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Case study of a sixth-grade class using Marine Science Project: FOR SEA

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CASE STUDY OF A SIXTH GRADE CLASS USING MARINE SCIENCE PROJECT: FOR SEA

by

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CASE STUDY OF A SIXTH GRADE CLASS

USING MARINE SCIENCE

PROJECT: FOR SEA

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Case Study of a Sixth Grade Class using Marine Science Project: FOR SEA
(Under the direction of MICHAEL J. PADILLA)

The purpose of this study was to investigate students' academic achievement and attitude towards the marine environment before, during, and after the Marine Science Project: FOR SEA experience. This case study was conducted with 19 students and their teacher in a sixth grade honors science class in a private school located in Atlanta, Georgia. The students experienced a 22 day unit regarding physical and biological aspects of the marine environment.

Students' knowledge about the marine environment before and after their FOR SEA experience was measured by a pretest/posttest and "brain storming" (concept) maps. The students' attitudes toward the marine environment before and after their FOR SEA experience were measured by open-ended questionnaires, "brain storming" maps, interviews, and student journals. The students' attitudes towards the marine environment during FOR SEA were monitored by student journals, participant observation, and informal and formal interviews.

There is significant positive gain in students' knowledge of the marine environment as a result of FOR SEA. After experiencing FOR SEA, students were less likely to consider lakes, rivers, ponds, or swamps as concepts of the marine environment. Students' attitudes

during the FOR SEA experience changed significantly toward the subject of pollution. Initially their interest centered around recreational activities, whereas at the unit's conclusion they emphasized concern for the damaged marine environment and it's resources. Finally, the FOR SEA experience positively enhanced and/or changed students' prior attitude toward marine concepts. In some students, preconceived fears were replaced with interest in and desire to learn more about the marine environment.

INDEX WORDS: Case Study, Qualitative Study, Science Education, Marine Science Education, Environmental Science Education, Elementary School, Attitudes, Conceptions, Misconceptions, Achievement

I dedicate this dissertation to my wife
Lisa and two sons Lee and Jack

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Chapter One

INTRODUCTION

Although marine educators are not sure when or where marine and aquatic education emerged as a separate entity, Cantrell states (1981), "Marine and aquatic education evolved from the science education movement which was spurred by the launching of Sputnik I and the environmental movement which was marked by Earth Day in 1970" (p. 4).

From 1970 to the present marine education has become more widespread around the U.S. because students and teachers are more concerned about the environment. Several incidents have stimulated this concern; for example, the Alaskan oil spill on Good Friday of 1989 awakened the American conscience regarding the fragile ocean ecosystem (Church, 1989). World wide awareness has caught the attention of the media. Daily, newspapers and magazines are filled with articles about the adverse effects of marine pollution, citing specifically the declining health of marine mammals and the erosion and debris on beaches used for recreation (Sanction, 1989).

The United States, a maritime nation with coasts on two oceans and states that border the world's largest

fresh water lakes, should have a special interest in education related to the marine and aquatic environment. The Great Lakes region and many inland states have successful marine education programs (Picker, 1980). Most states bordered by oceans have marine education programs supported by their own state's Sea Grant agency. However, there is an urgent need for marine and aquatic education to become part of the typical science curriculum to help inform all in our nation of the importance of marine and aquatic environments (Madrazo & Hounshell, 1980).

What is marine and aquatic education? The definition provided by Goodwin and Schaadt (1977) is commonly accepted:

> Marine and aquatic education is that part of the total educational process which enables people to develop a sensitivity to and a general understanding of the role of the seas and freshwater in human affairs and the impact of society on the marine and aquatic environments. (p. 6)

The development of a marine-literate populace should be an important goal. In the words of Dr. Gilven Slonim, (1977), then president of the Oceanic Education Foundation:

> The United States' future will be inextricably tied to the oceanic world. How well the nation rises to this challenge of the sea will depend ultimately on the enlightenment, the determination, the direction of its policy drive, and this is a function of how well its people understand the sea, . . . every single substantive aspect of the global sea's influence upon the human condition . . . For the United States must invest

> its energies and ingenuity, as well as additional educative resources, in multi-cultural, multi-disciplinary oceanic education to sharpen its citizens' understanding of the world ocean. Once knowing their profound stake in the sea, their new knowledge will enrich their sense of the future destiny of this nation, which manifestly remains oceanic (p. 6).

Historical Background

In 1966, the federal government created the National Sea Grant College Program to provide support for marine education, research, and marine advisory programs in every state bordering the Great Lakes or having an ocean coastline (Spector, 1980). In the 1960's, Will Hon was one of the first to receive a grant from the Office of Education to develop a series of resource materials about the marine environment for teachers in North Carolina (Hon, 1969). This grant was one which led the way for other educators to apply for grants to develop marine curricula for their respective states.

Two regional organizations, the Florida Marine Science Education Association and the Massachusetts Marine Educators were formed in the early 1970's to provide teachers in those regions with a forum and teaching materials (Schweitzer, 1973). In 1973, Schweitzer published the Directory of Marine Education which included "400 names and addresses of teachers, marine science education specialists, consultants, and others actively engaged in marine science education at

the precollege level" (p. 26). Marine science educators were making significant advances in organizing themselves as a group from which to collectively pool ideas and materials.

The national office of Sea Grant stressed the need for marine education at the precollege level in 1977. As a result, more programs were developed for elementary and secondary school curricula. The Sea Grant goal was to make each student a more "marine literate" individual (Spector, 1980). Also in 1977, the Office of Education and the National Ocean and Atmospheric Administration (NOAA) sponsored regional development of K-12 marine education materials and workshops for teachers (Graham, 1985).

A group of teachers, science educators and other concerned people met in 1976 and formed an organization called the National Marine Education Association [now called "National Marine Educators Association" (NMEA)]. The purpose of this group was to share ideas about marine education through annual conferences, NMEA News and a journal called CURRENT: Journal of Marine Education. At present, NMEA has about twelve hundred members in fifteen regional chapters.

Other events focused attention on marine education. 1980 was designated the "Year of the Coast" by the United States Congress. The October 1980 issue of Science and Children, a journal devoted to preschool through

middle-school science teaching, dedicated the issue to "the rationale, activities, resources, and funding opportunities for marine education . . ." (Lanier, 1980, p. 7). In the same issue the National Science Teachers Association (NSTA) published the following "Position Statement on Furthering Marine Education":

> We encourage and recommend that federal and state agencies, colleges and universities, local education agencies (LEA), and private schools foster the development of marine and aquatic education programs throughout the educational continuum, both formal and nonformal.
>
> For our part we intend to utilize our normal channels of communication to maximum capability, in order to inform and train educators to infuse marine education in their programs. In addition, we intend to develop an aggressive editorial policy that will help give marine education the national priority that it deserves, that our times demand, and on which our future depends. (Picker, 1980, p. 11)

Purpose and Overview

The purpose of the study was to investigate the effects of the Marine Science Project: **FOR SEA** on students' academic achievement and attitude toward marine science when implemented in a sixth grade class. "Achievement in marine science" referred to student performance as measured by pre- and posttests and teacher made tests over material covered. "Attitude toward marine science" referred to the predisposition of student to respond either positively or negatively toward marine science as measured by interviews, observations, documents, and questionnaires.

The Marine Science Project: **FOR SEA** curriculum was used in this study. Using **FOR SEA: Investigating Marine Science** (hereafter designated as **FOR SEA**) students investigated the living and non-living factors that affect the marine environment. The setting of this study allowed the collection of both quantitative and qualitative data.

The following research questions provided a focus for this study:

1. What knowledge do the students have about the marine environment before and after the **FOR SEA** experience?
2. What attitudes do the students have about the marine environment before and after the **FOR SEA** experience?
3. How does the **FOR SEA** experience affect students' attitudes towards the marine environment during the unit?

The first research question was measured quantitatively by use of a pre- and posttest and qualitatively using "brain storming" maps (concept maps) and interviews. Research question two was explored through observations, interviews, and open-ended questionnaires. Question three was explored through the use of personal documents such as student journals and drawings (refer to Appendix E).

Other qualitative questions arose during the study. Those questions were dealt with as the study progressed

by using the constant comparative method of analysis and were included in the final results. No research hypotheses were stated for questions of a qualitative nature.

Research Hypothesis

Based on research question number one, the following hypothesis was proposed:

> Hypothesis 1: Academic knowledge regarding the marine environment will increase as result of the FOR SEA unit.

A recent publication from the U.S. Department of Education documents the research finding that "Children learn science best when they are able to do experiments, so they can witness 'science in action'" (1986, p. 23). The FOR SEA curricula emphasizes this approach in which the students were involved in hands-on learning and inquiry. Students use process skills to learn this content by "doing" science. In this way students combine reasoning skills with the experience of hands-on activities as a way to reinforce the concepts being presented. The students engage in various levels of learning through the combination of teacher presented material, discussion, lab and activities. Therefore, it was expected that academic knowledge regarding the marine environment would increase as a result of the FOR SEA unit.

Definitions

Fishbein and Ajzen (1975) define "attitude" as a "learned predisposition to respond in consistently favorable or unfavorable manner toward an attitude object" (p. 6).

Ausubel (1978) defines "concept" in the following terms:

> . . . (any) objects, events, situations or properties that possess common critical attributes and are designated in any given culture by some accepted sign or symbol (p. 105).

Webster's Seventh New Collegiate Dictionary defines "conception" as "the sum of a person's ideas and beliefs concerning something" (p. 171).

Novak (1981) defines "concept mapping" as:

> a process that involves the identification of concepts in a body of study materials and the organization of concepts into a hierarchical arrangement from the most general, most inclusive concept to the least general, most specific concept (p. 3).

Rationale of the Study

Previous research data on FOR SEA, collected from 1985-1988, consists of pre and posttest results of the students' content knowledge, demographic information, gender identity and ethnicity (Kolb, 1988). The above characteristics reflect only the quantitative approach in evaluation of this program. This information indicates student background and their knowledge base,

but it fails to survey their attitudes regarding the marine environment, specifically those attitudes developed through the **FOR SEA** experience.

Previous **FOR SEA** qualitative research consists of teacher evaluations following pre-service workshops and unsolicited teacher comments after use of **FOR SEA** in the classroom (Kolb, 1988). This study qualitatively investigated the students' knowledge and attitudes before, during, and after the **FOR SEA** unit.

Previous evaluations of **FOR SEA** have not reflected both a quantitative and qualitative perspective. This study included on site data collected from students, data that provided a simultaneous understanding of knowledge and attitude from both points of view regarding the curriculum **FOR SEA**.

To evaluate a curriculum, Rosenshine and Furst (1973) have proposed intensive descriptive research (case study) on teaching of that curriculum in natural settings. This case study functioned as a continuing contribution to the development of grounded theory in knowledge and attitudes in a marine-science education context. According to Strauss (1987), grounded theory is developed by systematically and intensively analyzing data using the constant comparison method. To best facilitate this study, the researcher used inductive techniques to provide the basis for grounded theory.

The need for research in the context of marine-science education is important because there is a lack of knowledge and attitude research as evidenced by the search of the literature. This case study was conducted in order to better understand and to contribute to the knowledge and attitudes in marine-science.

Chapter 2

REVIEW OF THE LITERATURE

The purpose of my study was to investigate the students' academic achievement and attitude towards the marine environment before, during, and after the FOR SEA experience. This chapter presents a review of related literature and research.

Surveys of Marine Education

During late 1976 and early 1977, Schlenker and Qureshi (1978) conducted a survey in the fifty states and Puerto Rico to gather information from the Departments of Education on the status of secondary-school marine-science education. From the responses of 35 states and Puerto Rico, they reported the following findings:

> (1) Marine science teachers accounted for 1.9% of the total number of secondary school science teachers . . .
>
> (2) Nationwide, 48 schools offered marine science instruction with 442 classes and an enrollment of 13,696 students (p. 3).

