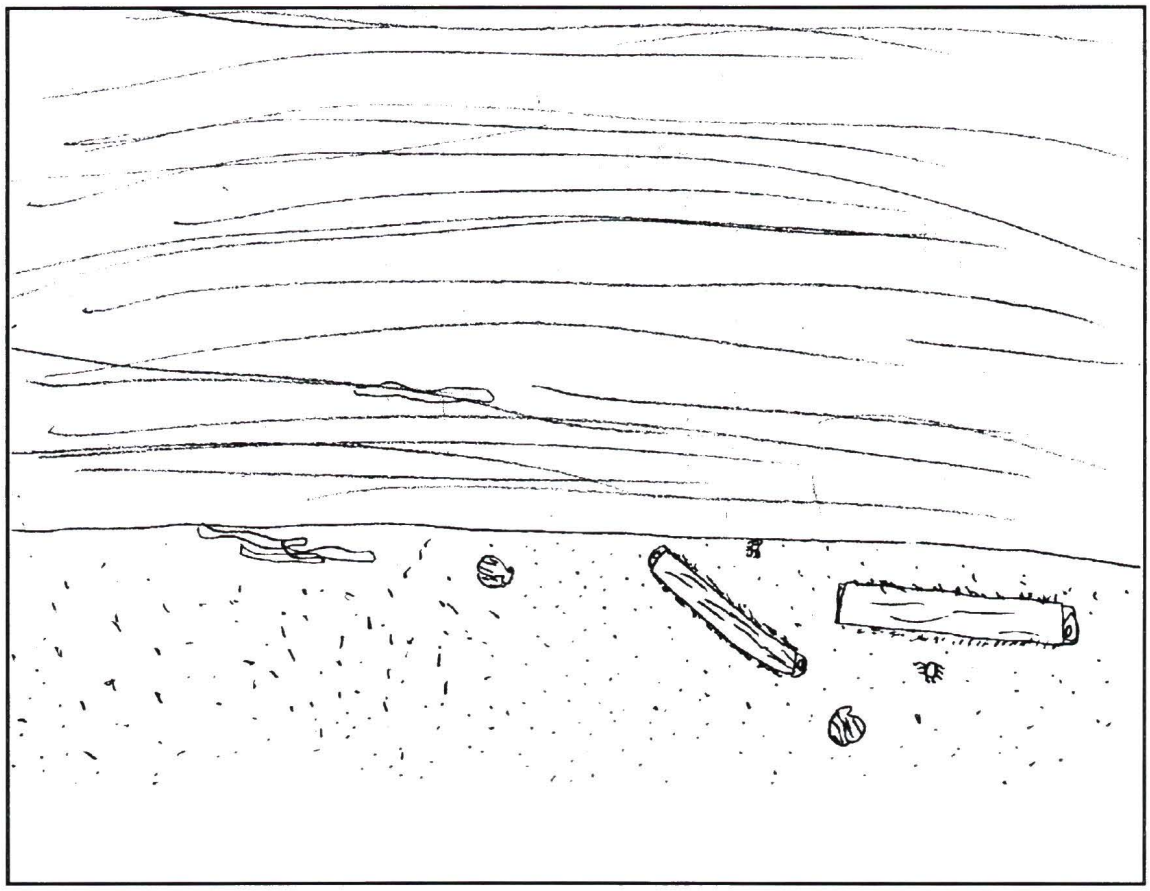
Kelly's drawing (see figure 3.3) was ocean-related and included some predator-prey relationships in the form of large aggressive sharks eating smaller fish. One of the sharks included was a hammerhead shark. She also depicted a jellyfish and octopus. The ocean floor was relatively lifeless.

Figure 3.3 - Kelly's Pre-instructional drawing.



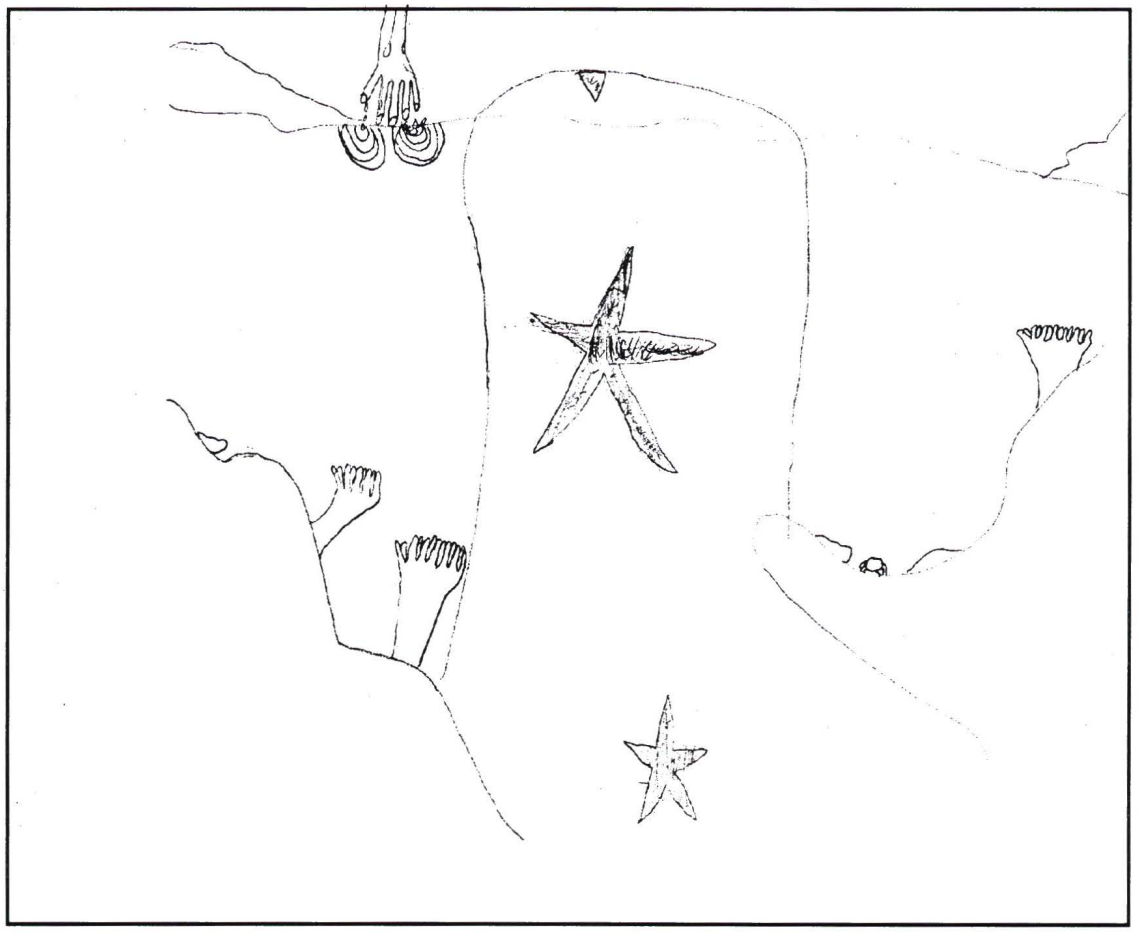
Only seven (33%) of the students' drawings actually represented the seashore or the beach. These were scenes almost devoid of life and contained mostly sand, logs, water and seashells as seen in Jamie's drawing (see figure 3.4). The only living creatures represented were a few small crabs. Because a large proportion of the books, T.V. programs and movies about sea creatures focus on larger ocean animals (sharks, whales, sea turtles) Jamie was probably unfamiliar with many of the smaller seashore creatures, especially those that are found on local beaches. Another reason could have been that Jamie's only visits to the seashore had been during high tide times and he had not seen the plants and animals that become visible during the low tide intervals.

Figure 3.4 - Jamie's Pre-instructional Drawing



Robbie's drawing (see figure 3.5) was the only one that represented a seashore with living creatures. However, the life depicted in his tide pool was very sparse and limited to three animals (sea stars, anemones, and a crab). Robbie also connected himself to the seashore with the inclusion of a hand dipping into the tide pool indicating that he probably spent time exploring the seashore. Also, his picture only included local indigenous organisms.

Figure 3.5 - Robbie's Pre-instructional Drawing



Along with the drawings, the students were asked to make a list of as many plants, animals and things that would be found at a seashore or in the ocean. All items on the lists were totalled and then catergorized into living and non-living (see Table 3.1).

Table 3.1 Pre-instructional Lists (n=21)		
Total items	299	
Living (Animal and Plant)	238	(80%)
Non-living	61	(20%)

The living plants and animals were further catergorized into those plants and animals that would be found at a local rocky seashore such as the target site (Saxe Pt. Park) and those plants and animals that would not be found at the site. These included tropical sea life (sea turtles, seahorses, hammerhead sharks); ocean mammals (killer whales, dolphins); freshwater life (catfish, frogs, goldfish); and penguins. One child mentioned a rock climber which represented less that 1% of the total responses in the living category and was not included in this table (see table 3.2).

Table 3.2 Pre-instructional Lists - Living Plants and Animals (n=21)		
Living (Animal and Plant)	238	
Local seashore life	99	(42%)
Ocean life	127	(53%)
Freshwater life	12	(5%)

The most items any one child listed was 28 and the least was 2 making the average number of responses 14. Of the 127 ocean plants and animals, 25 were tropical sea life (e.g. sea turtle, seahorse, stingrays). The rest were marine mammals (e.g. killer whales, dolphins); penguins; and lobsters. The one child whose response was a mountain climber, probably referred to a local beach that has rocky cliffs used frequently for mountain climbing practice. In summary, 59% of the responses on the student lists were not plant and animal life that would be found at a local beach. The researcher was aware that she did give open ended instructions before the lists were compiled. However, prior to instruction, the grade four students in this study had a very minimal awareness of the existence of seashore plants, animal, and objects. They seemed to be cognizant of ocean creatures and a few indigenous seashore creatures, however, the conception of the seashore as a diverse and interdependent community was clearly not understood. The understanding of the great diversity of seashore species, of relationships between plants and animals at the seashore, as well as the location of specific species of seashore plants and animals was not evident in most of the drawings. Therefore, the researcher's focus for curriculum design would be to present the concept of Pacific Northwest seashore communities.

Questionnaires

The Students' Ocean Background. The Ocean Background questionnaire provided the researcher with information about the students' experiences related to the ocean. The students were asked to reply to the questions using the words never, sometimes or often and the researcher summarized the data according to frequencies of similar responses. Most of the children were frequent visitors to the seashore with more than 78%

making 2 or more trips in the last year. No one reported never having been to the seashore.

When asked what topic they would choose to study in school (city, seashore or oceans, mountains, prairies, or pond, lake, or river) the children chose the mountains (35%) and seashore or oceans (22%) as a first choice. Only 9% chose the seashore and ocean as what they would least like to study in school. It was interesting to note that 75% of the mountain choice was made by boys. A father of one of the boys in this group is a mountain climber and this boy has shared many stories with his friends about his dad's adventures. The researcher feels this may have influenced some of the boys choices.

The most frequent use of the beach resulting in an often or sometimes choice for these students was: (1) exploring (83%; (2) collecting shells (78%); (3) suntanning or picnicking (74%); and swimming (69%). The students reported that 48% of them had never been sports fishing or boating or sailing (39%).

The children reported they had learned about the ocean or seashore from movies and TV shows (95%), classes in school (95%), doing things on or by the ocean (91%), nature books and magazines (74%), and public aquaria or nature centres (70%). The newspaper was a very infrequent source of information about the ocean for these children with 87% choosing "never" as their response.

Salmon (74%), tuna (77%), and other fish (74%) were the most popular seafoods reported by the students. Many children had never eaten oysters (78%), seaweed (91%), or clams (78%). Shrimp (48%) and crab (44%) had sometimes been eaten by the students.

Snively and Sheppy (1991) had administered the same questionnaire to grades 5 and 9 students in 3 different geographical communities in British Columbia (Victoria. Campbell River, Williams Lake). Over 90% of

the coastal community students in the Snively and Sheppy reported visiting the ocean two or more times as compared to 78% of these grade four students in this study.

Concerning the topics suggested for study in school, the Snively and Sheppy respondents chose the ocean first (41%) or second (26%) as compared to mountains first (35%) and oceans second (22%) as preferred by the students in this study.

Interesting differences were also observed between the two studies with other items on the questionnaire (see table 3.3).

Table 3.3 -

Ocean Uses (often and sometimes)	1991 Study	1996 Study
1) suntanning/picnicking	64%	73%
2) exploring	57%	83%
3) swimming	51%	69%
4) collecting seashells	49%	78%
5) boating and sailing	40%	39%
Learning about the Ocean (often and sometimes)		
1) TV and movies	60%	95%
2) nature houses, aquaria	58%	80%
3) first hand experience	55%	91%
4) books/school	40%	75%

It was interesting to note that 45% of the grade 5 students in the Snively and Sheppy study stated that they "rarely" or "never" learned about the ocean from classes in school compared to higher percentage of grade

four students in this study that felt school was an important resource.

The Students' Ocean Attitudes. The pre-instructional Ocean Attitude questionnaire provided the researcher with information on how strongly the students felt towards a variety of specific coastal resource issues. The students responded on a Likert-type scale of strongly agree to strongly disagree. These responses were coded according to whether a strongly disagree response was considered a positive or negative attitude towards marine issues. Values were assigned to the frequency of responses in each of the 37 questions. A value of 0 was considered to be very positive, 1 was positive, 2 was undecided, 3 was negative and 4 was very negative. Of the choices the students made, 30% were considered to be very positive, 21% positive, 14% undecided, 9% negative and 25% very negative.

The students strongly disagreed with polluting the ocean and did not agree with Victoria dumping raw sewage into the ocean (83%) as well as pulp mills dumping chemical waste into the ocean (87%). The other areas where strong student feelings were evident was the shooting of seals by fishermen (78% strongly disagree), the killing of harp seals (83% strongly disagree) and world wide whale hunting (91% strongly disagree).

Only one item represented a very negative attitude response. A surprisingly large number of students (47%) strongly disagreed that more coastline should be set aside as park land. These student responses could be a reflection of widely publicized governmental decisions over the past three years to set aside more areas of British Columbia as park land.

On six items the children showed a higher percentage of undecided responses compared to the other choices for that item. The areas wherein the students did not take a strong position either positive or negative were taking seashells and sand dollars home as decorations (44%), whether native people should follow the same rules as everyone else (35%),

encouraging more tourists to visit our seashores (30%), spending more money on scientific research (35%), and whether or not the activity of scientists usually results in making problems of the environment worse or not (39%). On twenty-five of the items (68%) the 0 and 1 values (very positive and positive) were 60% or greater. Only one item, that more coastline be set aside as park land (61%), represented a higher percentage of negative choices. The researcher interpreted all these responses as an indication that the students involved in this study had a positive attitude towards these specific ocean issues. Fortner and Teates (1980) in their study of marine issue attitudes found 93% of the subjects involved expressed positive attitudes toward marine issues. They surmised that ocean "preservation does not make personal demands, as a general rule, and since the students were not required to indicate how they personally would behave toward any issue, positive responses could be given more freely" (p. 16).

The Students' Ocean Knowledge. The students found this questionnaire difficult as evidenced by an over-all mean score of 14.24 out of 30 items (41%). The researcher suspects that some of the items under the Physical Oceanography, Ocean Ecology, and the Human Effects on the Ocean Environment sub-tests were very unfamiliar concepts for most children of this age.

On the Physical Oceanography sub-test, only three items out of the seven (43%) were answered correctly by more than 50% of the students. Many children (74%) knew how much of the earth was covered by oceans, what tides were (70%) and what caused tides (57%). However, only 4% of the students knew about ocean currents and 9% were familiar with the nature of the British Columbia coastline.

The Ocean Ecology sub-test items asked questions about general

ecological principles and how they apply to the ocean, questions about seashore habitats and questions relating to B.C.'s own shores and waters. The students fared slightly better on these items than on the previous sub-test items with seven of the fourteen items (50%) being answered correctly by more than 50% of the students. However, the best answered question was the meaning of the word plankton in which 65% of the students knew the right answer. Considering how many times these students said they had visited the seashore and been exposed to information about the seashore and ocean in school, through movies and TV and by reading nature books and magazines, their general knowledge of seashore and ocean ecology concepts was relatively low. For example, only 22% knew that coral reefs were not indigenous to the Pacific Northwest or Atlantic coasts of Canada. Also, considering that many of these children have been involved with classroom salmonid enhancement programs, it was surprising to find out that only 52% of the students knew that salmon hatch in fresh water, but live most of their lives in salt water, and only 43% were aware that each of the five kinds of salmon found in B.C. prefers different kinds of spawning places from the other kinds.

The Human Effects on the Ocean Environment sub-test explored students' knowledge of some effects of changes humans have or are likely to make such as oil spills, estuary development, and dumping effluent into the ocean. Five out of the nine items (56%) were answered correctly by more than 50% of the students. The best answered question was the item concerning the outcome of the loss of a seaweed forest wherein 70% of the students decided that it would mean the loss of homes for a variety of animals. Most of these students are in favour of preserving or using the seashore and ocean environment as will be seen in the results of the Ocean Opinions questionnaire, and they have a positive attitude towards the ocean as seen through the Ocean Attitude questionnaire results, however these

attitudes and opinions were not always backed up by sound knowledge of the effects of change. For example 17% of the students stated that polluted water always looks dirty, 13 % said polluted water always smells bad, 52% stated that polluted water always kills the animals in it and only 9% knew that polluted water sometimes looks quite clear. Only 22% of the students knew that oil spills affect birds and seashore creatures more than marine mammals and only 30% of the students knew that river mouths and bays are more sensitive to changes than sandy beaches on outer coastlines. The students also were unaware of the ocean's capacity to handle waste materials and felt than any waste materials poured into the ocean will do extensive damage (52%).