These results indicate that only a small percentage of teachers, schools, science classes, and students at the

secondary level were involved in marine science during 1976-1977.

In the spring of 1979, the Mississippi-Alabama Sea Grant Consortium conducted a survey as an initial step in the Man and the Gulf of Mexico (MGM) marine education project. The Consortium used the results of the questionnaire to establish objectives related to teacher education and curriculum implementation of the MGM program in those two states. They sent the questionnaire, relating their knowledge and educational background to the marine environment, to 177 teachers in Mississippi and 144 teachers in Alabama. They also attempted to determine preferences in types of materials and strategies which might be used to study marine education materials (Milkent, 1979). Completed questionnaires were received from 45 Mississippi teachers and 42 Alabama teachers. From the survey Milkent concluded the following:

> The results of this survey have far-reaching implications for any individual, group or organization attempting to improve marine education at the pre-college and at the university level, and the following conclusions appear warranted:
>
> 1. Most high school science teachers have had little or no academic preparation and formal coursework pertaining specifically to the marine sciences.
>
> 2. High school science teachers feel they do not have adequate knowledge for teaching most marine related topics, with many teachers indicating little or no knowledge about many of the topics.

> 3. In rating the importance of marine topics, teachers tend to give the highest ratings to those topics with which they are most familiar.
>
> 4. Teachers are receptive to a variety of teaching strategies and approaches and marine education curriculum materials should employ a range of types of strategies to meet the needs and teaching styles of as many teachers as possible (p. 10).

One implication from this study is that implementation of a marine science curriculum should include inservice and background content information for teachers who have little experience in marine science. Such information would make the material more teachable because the teachers would possess more knowledge of what they are presenting in the classroom.

Thornley (1981) determined the need for marine education in California, a state that has 1,845 miles of coastline with 17.6 million people (80% of the state's population) living in coastal counties. Working in conjunction with California Sea Grant College Program personnel, Thornley (1981) conducted a general inventory and initial assessment of marine education in the state's elementary and secondary public schools. She reported that about one percent of the students enrolled in science courses in California were in oceanography courses and that "elementary school science textbooks devote only 3 percent of their pages to marine topics" (p. 11). She concluded that given the importance of the ocean to the state and the "well-being" of the population

of California, marine education was given minimal attention. At the secondary level, typically marine science curriculum is presented in the context of an earth science course. For example, Harcourt Brace Jonvanovich's 1989 text, Earth Science, devotes 3 of 24 chapters to marine science. Prentice Hall's 1988 text, Earth Science, has 1 chapter of 23 related to marine science. Significantly, a student's classroom exposure to marine science is often limited to only a unit under the umbrella of an earth science course. Slonim summarized the need for marine education in 1977: ". . . we know more about the backside of the moon than we do about the drop of water upon which each of us, and all living organisms, depend for survival" (p. 5). His expression of the dearth of knowledge should be the impetus for attempting to increase the amount of marine education our population should receive.

The Goals of Marine and Aquatic Education

In June, 1976, a group of Sea Grant and Marine Science educators met to review the role of the National Sea Grant Program in marine education. The group recommended that a committee chaired by Harold L. Goodwin and James G. Schaadt draft a statement representing the views of marine educators regarding the importance of marine and aquatic

education. The draft went through numerous revisions, and was presented and reviewed at 26 workshops, held in 16 states, by different educators involved in marine and aquatic teacher education.

As a result of this effort, Goodwin and Schaadt (1978) coordinated the following goal statement for marine and aquatic education:

> The goals of marine and aquatic education do do not exist in isolation from other educational goals. On the contrary, they should be considered an integral part of the goals of environmental education, and a valuable asset in achieving the goals of general education. The goals are:
>
> - To develop a public which has a basic understanding of the marine and aquatic components as part of the whole environment, and their importance to American life and society.
>
> - To create a public with an awareness of and sense of responsibility for water; to evolve a new "water ethic" embracing the proper uses, protection, and conservation of the oceans, the coastal zone, and freshwater resources.
>
> - To motivate people to take part in decisions affecting the sea and fresh water while equipping them with the principles and information necessary to evaluate problems, opportunities and events.
>
> Achieving these goals would result in the American public becoming "literate" in marine and aquatic affairs. (p. 6)

These goals were written almost 13 years ago. They were widely adopted by the Marine Technology Society's Committee on Education, the Education Council of the National Sea Grant Association, and the members of the National Marine Educators Association (Goodwin and

Schaadt, 1978). Their mission is to have a marine-literate society in which these educational goals will be widely implemented throughout all levels of science curricula.

Attitudes in Science Education

There are numerous studies of attitudes and related concepts in science education as evidenced by the research literature in the field. Shibeeci (1984) reported that more than 200 studies between the years of 1976 and 1983 examined affective variables.

One of the problems in attitude research in science education is finding a clear definition of what is meant by science-related attitudes. Science-related attitudes have been subdivided into two major groups: "attitudes to science" and "scientific attitudes." Gardner (1975) discussed this difference, writing that "attitudes toward science" always have ". . . some distinct attitude object to which the respondent is invited to react favorably or unfavorably. . ." while the "scientific attitude" is made of traits ". . . better described as styles of thinking which scientists are presumed to display" (p. 1-2). Munby (1980) noted that "attitudes to science" is used by people to express their attitudes to some of the following: to science careers, to science instruction (e.g., 'I enjoyed the science lesson.'), and to science

issues (e.g., 'I am concerned about pollution in the ocean.'). My study was concerned with how the students expressed their "attitudes to science."

The majority of attitude research in science education has been quantitative in design. Gardner (1975) discussed 9 different techniques and/or instruments: differential (Thurstone) scales, rating scales, summated rating scales (Likert-type), semantic differential scales, interest inventories, preference ranking, projective techniques, enrollment data, and clinical and anthropological observations. My research design was what Gardner considered "clinical and anthropological" because I was a participant observer and used interviews to collect the students "attitudes to science." I also made use of concept maps, questionnaires, interviews (formal and informal), and journals in order to have the students express their attitude towards the marine environment.

Attitudes in Environmental Education

The assessment of attitudes towards the environment started in the early 70's, at the time of celebration of the first Earth Day in 1970, when people were becoming more aware of the environment. Hounshell and Liggett (1973) reported on a 65-item **Environmental Knowledge and Opinion Survey (EKOS)**, designed by a team of

environmental education experts, which measured knowledge and attitudes about the environment and man's relationship to it. The EKOS survey was given to a random sample of 1,881 6th-grade students representing 9 county schools (urban and rural) in western North Carolina. Their results from the survey indicated that the female students had a significantly more positive attitude toward the environment than did the male students but that there was no significant difference in their knowledge about the environment. There was no explanation given in the article.

Cohen (1973) designed and tested an instrument that investigated environmental information and attitude of 454 high school students in 7 high schools in Indiana. His 70-item questionnaire contained 35 informational questions and 35 attitudinal questions about the environment. His data indicated a relationship between environmental information and environmental attitude. The students who had more environmental information were more willing to express a positive attitude towards the environment.

Burrus-Bammel (1978) investigated the effect of a week-long environmental education youth camp (West Virginia Forest Industries Camp) on campers' knowledge and attitude towards the environment. Her instrument consisted of a 16 Likert-type statements on a variety of

environmental topics and 15 true-false items on environmental concepts that were taught during the program. She administered the same instrument as a pre-posttest to 29 young men. As a result of the environmental education program at camp, her test scores reflected a greater understanding of and positive attitude toward the environment.

Jaus (1982) investigated the effectiveness of environmental education instruction on 5th graders' attitudes toward the environment. She chose two intact 5th grade classes at separate schools in Indiana to participate in the study. One class was designated the experimental group and received a total of 10 hours of environmental education. The other 5th grade class, designated the control group, did not receive any instruction in environmental education. Following treatment, both groups of students were administered a 20 statement Likert-type scale questionnaire designed by the investigator to measure their attitudes toward the environment. The group of 5th graders who received instruction in environmental education possessed significantly more positive attitudes toward the environment than the group of students who did not receive this instruction.

These studies represent a sample of the few studies that were conducted in the 70's and early 80's to assess

students' knowledge and attitudes towards the environment. All these quantitative studies reflected limited findings from the instruments that the researchers developed and used to conduct these studies. Therefore, a need for more qualitative research in this area is suggested in order to reflect the students' perspective rather than the researcher.

Attitudes in Marine Science Education

I found that there have been numerous quantitative studies conducted with students pertaining to their attitudes and/or knowledge about the marine environment. Neeedham (1975) developed and tested an instrument for measuring attitude changes toward the sea among ninth-grade Samoan students. His results indicated that those students who had participated in the Samoan Study Laboratory had substantially improved attitudes in comparison to nonparticipants.

To investigate attitudes and knowledge of the marine environment, Howe and Price (1976) designed and tested an instrument made up of items that were taken from marine literature, history, geography, and science. They administered this instrument to tenth and twelfth grade students in Ohio. Their results from 1,723 students indicated that the students had relatively little

awareness of many of the items included on the test but expressed positive attitudes toward the marine environment.

Fortner and Wildman (1980) in their article, "Marine Education: Progress and Promise," discussed Fortner's 1978 study results of her Survey of Oceanic Attitudes and Knowledge (SOAK) which was given to inland and coastal tenth graders from 30 Virginia schools. Her three-part Likert-type survey (SOAK) was developed to measure attitudes and knowledge of the ocean. Her (SOAK) instrument contained measures of

> (1) knowledge about the ocean's role in such aspects of human culture as science, art, politics, and literature;
>
> (2) attitudes toward a variety of marine issues;
>
> (3) participation in marine-oriented activities such as beach recreation, pleasure reading about the sea, ocean study classes, and visits to public aquaria (p. 721).

Results showed only moderate levels of marine awareness, with students living near the coast having the highest scores. The majority (93%) of the 787 students indicated positive attitudes toward the marine issues addressed in the survey. In reference to their source of marine knowledge, both inland and coastal students indicated that TV specials (e.g., Cousteau) and movies are more influential in developing their marine knowledge than beach recreation, pleasure reading, classes on marine topics, and visits to public aquaria.

Hounshell and Hampton (1982) developed a 22-item **Marine Attitude Survey** to measure elementary/middle school students' attitudes about various aspects of marine science. Their results from over 400 students in North Carolina, inland and coastal locations, indicated that positive feelings were more numerous than negative feelings about the coast.

These quantitative studies were conducted between 1976 and 1982; a search of the literature indicates that very few similar studies or qualitative studies in marine education were done in the late 80's. Therefore, because of changing environmental issues and subsequent attitudes of students, as well as curriculum design, a need has arisen for current research in this area.

Previous research data on **FOR SEA**, collected from 1985 - 1988, consists of pre and posttest results of the students' content knowledge, demographic information, gender identity and ethnicity (Kolb, 1988). This information indicates student background and knowledge base, but fails to survey their attitude regarding the marine environment. Previous **FOR SEA** qualitative research consists of teacher evaluations following pre-service workshops and unsolicitated teacher comments after use of **FOR SEA** in the classroom (Kolb, 1988).

Conceptions of the Marine Environment

Since the late 1970s, numerous studies have focused on students' conceptions of science. These studies have dealt with scientific concepts related to the nature of matter (Novick & Nussbaum, 1981), the earth (Nussbaum, 1979), light (Eaton, Anderson, & Smith, 1983), living and non-living (Tamir, Gal-Choppin, & Nussinovitz, 1981; Brumby, 1982), photosynthesis (Smith & Anderson, 1984), and the human body (Quiggen, 1977; Arnaudin & Mintzes, 1985). Although this research has led to a greater awareness of the effects of prior knowledge and misconceptions about specific scientific concepts, few studies have focused on students' knowledge of the marine environment.