Many of these findings are similar to the Snively & Sheppy (1991) results. The students in their study were given the complete 35 item questionnaire and had an over-all mean score of 14.75 (42%) and the difference between the grade 5 and grade 9 students was surprisingly small (3.60 or just over 10% on the whole test). Only 9% of the grade four students in this study knew that B.C.'s coastline is mostly protected by bays and islands from heavy surf, as compared to 26% in the Snively and Sheppy study.

The students in both studies were best informed about tides and how much the earth is covered by ocean and least informed about global patterns of ocean currents. Also, the best answered question in the Ocean Ecology subtest in the Snively and Sheppy study was related to beach creatures (kinds of crabs and starfish) and this item received a fairly high response (61%) with the grade 4 students in this study. Knowing that salmon hatch in fresh water was known by 59% of the 1991 study compared to 52% in the 1996 study. Snively and Sheppy noted that 48% of the students in their study chose salt or minerals as a source of energy for all living things, while only 17% of the students in this study responded similarly

and 48% chose the correct response which was surprising for the youngest group to realize the importance of sunlight for life. Traditionally, growing seeds in the classroom and the discussion of photosynthesis takes place in grade two or three, so perhaps these concepts were still fresh in the minds of these students.

In the Human Effects on the Ocean subtest, only 9% of the grade 4 students in this study knew that polluted water can sometimes look clear as compared to 22% of the Snively and Sheppy students. Twenty-three percent of the students in the 1991 study thought that polluted water always looks dirty compared to 17% of the students in the 1996 study.

The researcher concurs with Snively and Sheppy that students seem to react strongly to the word pollution and considering the importance of ecological issues concerning our seashores and oceans, the results of this test does not give much assurance that students' opinions are based on a solid knowledge base. It is apparent that the cognitive aspects of seashore and ocean ecology and relating this information to marine resource issues is indeed necessary to ensure that students can wisely base attitudes and opinions on factual knowledge.

The Students' Ocean Opinions. The students' responses on the Ocean Opinions questionnaire were scored so that each student received an "exploitive" score, a "conservationist" score and a "preservationist" score. Of the choices made by the students in the pre-instructional questionnaire, 52% were preservationist, 44% were conservationist and 4% were exploitive. No item had an exploitive stance as the preferred choice, and only on one item did this stance draw more than 17% of the students. In the Snively and Sheppy (1991) study, 33% of the responses were preservationist, 52% were conservationist and 15% were exploitive. The 1991 study, which included all the scores of grade 5 and grade 9 students,

revealed that the younger students were consistently more preservationist than the older students. So, it would seem logical that grade 4 students would be more preservationist in their stances.

The grade 4 students in this study took strong preservationist stands with respect to the following:

- killing of baby harp seals for their fur (91% against)
- the danger of oil tankers travelling along coastlines (83% felt that travel should not be allowed)
- the hunting of whales not near extinction (74% against)
- the exploitation of the Canadian fishing industry (83% felt too many fish are being caught and favoured reduction of industry)
- fish farming (78% against)
- drift-net fishing (65% against)
- control of seal populations by salmon fishermen (65% against)
- chemical pollution by pulp mills in B.C. (30% favoured closing down the offenders and 39% wanted the mills to find other places other than the ocean to dump their wastes)

The strong protectionist attitude toward marine mammals as cited by Snively and Sheppy (1991) was certainly evident in these student responses. In the 1991 study, 77% of the students were against harp seal killing and 61% were against the whaling of non-threatened species. When considering killer whales in captivity, the two studies showed similar stance emphasis (see table 3.4).

Table 3.4 - Student opinions about killer whales in captivity		
	1991 Study	1996 Study
1) those favouring release	30%	53%
2) no new captures	20%	30%
3) keep for a few years	17%	24%

The grade four children in this study also took a strong conservationist stance toward some other British Columbia fishing resource issues. They felt that native people should have rules regarding fishing (91%). Also, the students favoured laws about when and where they should fish for fun (74%) and that governments should make and enforce rules to control the number of fish that are caught (74%). In the Snively and Sheppy study, 81% of the students thought fishing by native people should be regulated and 53% favoured stronger maritime laws.

On an item about seashell collection, a few of the students took a strictly preservationist stance that no shells be taken from the beaches (22%), however most felt that only empty shells of dead animals should be taken (65%) or that it is alright to take a few shells of abundant animals (9%). It was encouraging to the researcher to find that no child in this study felt it was alright to take as many shells as live animals and that there was obviously some knowledge that seashore animals needed to be protected. In the Snively and Sheppy study, only 8% took the preservationist stance, while 15% thought it was alright to collect a few shells of abundant animals and 67% felt that only the shells of dead animals should be taken.

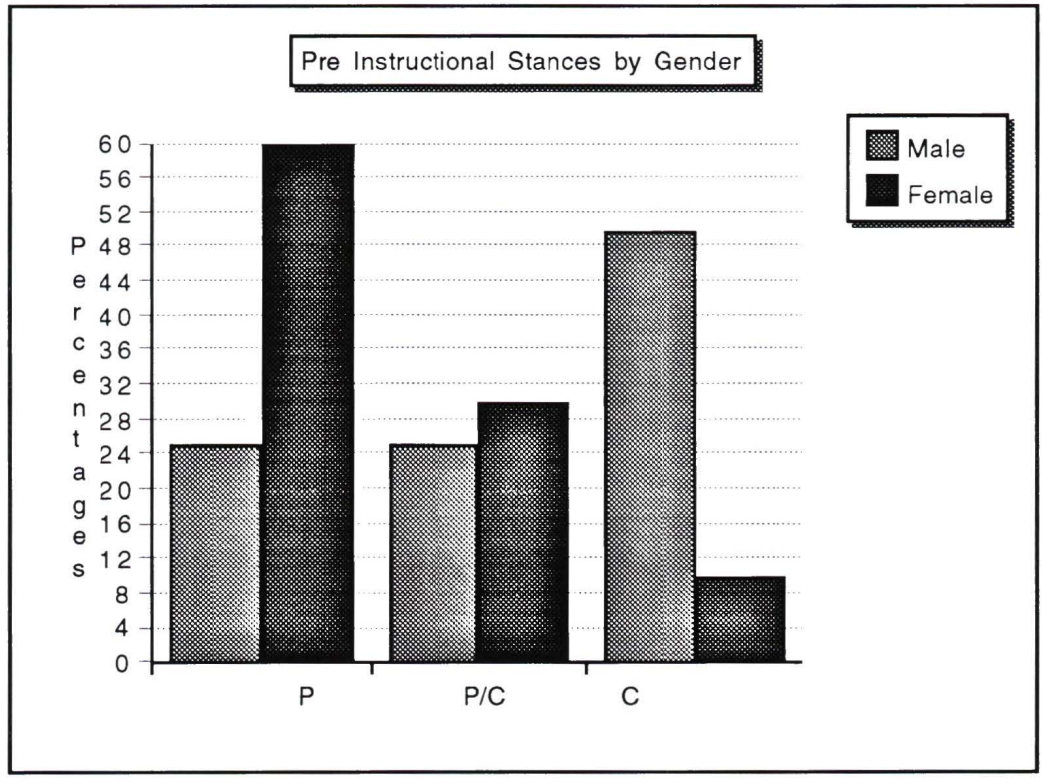
In one item a few of the students showed exploitive inclinations. The

first was that British Columbia has too many coastal parks that keep the coastline being used for industry and development (17%). The students in the Snively and Sheppy study felt that coastal parkland should be increased (67%). As previously mentioned, a significant increase in the number of B.C. parks has taken place since the 1991 study and this factor could have given these students the impression that B.C. now has enough parkland.

When examining the stance differences between gender, the girls were more preservationist than the boys. Even though the exploitive choices were few (18 out of 440 possible choices), the girls were slightly higher (10) than the boys (8).

All the stance responses for each student were viewed separately to determine whether one label (preservationist, conservationist, or exploitive) could describe individual students. The criteria for deciding whether any one student was a preservationist, a conservationist, or an exploiter would be that the student would have to have to a difference of at least three responses in any one category in order to be considered that stance. For example, out of the 20 responses on the questionnaire, one student chose 14 preservationist responses, 3 conservationist responses, and 3 exploitive responses. According to the criteria, that student would be considered preservationist. However, several students did not fit the criteria because their responses were more or less evenly distributed between the preservationist and conservationist stances. These students were then considered to be a mixture of these two stances. The boys were then compared to the girls and the girls demonstrated a greater tendency to be preservationist while the boys were strongly conservationist. The exploitive stance was not illustrated because no student was considered strictly exploitive (see figure 3.6).

Figure 3.6 -



P = Preservationist C = Conservationist P/C = mixture

The Snively and Sheppy (1991) study found that the boys and girls in their study responded to the opinion questionnaire in remarkably similar ways, having virtually the same mean scores on the three stances. On all items the patterns of responses were not significantly different. Two exceptions were:

- More girls than boys favoured the retention of killer whales in captivity with no new captures, while more boys favoured releasing whales after a few years.
- More boys than girls were prepared to send the navy out to destroy drift nets.

Summary

The researcher collected several types of data from the grade four students involved in this study. The drawings the students sketched assisted the researcher in viewing the seashore through the eyes of her students. The children had difficulty in depicting the seashore as a rich community of living plants and animals but instead created pictures of the ocean filled with large fish or mammals. This seemed to indicate that they were more familiar or impressed with marine mammals and fish than with intertidal invertebrates. It would seem that these children had seldom ventured into the intertidal zone at low tide and had not learned to closely observe the seashore plants and animals found in this zone. From their lists, the researcher found that the children were unable to name many of the common seashore animals and plants that could be found on local beaches. The children were also confused between fresh water, tropical, and indigenous seashore and ocean life.

The questionnaires provided another dimension of information for the researcher. The Ocean Background questionnaire gave the researcher an idea of how the students used and learned about the ocean. The students stated that they visited the seashore many times, however, the boys especially would rather study about the mountains. The Ocean Attitude questionnaire demonstrated that these grade four students were concerned with the preservation and care of the ocean and its creatures and that their attitudes towards the wise use of marine resources were positive ones. However, the Ocean Life questionnaire revealed that these students' knowledge of ocean and seashore ecology was very low. Even with this limited understanding of the seashore and ocean environments, these students were able to form definite opinions or stances as seen in the Ocean Opinions questionnaire. The children adopted very preservationist or

conservationist stances towards a variety of marine resource issues.

With this information, the researcher's job became one of designing a sequence of learning experiences that would enhance students' knowledge about the seashore and ocean. Through direct experience with local seashore communities and the development of the relevant seashore and ocean ecological concepts in the classroom, the researcher intended to provide the students with a knowledge base from which rational opinions could be derived and positive attitudes maintained.

CHAPTER 4: THE CURRICULUM IN USE

Introduction

The learning of scientific concepts often requires realignment in thinking and construction of new ideas that may be in conflict with earlier ideas. This, as described by Piaget is assimilation, the "activity that permits the gradual incorporation of new ideas into a person's mental schemes" (Bliss, 1995, p.147) and accommodation, "the activity of modifying assimilatory schemes" (Bliss, 1995, p.147). However, this change may not be as radical as it seems as Posner, Strike, Hewson & Gertzog (1982) state:

> Students are unlikely to have at the outset a clear or well-developed grasp of any given theory and what it entails about the world. For them, accommodation may be a process of taking an initial step toward a new conception by accepting some of its claims and then gradually modifying other ideas, as they more fully realise the meaning andimplication of these new commitments. (p.223)

Teaching for conceptual change is, in essence, setting the stage for this "realignment of thinking". The environment the teacher provides and the strategies that are applied within that environment are crucial elements that can effect children's thinking and learning and promote the assimilation of new ideas and the accommodation of these with existing ones.

The students in this study initially demonstrated some of their existing conceptions of a seashore through their drawings of what they thought a seashore was and the lists of the living and non-living things that may be found there. By examining these preliminary data the researcher then decided to design a curriculum that would extend and perhaps change

the students' ideas from the seashore as being a place sparsely inhabited by living creatures to one that was an interdependent and richly diverse community of living plants and animals. Included in this curriculum were topics that provided students with the knowledge necessary to formulate new ways of thinking about seashore communities and how they related to the greater picture, the ocean. Lessons and activities were centred around the concepts of (1) ocean currents, waves and tides; (2) seashore zonation; (3) seashore plants and animals characteristic of each zone; (4) predator/prey relationships; (5) food chains and food webs; (6) interdependence of seashore plants and animals; (7) marine mammals; and (8) marine resource issues.

The purpose of this chapter will be to present the strategies the researcher employed to present to her students the concepts associated with the rocky seashore. The foundation for these strategies was derived from constructivist theories of learning. The researcher was mindful of many of the aspects of teaching for conceptual change and this information helped to form a global perspective, however the researcher also considered the age level and ability of the students involved in her study as well as the time constraints imposed upon her by other curricular obligations. The task then became one of wisely choosing specific and appropriate strategies that would enhance the students' experiences within a six to eight week period of instruction. The learning experiences of the children and how the researcher attempted to present an explicit view of the plants and animals of the rocky seashore will be presented in the context of three themes; (a) experiential learning; (b) reading and writing to learn marine science; and (c) marine resource issue investigation.

Experiential Learning

The greater part of the experiential learning that took place in this study was the actual observations and interactions with seashore plants and animals in their own environments. However, other types of sensory experiences were used to supplement and reinforce the curriculum concepts that were covered. Such activities as teacher demonstration and modelling, hands-on/minds-on classroom inquiry, games, and visual media (films, videos) all were part of an integrated approach to engaging the children in meaningful learning.

The first field trip to the beach was purposely executed at the very beginning of the teaching unit. The objective was two-fold: (a) to acquaint the children with the site; (b) to introduce the children to the uniqueness of the seashore and ocean environments.

The first feature the researcher wanted to establish when all participants had arrived at the site (Saxe Pt. Park) was that of the water being viewed was an ocean, the Pacific Ocean. Through large group discussion, the importances of the ocean were recalled and size of the ocean was illustrated through the "Apple Ocean" activity adapted from Millman (1988). The researcher used this simple yet vivid demonstration to compare the size of the world's oceans to its land masses. It was not the researcher's intent to take too much of the children's attention away from the prime reason that they were at the seashore and that was to explore using as many senses as possible. The children were then allowed to freely wander within the established boundaries, encouraged to question the accompanying adults, or refer to any of the field guides if desired. Field notebooks had been brought by all students and they were asked to sketch the beach, and to list three things they touched, three things they saw, and three things they heard. Also, any other information the children wished to

record was encouraged. The children were asked to work with one or two buddies and talk about any treasure they found.

During this first expedition, the researcher noticed that most of the children could only identify a few of the seashore plants and animals. Many did not know the difference between living and non-living things. Some children thought that barnacles were not alive because they "looked" dead and that the aggregate anemones that were so plentiful on this beach, were not really living creatures. A few of the children preferred to throw rocks into the water rather than focus on using their senses to explore the environment. Some children were very focussed on their field notes and worked together in small groups sharing information.

When the children returned to the classroom, they were asked to choose a partner other than the one they had at the beach and compare their field notes. They could then add anything else they wanted or colour the pictures they had drawn.

During this first visit to Saxe Pt. Park, some of the children noticed the black demarcation band of the high tide zone. This observation became a reference point for class instruction and discussion about the intertidal zones of a rocky seashore. The researcher used overheads and videos to illustrate the arrangement of seashore plants and animals in the four tidal zones. The children were able to verify the information they learned about seashore zonation on the subsequent trip to the beach.

In developing the understanding of vocabulary pertinent to the understanding of how the ocean affects the seashore, the researcher thought it necessary to discuss the meanings of the concepts of current, tide, and wave. A short video was shown that addressed these three concepts. Five stations were then set up and the class was divided into five learning groups. Each station contained instructions to perform an activity that referred to tides (Tides in a Pan); waves (Making Waves); and currents

(Create Some Ocean Currents; Is Cold Water Heavier than Warm Water; Making Currents). The children were given 10 minutes in each station to perform the activity and respond on their inquiry sheets with the assistance of all the members of the group. The researcher found that the children didn't clearly understand what it meant to "draw what you see" and as she circulated throughout the stations observing the various groups. The researcher/teacher found she had to prompt many of the children to focus on the important ideas. During the debriefing session, when the whole class shared their findings, the activities were revisited and modelling of responses was demonstrated by the researcher/teacher. Emphasis was targeted at recording actual happenings based on careful observations. The children were the scientists and what they saw was of prime importance, not what they thought they should see or what they thought the teacher wanted them to see.

The second field trip to Cowichan Bay Marine Ecology Station involved the children in actual hands-on experience with seashore creatures. Before the trip, the children had learned about seashore zonation, predator/prey relationships and food chains. They had watched some videos on the seashore, ocean, and plankton. At the station, the children readily focussed on the touch tanks that were alive with a variety of sea creatures. The children were able to observe several communities of seashore plants and animals in aquaria and after a boat trip to the bay, they were able to observe on real time video the plant and animal plankton they had gathered. The researcher observed the children using correct vocabulary when naming or discussing various seashore life as well as enthusiastic group and partner sharing of information. Some of the children recorded facts and drew pictures in their field notebook, but most of them spent their time observing, touching, and telling their friends about what they saw.

The researcher wanted to connect what the children had learned about the seashore plants and animals to a key concept, the interdependence of all the living plants and animals at the seashore to each other and to the non-living features of their particular habitats. The children had built food chains using the Pacific Coast Information Cards (Snively, 1997) and the researcher wanted to demonstrate how the food chains form food webs. The Food Web Game, developed by Snively for the *Exploring Beaches with Kids* curriculum, was played by the class with eight children chosen as selected seashore plants and animals and four children chosen as habitat features (sun, seawater, air, rocky shore). The other members of the class interacted with the performing members as the web was constructed by suggesting the relationships among the components of the web. When the game was completed, the researcher noted that the word "inter-connected" was being used by the children in their discussion with each other and the whole group. The repercussions on all the components and members of the food web by being "cut" was an astonishing revelation for many of the children. This simple demonstration had a powerful effect on the children in this study. Many times in following discussions, all the researcher had to do was refer to the "Web Game" and immediate recognition was apparent on the faces of the children. This game became an important reference point for reinforcing many of the ideas of community that the children later encountered.

The final field trip to the seashore was a return to Saxe Pt. Park. A longer period of time was allowed because the researcher felt it important to use this trip as an opportunity to apply many of the concepts learned during the previous weeks. The researcher wanted to find out how many plants and animals the children could identify, how the children's attitudes and observational skills had changed since the first visit, and whether their actual concept of the seashore had altered. Magnifying glasses, plastic

buckets, and small nets were brought and the children were encouraged to really "get to know" the plants and animals of the seashore yet at the same time realizing they are guests in someone's home. The researcher at once observed the differences in what had happened during the first trip and this one. The children very quickly broke up into small learning groups and with field notebooks in hand began to draw what they saw and tell each other the names of the various sea life they encountered. Every child recorded the names of at least ten seashore plants and animals and wrote details about what they ate and how they moved. Not one child engaged in inappropriate behaviour (rock throwing, unnecessary tampering with plants or animals, unfocussed silliness) and they were seen very carefully lifting rocks, observing the creatures and returning them to where they belonged. Any creatures or plants that were caught for temporary observation were dutifully returned to their habitats.

The researcher presented the concept of protective colouration using three tide pool sculpin. She invited the children to make predictions about what would happen in each of three jars containing the fish and covered the jars with black, white, and pink paper respectively. The fish were left in the covered jars for about fifteen minutes while the children discussed their ideas of why this unique adaptation would be useful to the sculpin. Many of the children were accurate in their predictions that the fish would change their colour. The sculpin in the black covered jar was indeed much darker than the sculpin in the lighter covered jars. Even though the children guessed what would happen, they were very surprised in how dramatic the results were in this demonstration. Many of the children remarked at how many creatures had previously gone unnoticed and only through patient and watchful eyes did these well camouflaged animals reveal themselves.

The researcher noticed that all the children were engaged in activities that tested and reinforced the knowledge and experiences previously

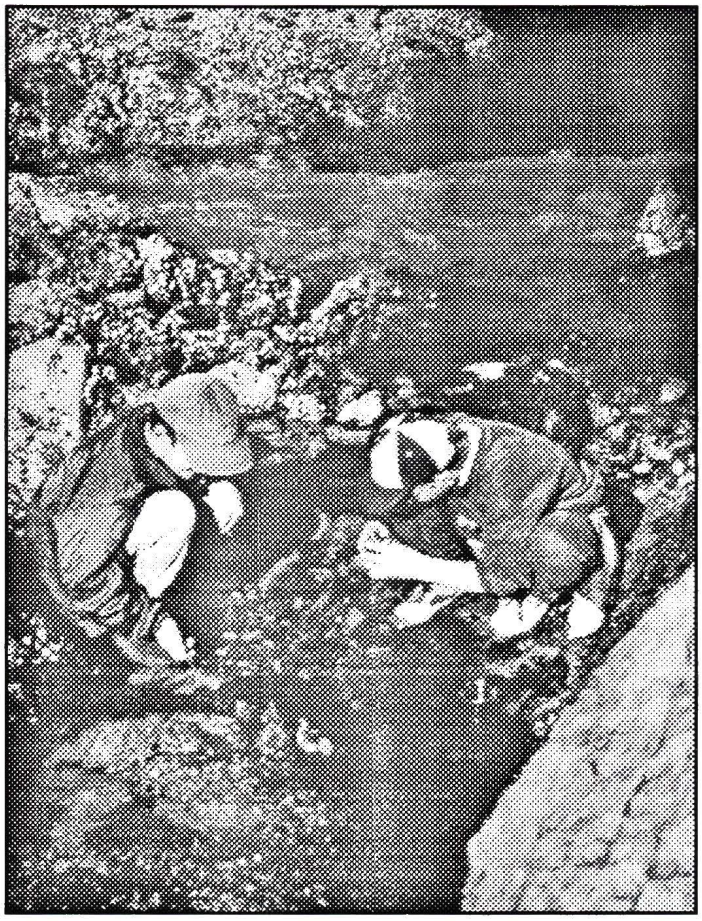
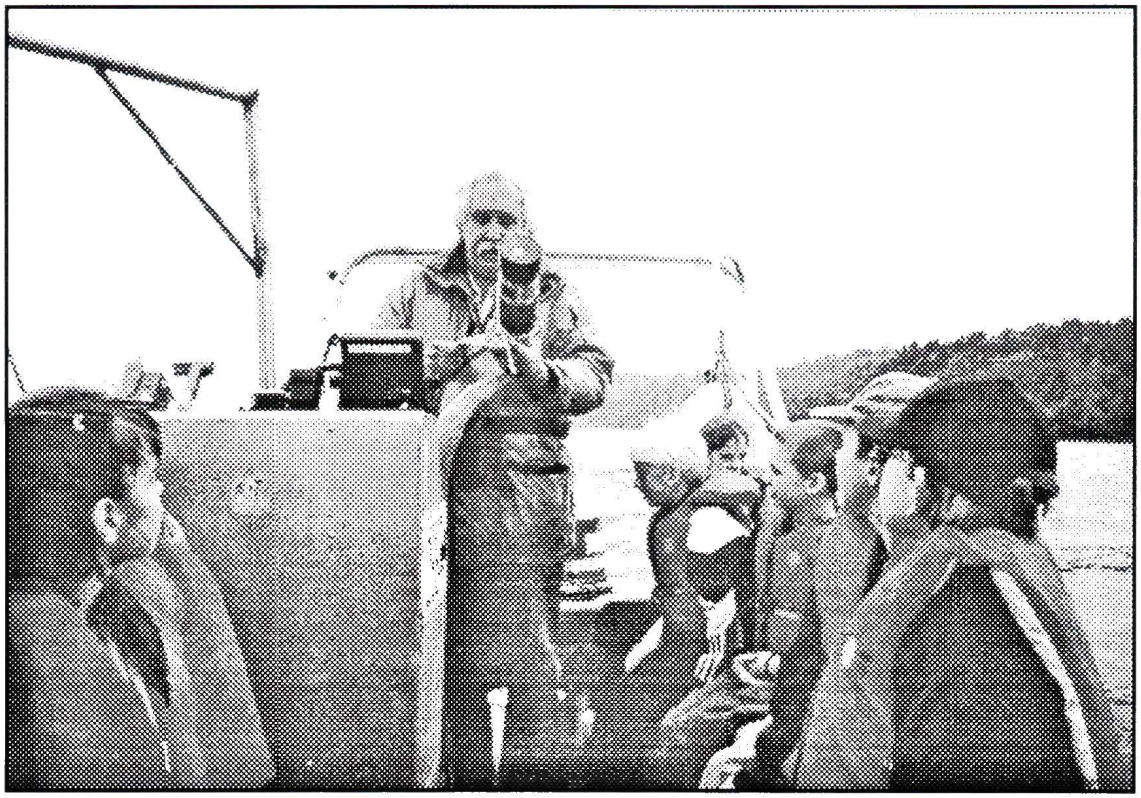


Figure 4.1: (right)

The rich diversity of the seashore become evident when exploringtide pools during low tides. Here two students carefully examine the seashore creatures at Saxe Pt. Park in Esquimalt. Victoria, B.C.

Figure 4.2: (below)

Plankton are the minute plants and animals that drift or swim in the ocean providing food for many sea creatures. The students observe as Dr. Bill Austin prepares a plankton net to gather samples at Cowichan Bay, B.C.



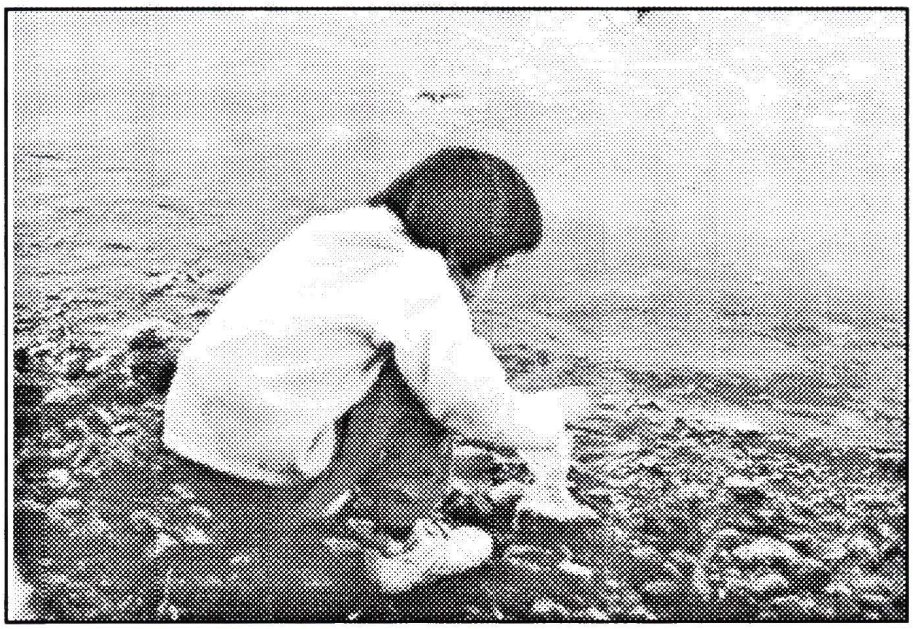


Figure 4.3: The study of seashore creatures provides a clearer understanding of the interdependence of plant and animal communities. In this photograph, a student collects a sample of a seashore animal for closer observation and to help with accurate sketching in her field log.

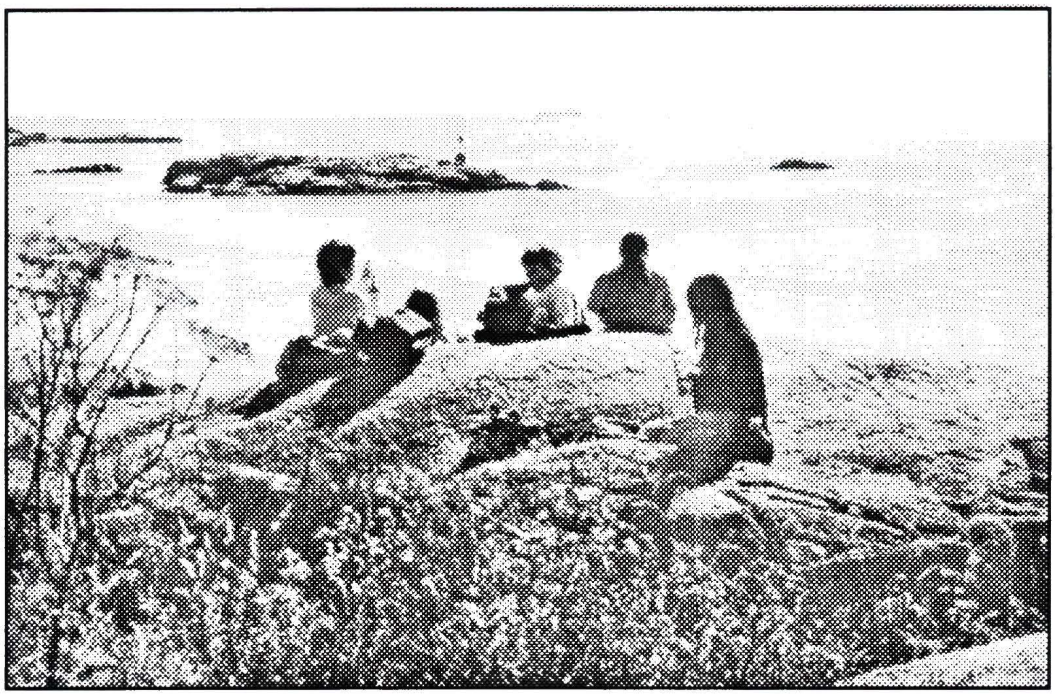


Figure 4.4: The seashore offers a place for quiet reflection and renewed connections to the natural world. The students in this picture are enjoying their lunch as they gaze at the majesty of the Pacific Ocean.

encountered. In fact, two of the children spent an hour just observing and making notes around a single tide pool. Even though they had been here before, it was like these children had suddenly discovered a whole new world.

Reading and Writing to Learn Science

Meaningful learning involves constructing relationships between new knowledge and existing knowledge. In science, this meaningful construction should take place within the framework of related information and not isolated lists of facts. Students need to complement their direct experiences with what the scientific community has written about those experiences and how they fit into the whole schema of scientific literacy. Therefore, familiarization of existing scientific knowledge and efforts to make personal sense of it is a necessary endeavour. Activities that involve reading and writing "are ideal media for engaging students' minds and for fostering the construction of conceptual relations. Students who are learning constructively will challenge the science text they are reading or writing, struggle with it, and try to make sense of it by integrating it with what they already know" (Glynn & Muth, 1994).

The children in this study were involved with integrated reading and writing activities. No specific science text was used to support and verify the curricular concepts covered in the study of the seashore and ocean. Instead, a variety of meaningful reading materials were used. These included field guides while on the field trip sites, specific information gathered by the researcher to add to the students' notebooks to clarify topics discussed, and explicit instructions for children to follow during their study of ocean currents, tides, and waves. During the field trip to the Cowichan Bay Marine Ecology Station, the children eagerly read the

fact sheets attached to all the stations and aquaria they visited. Trade books were used to supplement classroom and group discussion and as research project resources. Students were encouraged to read current newspaper and magazine articles that addressed local and global marine resource
issues. All reading activities were appropriate to the age level of these grade four students and were chosen because of their relevance and interest. The researcher was amazed at the enthusiasm of the students for any book on the seashore or ocean that was provided and the number of times the students asked to share discoveries they had made through their reading.

Closely related to the reading activities, were the writing exercises in which the children were engaged. Several venues of written expression were explored. The children were required to keep a field notebook on all the trips taken out of the classroom. These books were modelled after a field notebook the researcher had shared with the students. Most children concentrated on the pictures and labelling of seashore plants and animals. All were encouraged to write specific information. Differences in amount of detail and observations were evident. For example, Sarah's first responses were, "I saw barnacles, sea anemones, seaweed. I heard seagulls and the ocean. I touched seaweed". On a following trip, Sarah writes:

> I saw a sea star move in the water and it has tube feet.
> A crab moves sideways and moves quite fast. Isopods swim
> on their backs and look like they have a little outboard motor.
> A cling fish swims near the bottom of the tide pool and sometimes
> sticks to the rocks.

Sarah's observations became more focussed and she began to experiment with analogies.

Marianne's only entry in her first visit to the seashore was, "sea

anemone, soft, very slimy, very icky; barnacles have hard shells". Her later entry was:

> At the edge of the beach and the edge of the shore and in tide pools there were wrinkled whelks, hairy hermit crabs, limpets, chitons, jellyfish, cling fish, bull kelp, black tar algae, and rockweed. I saw a sea star move in the water with its tube feet. It eats shrimp and clams. Hermit crabs live in a shell of another animal. Isopods swim on their backs and eat any meat they can.

Marianne came from a non-English speaking family and was often very shy with any kind of the much needed oral communication she needed to practice the English language. The seashore study helped her to develop not only scientific knowledge, but ways of expressing her thoughts in a meaningful and non-threatening environment.

On his first trip, Paul wrote:

> I saw a crab shell, sea anemone, a big starfish, barnacles, kelp, rocks, drift wood, a tire, snails, seaweed, Chinese hats, hermit crabs, bull heads, trees, feathers. I heard birds, the ocean, the sand moving. I smelled sea water, seaweed and crabs.

Later, he wrote:

> Barnacles move [close up] when they are in danger. They eat plankton and store water. Crabs move by walking sideways. They eat fish and stay by the water so they don't dry out. Starfish have an exoskeleton.

Instead of simply making a list, Paul chose particular creature to write about in detail and solidify his knowledge of their particular habits.

Written language assignments in classroom lessons were integrated with the seashore and ocean study. The primary focus for the first month of school had been description techniques. The objective had been to move from describing events or objects in simple terms, such as the clam was

big, to exploring interesting vocabulary, addition of details and the use of analogy. Comparison of two accounts of two of the field trips the students made showed growth in all of the language development areas as well as an increase in the understanding and knowledge of seashore life.

Jill, a physically handicapped student writes of her first trip,

> Yesterday I went to Saxe Point Park with my class. We left at ten o'clock in the morning. I saw the water. It was very beautiful. I felt seaweed for my first time in my life. We had our snack. Then I went down on the ground to feel the rocks. I was looking at a feather. It was very soft. Miss Brown helped me with my drawing of the beach. I want to go back because it had a nice view.

Later Jill writes,

> Yesterday our class went to the Marine Ecology Station in Cowichan Bay. It took us an hour to get there. When we got to Cowichan Bay, we looked at the different tanks. The tanks had different sea creatures. What I liked best was the sea cucumbers and starfish. I picked up a sea cucumber. It felt slimy and was orange and green. When I was holding the sea cucumber, it sprayed water out. It reminded me of a water fountain. I had to put it back into the tank very carefully. Also, there were many different kinds of sea stars. I went on a boat ride and saw some plankton. I saw some sea anemones as well as other sea life including coral. We talked about how they cling onto the glass so tight that you can't get them off. The field trip was very interesting and I learned many different things about sea creatures.

Randy's first account was very short and very few details or interest in seashore life was evident.

> Yesterday I went to Saxe Pt. It took twenty minutes to get there. When we got there we walked on a gravel path through the forest. We got to eat our snack. After we ate our snack we got our field note books. We wrote about stuff and also drew stuff and felt stuff as well.