Greens and Stegner (1974), at the University of Delaware, developed **Project COAST (Coastal/Oceanic Awareness Studies)**, a multidisciplinary resource collection for grades K-12 to study the marine environment. Leek (1979) focused on marine knowledge and developed the **Leek's Marine Environmental Awareness Tests** (30-question knowledge survey) for grades 4, 8, and 11 to evaluate the influence of some of the **Project COAST** materials. Results using the survey from 14 states in 1977-1978 reflected moderate mean scores of 42%, 38%, and 42% correct in grades 4, 8, and 11, respectively.

Brody and Koch (1989) focused on the assessment of 4th, 8th, and 11th grade students' knowledge related to marine science and natural resource issues in the Gulf of Maine area. The research team (two authors and twelve graduate students in science education at the University of Maine) developed five concept maps representing 15 major concepts involving geology, physical and chemical oceanography, natural resources, ecology, and decision-making pertaining to the Gulf of Maine. Then they interviewed 187 students from 12 schools (urban and rural) in Maine: 4th graders (64), 8th graders (60), and 11th graders (63), concerning ideas found on the five concept maps. The results show that at least half of the students revealed a number of misconceptions. An example of one the most noticeable misconceptions was that "coral reefs exist throughout the north Atlantic Ocean (p. 23)." They found that students learned this misconception by watching TV specials on tropical marine life and then generalized this information to all oceans. Another misconception pertaining to living resources from the ocean was that "the oceans are a limitless resource (p. 23)." Brody and Koch felt that this misconception was a result of the students' beliefs that the vastness of the oceans precludes the depletion of living resources in the near future.

The researchers found that several general conclusions concerning student knowledge of marine ecosystems in the Gulf of Maine emerged from this study:

> (1) students learned only a few basic marine science and resource concepts in the elementary grades relevant to current marine natural resource issues;
>
> (2) there was relatively little further assimilation of new concepts or differentiation of existing concepts as students progressed through the grades;
>
> (3) overall, the level of understanding of basic concepts and principles related to marine ecosystem dynamics, resource utilization, management, and decision-making processes was low (p. 25).

This study is novel in the area of conceptions of marine science, but it limits the students on their personal conceptions of marine science because of the previously developed concept maps emphasizing concepts which the researchers thought were important in the study of marine science.

Chapter 3

PROCEDURES

This chapter contains descriptions of the procedures used in the study including the focus of the study, research design, study sample, treatment, researcher characteristics, data collection methods, instruments, and data analysis.

Focus of the Study

The purpose of my study was to investigate the the student's academic achievement and attitude towards the marine environment before, during, and after the FOR SEA experience. In this program students investigated the nonliving and living factors that affect the marine environment. Students learned this content by "doing" science, using process skills to gather data, thus enabling them to generate their own concepts about the world (Kolb, 1988). The study examined constructs measured qualitatively and quantitatively in this case study, with student learning and attitudes being the focus of the study.

The students experienced a 22 day unit regarding physical and biological aspects of the marine

environment. Students' content knowledge concepts were measured with a pre- and posttest and "brain storming" maps. Students' marine-science attitudes were measured by the use of interviews, observations, documents (journals), "brain storming" maps, and open-ended questionnaires.

Research Design

Using Campbell and Stanley (1963) notation, the research design was as follows:

O1 O2 O3 X1 O4 O5 O6

O1 Pre-interview covering attitudes about the marine environment with 5 students.

O2 Paper and pencil pretest covering marine science concepts from the **FOR SEA** unit.

O3 Paper and pencil open-ended questionnaire determining attitude about the marine environment.

X1 **FOR SEA** unit on nonliving and living aspects that affect the marine environment.

O4 Paper and pencil posttest covering marine science concepts from the **FOR SEA** unit.

O5 Paper and pencil open-ended questionnaire determining attitudes about the marine environment after the **FOR SEA** unit.

O6 Post-interview covering attitudes about the marine environment with the initial 5 students.

Study Sample

This case study was conducted with students and teacher in a sixth grade intact honors science class in a private school located in Atlanta, Georgia. This class is part of a PK-12 school (99 resident and 2099 day students) which consists of a diverse student body representing 11 countries, 4 states, 62 cities, including suburbs around the city of Atlanta, and cities throughout the state of Georgia. The nineteen students (11 boys and 9 girls) in this study represent a range of ethnic groups (12 white, 1 Black, and 6 Asian [4 Indians and 2 Orientals]). All students are required to wear a school uniform.

The tuition for grades 4-6 the 1990-91 school year was $5,490. Approximately $200,000 in scholarship monies were awarded annually to students in grades 9-12. Most of the students are from middle to upper-middle income families.

I selected this school due to ease of access and because the science department chairperson and administration allowed this teacher to implement the FOR SEA program into the curriculum. I had connections with this school because I taught in its high school science department for nine years.

This teacher was selected because of his experience teaching environmental science topics and because I believed that this individual could implement the **FOR SEA** program with some expertise. The teacher with whom I worked completed an eight hour training workshop on use of the **FOR SEA** materials for the sixth grade. He had been teaching science to elementary school students for 25 years. He was well thought of by other teachers and parents at this school. He had the following degrees: B.S. in Biology and M.Ed. in Science Education.

The sample group was the sixth grade honors section, part of a population of 105 sixth graders (56 boys and 49 girls). This teacher had five sections of prep students and one section of honors. This sample was chosen because studying the entire population would be too unwieldly and time consuming. I concentrated on one small group of students. I did sometimes observe the other prep sections to get another point of view in order to help verify some of my findings in the honors section. I also spent time during the day interviewing students, observing students in activities other than their science class, and analyzing some of my fieldnotes taken that day. Therefore, this honors section was also a convenient sample because of the time of day this class was taught (9:20-10:05 am). **FOR SEA** was a component of an environmental science study being taught to all

sixth-graders during the Fall quarter. For the remainder of the year, the students studied a SAPA unit on chemistry and physics followed by units on plants and the human body.

I received approval from the Institutional Review Board (Human Subjects) at The University of Georgia to conduct this study. I abided by all aspects of the research procedures involving human subjects, all research procedures that were in accordance with the principles and policies of the Institutional Review Board.

Treatment

The treatment used in this case study consisted of a day marine-science curriculum unit of activities and readings dealing with both the physical and biological environments of the ocean. Specific lesson content came from the sixth grade **FOR SEA** curriculum guide. This unit contained activities designed to facilitate acquisition of content knowledge, specifically by presenting, "activities focusing on the physical factors that affect plants and animals of the sea" (Kolb, 1988).

Processes developed in **FOR SEA** included observing, comparing, measuring, organizing and communicating observations, predicting and drawing inferences, and

applying knowledge. The **FOR SEA** curriculum emphasized this approach to science teaching.

Instructional Topics

The instructional topics covered during this study were divided into two areas, nonliving and living aspects of the marine environment.

Area one, nonliving aspects, covered the following topics from the **FOR SEA** curriculum guide: sea water investigations (salinity, density), oceanographic instruments (hydrometer), physical features of the marine environment (measuring the ocean depths, ocean floor features), and beach environmental conditions (beach sand, types of beaches).

Area two, living aspects, focused on the following topics: the biological environment (food chain and food web, marine aquaria study) and coastal environment (plants and animals).

The instructional materials were presented over a 4 week period during the second half of Fall quarter. The nonliving and living areas were taught together in order to give a holistic approach to the curriculum, an approach that enabled students to see the relationship between living and nonliving variables.

Instructional Strategy

All students were involved in five 50 minute sessions per week. Every lecture and activity involved the use of **FOR SEA** curriculum guide as an integral component. Other resources were brought in during this study.

On a typical day, the teacher introduced the new subject to the class through class discussion to assess the students' previous knowledge of the topic. Next, the students worked in 4 groups, with 5-6 students per group, on an activity or lab which explored the topic area. They discussed the results of the activity or lab in class discussion led by the teacher. As a follow up to the activity and class discussion, the teacher provided a 10-15 minute lecture, if needed, at the beginning of the next class session. The above implementation of the curriculum varied according to questions, difficulties or further explanations that the students desired at any given time. (see Appendix A for sample exercises)

Researcher

I was the primary instrument for data collection and analysis. Therefore, in this section I have described my role, my biases and my expectations for this study.

Researcher Role

My primary role in this study was as a participant observer. Most of the time I observed and took fieldnotes on the classroom activities, student-student and student-teacher interactions and other situations that affected the study. There were times where I assisted the teacher during a class activity or lab and conducted conversational interviews with students. During that time I was a researcher participant. Gans (1982, p. 54) calls a researcher participant one "who participates in a social situation but is personally only partially involved, so that he function as a researcher." There were other times in which I interviewed students on their attitudes and read their personal documents. Therefore, my role was flexible and changed according to the type of data I needed to collect.

I was introduced to the students as a former teacher in the high school who taught oceanography. I was also described as a person who was working on his Ph.D. (Ed.D.) in science education at the University of Georgia. The students, therefore, saw me as a former teacher and researcher who was with them for four weeks this Fall. I also had the opportunity to be with the whole sixth grade class as an adult chaperone for three days during the Fall while they attended the Rock Eagle 4-H Center on a field trip.

Researcher Biases and Expectations

I came to this study with some biases for a number of reasons. My first 16 years were spent in Rhode Island. I lived during the school year near a large bay, and during the summer my family lived in a beach house on the coast. Most of my activities were centered around the marine environment. I learned how to swim, fish, sail, surf and work in this environment. One of my summer jobs was being a lobsterman off the coast of Rhode Island. I always wanted to be an Oceanographer while I was living in Rhode Island.

I moved to North Carolina in 1970 because of my father's job. I attended North Carolina State University (NCSU) from 1972 to 1976 and graduated with a B.S. in Textiles. During my stay at NCSU I took two elective courses, Oceanography and Scuba Diving, and became a founding member of The Cousteau Society. These newly found interests led me back to the marine environment once more when I spent two summers (1976 and 1981) at Seacamp (Newfound Harbor Marine Institute) on Big Pine Key, Florida, teaching numerous science courses about the tropical marine environment in that area.

I spent the next three and half years working in unrelated fields other than teaching about the marine environment. In 1980-1981, I attended Georgia State University in order to take courses about the marine

environment to help prepare me to teach science. During the summer of 1980 I attended my first National Marine Educators Association national conference. The following year I co-founded the Georgia Association of Marine Educators (GAME). I took an active role conducting numerous teacher workshops about marine education and promoting GAME around the state of Georgia and at the Georgia Science Teachers Association annual conventions.

I taught Marine Science (Oceanography and Coastal Ecology) for 11 years in different settings. In 1981, I participated in a two month internship teaching all levels of students about the marine environment on the Georgia coast at the University of Georgia Marine Extension Center on Skidaway Island, Georgia. I spent the past nine years at a private school in Atlanta, Georgia, teaching 11-12 grade students. At this school I developed and implemented the following courses: Oceanography, Coastal Ecology, Environmental Science, and Earth Science. I also taught SCUBA diving and took students on numerous dive trips to Florida. I also took my students on field trips to study and experience the marine environment on the South Carolina, Georgia, or Florida coasts during the school year. During the summers of 1983 and 1988 I took four students with me to participate on the Caretta Research Project conducted by the Savannah Science Museum on Wassaw Island National

Wildlife Refuge, Georgia. This project dealt with the ecological study and protection of the loggerhead sea turtle. During 1986 and 1987 I attended teacher workshops at Georgia State University on use of the Marine Science Project: **FOR SEA** curriculum in the classroom.