Later, after the trip to Cowichan Bay, Randy writes,

> Yesterday me and my class went to Cowichan Bay Marine Ecology Station. It was 9:30 in the morning. It took one hour to get there on the bus. Me an my class got inside the lab. We saw lots of kinds of animals. We sat down in some desks. I sat in a desk with two starfish. One was small and the other was a little bigger. There was a microscope beside me so I took a look inside. I saw white on the sea star. Me and my class moved around and I saw a huge jellyfish with a yellow bottom. There were two sea stars they were huge. I also saw three big crabs. One of them was climbing around the box. It climbed to the top and fell down. The other one was just lying around and looking at me. The last one was in another box. It was walking around and eating plankton probably. I saw giant green sea anemones. They were kind of big and some were small. After we grouped up with partners and we had this sheet. My partner was David. He didn't know what was the longest thing in the lab. David wanted to put a spoonworm, but I didn't because it looked pretty fat, so we didn't put anything and we waited for the answer. The longest thing was the ribbon worm. After the sheet answering stuff, me and some of my class went on a boat with our life jackets on. We went on the boat to get some plankton with a net. We went in one group at a time. The second group got a finer net and the other group got a less finer net than the second group. When we got back we watched a video...

Randy was able to remember and describe many accurate details about his second trip. Compared to the first account, where he seem totally unengaged with any sea plant or creature, Randy's focus was definitely on the fascinating world of the sea and the enthusiasm of new found knowledge exudes from his second account.

Revelations were common features of the children's descriptive narratives. Patricia writes:

> Yesterday, me and my class and a few helpers went down to Saxe Pt. Park on field trip. So as we walked along the sidewalk and along the hill we came upon a sign that said Saxe Pt. Park. When we passed the sign we went on to the road. Beside the road on the left were very exquisite flowers. Then we came off the road onto a foot path. So as usual we followed it until we came to a clearing. All I thought I saw was...pebbles, seaweed, and a few washed up logs. But! I was wrong. When I looked closer, there were little limpets, and barnacles. You could say they were camouflaged because they were the same colour as the rocks. I also saw some sea anemones at the bottom of some rocks. There were some little pools of water with bull fish

> and hermit crabs and a type of seaweed called kelp. We also saw some seaweed that some people thought was tar or an oil spill but it was algae. We had to go back for lunch so we went through the foot path, onto the road, passed the exquisite flowers and onto the sidewalk...

Many of the children shared there impressions with a partner or in small debriefing groups. Those students who were still having difficulty expressing their ideas using descriptive vocabulary were paired with students whose writing demonstrated unique methods of articulation. These students then would share their ideas and the researcher noticed that the students would voluntarily want to edit their first drafts spurred on by the support they had received from their peers.

The students were also required to write two research reports. One was to involve a seashore creature and the other a marine mammal. The children were given free choice and the criteria was specific to both projects. The children had to describe what their animal looked like, how it moved, what it ate and how, where it lived (habitat), its enemies, how it protected itself and any other interesting facts the children wished to include. A hand drawn picture accompanied the written report. With the practice the children had received from their trip descriptions and peer assistance, the two projects were completed successfully by all students. The researcher noticed that during both assignments the students were focussed, did not complain that they did not know what to write about, but rather constantly asked for more reading material to supplement what they already had. Children who had chosen the same animal (many chose killer whales) worked in small groups together, yet each report was unique and the same details were personalized. The children's reports were displayed in the school hallway and their descriptions and detailed illustrations were admired by other children and adults in the school.

These children, by reading and writing about their seashore and

ocean experiences, used the scientific knowledge available to them in the context of the real world. Reading and writing activities throughout this curricular experience supported active constructive learning and inquiry processes and presented many marine ecology concepts dynamically and meaningfully.

Resource Issue Investigation

Learning about natural environments such as the seashore and ocean progressively leads to the consideration of marine resource issues. During the visits to the local target site in this study, student conversations often expressed concern about human impact upon these fragile ecosystems. After discovering the diversity of life found at their very doorsteps, the children were often appalled at the amount of garbage on the beach and in the water even when waste receptacles were readily available. One child suggested we come back and do a "beach clean up" to which the class agreed unanimously. When the children were learning about black tar algae, the issue of oil spills was discussed and many children related tales of the damage to local beaches and water fowl that they had seen or heard of. The children became very interested in the plight of wild marine mammals in captivity, particularly killer whales when many of them found information through their own research and by the videos they had watched in class.

The researcher wanted to address the topic of resource issues and involve the students in instances that involved critical thinking skills. The prime objective was for the students to realize that solving an issue that affects many different segments of society was not an easy task. To make the discussion relevant, the current topic of the depletion of Pacific salmon stocks was chosen. Many of these children had indicated that they had

been fishing in local waters, were aware of recent government restrictions, and had been involved in classroom salmonid enhancement programs.

The strategy employed was to institute a round table discussion. The children were presented with the proposal that the government had issued a two year moratorium on all salmon fishing for everyone. The initial reaction of many of the students was that they thought this was a good idea. Those children who had been involved in raising salmon in the classroom view these animals with a fierce protectionist attitude. The concept of a round table discussion was then developed. The children were asked to illicit who they thought would be interested in the plight of the salmon. The researcher then provided the children with ten roles (fisheries manager, laid-off cannery worker, chief of Ahousat people, small-scale commercial fisherman, mayor of a coastal town, conservationist, sports fisherman, fishing lodge operator, member of Friends of Endangered Wildlife, large-scale commercial fishing operation). The children then broke up into groups of two or three and discussed their role cards and the accompanying information that stated the case of each participant. Then the children were instructed to come to the round table (the significance of the shape was established beforehand) and represent their groups point of view.

Some of the children were very convincing. Others were a little uncomfortable and were not sure of how to state their case. This activity was difficult for some of the children to understand.

However, a list of pros and cons were made for each participant and then the children were asked to consider how they would solve the problems that some of these groups would have with the two year moratorium. The children seemed to realize that a decision of this kind was not a simple matter. Although they still felt strongly about protecting the salmon, some of them said that they would miss not being able to fish with

their dads or eat as much salmon as they liked.

It was not immediately apparent of the effect that this activity had on these children. Given their age and backgrounds, it was not expected that the students would fully understand the issue completely and make sophisticated decisions. The intent of the researcher was to introduce the students to what is involved in trying to resolve conflicting interests involving such topics as the depletion of salmon stocks.

As well as having the children appreciate the difficulties involved in resolving the problems associated with the B.C. salmon resource, the researcher wished the children to realize that there is an appropriate stance to adopt towards this particular issue. When considering all the opinions of the stakeholders involved with the salmon resource, the fact remains that if the peoples of B.C. don't manage this fragile commodity wisely, there will not be salmon left for future generations. Therefore, subscribing to a conservationist's view when attempting to solve the salmon resource issue would be warranted.

In order to present a conservationist view as the desirable stance to adopt in order to arrive at a prudent solution to the B.C. salmon stock depletion issue, the researcher employed two teaching strategies. One strategy involved using explicit questioning techniques that would allow the children to realize that careful use and management solutions were favoured over uncontrolled usage and destruction of the salmon resource (overfishing, certain logging practices) and strictly preservationist decisions (fishing and logging moratoriums). The researcher wanted the children to realize that both utilizing salmon as a food source as well as appreciating their role as a fascinating and beautiful animal are addressed in a conservationist view of dealing with resource conflicts. The second teaching strategy used by the researcher involved working within student small group discussions. When the children were actively engaged in

talking to their peers about a specific feature of the salmon resource issue, the researcher would join the group as one of the participants and share her ideas based on her conservationist beliefs.

Time constraints did not allow the researcher to collect any written data on student thinking about this activity, however it was hoped that the children would begin to realize that solutions to large problems were not simple, particularly when opposing views are involved and that it is important to look at many sides of an issue before forming opinions.

CHAPTER 5: THE STUDENTS' KNOWLEDGE AND BELIEFS AFTER CLASSROOM INSTRUCTION

Qualitative data representing students' conceptions of a seashore community and quantitative data pertaining to students' knowledge, attitudes, and stances were compiled and analysed after a unit of instruction. The curriculum included the following marine science topics: (1) ocean currents, waves and tides; (2) seashore zonation; (3) seashore plants and animals characteristic of each zone; (4) predator/prey relationships; (5) food chains and food webs; (6) interdependence of seashore plants and animals; (7) and marine mammals. Also, marine resource issues were discussed with the issue of depletion of Pacific coast salmon stocks examined in detail.

This chapter will outline the post-instructional findings of the samples collected of students' drawings and their lists of seashore items. These findings will be compared to the students' pre-instructional drawings and lists.

Three of the four questionnaires were administered after the unit of instruction. These were: (1) Ocean Attitudes; (2) Ocean Life and; (3) Ocean Opinions. Statistical techniques were employed to test the significance of mean differences between the same three pre-instructional instruments and post-instructional questionnaires. Through the applications of paired sample and independent sample t-tests and through the calculation of Pearson product moment correlation coefficients, possible increases and relationships concerning the students' attitude, knowledge, and stances were examined.

Student Drawings and Lists

The culminating data collecting activity for the students in this study was to draw their impressions of a seashore community. This task was performed after all pre-instructional instruments (drawings, lists, questionnaires) were administered, the unit of instruction completed, and the post-instructional questionnaires executed. The students could now draw upon any new found knowledge about individual seashore plants and animals and how marine biota were arranged in interdependent communities. The same twenty-one students' drawings were examined at the end of this study as was at the beginning. All of the 21 drawings had some part of a rocky seashore community represented. The pictures were close replications of what the students had actually seen and experienced during their field trips to Saxe Pt. Park and Cowichan Bay Marine Ecology Station. Three children added indigenous whales to the background of their drawings. The remaining 18 drawings were exclusively that of the seashore. Many of the drawings were labelled and some of them were numbered to correspond to the lists that were compiled with the pictures.

Some children drew their pictures in scenic form, that is, looking at the seashore through a camera lens that would encompass the shore, the distant waters and the sky. Nineteen children chose to do their drawings this way. Two of the children preferred to just concentrate on the plants and animals of the seashore and drew them in organized communities on rocks and in tidal pools.

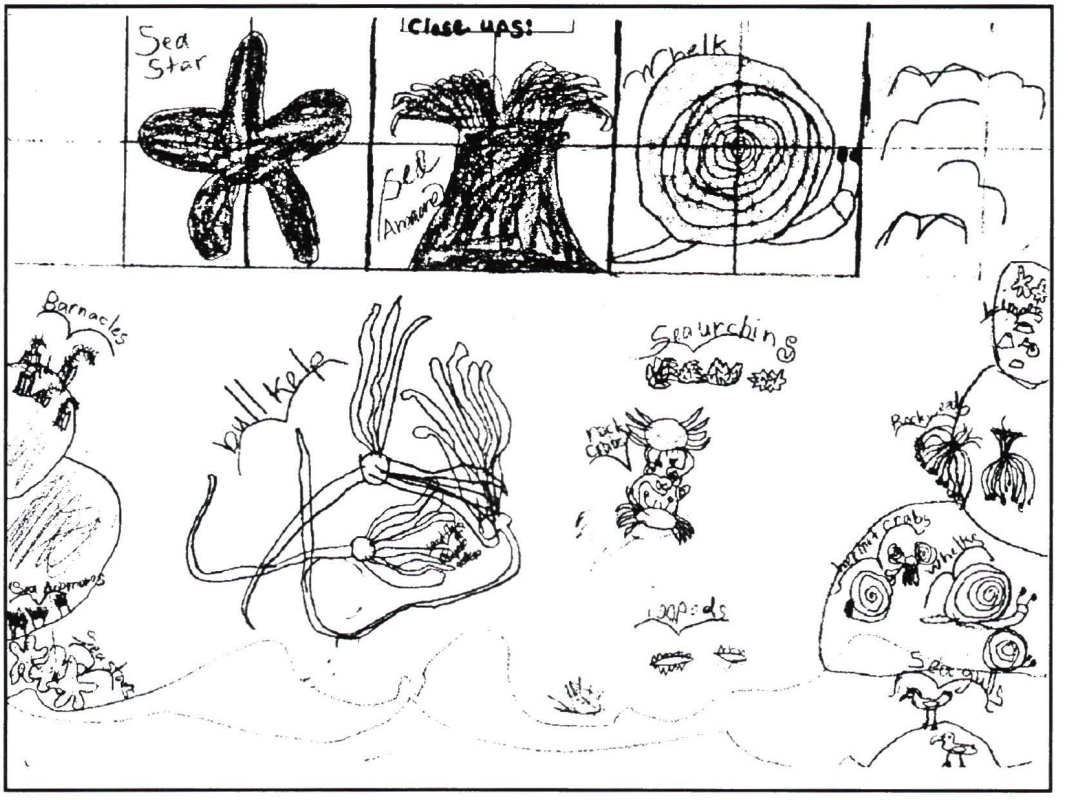
A feature that was not present in the pre-instructional drawings was the addition of humans. The pre-instructional drawings had inferred human involvement in marine ecosystems (boats, submarines, treasure chests) but no person was actually drawn. Four children drew either themselves or their friends at the seashore along with the plants and animals that they were investigating which seemed to indicate that they viewed themselves as

part of the seashore community as an observer.

When the researcher gave the instructions for this activity, no students asked any questions about what to draw and very quickly engaged in the task until the session ended (approximately 40 minutes). Many children wanted more time to work on their drawings and lists, however the researcher wished to keep the pre-instructional and post-instructional time limits consistent. The same student drawings (Laura, Greg, Kelly and Robbie) were then chosen as being representative of the whole group and were used to compare to the pre-instructional drawings.

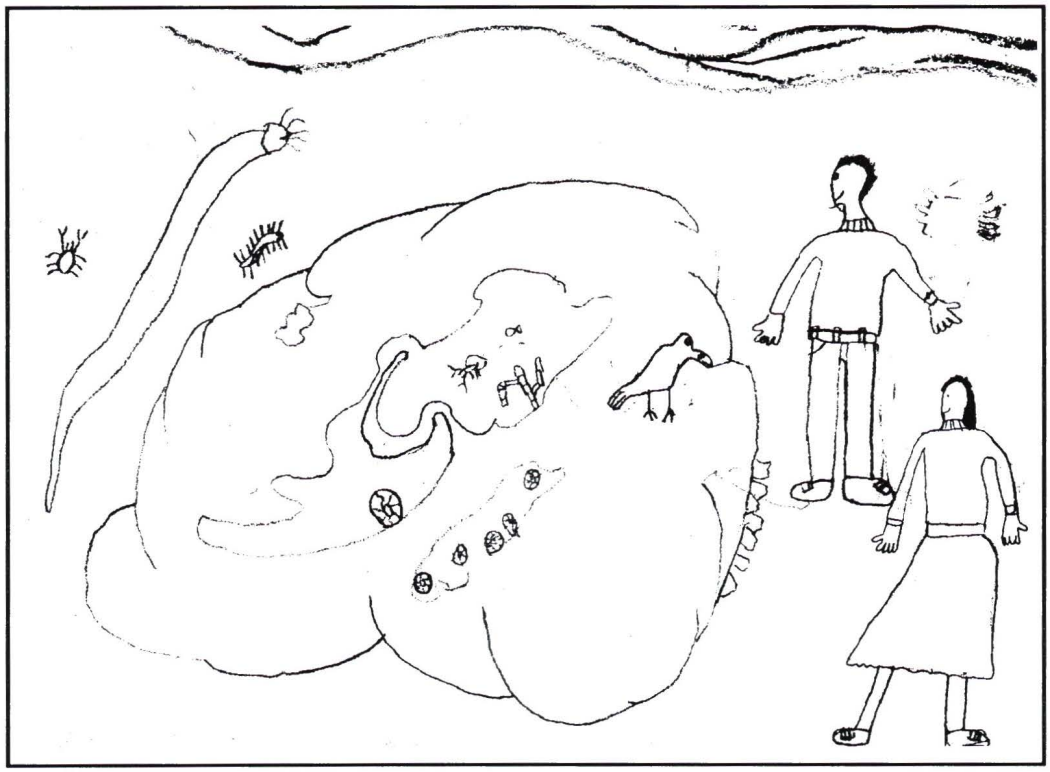
Laura's picture (see figure 5.1) included many seashore creatures and a few seashore plants. She drew some "close-ups" of a sea star, anemone, and whelk that she had observed using a magnifying glass when she was at the seashore. The seashore animals were arranged in community groupings and included non-living features such as the rocky habitats where these creatures made their homes. It was interesting to note how the correct common names for many of the plants and animals were used (rock crabs, whelks, limpets, sea anemones, rock weeds, sea urchins, sea star, barnacles, isopod).