In June, 1987, I attended a six day certified inservice trainer workshop in Poulsbo, Washington, on how to train teachers (K-12) in the use of FOR SEA curriculum materials. I represent the Georgia Facilitator Center (part of the National Diffusion Network) at the University of Georgia and the Marine Science Project: **FOR SEA** as their certified inservice workshop trainer for the state of Georgia and parts of the eastern United States. From 1987 to 1989 I conducted seven awareness sessions and four teacher inservice workshops on the use **FOR SEA** to hundreds of educators. In the Fall of 1989, I conducted a **FOR SEA** teacher training inservice workshop for The Georgia Independent School Association annual conference in Atlanta. The project teacher with whom I worked attended this workshop. The workshop was offered to all science teachers from his school (K-12) and out of 20 teachers attending the workshop, 10 were from his particular school. After this workshop I decided to ask this teacher if he would be interested in implementing the **FOR SEA** curriculum in his class. He indicated that he

was interested in using this material as part of the second part of an environmental unit taught during the Fall quarter.

My expectations about the FOR SEA curriculum and the students' attitudes about the marine environment were positive. My limited experience with teaching all levels of students about marine science led me to believe that most people were interested and curious and possessed a somewhat positive attitude about the marine environment. I expected the students' knowledge and attitudes about the marine environment to be enhanced because the FOR SEA unit. I approached this study with an open mind and an "emic" approach of collecting data from the students' perspective and not mine.

I know I was not able to get rid of all my subjectivity. I pursued my subjectivity by keeping a daily journal. In this journal I tried to record anything that would affect the results of this case study. I sought to obtain truth from the data with this study rather than to judge or make value statements from what I observed (Peshkin, 1988).

Data Collection Methods

Using a triangulation design I collected data from the students. Multiple triangulation includes multiple data sources, investigators, and theories, as well as a

variety of methodologies when studying the same phenomena (Denzin,1987). In this study I used different data sources and methodologies in data collection.

My use of data triangulation included time and space. I triangulated data sources by examining the students in a variety of conditions. I collected data from the students at different times of the school day and in different settings such as the classroom and the cafeteria.

One type of methodological triangulation is the between- or across-method. The researcher uses multiple methods to collect data when studying the same phenomena. "The rationale for this strategy is that flaws of one method are often strengths of another, and by combining methods, observers can achieve the best of each while overcoming their unique deficiencies" (Denzin, 1978, p.302).

Mathison (1988) states that using the triangulation strategy to collect data might result in any of the three outcomes: convergence, inconsistency, or contradiction. The convergent findings are not the only ones important in a triangulated study. In addition to the convergent findings, the inconsistent and contradictory findings can help construct "plausible explanations about the phenomena being studied" (Mathison, 1988, p. 17).

Quantitative and qualitative data were collected from the students in this case study. The quantitative data came from the results of the pre- and posttests to measure achievement. The qualitative data was obtained from observations, interviews, documents, and questionnaires. Goetz and LeCompte (1984) "believe that ethnographers must consider lack of reliability and validity to be serious threats to the value of their results" (p.209). Therefore, to make an attempt to enhance the validity and reliability of this study I used different data sources and methodologies.

Data Collection Strategy

I used the general interview guide approach by systematically interviewing 5 students (3 boys and 2 girls) to assess their attitudes about the marine environment before the FOR SEA unit began. I chose 5 students because I thought this would be a representative sample of the honors class. I chose the students with the help of the teacher on the basis of their first six weeks grade (high, average and low), ethnic background and gender. I created an outline of questions to be covered during the interview with the students (see Appendix C for example). Their answers generated common categories from which four questions were presented to

the entire class in a open-ended questionnaire during the second class meeting (see Appendix D).

The first class meeting was devoted to assessing students' content knowledge and attitudes about the marine environment. To assess understanding of concepts involving nonliving and living variables, I administered a paper and pencil pretest (refer to Appendix B). This pretest covered all marine science concepts included in the study. Details relating to construction of this instrument are in the next section of this chapter.

I conducted participant observations daily. The purpose of these observations was to witness firsthand the interactions taking place between student-student and student-teacher. Fieldnotes taken during each class and during other situations recorded the following observations: setting, participants, activities and interactions (comments by teacher and students), frequency and duration of activities, subtle factors (nonverbal communication), unplanned events, and other information. In addition, as part of my fieldnotes, I recorded ideas, strategies, reflections, and patterns that emerged. These fieldnotes are a written account of what I saw, heard, experienced, and thought in the course of collecting and reflecting on the data during this study. I coded the data from my fieldnotes daily at school to develop emerging categories that helped

contribute towards the grounded theory. This analysis in the field also contributed to theoretical sampling. Theoretical sampling (Strauss, 1987) was a means whereby I decided from my analysis of data what data would be collected next, from whom, and where.

I used two of the three basic approaches to collect qualitative data through open-ended interviews. They were conversational interviews and the general interview guide approach. The purpose of interviewing according to Patton (1980) "is to allow us to enter into the other person's perspective" (p. 196). I used the "emic" approach (Spindler, 1982) while conducting interviews and other data collecting methods in order to see and record the other person's perspective. I used conversational interviews frequently in combination with observations during the class period to help understand the students' reactions to the experience. I used conversational interviews with students in other settings during the day to help collect and elaborate on the data. I followed the general interview guide approach with students to assess their attitudes on the marine environment before and after the study.

During the study the students kept a diary (personal document) to record their thoughts about the **FOR SEA** daily discussion, activity or lab experience. Students were given time daily to write in their journal. Other

personal documents used during this study were students' homework, drawings, and projects throughout the unit. I believed that the use of these personal documents were a reliable source of data concerning the students' attitudes, beliefs, and view of their world (Merriam, 1988).

At the conclusion of the unit, students' content knowledge and attitudes about the marine environment were assessed. To assess content knowledge, I administered a paper and pencil posttest, the same instrument as the pretest; it covered all marine science concepts taught in this unit.

To obtain the students' attitudes about the marine environment, I administered an open-ended questionnaire (see Appendix F). I also conducted interviews with the same 5 students, that were interviewed at the beginning of the study, to assess their attitudes after this experience.

Instruments

The instruments used in this study were a pretest and posttest of marine science knowledge. All tests were of a multiple choice format. I administered the sixth grade pretest/posttest developed by the Marine Science Project: FOR SEA program.

According to Kolb (1981), "every effort was made to assure that the instruments [grades 2, 4, 6 pretest/posttests] measured validly and reliably the knowledge and skills taught by the project" (p. 5). The following procedural steps were used in the construction and validation of the 6th grade pretest/posttest by the Marine Science Project:

1. The major curriculum strands were identified by the Project Developer.

2. A scope and sequence was developed which specified the major concepts taught at each grade level.

3. Multiple choice test items were developed reflecting the major concepts taught at each grade level.

4. All items were reviewed by the Project Evaluator for ambivalence, clarity of content, and level.

5. All compiled tests were submitted, along with a keyed index of concepts to be measured, to three specialists in the area of marine science education.
   Each specialist was asked to judge which test items in their opinion did not adequately measure the concept being taught.
   The instruments were then revised using the information from steps 4 and 5.

6. The instruments were then checked for reliability by administering the tests to sample of students (N=30) at the grade level for which the test was developed. The resulting data analyzed for both internal (Kuder-Richardson = .79) and test-retest (Pearson r = .76) reliability.

7. The instruments were then checked for validity by administering them to an astute population (advanced students grade 11-12) who were known to have had course work in Marine Science.

8. At each stage of field administration the tests were checked for adverse floor and/or ceiling effects.

   In only one instance throughout the study did any student miss all items or answer all the items correctly (Kolb, 1981, p. 5).

Data Analysis

In addition to quantitative data, this case study utilized qualitative data to obtain a much richer understanding of the outcome than was possible by using only quantitative methods. This section describes the analysis of both the quantitative and qualitative data.

Quantitative Analysis

A t-test for dependent samples was used to analyze the pretest to the posttest of the students taking the marine science unit. This analytical approach provided evidence for the educational significance of the achievement gained by the student participants.

Qualitative Analysis

The method of analysis used in the qualitative component in this study was constant comparison. The constant comparative method began early in the study, and it continued throughout the whole process by collection of multiple data sources used to generate grounded theory about the study.

Glaser and Strauss (1967) describe the constant comparative method in four stages: (1) comparing incidents applicable to each category, (2) integrating categories and their properties, (3) delimiting the theory, and (4) writing the theory. I used these steps as a guide to describe the conduction of data analysis.

I started coding incidents from data collected in the field. The data came from my fieldnotes, interview transcripts, documents and other sources. Data collection was a continuous process because I coded and memoed my data at school every day.

I used codes to help divide the data into categories. I then compared these categories with the different types of data that were collected to see whether some of the categories were starting to repeat themselves. I constantly compared these categories to help generate theoretical properties of the category. Once a category became coded three to four times, I stopped coding and recorded a memo to myself regarding this category. I then wrote an analytic memo concerning the meaning of this category and the conditions in which this category existed. I conducted some theoretical sampling at this time. I chose where and from whom I collected data and determined what type of information was needed from my memos to help verify or elaborate that category. This process continued in cycles (data

collection, coding, data analysis and memoing) until there was data saturation and no new categories were being created.

I then integrated other categories and their properties through constant comparisons of the data. Next, I wrote propositional statements or hypotheses which helped explain the data and added to the grounded theory about the phenomenon (Glass & Smith, 1987). I conducted theoretical sampling, along with this process of integration, to help solidify my data towards a grounded theory. Next, I delimited the theory and categories at two levels. I started to reduce and modify the original set of categories as the theory started to develop. I discovered uniformities in the original data and wanted to conduct some more data collecting, coding, and memoing to elaborate or reduce this data. This helped ground the theory and reduced the number of categories. As the theory solidified and the data became reduced, I spent more time with the constant comparison of incidents. Also, I wanted to strive for theoretical saturation of the categories. Strauss (1987) defines theoretical saturation as the time "when additional analysis no longer contributes to discovering anything new about a category" (p. 21).

At or in the last stage I was ready to write some theory pertaining to this study. According to Glaser and

Strauss (1967), in "this stage in the process of qualitative analysis, the analyst possesses coded data, a series of memos, and a theory" (p. 113). In order to create grounded theory I collated my memos from each category. The discussions in my memos provided the content behind the categories, information which became the major themes of the grounded theory about this study.

In summary, the constant comparison method was a continuously growing process in which each step led to the next. But much of this method was doubling back to collect data, code, and memo. This cyclic routine was necessary to develop the needed saturation of data to validate the grounded theory which emerged from this study.

Chapter 4

INFORMANTS

This chapter describes the five informants that were used in this study. The background information includes their age, gender, ethnic background, years attending this school, relationship to their peers, places where they have lived, experiences with and attitude toward the marine environment.

Al

Al is an 11-year-old white male who entered this school as a new student at the beginning of this year. He is average height and slightly over weight. Al has brown hair and wears black rimmed glasses. At the end of the first grading period, his science grade was "A." He told me that science was one of his favorite subjects at school and that he enjoyed being in Mr. Wood's class.

Because of his parents' occupations, he has lived in different parts of the United States and Australia. His dad is in sales, and his mom is an office manager. His previous residences include Northern Virginia, near Washington, D.C.; Maryland; Dallas, Texas; and near the coast in Australia. While living in the Washington, D.C.

area, his family took vacations to the Outer Banks of North Carolina and rented a house for a week or two at a time. Al enjoyed visiting historical lighthouses and the Wright Brothers Memorial and playing miniature golf when he vacationed in this area. When he moved to Georgia, his parents took him to Mexico Beach, Florida, where he enjoyed fishing on two occasions. Until this year Al's experiences with marine environment centered primarily around recreational type activities while vacationing at the beach one or two weeks per year.

Al is an articulate young man who enjoys school, reads widely and spends time thinking about technical things. In the initial interview, he told me that he believes the marine environment is important and useful because of its potential for "food from the ocean" and ". . . provides water, . . . well, it could provide water if we came up with the technology to separate the salt from the water and collect the water and use it for drinking." Al continued: "Well, usually I just think of these things. Well, I like to think about technical things. I was thinking about this technology . . . they could boil this water and evaporate it and purify it and just supply it and pump it out."