Figure 5.1 - Laura's Post-instructional Drawing



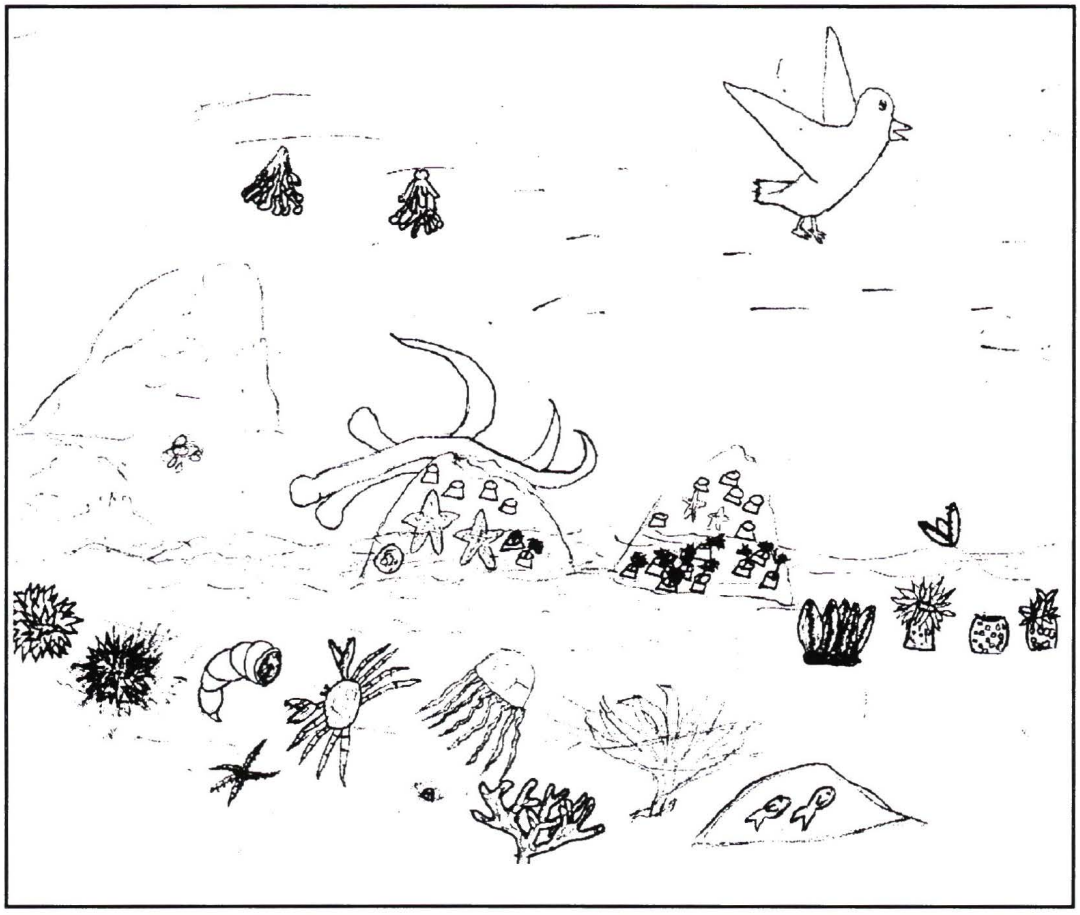
Greg, another student whose pre-instructional drawing depicted the ocean, now drew a picture of a rocky shore (see figure 5.2). In the foreground, Greg drew a large rocky outcropping with a tidal pool in the middle. Along with the creatures and plants that he remembered seeing including bull kelp, isopods, barnacles, a seagull, coral seaweed, anemones and crabs, Greg drew himself and a friend observing the marine landscape.

Figure 5.2 - Greg's Post-instructional Drawing



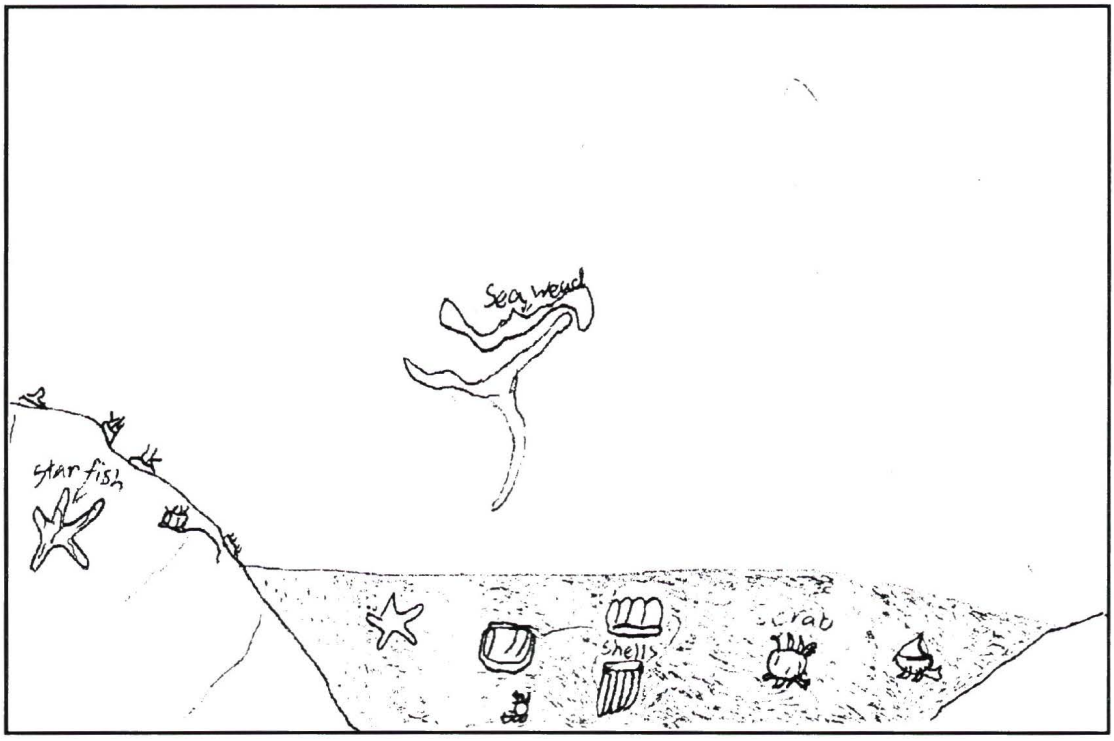
Kelly's pre-instructional drawing had been completely under the ocean while her post-instructional drawing (see figure 5.3), was a very detailed arrangement of seashore plants and animals in their natural habitats. Many of the children included a seagull like Kelly did, as these birds were very prominent on all the field trips to the seashore.

Figure 5.3 - Kelly's Post-instructional Drawing



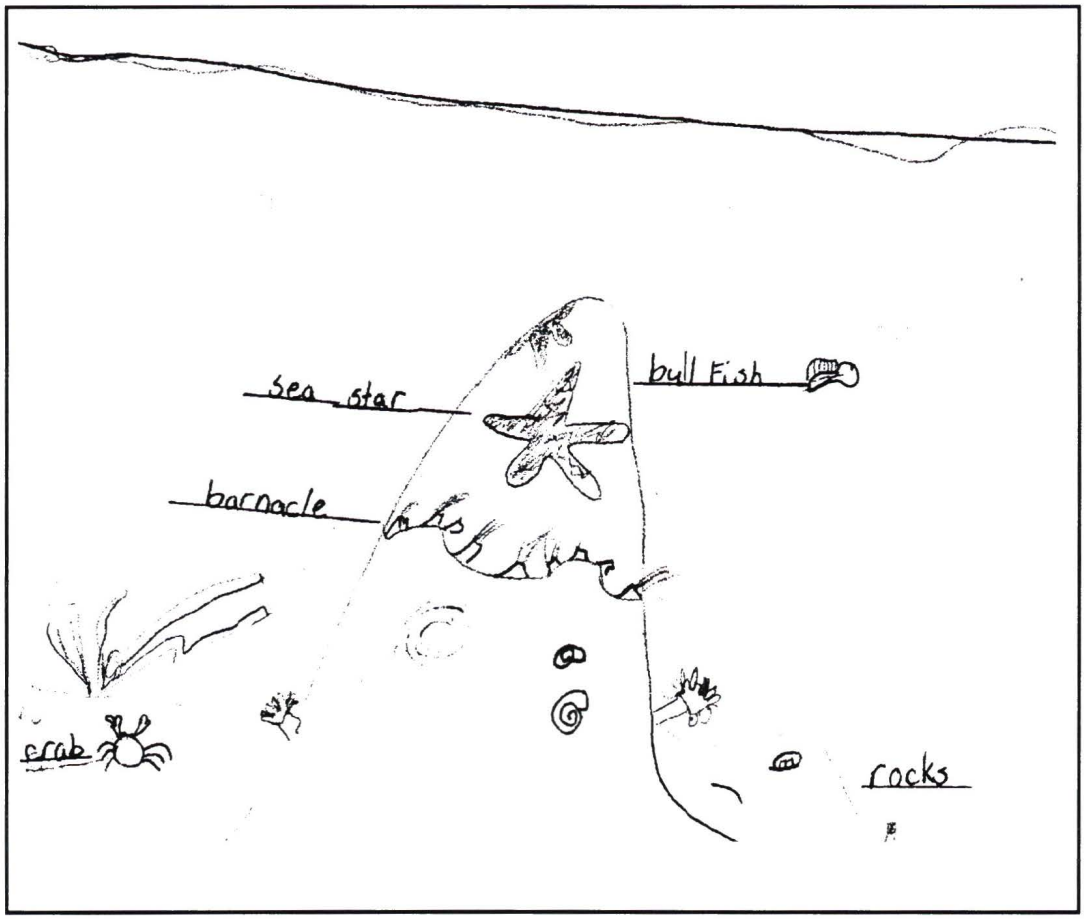
Jamie's pre-instructional drawing (see figure 5.4) had been of a desolate beach while his post-instructional drawing represented the beach with a few added features. Jamie's picture included rocky outcroppings with barnacles and sea stars and the sandy area included shells, crabs, and a hermit crab. The background was the ocean with seaweed floating on the surface. Jamie's conception of the seashore as being a lifeless mound of sand and logs seemed to have changed.

Figure 5.4 - Jamie's Post-instructional Drawing



Robbie had drawn a tide pool in his pre-instructional picture and had added two sea stars, three anemones, and a crab. In his post-instructional drawing (see figure 5.5), Robbie drew a rocky outcropping and included barnacles, sea stars, crabs, whelks, a bull fish (sculpin), anemones and some kelp and arranged these creatures on the rock in particular groupings. This seems to indicate that Robbie's idea of a seashore community was expanding.

Figure 5.5 - Robbie's Post-instructional Drawing



All of the drawings the children made contained animals and plants that they had either seen on the field trips, in the videos they viewed, or in the resource material the researcher had made available to them. Inappropriate items that were not part of the instructional unit and not indigenous to Pacific Northwest seashore environments that the students studied were two turtles and a pelican. However, there was a poster in the classroom that depicted sea turtles and non-native sea birds such as the pelican. Only four students depicted marine mammals in the form of three killer whales and one right whale. These students had recently completed research papers on these animals. In the pre-instructional pictures, fifteen students had included a wide variety of generic fish-like creatures and a few identifiable whales and sharks. An aspect that was not evident in the pre-instructional drawings was that many of the children correctly labelled the plants and animals in their pictures. The students seemed to be trying to tell a story in their drawings about the things they had discovered at the seashore.

The children also tabulated as many seashore plants and animals that they could recall and that time would allow. All items on the lists were again totalled and then catergorized into living and non-living with living plants and animals being further catergorized into those plants and animals that would be found at a rocky seashore such as the target site (Saxe Pt. Park) and those plants and animals that would not be found at the site.

The most items any one child listed was 48 compared to 28 in the pre-instructional lists and the least was 1, making the average number of responses 17 which was an increase of 3 over the pre-instructional lists. Many of the children concentrated on the details of their drawings and left little time of the 40 minute period to make a list. Of the non-seashore plants and animals most were marine mammals (e.g. killer whales, dolphins, seals, sea otters, sea lions). There were no fresh water creatures

listed and no plants, animals, and objects that were not relevant to a marine environment. Only five responses out of the total 349 were non-native species of marine life (coral reef, 3 sea turtles, and 1 seahorse) representing 1.5% that could be considered to be misconceptions when viewing only local marine ecosystems.

There was a greater emphasis on plant and animal life in the students' post-instructional lists than in the pre-instructional (see table 5.1) and less on non-living items

Table 5.1 - A comparison of pre-instructional and post-instructional lists

n=21	Pre-instructional		Post-instructional	
Total items	299		349	
Living (Animal and Plant)	238	(80%)	323	(93%)

The most dramatic change in the lists occurred with the increase (35% greater) of the number of seashore plants and animals listed and the decrease of non-seashore plants and animals (see table 5.2). There were no fresh water plants or animals recorded in the post-instructional student lists.

Table 5.2 Living Plants and Animals (n=21)

	Pre-instructional		Post-instructional	
Living (Animal and Plant)	238		323	
Local seashore life	99	(42%)	248	(77%)
Ocean life	127	(53%)	75	(23%)
Freshwater life	12	(5%)	0	

While many items on the pre-instructional lists were general in nature (fish, bird, sea star), the post-instructional lists were more species specific. Many of the children used the correct common names for the animals and plants they listed (periwinkle, purple sea star, shore crab, black tar algae, chiton, sculpin, bull kelp).

Questionnaires

The Students' Ocean Attitudes. The post-attitude scores on the Ocean Attitude Questionnaire were tabulated using the same method as was used in calculating the pre-attitude scores. The responses for each student were tallied from using a 0 to 4 coding, wherein 0 was considered very positive and 4 very negative. The number of responses in each category (0 - 4) were then totalled. The very positive and positive responses (0 and 1) were then added together as were the negative and very negative scores (3 and 4). The number 2 coded responses were considered undecided and therefore disregarded in the final calculation each students' attitude score. The negative response totals were then subtracted from the positive responses resulting in a score that was then considered to be that student's attitude score. The higher the score, the more positive the attitude. A paired sample t-test was then administered to the pre-attitude and post-attitude scores. The results indicated a significant increase in attitude (see table 5.3).

Table 5.3 - Paired Sample t-Test for Pre and Post Attitude Scores			
Variable	Number of pairs	Mean	SD
Post Attitude	21	19.0476	4.105
Pre Attitude		5.3810	5.399
t-value	df	2-tail Sig	
10.04	20	.000 (p>.001)	

The students remained very positive (0 and 1 values combined) in their attitudes (>90%) towards the statements on the post-instructional Ocean Attitudes questionnaire concerning pollution (pulp mills, Victoria's sewage disposal, damage to wetlands) and the treatment of marine mammals (harp seals being hunted for their fur, whales in captivity, seals being shot by salmon fishermen). Also, in 91% of their responses the children indicated that they thought all living things had a right to exist. The same percentage of students agreed that stronger laws are needed to protect our ocean, seashore and wetlands. Other positive responses (>74% of the responses) included disagreeing with marshlands being filled in and the exploitation of natural resource. Most of the students agreed that commercial fishermen take too many fish (87%), the taking of shellfish should be restricted (87%), and that learning about Arctic and Atlantic animals is important (78%). Certain items illustrated the increase in positive student responses in the posttest questionnaire as compared to the pretest questionnaire very clearly (see table 5.4).

Table 5.4 - Pretest and Posttest Student Attitude Responses

Item No.	Pretest	Posttest
4. - oil and gas exploration should not be allowed	22%	43%
9. - shore crabs should not be taken home as pets	78%	91%
13. - killing of harp seal pups should not be allowed	83%	96%
20. - fishing for fun should have restrictions	17%	56%
24. - the taking of shellfish should be regulated	30%	87%
28. - more money should be spent on scientific research	35%	55%
32. - all living things have a right to exist	70%	91%
37. - scientist activities don't make environmental problems worse	26%	57%

The Students' Ocean Knowledge. The post-instructional knowledge scores from the Ocean Life questionnaire were compared to the pre-instructional knowledge scores by administering a paired sample t-test to determine the level of significance. Even though the mean score for the students only increased by 2.38, the comparative analysis supported the rejection of the null hypothesis and a level of significance became apparent (see Table 5.5).

Table 5.5 - Paired Sample t-Test for Pre and Post Knowledge Scores			
Variable	Number of pairs	Mean	SD
Post Attitude	21	16.4762	5.154
Pre Attitude		14.2381	4.504
t-value	df	2-tail Sig	
2.81	20	.011 (p=.01)	

The items of three sub-tests (Physical Oceanography, Ocean and Seashore Ecology, Human Effects on the Ocean Environment) were examined to compare individual item differences to the pre-instructional treatment.

On the Physical Oceanography sub-test, four items out of the seven (57%) were answered correctly by more than 50% of the students. The number of children correctly answering these items increased (see table 5.6).

Table 5.6 - Percentages of Correct Student Responses on the Physical Oceanography Sub-test			
Item No.	Content	Pretest	Posttest
1	- % of ocean covered by water	74%	78%
2	- meaning of tides	70%	91%
3	- cause of tides	57%	74%
4	- ocean currents	4%	28%
5	- B.C.'s shoreline	9%	28%
6	- oil spill areas	26%	35%
7	- meaning of mudflat	39%	70%

Even though the other items were not answered correctly by more than 50% of the students, they all showed an increase of student responses as compared to the pretest results.

The response to the Ocean Ecology sub-test items on the posttest remained the same as the pretest with seven of the fourteen items (50%) being answered correctly by more than 50% of the students. However, the percentages of children answering each question correctly increased. For example, 91% of the students knew about plankton in the posttest as opposed to 65% in the pretest. Similarly, 91% of the children knew that the energy of living things in the ocean come from the sun post-instructionally compared with 48% pre-instructionally. There was also a percentage increase of correct student responses in items that were answered correctly by less than 50% of the students.

It is important to note that the items that were directly related to the concepts covered in the instructional unit had the highest percentages of correct responses. For example, food chains and food webs were emphasized using several teaching strategies and before instruction the number of correct student responses to the item that referred to food chains was 52%. After instruction the number of correct student responses to the food chain item was 91%.

The increase of correct student responses on The Human Effects on the Ocean Environment sub-test indicated that some students had a better idea that birds and some seashore creatures are affected by oil spills the most, where it is safest to harvest seashore animals for consumption, and the value of salt marshes. The students in this study still did not have a clear understanding of the different types of marine pollution as revealed through the mixed frequency of responses to the items concerned with how polluted water can look and the effects of pollution on living plants and creatures. Marine pollution was only briefly discussed over the period of

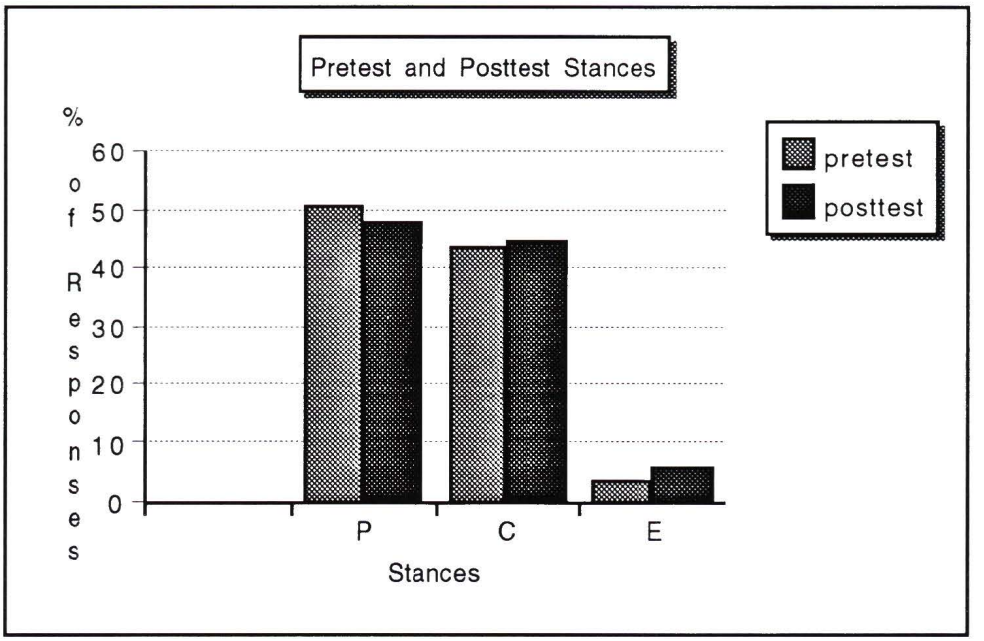
instruction and the student responses in both the pretest and posttest and actually showed a decrease in correct responses (see table 5.7).