I observed that Al liked to explore and work with FOR SEA activities that had an element of inquiry to them. At the beginning of the study he was quiet and had few friends with whom he interacted, during class, since

he was mostly a loner. He really did not like to work in groups or with a partner when on the activity work with FOR SEA. One day he was supposed to work with John, who was his partner at the desk. Together they were to construct a hydrometer, using clay and a plastic straw. Al decided to build his own hydrometer in half the time needed by John and the other boys at the table. He was quite determined and worked arduously on individual tasks that had to do with some of the activities that were exploratory and "technical" in character.

One of the activities named "boatin" dealt with designing and constructing a clay boat which would float in a small basin of water and also hold marbles that represented people. Because Al was determined to have one of the first "floaters" and to have the best design, he worked quietly at his own desk to design and shape his boat. After several attempts and failures, he finally produced a "floater." Mr. Woods congratulated him on a job well done and displayed his boat to show the rest of the class the basic design that they could use to get a "floater."

During classroom discussions, Al mostly listened to his classmates and the teacher and would contribute to the discussion only when he was called on by the teacher and when he wanted to show off his knowledge of that particular area. Mr. Woods called on Al when he wanted a student to tell him the right answer or to have one

student assist a fellow classmate with the question. One day Mr. Woods called on Al to go to the white board to diagram and explain why a boat floated. Al told the class the correct answer and showed by his body language that he was quite proud of himself. He smiled and walked proudly back to seat. One other example of Al's comprehension occurred when Mr. Woods wanted a volunteer to go to the white board to explain and illustrate an example of a food web found off the beach in the subtidal zone. Some of the students yelled out to Mr. Woods that Al could draw well; therefore, Mr. Woods chose Al to go to the board and draw the food web. Al was really taken back because of the response from some of his classmates. Al proceeded to go to the board and draw a good illustration with a fine explanation of how the food web works. When he was on his way back to his seat, seven of his classmates gave him a spontaneous approval of his superior performance by clapping their hands together. Al was really shy, but he liked to be recognized for his "technical" knowledge of the subject.

I observed that sometimes during class he would stare into the saltwater aquarium that was located next to his seat and watch the blue crabs walk around the tank. He said to me one day after class, "I like having the crabs here." Al later told me that "they were fun to see them walk around, and I just think that they are fascinating creatures; they have so many adaptations;

they are really interesting and their claws are very good." He took this observational experience from class and applied it to one of the **FOR SEA** activities.

One of the activities that Al had fun with was "Design a Winner." The students were given a blank sheet of paper and told to create their own "winner," an animal that would survive in a beach environment. They were to label its adaptations and to give it a name. He designed and drew a "winner" named *Palinus retrateral II*. He described this crab-looking animal (refer to figure 3) as

> very strong and rugged, and yet very delicate and vulnerable to predators. That is why every extremity, including the eyes is retractable except the feelers. . . . Because everything is retractable, the internal organs are concentrated in the very center of the torso.

When it was his time to display his animal to the class and Mr. Woods, he was very serious with his presentation. Mr. Woods responded to him when he was finished, "Now that is kind of neat; I appreciate that, Al."

Al is also interested in the "future usages" of the marine environment, particularly in the area of generating electricity for land dwellers (refer to figure 2). Al believes that the marine environment's importance to him is centered around food, water (future usage), and recreation (fun) [refer to figure 1 and 2]. He told me that he wanted to study engineering when he attends college. Al said he is interested in the "inventing side" of engineering.

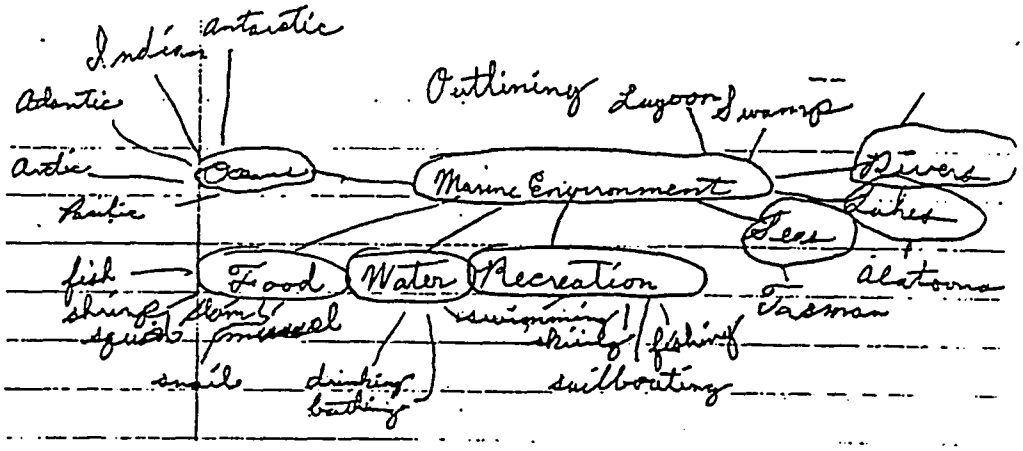

Figure 1. Al's first "brain storming" map

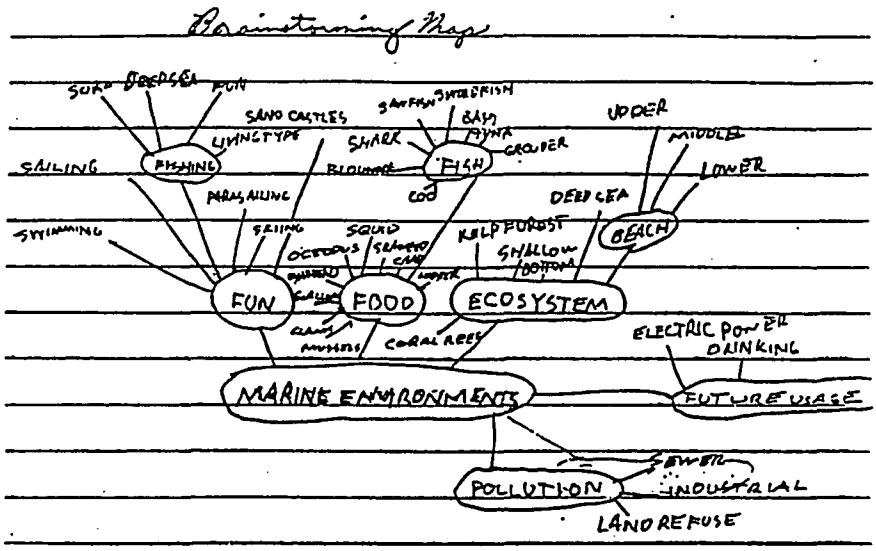

Figure 2. Al's final "brain storming" map

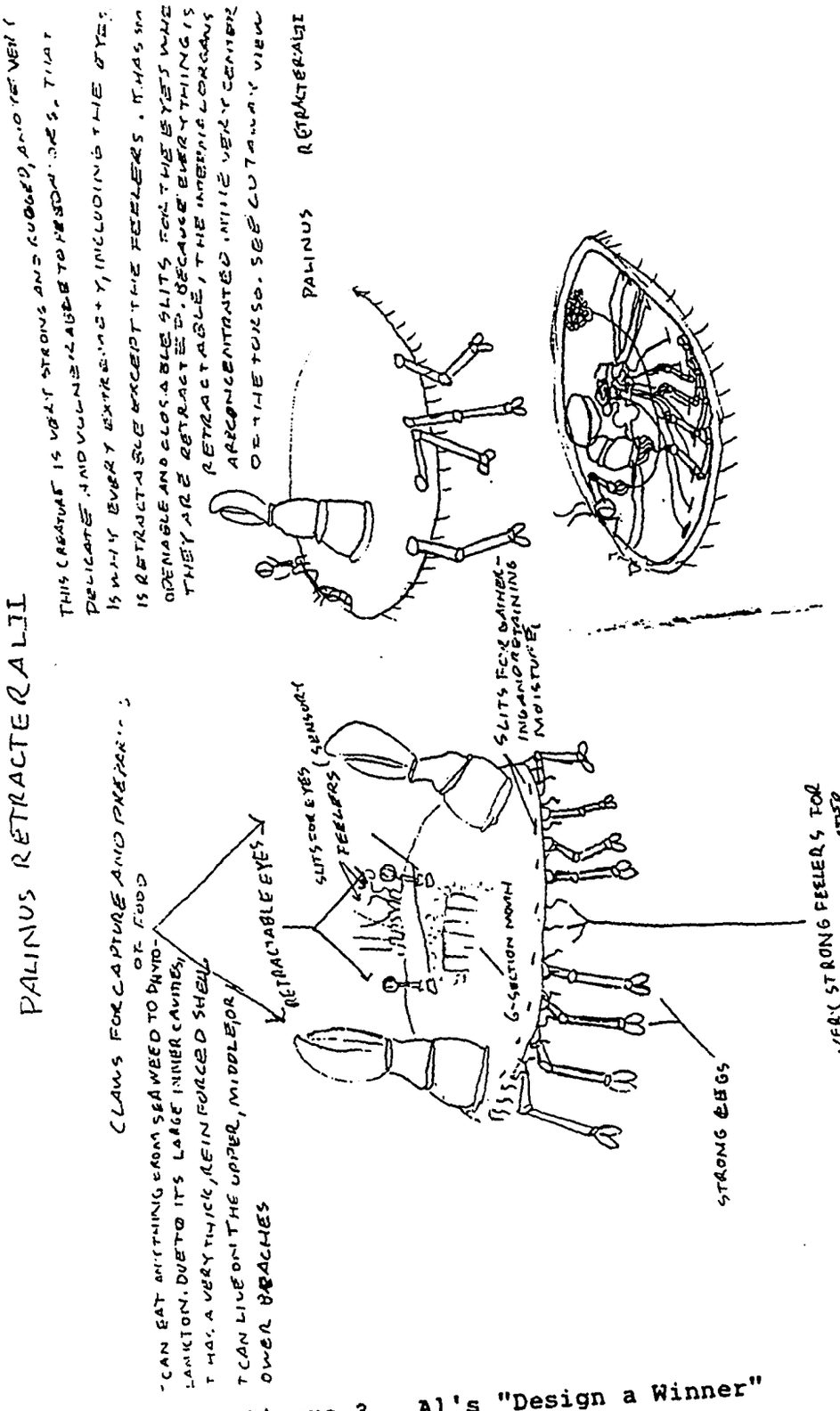

Figure 3. Al's "Design a Winner"

Conceptions of the Marine Environment

I discovered that Al's conception of the marine environment was not originally clear or correct. He initially described the marine environment in our first interview as "all the water and all the things directly related to water in the world." Then he illustrated on his first "brain storming" map (refer to figure 1) that rivers (Chattahoochee) and lakes (Allatoona) were a component of the marine environment. These above concepts of the marine environment comprise his preconceptions (alternative conceptions) about this environment.

At the end of the four week period, there was evidence that AL's preconceptions had changed. He wrote in his exit questionnaire that "I would describe it as a diverse water network consisting of very complicated food chains and webs." When I asked Al if the FOR SEA experience had any thing to do with his conception of the marine environment, he replied, "I learned some more new things, and I was not really aware how diverse the ocean was until we had the class." His second "brain storming" map (refer to figure 2) reflects more diverse components that were covered during the last four weeks in the FOR SEA curricula and the absence of rivers and lakes. Al added items such as "ecosystem," "beach," "future usage." and "pollution" that were not included on his first

"brain storming" map. Also, during our last interview, he told me that the marine environment is "very complicated" and that there is a sense of interdependence between all the organisms in this environment.

General Attitudes

Al had many positive feelings about the marine environment. In the initial interview he told me that most of the time when he was at the coast he had a great time. When I asked him to describe it to a stranger from a different planet, his reply was,

> I like the ocean because when it is calm, it is very pretty. It is nice and placid, and I like thinking about animals and plants that live in the ocean. I just think of some of the things that go on in the ocean.

Al continued to tell me about how refreshing and beautiful the environment is and how he would tell that person that "they have to go see it." At the end of the study, his positive feelings about the marine environment were linked with his desire to learn more about it. His passion to learn more about the technical things, such as desalinating sea water for future use on land, became important to him. Al also increased his interest in the potential of getting electric power from the ocean. His yearning to learn about the technology connected to the marine environment was reflected in his positive attitude

toward this environment. He acquired his knowledge about this environment from direct experience, school, and the books he reads.

Attitude about Pollution

Al's attitude about pollution was a result of numerous prior experiences that he had witnessed while visiting the various marine environment locations. During his first interview, he expressed his concerns about the marine environment. He told me, "usually I feel happy unless the beach is extremely polluted. . ." Al had experience with pollution when he observed garbage and cigarette butts on the beach in Hawaii and saw a fish in the water with a wrapper in its mouth. He told me: "I did not like it. It made me feel terrible; beaches like that are no fun." He said that he had seen other types of pollution such as beer cans and other litter on the beach when he had visited the beaches on the Outer Banks of North Carolina.

Some of these prior experiences with pollution emerged at the beginning of **FOR SEA**, but his past memories were enhanced and made meaningful to him because of his **FOR SEA** experience. Al wrote in his exit questionnaire that his feelings about the marine environment had "changed slightly" and that he was "more conscious about pollution" because of the **FOR SEA** experience. He also wrote in reference to man's (people)

relationship to the marine environment that it ". . . provides for man, but man does not seem to always care about the marine environment."

His feelings and experiences about pollution were intensified because of his exposure to these issues during **FOR SEA**. He stated in his exit interview that he "learned about pollution and how it affects you, . . . I feel more aware". The students saw a slide show entitled "We Care About Oceans." This presentation included slides and a narrative that discussed dumping of sewage sludge and acid into the ocean and discussed the consequences of litter and garbage washing up onto our beaches. Also, when they were discussing man's role in the environment, the class had a discussion on pollution. Most of the students concluded that man does harm the environment, and especially the marine environment.

His past experiences with pollution were brought more into focus for him because of **FOR SEA's** lesson on pollution, "We Care About Oceans," and class discussions of man's role in the marine environment. Al elaborated in his exit interview about more personal experiences with pollution in the marine environment. He had not written about or discussed these experiences previously.

> We use to live in Australia, and they had bad problems with pollution cause we lived near the coast. They were having a problem with them dumping raw or partially treated sewage in the water and the ocean. It really made me sick because they would show aerial shots off Sydney, with brown coating all the way up to the beach and people would swim there and it smells, it was awful.

He also stated that "pollution was dangerous." He shared with me some information that he had heard concerning mercury pollution in the ocean, that a few years ago people were scared about eating tuna. "Mercury would have not gotten in the tuna without the help of people." Al described the process of how the mercury was dumped into the ocean because of people and how it traveled through the food chain and eventually got into the tuna we ate.

Al's feelings concerning what he could do personally about pollution result from his past experiences in Australia. He felt quite optimistic but concerned. He told me that "man does not care." I asked him what he meant by that statement. He shared with me how people in Australia had signed petitions to have the sewage department stop the dumping of raw sewage, but it did no good because "they just kept it up and it killed the beach." He went on to tell me how he thought people could make a difference: groups could lobby and protest. He believes that their unified voice would make a difference against pollution. Al told me how he could write letters to corporations or to the sewage department that dumped sewage into the water system and that he, as a student, could make a difference.

Fran

Fran is an 11-year-old Indian female who has attended this school since the first grade. She is slender and of average height. She has straight black hair worn to her shoulders. Her eyes are brown. Her skin is clear and slightly on the dark side.

She is one of the weakest students in this honors class. Her grade after the first grading period was a low "C." According to Mr. Woods, she had a habit of turning her work in late. I noticed this lack of effort and/or motivation when she did not submit her journal to me on time and at the end of the study when she did not turn in her final "brain storming" map. Mr. Woods admonished her about not turning her journal in on time. He said to Fran: "You already have five red dots (zeros) in the grade book. You better bring in your journal in tomorrow." She decided not to follow his suggestion and did not turn in her journal to me. Fran told me at the end of the study that she did not like writing in her journal and had a hard time keeping up with it.

The reliability of the data that Fran gave me was not as strong as that submitted by the other informants. I felt that Fran was really shy and not open with me when we talked at the first interview. Also, sometimes I had the feeling that she was writing things in her journal about her attitude and reactions to class that day just to please me. For example, she wrote: "Like I said

before, I think the ocean is more than it use to be to me. I think that is probably one of your main goals Mr. Howick! Well, guess what!! You've acheived [sic] it"!

Because she was not diligent about keeping up with her journal by writing on a daily basis, Fran did not write down as many thoughts, feelings, or experiences about the marine environment compared to her classmates. Therefore, the little information that she did give me was not as strong or reliable as that given by the other classmates.

In personality a real extrovert, Fran is well-liked by classmates and by other teachers in the school. She always seemed happy and interacted well with the three other girls with whom she shared a table during the science class. She was involved with tennis and other activities at school during the year.

I observed that she did not always get along well with Mr. Woods. He interacted with Fran often during the study. On one occasion he cut her off when she was responding to a question that he had asked her. He chose another student, a male, to tell him the correct answer. By the body language which she projected, I could tell that Fran was offended by this sudden "put down" that she did not like to be embarrassed in front of her classmates. She sat very quietly at her seat, stared down at her notebook, and did not joke around with Susan as she usually did during class time. This "put down"

happened on one other occasion when Mr. Woods asked Fran to explain why too much phosphate was a type of pollutant in a fresh water environment. She proceeded to go through the process of how it affected the system in the pond, but then he stopped her in mid-sentence with "very close to being right." Mr. Woods chose a male to complete the process. I noticed on several days when Mr. Woods was lecturing that Fran would stare at the aquaria that was located on the table next to her seat and not pay any attention to him. He did give her praise during one class time when she went to the white board to show her classmates how to read a salinity chart. Mr. Woods' response was "very good and thank you, Fran."

Fran's Environmental Concerns

Fran did show concern for the environment. One of the teachers told me a story about an incident when Fran confronted Mr. Jefferson, president of the entire school, (lower to upper). He came to the lower school cafeteria to visit the students during their lunchtime one day. She approached him in the room and asked him what he could do about the styrofoam trays that students and teachers used for lunch. She was very much concerned about how the school was doing its part in recycling materials that they used. Some of Fran's other environmental concerns surfaced during her exit interview with me because of **FOR SEA**. She told me some of her

concerns about the marine environment. Fran expressed her feelings about pollution in this environment: "I did not like the idea about (pause) this is man's fault, but I don't like the idea of man dumping acid and stuff into the marine environment." Fran continued and told me that "it was done a lot" and that she felt "pretty rotten." She said that she had seen litter and garbage that had been washed up onto the beach in Hilton Head, South Carolina, during her last visit. I asked her what she could do to help, and she replied, "Pick it up I guess, but I feel helpless sometimes." Fran could not explain why she felt helpless about her role in preventing pollution. When I asked her how she knew that man dumped acid into the ocean, Fran shared with me the information that she had learned by watching the "We Care About Oceans" slide show. This slide show was part of her FOR SEA experience. She also wrote in her exit questionnaire that "I feel that I can relate more to the marine environment because of this class." Fran's prior experience and knowledge of pollution was enhanced with the new knowledge and awareness she learned because of FOR SEA.

Conception and Attitudes about the Marine Environment

Fran has lived in Georgia all of her life. In the past when her family has taken vacations, they have usually gone to Hilton Head, South Carolina, and stayed

in a hotel located on the beach for three days at a time. While she was there, she enjoyed collecting sea shells, making sand castles, and "just sitting in the water." Fran told me that it was "refreshing" to be down at the beach. She told me that she did not have a lot of experiences with the marine environment. She mentioned to me that one of the most interesting things that she had observed at the beach was a "high tide."

Her limited knowledge about the marine environment was taken from books and trips to the beach. Fran was weak in terms of information about this environment. She initially explained this environment to me as a "big gap filled with water and lots of different fish." In terms of concepts her "brain storming" map (refer to figure 4) was very simple compared to those of her classmates. The only map she did is poor quality, expresses few concepts, and makes few connections between concepts. She described the marine environment as "rocks," "plants," "fish," and "salty" on her first questionnaire and also on her "brain storming" map.

Fran's concept of her relationship to the marine environment resulted from her connection with the Indian culture and diet. Fran's initial response during our first interview about the importance of the marine environment was "Well, if we did not have the ocean, all the fish would die inside the ocean, and if we did not have the fish, almost all of our food would be gone."