Table 5.7 - Percentages of Correct Student Responses on the Human Effects on the Ocean Sub-test

Item No.	Content	Pretest	Posttest
22	- how polluted water appears	52%	30%
25	- environments damaged most by human activity	30%	22%
30	- loss of habitat is a greater danger than pollution	30%	22%

The Students' Ocean Opinions. The students' preservationist, exploitive, and conservationist stances on the Ocean Opinion posttest were examined. Of the choices made by the students in the post-instructional questionnaire, 48% were preservationist, 45% were conservationist and 6% were exploitive. Compared to the pre-instructional treatment, there was a slight decrease (3%) in preservationist responses, a slight increase (1%) in conservationist responses and a slight increase (2%) in exploitive scores (see figure 5.6).

Figure 5.6 -



No item was an exploitive stance the preferred choice, and only on one item did this stance draw more than 17% of the students. Although the posttest percentages of responses remained close to the pretest responses, the major difference appeared not in the student percentages for each stance, but in the variety of stances each student chose for the total number of items on the questionnaire. In other words, fewer students were strictly preservationist or conservationist but a mixture of these two stances. As well, there were two students whose 20 responses were evenly distributed among the preservationist, conservationist, and exploitive stances. The researcher interpreted this as meaning that the students were trying to approach these issues from many different perspectives and perhaps less than idealistic in their thinking.

Students remained the same in some of the stronger preservationist stances that were evident in the pre-instructional questionnaire and some of the post-instructional responses showed an increase in preservationist opinions (see table 5.8).

Table 5.8 Pretest and Posttest Preservationist Stances		
Item	Pretest	Posttest
1) killing of harp seals	91%	91%
2) oil tankers along coastline should not be allowed	83%	83%
3) stronger maritime laws needed	65%	70%
4) no whale hunting should be allowed	73%	78%
5) off shore oil and gas exploration should not be allowed	39%	48%
6) driftnet fishing should be stopped	65%	87%
7) Victoria should not dump raw sewage into ocean	17%	57%
8) pulp mills should find other places to dump their chemicals	39%	54%

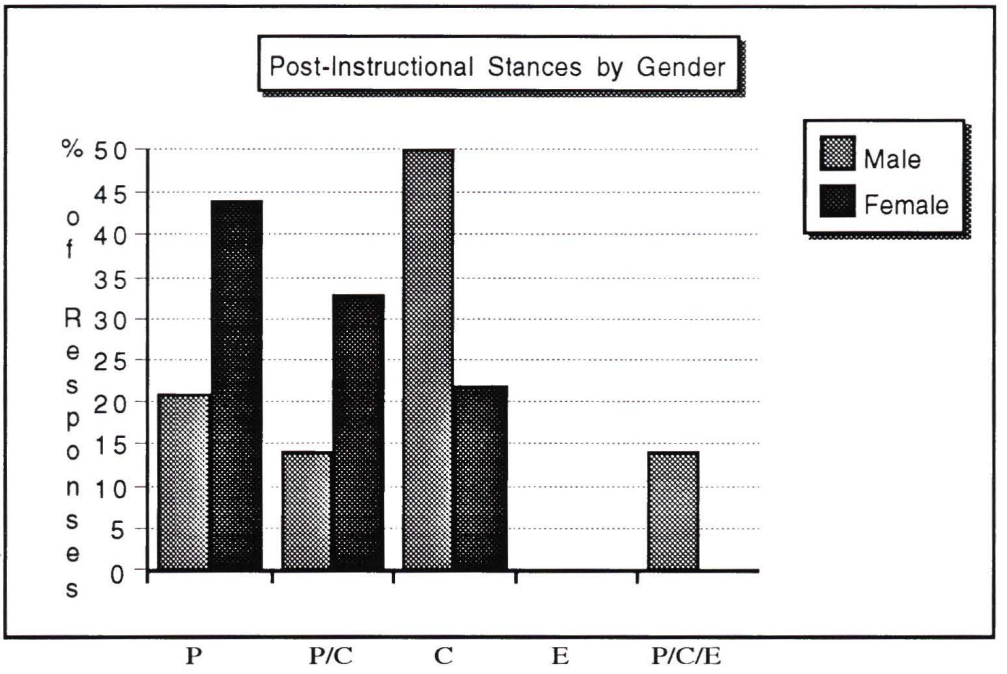
The one item where an exploitive stance represented more than 17% of the responses was the question "Should killer whales be kept in places like the Vancouver Public Aquarium and Sealand?" Of the responses, 17% represented the preservationist stance of all killer whales should be free; 48% represented conservationist stances of no new killer whales being captured or keeping killer whales for a few years and then letting them go; and a surprising 35% represented the exploitive stance of keeping some killer whales because they are fun to watch and a lot can be learned from them. There was a shift from the pretest frequencies where 43% of the children favoured a preservationist stance and 17% favoured an exploitive stance. The researcher observed student reactions to a video shown during instruction depicting whales doing tricks in aquariums. The video was

shown in contrast to another video which related the saga of two scientists who had studied killer whales in the wild for twenty years with minimal interference with the animals in their natural environments. It may be that some of the students in this study were more impressed with the tricks.

When viewing the stance differences between gender, the girls remained more preservationist than the boys. The boys' and girls' individual responses for the twenty item questionnaire were tallied, resulting in a cumulative total of 460 (23 students x 20 items). Out of these 460 responses, only 30 were exploitive. The boys accounted for 22 out of the thirty and the girls, 9.

The students were then coded according to how many responses they chose in each category (preservationist, conservationist, and exploitive). Five categories were established to describe the stance of a particular student. A student could be preservationist (4), conservationist/preservationist (3), conservationist (2), exploitive (1) and mixed (0), that is, a combination of preservationist, conservationist and exploitive responses. In order for a student to be rated in any of these categories, the difference between the number of any of their responses (preservationist, conservationist, exploitive) to the 20 item Ocean Opinions questionnaire had to be at least 3. For example, if a student had 12 preservationist responses, 7 conservationist responses, and 1 exploitive response, that student would be given a code of 4. The codings were then summarized and divided according to gender to determine the post-instructional percentages of stances for male and female (see figure 5.7).

Figure 5.7 -



P = Preservationist
P/C = Preservationist/Conservationist
C = Conservationist
E= Exploitive
P/C/E = all three stances

Correlations. Pearson product-moment coefficients were calculated to estimate the correlations among the students' knowledge, attitudes, and stances. No correlation was found between knowledge and stances or between attitude and knowledge using the pre-instructional and the post-instructional scores. There was only a very weak positive correlation between the pretest stance scores and the posttest stance scores ($r=.47$, $p=0.030$). A larger sample may have provided a more representative index of the nature of the relationships among the three variables of knowledge, attitude and stance. This means that a relationship could possibly exist among the variables in question, however the sample in this study was too small to reveal one. With this information concerning correlations in mind, together with the fact that there was a significant increase in

knowledge and attitude as well as some rather interesting differences in students' opinions merits further investigation into the intervention that transpired between the pretests and the posttests.

Gender Differences. Independent sample t-tests were administered between the male and female scores for attitude, knowledge, and stances. There were no significant mean differences in the male and female attitudes, knowledge, or choice of stances in any of the comparisons made between the pretest and posttest scores.

Summary

The post-instructional drawings revealed a change in how the students in this study viewed the seashore. Some of concepts that were covered within the instructional unit (zonation, seashore plants and animals characteristic of each zone) were evident in the student drawings. The post-instructional lists were more accurate and detailed than the pre-instructional lists. The students were able to name several common seashore plants and animals that were indigenous to the Pacific Northwest coastal areas. All the post-instructional list items were marine plants or animals.

The results of post-instructional questionnaires and the comparisons made with the pre-instructional questionnaires, provided the researcher with another view of student response. The students remained strongly preservationist or conservationist in their stances toward a variety of marine resource issues. Yet there were changes in the way the student responses were distributed. Girls were strongly preservationist and the boys were strongly conservationist. The knowledge scores had increased significantly between the pretest and the posttest. Similarly, the attitude

scores indicated a significant increase in positive attitudes toward the seashore and ocean. But, no strong statistical relationship could be found among student attitude, knowledge and stances in this study.

However, the comparisons and analyses of all post-instructional and pre-instructional data assisted the researcher in addressing her research questions. Conclusions were formulated concerning the Grade four class involved in this study, as well as implications suggested for further research.

CHAPTER 6: CONCLUSIONS AND IMPLICATIONS

Most people are on this world, not in it--having no conscious sympathy or relationship to anything about them - undiffused, separate, and rigidly alone, like marbles of polished stone, touching but separate.

John Muir

Science educators, particularly environmental educators, hope to connect their students with the natural world around them and seek ways of evaluating and assessing the success of their efforts. The strategies of instruction that were employed in this study were an attempt at cultivating such a connection and to develop a relationship between a group of Grade Four children and a rocky seashore by increasing their understanding of seashore and ocean ecology. This chapter will begin by summarizing the findings of the study of these Grade Four students' knowledge, attitudes and stances before and after instruction, then outline the conclusions derived through the comparisons of the three questionnaires and the students' drawings and writing. In addition, implications for instructional strategies will be discussed as well as implications for future research and, in a final comment, recommendations for marine education.

Findings and Conclusions

The researcher was interested in examining students' knowledge about and attitudes towards the seashore and ocean as well as their opinions towards a range of marine resource issues. Validated questionnaires were selected from several that had been used in previous studies by Snively and Sheppy (1991) and the researcher used them as pre-instructional and post-instructional instruments of measurement of attitude,

knowledge and opinion. Snively and Sheppy (1991) had not used these questionnaires where an instructional treatment was the focus as their study had been a comparison of the student background, attitudes, knowledge, and stances of two grade levels (grades 5 and 9) in three different geographical communities in British Columbia (Victoria, Campbell River and Williams Lake). Therefore, the researcher wanted to determine if these instruments were valuable as pretest and posttest instruments and if they could be used with a younger group of children (grade 4). The researcher also chose to examine pre-instructional and post-instructional student drawings and writing to add a further dimension in assessing the changes in knowledge and understanding.

The statistical analyses of the questionnaires provided the researcher with information about the pre-instructional and post-instructional nature of the attitudes, knowledge, and stances of the grade four children involved in this study. There was a significant increase in knowledge as well as a significant increase in positive attitudes. The students also made some interesting shifts in their stances as illustrated in the comparisons of pretest and posttest results. However, a significant relationship between the increase in knowledge and the increase in attitude was not evident. A further relationship between the students' stances and their increase in attitude could not be established in the study sample.

The students' drawings and writings substantiated the increase in knowledge as was evident in the Ocean Life questionnaires. The researcher was able to sequentially trace the development of understanding for all of the students through their pictorial representations as well as the written lists they compiled and narrative accounts they produced. For young children, the use of several data gathering instruments seems to be essential for the interpretation of not only knowledge but how that knowledge is acquired and viewed.

The researcher needed to be ever conscious when examining the data, that the sample was very small and that generalizations for all grade four students could not be made. The findings were specific to the parameters set by the researcher and the circumstances of the participants. However, several indicators supported the importance of explicit instruction as well as prior and ongoing knowledge of students' interpretive frameworks.

The very fact that there was a significant increase in attitude appeared to indicate a connection to the instructional strategies used to provide the students with the firsthand experiences and concepts necessary to develop an understanding of the seashore community and the impact of human intervention. Closer scrutiny of the responses to the pre-instructional and post-instructional attitude questionnaires revealed that the items showing the most increase in positive scores were ones that could possibly be linked to first hand concepts covered during the course of instruction. Furthermore, the increase in attitude scores may indicate that attitude is an indicator of surface thinking and more easily changed than stances, which may be more deep-set conceptual structures.

For example, many children had not realized that barnacles and aggregate anemones were actual living animals until their field experiences in this study. Much discussion focussed upon seashore communities and how careless humans can either purposely or unknowingly destroy these fragile habitats. Seashore etiquette became a very important feature of the students' trips to Saxe Pt. Park. When the researcher compared individual posttest attitude items to pretest items, there was over a 20% increase of the number of children who strongly agreed that all living things have a right to exist.

The respect for the living creatures and habitats of the seashore was emphasized by the researcher when she taught the importance of viewing the rocky shore as a home for many plants and animals. The people who

visited these environments were to be considered "guests". Therefore, clear expectations about how to visit the seashore from a polite visitor's perspective was outlined with the students before the first trip to the seashore and reinforced at the site through modelling by the researcher. The same rules were repeated for the second trip and the researcher demonstrated proper handling and releasing techniques when capturing small beach animals for closer observation.

Another item that showed a similar increase of percentages of students' strong disagreement was one that stated it was alright to take a shore crab home as a pet. The children had observed these creatures in their natural surroundings and may even have turned up rocks at the seashore and temporarily captured a few for closer examination. However, the children tried to minimize their impact on the crabs' habitat by carefully returning them under the same rocky places.

Furthermore, on the posttest, 87% of the students agreed that people should not be allowed to take as many shellfish such as clams and crabs as they want. This was a 57% increase over the pretest. The researcher cannot help but wonder if the trip to Cowichan Bay Marine Ecology Station and the students' hands-on experiences with many kinds of shell fish resulted in this positive increase in attitude.

The observations made by the researcher of the associations between specific strategies of instruction, and the development of positive environmental attitudes in this study, coincide with and supplement similar findings of other studies that feature direct experience as a critical element of instruction (Armstrong & Impara, 1991; Fellows, 1994; Jaus, 1982; Ryan, 1990/91; Shepard & Speelman, 1985/1986).

Another undeniable occurrence in this study was the significant increase in the students' knowledge. Again, there appears to be a relationship between not only the concepts taught in the course of

instruction, but the methods used in presenting these concepts. The researcher examined individual items on the Ocean Life posttest that represented a notable percentage increase of correct responses over the same pretest item.

One of the items on the questionnaire referred to the flow of energy through a food chain from predator to prey. The posttest correct response had increased by 40% over the pretest. A possible explanation for this increase could lie in the emphasis placed on presenting the ecology of a rocky seashore. The researcher demonstrated the meaning of a seashore community and the interdependence of the members of that particular community by studying predator/prey relationships. The students had been involved in role playing activities where they had assumed the roles of seashore creatures, plants and non-living components that were vital to a seashore community. On their trip to Cowichan Bay, the students had observed seashore animals feeding and been involved in collecting live plankton samples. The instructor at the station had outlined the connection between the smallest of living organisms to the larger members of ocean and seashore environments.

Another item on the knowledge questionnaire that related to food chains and food webs pertained to the source of energy for all living things. There was a 40% increase in the correct response and the class discussions and activities such as the "Food Web Game" could possibly have been responsible for this.

Added to the increase in knowledge scores on the Ocean Life questionnaires is the information gleaned from the students' drawings and writing. The examples cited in chapters 3 and 5 of this study support a possible relationship between selected experiences that took place in and out of the classroom. These findings add further information to other studies that support the inclusion of direct experiences as part of classroom

instruction to increase environmental science knowledge (Backman & Crompton, 1984/85; Falk, 1983; Lisowski & Disinger, 1991; Milton, Cleveland & Bennet-Gates, 1995; Orion &Hofstein, 1991).

A further indicator of the possible effects of the learning strategies was the change in the configuration of the students' stances between the pre-instructional and post-instructional Ocean Opinions questionnaires. Indications were that perhaps something had occurred during the treatment phase that caused some of the students to rethink their opinions about the ocean and seashore. Recall that marine resource issues were part of the ocean and seashore unit of instruction. The students briefly discussed several issues such as whales in captivity, ocean and seashore pollution (sewage disposal and oil spills) and one issue (Pacific Northwest salmon stock depletion) was investigated in greater detail.

A closer examination of individual student responses and how they changed in stance revealed some interesting trends. Only 5 students remained strongly preservationist out of the 9 whose responses had indicated that stance in the pretest. The movement of scores was towards a more conservationist stance thus less polarized. Two students demonstrated an almost even number of responses of all three stances (preservationist, conservationist, and exploitive). These patterns could be a result of the students viewing the resolution of marine resource issues as a complicated process involving tolerance of many opinions and critical evaluation of consequences. Perhaps, the many perspectives presented in the role play activity concerning the decline in the Pacific salmon stocks assisted students to examine their thinking on other resource issues. Therefore, it seems necessary that effective training and practice in dealing with controversial marine resource issues is needed so children can gain the experience to make wise judgments concerning our seashores and oceans (Brody, 1996; Brody, 1994; Brody & Koch, 1989; Newhouse, 1990;

Ramsey & Hungerford, 1989).

Overall, the researcher concluded that the instrumentations used in this study did help in assessing the effectiveness of instruction. The knowledge of how students think and believe the way they do is certainly worth investigation and will assist educators to develop curricula that will meet the needs of students with different beliefs, opinions, and levels of understanding. As well, it would seem likely that issue instruction could lead to active citizenship roles, the ultimate goal of environmental education.

Implications for Instructional Strategies

As previously indicated, the instructional component of this study was the pivotal element upon which all the investigations undertaken by the researcher were based. It was apparent to the researcher before structuring and sequencing the concepts that were important in a study of seashore and ocean ecology, that thoughtful consideration was needed in the initial choice of these concepts. However, more importantly, was the necessity of understanding how the students thought about the seashore and ocean and the reasons for their thinking. As the actual instructional segment of the study evolved, the researcher became more aware of the importance of explicit instruction. Upon completion of this study, the researcher reflected upon the the unit of instruction and analyzed the successful portions as well as the features that needed more attention.

The guiding principles for the unit of instruction were based upon the constructivist's view of learning and teaching. The focus of teaching from a constructivist perspective becomes one of changing misconceptions or alternative conceptions (Driver & Bell, 1986; Driver & Oldham,1986). In order to change or refine how the Grade Four students in this study

viewed the seashore and ocean, the researcher chose strategies that were appropriate and meaningful to these learners (Driver, 1987; Saunders, 1992; Ballantyne & Packer, 1996; Watson & Konicek,1990; Yager, 1991). The researcher found that partner and group learning strategies as well as opportunity for debriefing were effective. Examining student prior knowledge helped the researcher choose appropriate concepts that would enhance the children's existing understanding of ocean and seashore ecology and lead to further learning. However, analyses of student writing, drawings, and pre-instructional test results were not enough in forming a wholistic picture of students. In future investigations, the researcher intends to take into account what children say during instruction and analyse their reasons for saying what they do about the topics under discussion.

The learning environment was another aspect of the instructional unit that the researcher deemed important. The activities and experiences for the students in this study were child-centered and involved the students in a journey of discovery. Real-life situations and local sites that extended learning beyond the classroom were effective. The students were encouraged to seek information using alternative sources (resource persons, resource books and field guides) and they were given opportunities and encouraged to elaborate and explain their thinking as well as test their ideas (classroom experimentation; seashore exploration).

When the researcher designed her unit of instruction on seashore and ocean ecology, she strove to include activities that would be interesting and appealing to Grade four children. The value of experiential learning for science education in general and environmental education in particular has been well documented (Backman & Compton,1984/85; Falk, 1983; Lisowski & Disinger, 1991; Orion & Hofstein, 1994) and was certainly effective in this study as evidenced by student enthusiasm, participation,

and written responses. At the end of the first term of study for these Grade four students, they were asked to respond to a self-evaluation form that not only addressed their seashore and ocean studies but all other subject areas and term activities as well. One of the items was a sentence completion that stated, "This term I really liked learning about...." and the majority of the students (20 out of 24) made positive comments that referred to the seashore and ocean experience. Some of the responses were:

" I liked learning about the seashore."
" I liked learning about marine mammals. There are lots of kinds."
" I liked learning about the seashore. I thought it was going to be boring but it was fun."
" I have learned a lot about the seashore and ocean creatures."
" I learned that animals that do not look alive, still are."
" I hope we do more seashore exploration because I really liked it."
" I liked learning about the seashore and zoo plankton and marine life and the crabs and the living things on the shore."
" It is fun learning about the sea creatures and that there are zoo plankton and plankton that we can't see in the sea."
" I am proud of my barnacle research."
" I like studying food chains and food webs."

Still another strategy that proved successful for the students were the writing activities. The students were required to keep a field notebook during the study. This was used on the field trips taken and although there were specific tasks asked of the students in each trip, they were free to add their own impressions and pictures. Many of them mentioned how much they enjoyed writing in their field notebooks. Although the researcher was disappointed at the calibre of some of the entries, the children did not

perceive the note books as an ineffective learning tool. Perhaps the researcher was too hasty in making judgments, as this was a new experience for all of these students and as the notebooks are used for more outings their refinement will likely improve. More emphasis needs to be addressed toward debriefing and modelling techniques and the field note books will then become a better assessment of children's thinking and growth of understanding.

The children also wrote narrative accounts of their field trips as well as research and report on a seashore creature and a marine mammal. This reading and writing to learn science strategy (Glynn & Muth, 1994) was an excellent source of information for the researcher when investigating the growth of understanding and the facility with which the students were able to convey their ideas. It also gave the students an opportunity to interact with their peers in gathering and sharing of information, interpreting data, and cognitive restructuring. Many of the children told the researcher that they learned things about sea creatures they didn't know before and were very enthusiastic about sharing this knowledge with not only their classroom peers but other members of the school community and their families as well. They were proud of the display the researcher made of their research papers, art work, and photographs taken during the course of the instructional unit on seashore and ocean ecology.

Perhaps the most difficult aspect of the instructional part of this study was the focus on marine resource issues. The researcher wanted to create a balanced environmental education program that would address the three dimensions of knowledge, attitudes/values and behaviour (Ballantyne & Packer,1996). It was evident from the results of the pre-instructional questionnaires that even though these students had low knowledge scores, their attitudes were positive and their stances were preservationist or conservationist. The researcher thought by examining a local marine issue

in detail that this would provide students with strategies that would help them base their opinions on factual understanding and not be swayed by less knowledgeable opinions or attitudes. In the course of the role playing activity that was designed to present the issue of Pacific salmon stock depletion, the researcher realized that most of the students weren't really aware of their own ideas and opinions.

The lack of background experience at this age level has an effect on the amount of discussion that can take place around an issue. Also, it seems likely that the influence of each students' families' knowledge, attitudes and opinions had a powerful effect on these students' thinking. Therefore, the round table discussion strategy became more of an information sharing activity, whereby the children learned that many different people with a variety of interests are involved in any controversial issue. Educators would be wise to try to examine the thinking of their students' beliefs, attitudes, and opinions if meaningful curricula is to be developed wherein knowledge is a bridge in the formation of these beliefs, attitudes and opinions rather than a barrier.

Implications for Future Research

In order for an in-depth investigation to occur on the effects of an instructional strategy on Grade Four students' knowledge, attitudes and opinions, the sample size needs to be larger and more diverse. Ideally, a randomized pretest posttest control group research design with several grade four classes representing a wider spectrum of learning abilities would provide a broader picture for the researcher and perhaps result in some generalizations.

The questionnaires need to receive closer scrutiny if they are to be used with grade four students. The knowledge questionnaire (Ocean Life)

had already been altered to accommodate the students, however the researcher still felt that the items on seashore zonation may have been too sophisticated for a grade four child. Less complex questions that contain the same principles could be developed. The attitude questionnaire (Ocean Attitudes) was better suited for these children because the items were in the form of short sentences and the vocabulary, for the most part, was familiar.

The Ocean Opinion questionnaire posed a couple of problems for the researcher. First, the decision of whether a response was preservationist, conservationist, or exploitive was hard to determine for some of the items. The researcher had to consult with the designers of the questionnaire to clarify the appropriate stance answers for each item. Part of the difficulty lay in the fact that marine resource issues are constantly evolving and changing. Either some of these issues are resolved, some become a bigger problem, new ones take precedence or new technologies, laws or circumstances affect the issue positively or negatively. The Ocean Opinions questionnaire was used in 1990 and six years can certainly make a difference in determining the appropriate response on specific items as well as the choice of the stance a student may make. The designers agreed that some items on this questionnaire needed to be constantly updated to reflect the current emphasis on relevant marine resource issues.

The second problem was that there were four choices for each item and the choices were a random sampling of preservationist, conservationist, or exploitive stances. Every item had at least one of each stance but this made it difficult to develop a scoring value in order to compare pre-instructional and post-instructional data. The researcher was aware that the designers' intent was to allow for accurate evaluation of a particular students' stance by eliminating what would seem obvious choices. However, the researcher felt that most Grade Four children would

likely not be sophisticated enough to choose the same stance in every item but rather choose the stance that best describes their opinion.

When analyzing the pre-instructional and post-instructional Ocean Opinions questionnaire, the researcher was curious as to why the students chose the responses they did. In order to establish the reasons why a particular student chose a preservationist, conservationist or exploitive response, the researcher will need to employ informal or structured formal interviews to attain a deeper understanding of student thought.

The metaphor interview (Snively, 1987) used for probing the students' value orientations (scientific, spiritual, utilitarian, recreational, aesthetic, political) and enabling researchers to examine aspects of the cognitive system which are often hidden by more conventional approaches seems to be a good instrument to pursue in investigating student opinions. "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" (Snively, 1987, p.443). This type of interview also allowed an analysis of relationships between beliefs and instruction and could be used in any type of educational setting in any type of community. However, in order that the metaphor interview be used effectively, the interviewer must attain a thorough understanding of the process and application of this instrument.

The researcher found the students' pre-instructional and post-instructional pictures and lists very useful in the overall analysis of student learning in this study. Again it was another way to probe student understanding using non-threatening and familiar activities for Grade Four students. The only thing that the researcher would change is the initial directions given to the students. The drawings would be limited to students' depictions of an indigenous seashore environment rather than allowing the students to draw any seashore. In this way, alternate

conceptions would become more apparent in the pre-instructional drawings and the degree of conceptual change could be evaluated more effectively.

Recommendations for Marine Education

The fact cannot be ignored that the Grade four students involved in this study live within walking distance to the Pacific Ocean, yet their knowledge of the seashore and ocean ecology of the Pacific Northwest coastal areas was very limited. As the unit of instruction evolved, the researcher became aware of the value that these students began attributing to the rocky seashore plants and creatures with which they became familiar. Correct terminology began to become an integral part of these students' vocabulary, not only in naming individual seashore plants and animals but in describing processes and relationships such as interdependence, energy flow, community, adaptations, food chains and webs, and zonation. The researcher observed how these children, some who would have rather studied the mountains than the seashore, discovered new worlds to experience and explore. From these explorations, a respect for living plants and animals in their natural habitats began to emerge as well as a sense of protection towards a local rocky seashore. The final trip to Saxe Pt. presented a far different picture than the first. For instead of throwing rocks into the water and having to be reminded to keep on task, the children were engaged in self-directed observation activities, excited about what they saw, and respectful of the plants and animals they had come to know. The suggestion by some students to return for a beach clean-up will certainly be acted upon when the spring weather permits. More trips are planned for the June low tides to reinforce and reconnect these students to the rocky seashore in their community. The researcher only wondered if the enthusiasm and love for the seashore and ocean that seemed to be

developing in these students would be reinforced and enriched in subsequent grades in school and if they would meet other teachers who would utilize marine environments in their science curricula as a vehicle for meaningful instruction.

Marine education is not included as a specified unit of instruction for any grade in the British Columbia Science Integrated Resource Package for K to 7 students. Teachers who subscribe to the importance of teaching children about the seashore and ocean do interpret the learning outcomes to suit their instructional units. Educators who are conversant with the Environmental Concepts in the Classroom (1995) document, may use seashore and ocean studies to address the principles for integrating these concepts into their classrooms. However, when one realizes the importance of the ocean to the economic, social, and cultural well-being of our province, nation, and world, it is very puzzling why most British Columbian students aren't learning about this most vital resource. How can students gain experience in developing skills that will lead them to form clear and wise judgments and make sound decisions as adults regarding marine resource issues, if they do not develop a relationship with the seashore and ocean in their classroom studies? Moreover, "A well-informed future focussed society would provide openness to, and support for a commitment to the effective utilization of our marine and other aquatic resources" (Hawaii State Dept. of Education, 1982). Therefore, it becomes necessary to equip our children with the knowledge of marine environments and systems and practice the skills of sagacious decision making to prepare them for future global citizenship.

Marine Education should be an integral part the British Columbia school science curriculum. However, many factors need to be in place before such a curriculum becomes established. First, a set of basic assumptions, such as the ones developed by Snively (1989), that outline

the importance and need for a marine and aquatic focus in school programs need to be accepted. Viewing British Columbia as a maritime province, becoming familiar with the plants and animals that live along its coastlines and how they are interdependent and learning about the impact people have upon these environments can form a basis from which a sound marine curricula can emerge.

However, knowledge of seashore and ocean ecology is not enough. An appreciation for the beauty and value of marine ecosystems must be a critical element of a marine education program. Students who learn to cherish marine and aquatic environments will more than likely develop a sense of stewardship and reverence for a most valuable resource.

Once guiding principles have been established, appropriate marine ecology curriculum materials need to be utilized and many have been already developed. Teachers who have little knowledge of seashore and ocean ecology need to receive opportunities for in-service and to be inspired by those who already believe in the value of connecting students to seashore and ocean environments.

Community resources are needed to enrich the instructional opportunities for students. It seems rather odd that students in Victoria have to travel so far to experience such a rich and wonderful resource as the Cowichan Bay Marine Ecology Station, which operates with little help from any government ministry or agency. School district curriculum coordinators need to be convinced of the importance of maintaining effective communication within their constituencies and support teachers in their quest in developing meaningful seashore and ocean experiences as well as viewing marine education as a priority instead of an additional offering. "Marine and aquatic education must develop in all students an understanding of the role that the seas and fresh water play in society and society's impact on water environments" (Snively, 1989, p. 91).

Summary

This chapter has included a brief overview of the effects of experiential learning on grade four children's knowledge of marine ecology, their attitudes towards the ocean, and their stances towards marine resource issues. Conclusions from the data analyses led to implications for strategies of instruction as well as implications for future research. It would be remiss of the researcher if the importance of marine education were not addressed and therefore recommendations for British Columbia educators concerning seashore and ocean were also included.

This study resulted in an accumulation of learning experiences not only for the students, as has been outlined throughout the previous chapters, but for the researcher as well. This final chapter in the description of student knowledge of seashore and ocean ecology, and the attitudes and opinions towards specific marine resource issues, marks the end of a formal organized set of course work for the researcher, however it also represents a beginning of a change in an educator. The researcher will take back to her classroom a new perspective that gives a clearer meaning of explicit instruction. The experience of using the research instruments and designing a research study has given the researcher a better understanding of how to effectively analyze data and the importance of employing more than one method to view the whole child. Theoretical foundations for the teaching of science and environmental education have been examined, reflected upon and strengthened. Now comes the challenge for the researcher/teacher to balance these theories of teaching and learning within the constraints of the multi-disciplinary curricula expected of an elementary school teacher. The task is not an easy one. However, being a witness to the joy of children discovering the wonders of a tidepool for the first time, will always provide a renewal of spirit and a sense of purpose for the researcher in her role as an effective educator.

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APPENDIX A - OCEAN BACKGROUND QUESTIONNAIRE

STUDENTS AND THE OCEAN

These questions are being asked to help find out what students in British Columbia know about the ocean and how they think about it. It is important that you do your best to answer each question well. Your scores on these questions will not be used for your schools marks or grades.

To answer these questions you will need a soft pencil and eraser. Please DO NOT use a pen. Please DO NOT mark the question sheets in any way. You will answer the questions on the separate answer sheets. Read the MARKING INSTRUCTIONS on the answer sheet carefully.

WHEN YOU ANSWER, BE SURE THAT THE NUMBER ON THE ANSWER SHEET IS THE SAME AS THE NUMBER ON THE QUESTION SHEET.

Part 1 OCEAN BACKGROUND INFORMATION

The following questions are about how you use the ocean.

1. How many times did you go to the ocean or seashore last year?

   (A) once a month or more often
   (B) 2 to 10 separate trips
   (C) one trip
   (D) have never been to the ocean

2. If you could have a choice, which of the following places would you prefer to study in school?

   (A) a city
   (B) the seashore or ocean
   (C) the mountains
   (D) a pond, lake, or river

3. Which of the following would be your choice of a second place to study?

   (A) a city
   (B) the seashore or ocean
   (C) the mountains
   (D) a pond, lake, or river

4. Which of the following would you least like to study in school?

(A) a city
(B) the seashore or ocean
(C) the mountains
(D) a pond, lake, or river

For all of the following questions the choices of answers are the same.

(A) often
(B) sometimes
(C) never

Questions about how often you use the ocean

5. How often do you use the ocean and seashores for SWIMMING?

6. How often do use the ocean and seashores for SPORT FISHING? (catching fish for your own use or for fun)

7. How often do you use the ocean and seashores for COMMERCIAL FISHING? (catching large numbers of fish to sell)

8. How often do you use the ocean and seashores for BOATING OR SAILING?

9. How often do you use the ocean and seashores for COLLECTING SEASHELLS?

10. How often do you use the ocean and seashores for SUNTANNING OR PICNICKING?

11. How often do you use the ocean and seashores for EXPLORING?

Questions about how you have learned about the ocean or seashore

12. How often do you watch MOVIES and T.V. shows about the ocean?

13. How often do you read NEWSPAPER stories about the ocean?

14. How often do you read NATURE MAGAZINES or BOOKS about the ocean?

15. How often have you learned about the ocean from CLASSES IN SCHOOL?

16. How often have you learned about the ocean by DOING THINGS ON OR BY THE OCEAN?

17. How often have you learned about the ocean by visiting PUBLIC AQUARIUMS or NATURE CENTRES?

Questions about how often you eat seafoods

18. How often do you eat SALMON?

19. How often do you eat TUNA?

20. How often do you eat OTHER FISH?

21. How often do you eat FRESH OR DRIED SEAWEED?

22. How often do you eat OYSTERS?

23. How often do you eat CLAMS?

24. How often do you eat CRAB?

25. How often do you eat SHRIMP?

APPENDIX B - THE OCEAN ATTITUDES QUESTIONNAIRE

OCEAN ATTITUDES

The statements below tell how some student feel about SPECIFIC COASTAL ISSUES. Read each statement and then CIRCLE the choice that best describes how you feel about it.

Here is an example about chemical sprays which shows how to mark your answer if you disagree with the statement.

Farmers should be able to use any chemical sprays they think are necessary to kill insects.

STRONGLY AGREE (DISAGREE) CAN'T DECIDE AGREE STRONGLY AGREE

There are no right or wrong answers to this part of the questionnaire. Read the question, then choose the answer which comes closest to your feelings.