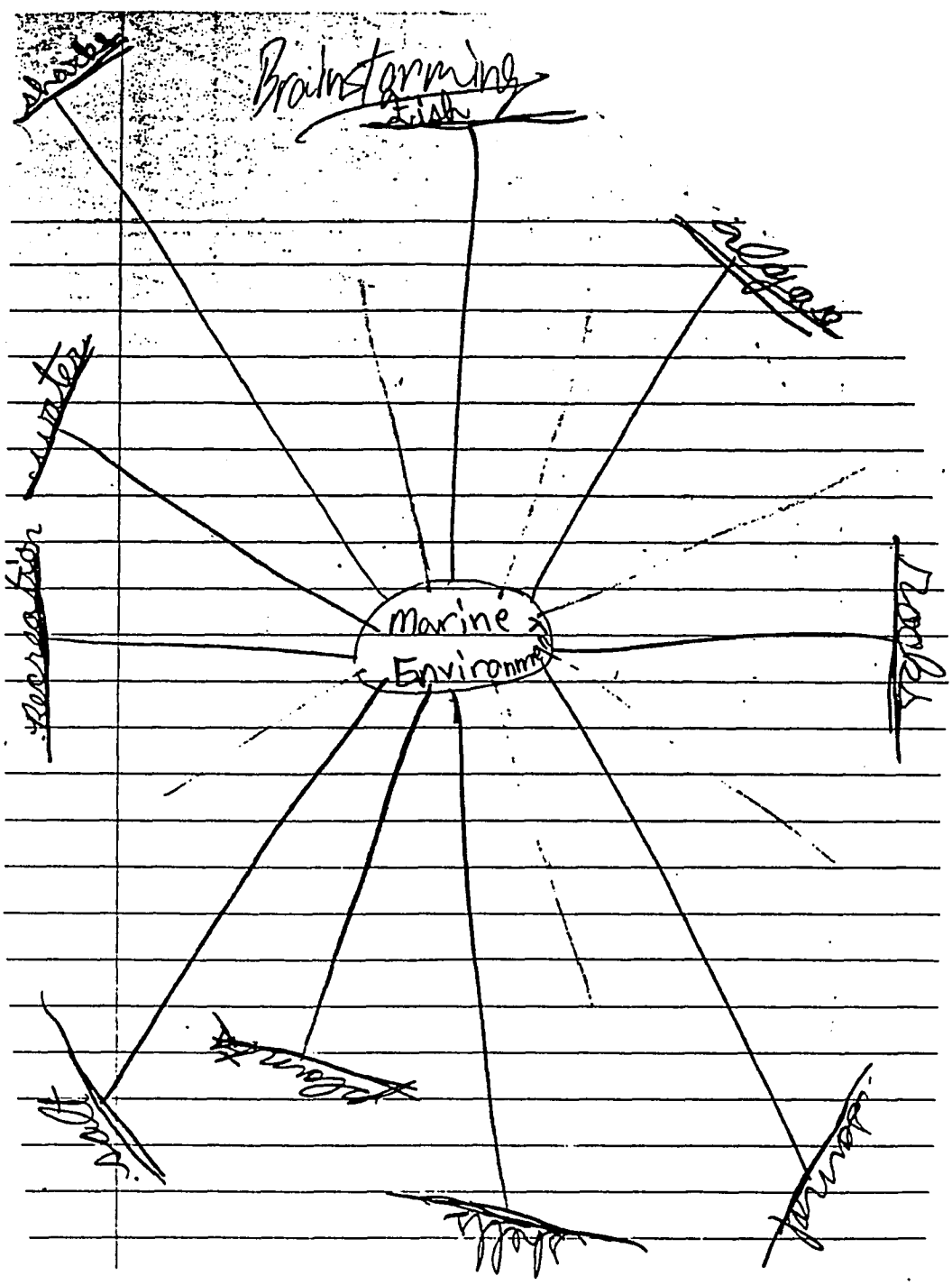

Figure 4. Fran's "brain storming" map

Then she wrote in the first questionnaire that "it is part of our diet." In Fran's exit questionnaire she wrote the following: "Without the marine environment almost all of our food supply would vanish because we eat the fish and animals in the marine environment." When I asked her to elaborate on the above statement, she replied, "I used to think the ocean was a big thing of fishes and things, but I know that there are important things about the ocean." When I asked Fran what important things, she responded, "like the fish in it, like half the stuff we eat, like shrimp, crabs, sharks, and fish. It would all vanish." Then Fran told me that if the marine environment vanished, then "we would die out a little faster". She told me that she and her family eat seafood about twice a week. They eat shrimp, fish, crabs, and seaweed as part of the dishes that were common in their native Indian diet. I believe that she developed these beliefs and feelings about the importance of the marine environment because of her diet and because her culture is directly linked to this environment.

One of Fran's negative feelings about the marine environment was that she thought it was "weird to swim in water where fish live." She continued: "big squeamish things lived in the water." Fran could not explain or tell me what type of "squeamish" things were in the water when asked to elaborate during our initial interview. When we had our last interview, I asked her if it still

bothered her about these "squeamish" things in the water. Fran's response was "sort of" and it is "real weird."

Fran's experience with **FOR SEA** had an impact on some of her conceptions and attitudes towards the marine environment. Her knowledge and attitude about this environment improved, as reflected by her response in her journal and exit questionnaire. She wrote, "I think the ocean is more than it use to be to me". Fran also wrote the following syntus (poems) in her journal on different days about the marine environment.

Turtles	Whales	Fish
swimmer	beautiful	colorful
sweet	royalness	neat (cool)
greenish	huge	graceful swimmers
reptiles	mammal	animals

The above syntus reflect her knowledge and attitude about these animals in the marine environment because information about these animals was covered in the biological component of **FOR SEA**. Fran told me in her exit interview that she liked learning about the marine environment because of her **FOR SEA** experience.

John

John is an 11-year-old white male who has attended this school since kindergarten. At the end of the first grading period, his science grade was "B." John is a slender boy of average height. He has short, brown hair.

He told me in his initial interview that science is his favorite subject. John shared with me that he loves

to study paleontology and had been to Colorado and Utah on two "fossil" field trip/vacations with his parents. His dream is to become a world famous paleontologist and travel the world to discover more information about dinosaurs.

I felt that John was very open and honest with me during our interviews and conversations during and after class. He has the attitude that life is fun, and he wants to share his enthusiasm with his classmates and others.

Well-liked by other boys in the class, John enjoyed being the center of attention, especially when his turn came to show his "Design a Winner" to the rest of the class and his teacher.

John was a very creative individual who spent much of his time working on special projects in other classes and on art contests that are school sponsored. He told me that he was the "winner" of last years drawing competition and that "I hope I win this year." He informed me that he loves to design and build models of military equipment, and he did a great job with the "Design a Winner" activity during the **FOR SEA** experience. The first thing he did when he received the **FOR SEA** student materials was to color in the picture on the front cover of this packet. During the whole 4 weeks he did not pay attention in class. When Mr. Woods lectured

to the class, John daydreamed or drew sketches of animals in his notebook and journal.

"Design a Winner" was a fun and creative FOR SEA activity for John. He made a big production of "Design a Winner," which consumed much of his energy and thought. He was determined to design the best "winner" in the class. He became so consumed with this assignment that all he thought about and did in science class for three days was this activity. He was so excited about his "winner" that he showed Mr. Woods his preliminary sketch of his crab-like critter at the end of the class that first day. John could not wait to share his second drawing of his "winner" with Mr. Woods and me at the beginning of the next class. He was hyperactive and excited about his critter when he was explaining the adaptations that his "winner" possessed. On the 3rd day, John rushed up to Mr. Wood's desk to share his colored paper 3-D model that he had made the preceding night at home. He was really proud of his model. Mr. Woods remarked to John and the rest of the class "Check it out, cool!"

He was the first student to present his oral report on his "winner" to his classmates. John presented his model and read his description of the his "winner" to the class with pride. He named his "winner" *Sco-Lob-Fl-Ab-Urtle-Iger*. The name originated from taken letters from the following animals: (Sco)rpion, (Lob)ster,

(Fl)ingfish, Cr(ab), T(urtle), and T(iger) [refer to figure 5]. John told me later that he had chosen these animals because these were animals with which he was familiar and that the crab (blue) was in the aquaria on his table. After he completed his presentation, Mr. Woods announced to John and the class, "I'm impressed."

John wrote in his exit questionnaire that "Design a Winner was fun and real neat." He told me during his exit interview: "I thought that it was real neat because everyone got to do whatever they wanted to do and there were no guidelines to tell you what to do." John liked the idea of having no directions and the notion of being allowed to create what he wanted. He told me that it was the best **FOR SEA** activity that he had done during the 4 weeks period. I asked him where he got the idea for his animal, and he replied, "I like having the (blue) crabs in class. I thought I could create a better animal to live on the beach."

Conceptions of the Marine Environment

John has lived the majority of his life in Georgia. His father is involved with the Carter Presidential Library, and on several occasions John has had a chance to accompany his parents on their business and pleasure trips around the United States. John's family owns a time-share condominium at Hilton Head, South Carolina, where they take John on vacation for a week at a time

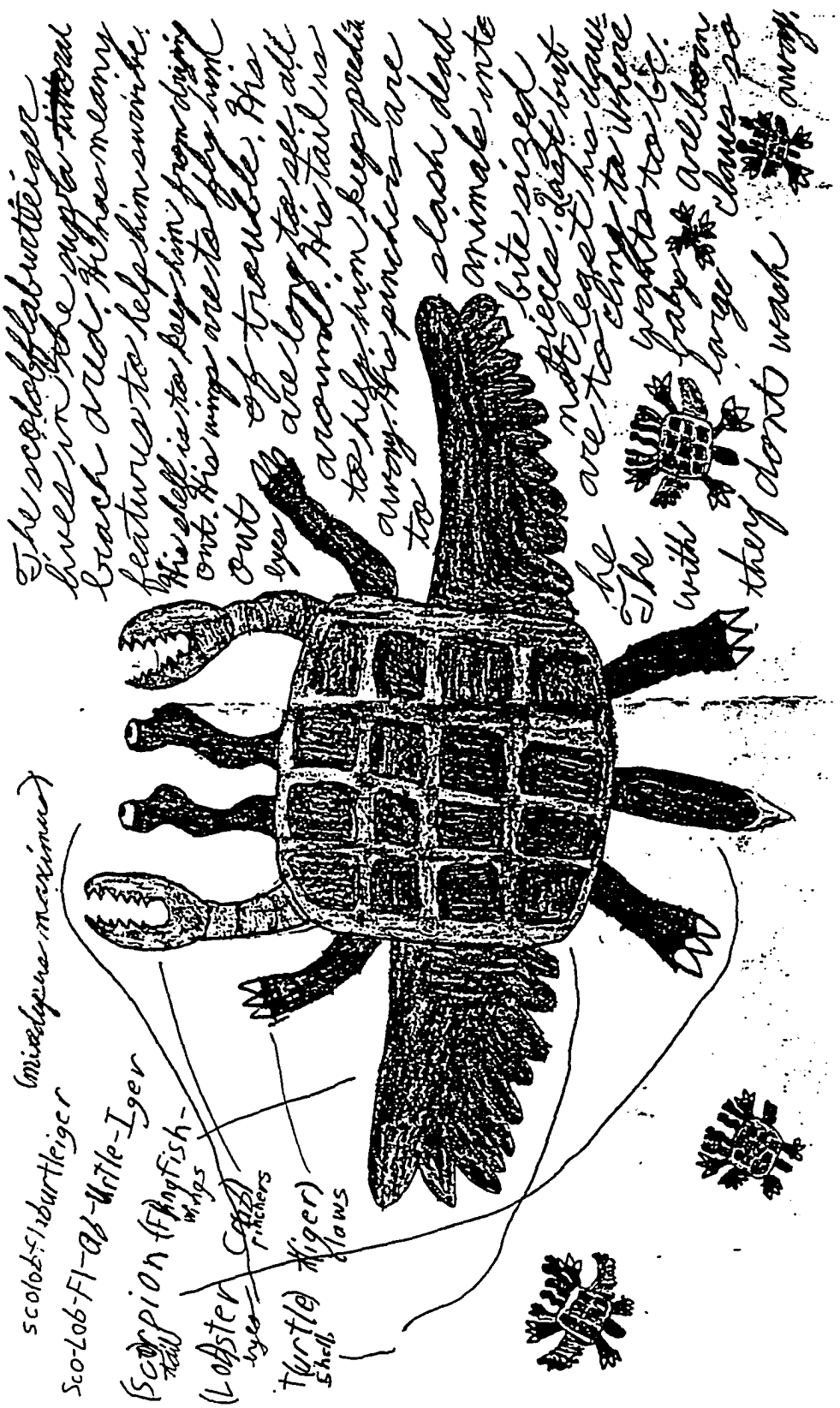

Figure 5. John's "Design a Winner"

once a year. He enjoys swimming, canoeing, and playing miniature golf while he is there. Also, he enjoys playing on the beach and collecting sand dollars. John likes to observe and investigate the animals that have washed up onto the beach.

John's knowledge about the marine environment before his **FOR SEA** experience was limited to a few books, illustrations, movies, and computer games. He told me in our initial interview that his favorite book was Island of the Dolphins. John said that the illustrations in one of his books "showed how deep the water was and the animals that lived there." He continued: "I really like sharks. I got all these books about them and watch a lot of movies about them and especially Jaws movies." He told me that he likes to play computer games about a scuba diver going after sunken treasure.