1. The killer whales in aquariums should be kept on display for the public to enjoy.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

2. Pulp mills should be allowed to dump chemical waste into oceans and lakes.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

3. Commercial fishermen should be allowed to fish whenever and wherever they want.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

4. Oil and gas exploration off the British Columbia coast should not be allowed.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

5. Seals that interfere with salmon fishermen should be shot.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

6. People should not take seashells and sand dollars home to use as decorations.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

7. Marshlands or estuaries should be filled to make land for housing.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

8. The city of Victoria should be allowed to dump raw sewage into the ocean.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

9. It is alright to take a shore crab home as a pet.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

10. The ocean is a good place to get rid of garbage from our cities.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

11. Native people should be allowed to catch as much fish as they want.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

12. More coastline should be set aside as parkland.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

13. The killing of harp seal pups for their white fur should not be allowed.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

14. Learning about animals that live in Canada's Arctic or Atlantic Ocean is <u>not</u> important.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

15. We need stronger laws to protect our ocean, seashores, and wetlands.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

16. Oil tankers should be allowed to travel along the B.C. coastline.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

17. Native people should follow the same rules as everyone else.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

18. The hunting of whales world-wide should be allowed.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

19. All activities which pollute the ocean should be stopped.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

20. I should be allowed to fish for fun wherever and whenever I want.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

21. We should encourage more tourists to visit our seashores.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

22. The number of salmon farms on our coastline should be strictly limited.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

23. The work of scientists is useful in helping people to solve problems.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

24. People should not be allowed to take as many shellfish such as clams and crabs as they want.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

25. Less coastline should be set aside as parkland.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

26. The killer whales in aquariums should be set free.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

27. The ocean is an unlimited source of food and energy for humans.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

28. Canada should spend more money on scientific research.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

29. Commercial fishermen take too many fish.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

30. The laws protecting our ocean, seashores, and wetlands are too strict.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

31. Pollution in our inland lakes and rivers can damage our coastal wetlands.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

32. All living things have a right to exist.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

33. Great white sharks should be killed because they attack humans.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

34. People should be more critical of companies' claims that their use of chemicals is safe.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

35. We can use all the natural gas, oil and gasoline we need now because future generations will find new forms of energy.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

36. We should get back to a simpler way of life and use up fewer resources.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

37. The activity of scientists usually results in making problems of the environment worse.

STRONGLY AGREE DISAGREE CAN'T DECIDE AGREE STRONGLY AGREE

APPENDIX C - THE OCEAN LIFE QUESTIONNAIRE

OCEAN LIFE

The following set of questions is about the ocean and living things in or near the ocean. Be sure the number on the answer sheet matches the number of the question. Read each question and all the statements carefully. Then fill in the bubble for the choice which you think is the best answer for that question. THE NUMBER FOR THE FIRST QUESTION IS 132.

132. How much of the earth is covered by oceans?

(A) very little
(B) about 1/4
(C) about 1/2
(D) about 3/4

133. What are tides?
(A) another name for waves
(B) giant waves that destroy coastal towns once in a long time
(C) the slow up and down change in the ocean level once or twice a day
(D) the movement of water through narrow straits or channels

134. Tides are caused chiefly by...
(A) strong winds and storms at sea
(B) the gravitational pull of the moon
(C) ocean currents and streams
(D) underwater earthquakes

135. Which of the following statements is true?
(A) The major ocean currents flow in huge circular paths around parts of the ocean
(B) There is no pattern of ocean currents
(C) Ocean currents flow only along coastlines, not in the open oceans
(D) Ocean currents change direction when the tide comes in or goes out

136. Most of British Columbia's shoreline is...
   (A) rocky and surf swept most of the time
   (B) protected from the open ocean by islands and peninsulas
   (C) mostly sandy beaches
   (D) straight and without bays and inlets

137. In the diagram opposite, which area would most likely be affected by a nearby oil spill?
   (A) A
   (B) B
   (C) C
   (D) D

138. In the diagram above, a mudflat will most likely occur in...
   (A) A
   (B) B
   (C) C
   (D) D

139. Which of the following best describes an estuary?
   (A) an inland fresh water lake or pond
   (B) a river bed or open area of water
   (C) the part of a beach between high tide and low tide
   (D) a swampy area in which fresh water from a river or stream mixes with salt water

140. What is plankton?
   (A) a school of fish
   (B) tiny floating plant and animal life
   (C) all living things in the ocean
   (D) the gang plank of a whaling ship

141. Energy for living things in the ocean comes from the...
   (A) sea water
   (B) salt or minerals in the water
   (C) the tides
   (D) the sun

142. Seaweeds do not grow at great depths in the ocean because...
(A) sunlight does not penetrate to great depths
(B) the water pressure is too great
(C) they float around in the ocean
(D) the water is too salty

143. In a healthy environment, if predators kill too many of their prey, then...
(A) the number of predators gets greater
(B) the number of prey keeps getting smaller
(C) the number of both predator and prey keeps getting smaller
(D) some predators eventually starve to death, the number of prey gets larger again, and a balance is restored

144. In a food chain diagram like the one below, what is the <u>most</u> important meaning of the arrows?

(A) they show which animals are predators
(B) they show which animals are prey
(C) they show the flow of food energy from prey to predator
(D) they show which animal is the biggest

45. Coral reefs are...
(A) found on Canada's Pacific coast
(B) found on Canada's Atlantic coast
(C) found on both the Pacific and Atlantic coasts of Canada
(D) not found on either the Pacific or Atlantic coasts of Canada

146. Some B.C. beaches are muddy, some are sandy, some are covered with small stones, some are rocky and some are mixed. Which of the following is true?

(A) There is only one kind of crab and only one kind of starfish and they are found on all beaches.

(B) There is one particular kind of crab and one particular kind of starfish for each kind of beach.

(C) There are several different kinds of crabs and starfish and some kinds are found on more than one kind of beach.

(D) Some kinds of beaches have only starfish but no crabs or only crabs but no starfish.

147. Which is the main reason that salt water marshes are important?

(A) They provide breeding grounds for mosquitoes.
(B) They support a great variety and number of plants and animals.
(C) They provide a resting place for migrating adult salmon.
(D) They are an important source of table salt.

148. The diagram opposite shows the arrangement of plants and animals at different heights or in zones, on a rocky shore. When the tide changes from high to low tide, the living conditions of animals in the middle tide zone change a lot. Which of the following is the greatest problem they must overcome to survive?

(A) the temperature may change quite a bit

(B) the animals may dry out

(C) fresh water rain may fall on them

(D) they may die from hunger because they can't feed at low tides

149. In the diagram above, the spray zone is almost completely dry, the upper part being only occasionally sprayed, and the lower part covered with water during the highest tides and storms.

Animals that occur in the spray zone...

(A) live only in the spray zone because there are laws against living lower on the shore

(B) live mainly in the spray zone, but move to the low tide zone when the tide goes out

(C) cannot live in the low tide zone because it is covered with seawater most of the time

(D) can live in any tide zone

150. Which of the following is true about salmon.

(A) They hatch in fresh water, but live most of the their lives in salt water.

(B) They hatch in salt water, but live most of their lives in fresh water.

(C) They live all of their lives in lakes, rivers, and streams.

(D) They live all of their lives in the ocean.

151. There are five kinds of salmon that live in B.C. waters. Which of the following is true about them?

(A) The five kinds compete for the same places to live and spawn on the same rivers and streams.

(B) Each kind of salmon has a 4 year live cycle.

(C) All of the kinds of salmon eat the same diet.

(D) Each kind of salmon prefers different kinds of spawning places from the other kinds.

152. A pair of salmon lay and fertilize about 3500 eggs. On the average, how many of these must survive to spawn to keep the fish population the same size?

(A) 30

(B) 10

(C) 2

(D) 1

153. Water that is polluted...

(A) always looks dirty

(B) always smells bad

(C) always kills the animals in it

(D) sometimes looks quite clear

154. The oceans...

(A) are so big that human and industrial wastes affect them very little

(B) can only take in some human and industrial wastes without being damaged

(C) are damaged a lot by all wastes people put into them

(D) are perfect dumps because the garbage and sewage sink to the bottom.

155. The most important outcome of the loss of a seaweed forest is...

(A) there is more room for water sports for people

(B) there is more room for fish and other marine animals to move into the area

(C) the loss of a seaweed harvest for people

(D) the loss of homes for a variety of animals

156. Which of the following environments will be <u>most</u> easily changed by human activities?

(A) a sandy beach on a surf swept outer coastline

(B) rocky shores on a surf swept outer coastline

(C) the mouths of rivers and bays protected by offshore islands

(D) the deep sea

157. Oil spills do most damage to...

(A) birds and some seashore creatures.
(B) fish.
(C) deep sea creatures.
(D) seals and whales.

158. It is safest to eat seashore animals that come from...

(A) areas near cities where the ocean currents are slow.
(B) areas with swiftly moving currents.
(C) high up on the shore.
(D) deep in sand or mud.

159. Many salt marshes are disappearing because...

(A) marsh water is draining out to the sea.
(B) there is less rain to fill the marsh.
(C) people are filling up the marshes to make more land.
(D) the sea level is rising.

160. Household wastes and sewage...

(A) do not contain chemicals like the wastes from factories.
(B) usually contain harmful chemicals from cleaning products.
(C) are always treated, so they are not harmful to sea creatures.
(D) do not damage the marine environment.

161. Suppose someone wished to drain and fill a marsh, which of the following is more important than pollution to think about?

(A) The loss of living places for plants and animals.
(B) The death of some living plants and animals.
(C) The death of all beavers in the marsh.
(D) Nothing is more important than pollution.

APPENDIX D - THE OCEAN OPINIONS QUESTIONNAIRE

OCEAN OPINIONS

The following set of questions asks your opinion about ways we are now using the ocean and about ways we should treat the ocean. There are no right or wrong answers to these questions. Sometimes you many have an opinion different from all of the choices given. When that happens select the choice that is closest to your opinion. Read each question and all the statements carefully. Then fill in the bubble for the choice that best describes how you feel .

1. Should killer whales be kept in places like the Vancouver Public Aquarium and Sealand?

   (A) All killer whales should be allowed to go free in the ocean.

   (B) It is alright to keep those we now have, but no new ones should be captured.

   (C) It is alright to keep killer whales for a few years, but then they should be released.

   (D) Some killer whales should be kept because they are fun to watch and we learn a lot from them.

2. Many people enjoy fishing for fun. How do you feel about this?

   (A) I should be allowed to fish for fun wherever and whenever I want.

   (B) I should be allowed to fish for fun wherever and whenever I want because I am careful not to hurt the environments.

   (C) There should be laws about when and where I can fish for fun and about what fish I can keep.

   (D) Nobody, not even me, should be allowed to fish for fun.

3. What should be done about marshlands and wetlands?

   (A) They should be filled in to make valuable farmland or land for housing.

(B) They should be left alone because they are most valuable as nurseries for fish and nesting places for water birds.

(C) It is alright to use them for fish farming.

(D) It is alright to fill in small parts of them as long as lots of marshlands are left.

4. What is your opinion about laws and regulations for the use of the ocean?

(A) Everybody should be free to use the ocean without rules. We should trust people to be careful.

(B) We need stronger laws to protect the ocean, seashores and marine life.

(C) There are already too many laws and regulations. They keep us from getting as many jobs from the ocean as we should get.

(D) The number and enforcement of the laws to protect the ocean and marine life is about right.

5. What should be done about killing baby harp seals for their fur?

(A) It should be allowed because seal fur is a good export and it provides jobs for many people.

(B) It should be allowed because if the number of seals killed is carefully controlled.

(C) It should not be allowed because it is cruel.

(D) It should not be allowed because the number of harp seals is quickly getting too small.

6. What rules about fishing should there be for native people?

(A) They should be able to fish whenever and wherever they wish because they were here first.

(B) They should have to follow the same rules as everyone else.

(C) Nobody should be allowed to fish at all.

(D) They should have some special privileges, but should obey some rules too.

7. What do you think about oil tankers travelling along coastlines?

(A) Getting oil to the places that it is needed is more important than a few oil spills.

(B) It is safe because the ships are well built. It there is any oil spills they will be small.

(C) It is necessary but should be carefully controlled to prevent spills and damage to coastal marine life, even if this makes the oil expensive.

(D) It is dangerous to marine life and should not be allowed.

8. People often take the shells of animals home from the beach for making jewellery or ornaments. Favourite shells are sand dollars, clam and oyster shells, and snail shells -- especially the large snails found in warm oceans. What do you think about this?

(A) No shells should be taken from beaches.

(B) Only empty shells of dead animals should be taken.

(C) It is alright to take a few shells of plentiful animals, even if the animals have to be killed and the shells cleaned.

(D) It is alright to take as many shells of live animals as you like because there are plenty of them.

9. What rules should commercial fishermen have to obey?

(A) Fishermen know best about fish and fishing so they should be allowed to fish when where they want without rules.

(B) Fishermen know best about fish and fishing so they should be allowed, as a group, to make the rules.

(C) Commercial fishing is destroying fish populations and should be stopped.

(D) Governments should make and enforce rules to control the number of fish are caught.

10. Some species of whales are not near extinction. What should be done about hunting these kinds of whales?

    (A) Hunting whales should be allowed because it provides people with food, clothing and money.

    (B) Hunting whales should not be allowed because whales are beautiful and intelligent.

    (C) It is alright to kill a certain number of these kinds of whales as long as plenty are left.

    (D) Hunting whales should not be allowed because whales are part of the food chain.

11. Some cities, like Victoria, pump their sewage into the sea with little or no treatment. What should be done about this?

    (A) Nothing needs to be done. The ocean is large enough to destroy this sewage.

    (B) Cities should be required to treat the sewage before pumping it into the ocean so that it does not wash back onto beaches.

    (C) Cities should be required to treat the sewage so everything harmful is removed before it is pumped into the ocean.

    (D) This should not be allowed. Other places should be found for the sewage.

12. At present, Canada sells a large amount of fish to other countries. Should we continue to do this?

    (A) We should find ways to catch and sell even more fish than we do because the world need food and it is a good way to make jobs and money.

    (B) We should try to keep the amount of fish caught about the same as it is now.

    (C) We are catching too many fish. We have to catch fewer or we will destroy our fishing resource.

    (D) We should only catch enough fish for Canadians to use.

13. What should we do about the number of salmon farms on our coast?

(A) Many more should be built because we need more salmon for food and money.

(B) Only a few more should be built because they compete with commercial fishermen.

(C) New salmon farms should be built only if we are sure they will not pollute the water.

(D) We should allow the salmon that are now penned in farms to go free.

14. What should be done about oil and gas exploration off the British Columbia coast?

(A) It should be stopped because oil spills can pollute the ocean.

(B) It should be increased because our country needs more oil and gas to use and sell.

(C) It should be encouraged because it will make jobs for people.

(D) It should be allowed only if it is carefully controlled to prevent oil spills.

15. Loggers, city developers, fish farmers and many others wish to use the coastline of British Columbia. What is your opinion about coastal parks?

(A) British Columbia needs many more coastal parks to keep the coastline unspoiled and beautiful.

(B) British Columbia needs many more coastal parks to preserve living place for ocean life.

(C) British Columbia has about the right number of coastal parks.

(D) British Columbia has too many coastal parks. They keep too much of the coastline from being used for industry and development.

16. Some fishermen from Asia use very long floating gill nets, called drift-nets, to catch fish in the open ocean. Many of the fish they catch are B.C. salmon. These nets often catch and drown dolphins and seabirds. What should Canada do?

(A) We should start doing this kind of fishing too to keep other countries from getting too many of our salmon.

(B) We should force the governments of Asian countries to stop by refusing to trade with any country that uses drift-nets.

(C) We don't need to do anything. What Asian fishermen do in the open ocean is their own business.

(D) We should send our navy ships out to destroy these nets and scare the fishermen away.

17. Should we encourage lots more tourists to visit B.C.'s seashore?

(A) We should only permit people from British Columbia to use our beaches and coastline.

(B) We should not encourage more tourists or build any more resorts, the number we have now is fine.

(C) We should encourage more tourists and build more resorts, but we should control them carefully so the environment is not damaged.

(D) We should build many more resorts and campgrounds along the coast because tourists bring in lots of money and create many jobs.

18. Over the past few years, the number of seals in British Columbia has increased rapidly. Commercial fishermen complain that seals kill too many salmon which makes it difficult for them to earn a living. What should be done about this?

(A) Seals should be protected and allowed to increase in numbers without control.

(B) Fisheries officers should shoot a certain number of seals each year so the population of seals does not get too big.

(C) Large numbers of seals should be killed so there are more salmon to catch.

(D) Many of the seals should be caught and moved to places where they won't affect fishermen.

19. Logging companies use bays and rivers to story, sort and ship logs. What is your opinion?

(A) They should never be allowed to disturb places where sea creatures live.

(B) They should be allowed to use some areas, but not those that are important living places for sea creatures.

(C) They should be allowed to use bays and rivers, but have to clean up the area when they leave.

(D) They should be allowed to use whatever bays and rivers they need for their operations.

20. The government recently found out that some pulp mills in B.C. are allowing dangerous chemicals to escape into the ocean. Shellfish found near these mills are considered too dangerous to eat. What should the government do?

(A) Make the pulp mills close down until ways are found to remove the chemicals even if this puts people out of work.

(B) Allow the pulp mills to continue to let the chemicals escape because pulp mills are important to people and their families.

(C) Give the pulp mills a few months to find ways to prevent this pollution. If they do not, then close them down.

(D) Make the pulp mills find other places for their wastes except the ocean.

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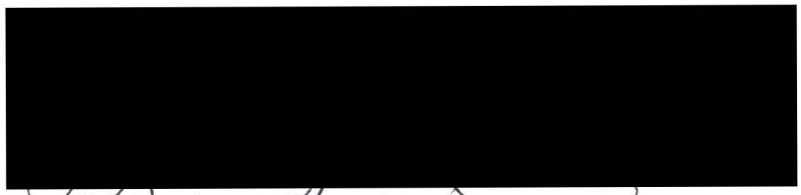
Author 

Shirley Anne Cummins
April 22, 1997