John's conceptions about the marine environment remained about the same in spite of **FOR SEA**. In his initial interview, John described the marine environment: "I would say there is sand that goes into water, sometimes salty." He wrote in his first questionnaire: "It is where sand which makes up the land meets the water which makes up seas, oceans, and other bodies of water." John wrote the following in his in his first "brain storming" map (refer to figure 6); he included "lakes" and "rivers" as part of this environment. His preconception (alternative conception) that "lakes,"

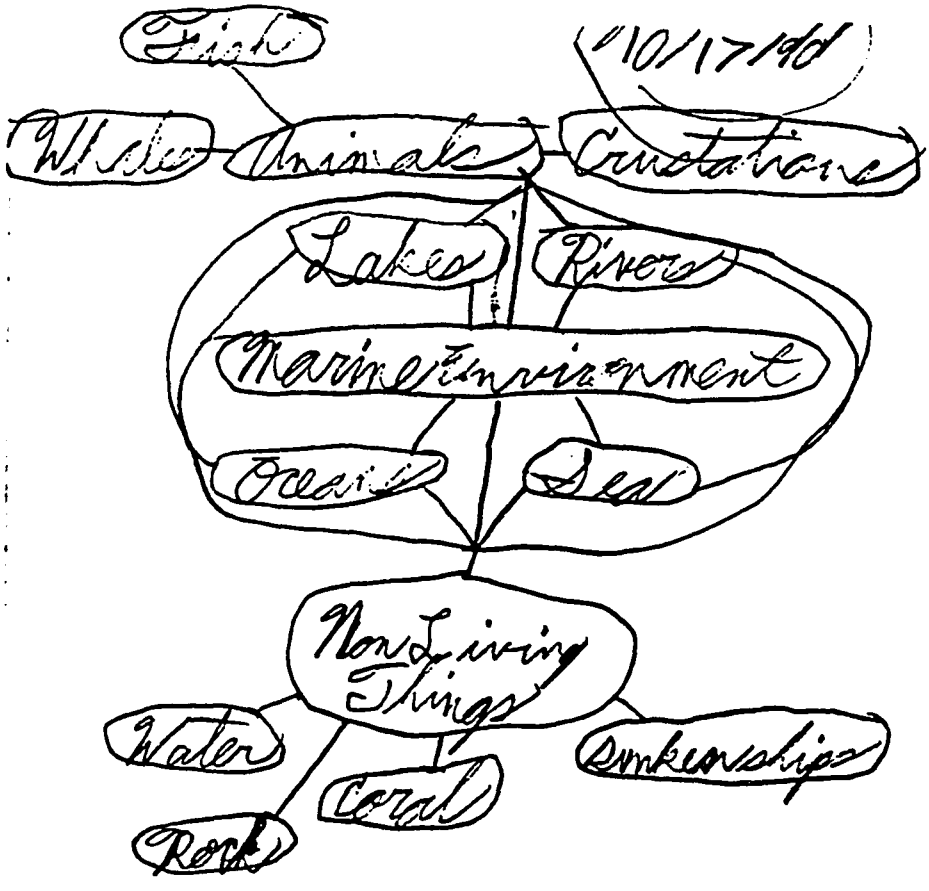

Figure 6. John's first "brain storming" map

"rivers," and "other bodies of water" are components of the marine environment did not change because of **FOR SEA**. I thought that his last "brain storming" map was less complex than his first map (refer to figure 7). Also he still had "lakes" and "rivers" as components of the marine environment.

When we had our last interview, I asked him if he still thought that "lakes" and "rivers" were part of the marine environment. John's response was, "Yes." Then I asked him where he would take me (types of areas or locations) to show me a marine environment. He replied, "We have a time share in South Carolina (Hilton Head), and I would show you things around there." John continued: "A trip to Sea World, a trip to Rock Eagle (fresh water lake), and the Okefenokee Swamp (fresh water)." I asked him if all these places were examples of marine environments. He nodded his head. John named these locations because these are places with which he has prior experiences. He told me in the first interview that he had visited Sea World and the Okefenokee Swamp with his parents on one of their vacations. Also, John and the rest of the sixth grade class went to Rock Eagle 4-H Environmental Center for three days one month prior to studying **FOR SEA**. I felt that John's prior experience and his limited knowledge about the marine environment was the reason for his preconceptions of the marine environment.

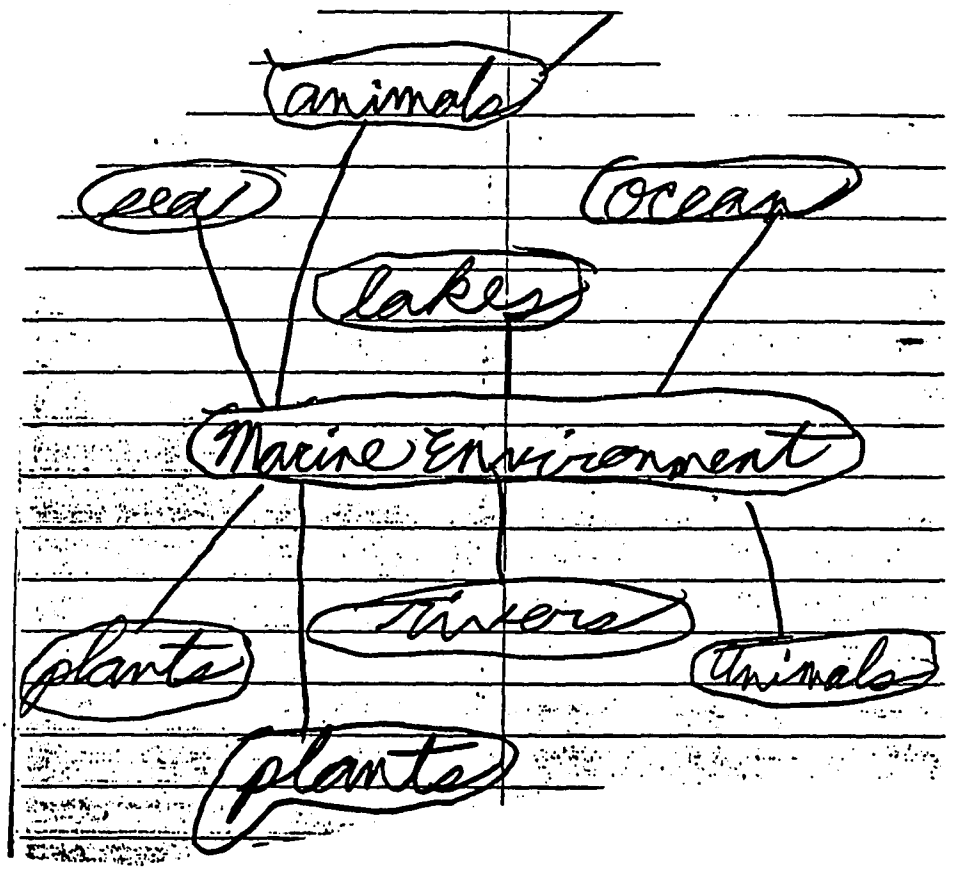

Figure 7. John's final "brain storming" map

John's conception of the human importance to the marine environment is advanced. He wrote in his first questionnaire about the importance of this environment: "It provides an alternate home to the land. It keeps the earth cool and provides water and seafood." The concepts of an alternate home in this environment and the oceans' cooling effect on the earth are quite advanced compared to the ideas of the majority of his classmates. I did not notice the inclusion of these concepts that he mentioned in that questionnaire on either of his "brain storming" maps, but later on, John wrote in his exit questionnaire, "Without the marine environment there is no water, snow, rain, and temperatures would be very high." When we had our last interview, I asked him to explain the above statement. John replied, "Those are the things that would not be there if there was not a marine environment. There would not be water so there would not be any life."

The above statement relates to John's views of man's relationship to the marine environment. He wrote the following concepts of the human relationship to the marine environment on both the first and exit questionnaires. "We eat seafood and drink water." Then he wrote "Man eats fish, man eats sea plants, man travels on water, and man drinks water." Both of these sentences show that John believes that the marine environment is important to us. He told me about his experience with

FOR SEA in the last interview: "We learned about the marine environment. I did not know a lot about it before this class." But there was no evidence that John's conception about the marine environment changed because of **FOR SEA**.

General Attitudes

John's beginning attitude about the marine environment was mixed. He told me in our initial interview: "I would say it was real fun to be around with all that water." John continued: "It is fun to swim in it, but you got to watch out for a lot of animals and conch shells and not step on them like I did." He shared with me a story about an accident that had happened to him last summer. John said, "I stepped on conch shell and cut my foot. I had to get five stitches on the first day of our week at the beach. It really got me mad!" He also told me that he has his fear of stepping on a sting ray or being stung by a jellyfish while he is in the water.

John's experience with **FOR SEA** had an impact on his attitude towards the marine environment. In the exit questionnaire, in reference to his feelings (positive or negative) resulting from his **FOR SEA** experience, John wrote the following: "I am now more positive and understand [sic] toward marine life." When I asked him to elaborate on the above statement in our exit

interview, he replied, "I understand more." He continued: "like how the food chains work, and things on the beach. I learned like (pause) about plankton. I did not know about it before." He justified his feelings being more "positive" because of better understanding the above concepts that he learned from the **FOR SEA** curricula. John shared his feelings about **FOR SEA** in his exit interview by saying, "I felt it was real important because everyone learned so much and it was fun."

Attitudes about Pollution

John had negative feelings about pollution before his **FOR SEA** experience. During his first interview, he shared with me his negative feelings about the pollution that he had seen at Hilton Head. He said, "I feel real sad because there are people who break bottles down at the beach and throw them (bottles) in the water, that really stinks! I'm afraid that I will step on glass." I asked him what the Hilton Head Authorities could do to help prevent this pollution, and he replied, "put 'No Liquor' beach signs on the beach, but I see a lot of people with beers out there."

John's attitude towards pollution in the marine environment is enhanced because of **FOR SEA**. He wrote in his exit questionnaire: "I am more negative toward pollution" because of the last four weeks experience with **FOR SEA**. He told me in his exit interview about this

statement: "Because on the film (slides - We Care About Oceans) we saw things (pollution)." John continued: "On the film it talked about the effects of pollution." Then we talked about his prior experience and negative feelings about the pollution (broken bottles on the beach in Hilton Head, South Carolina) that he had seen last summer. I asked him how his previous experience with beach litter makes him feel, as a result of what he had seen on the slide show. John replied, "It should not be happening." I asked him what he could do to help, and he replied "I am not really sure. (pause) Pick it up and throw it away. Just get people to stop doing it." John's attitude about pollution was always there but his exposure to FOR SEA helped intensify his prior negative feelings about pollution in the marine environment.

Christie

Christie is an 11-year-old white female who has attended this school since the first grade. She is slim and taller than most of the girls in the class. She has straight long blond hair. Christie wore a barrette on the back of her head to keep her hair out of her face. Her skin is clear and slightly on the fair side. She told me she like to "lay out in the sun, but I don't tan very much."

Her grade after the first grading period was an "A." She is a very conscientious student who takes detailed

notes, listens, and participates in the class. Sometimes she came to the teacher before or after class to share some experience that had happened to her or her family that related to the subject matter that day. She explained that she is quite active in school and church functions and that she loves to play tennis with her friends at school.

Christie spent more time and was more diligent about writing in her journal about her feelings and reactions to the class on a daily basis than most of her classmates. She shared with me the following about her journal, "I like to write. I like keeping a dairy. It is fun and stuff!"

I felt that Christie was very open and honest with me throughout the study. Without any reservations she enjoyed journal writing and sharing her feelings about the class and marine environment. When I interviewed her before and after the **FOR SEA** experience, she was very candid about her attitudes and experiences with the marine environment.

Conceptions of the Marine Environment

Christie has lived in Georgia all of her life. When the family has gone on vacations, they have always visited a "beach" location. She said she loved the "beach" and had been to the Bahamas and to several different beaches in Florida. She told me in her initial

interview that last year they went to Panama City, Florida, and "We decided we really like that beach, and we will probably be going there from now on." While she was at Panama City, she enjoyed swimming in the ocean, body surfing the waves, looking for sea shells, walking on the beach, shopping, and playing tennis.

Her acquisition of knowledge about the marine environment was about the same as most of her classmates. Christie told me initially that she had learned all of her knowledge about the marine environment from seeing filmstrips at school, visiting the beach, and reading information off the placards at the sea aquarium in the Bahamas.

Christie originally had a preconception (alternative concept) that "lake" was part of the marine environment before her **FOR SEA** experience. In her first "brainstorming map" (refer to figure 8), she had "lake" as a major component of the marine environment. "Lake" was parallel to ocean, and she gave "lake" as much emphasis on this map as she did for ocean. She also stressed that "recreation" is major dimension of both the "ocean" and "lake." This "recreation" concept of the marine environment relates to her first interview when she shared with me all of the "recreational" type activities that she enjoyed while at the "beach."

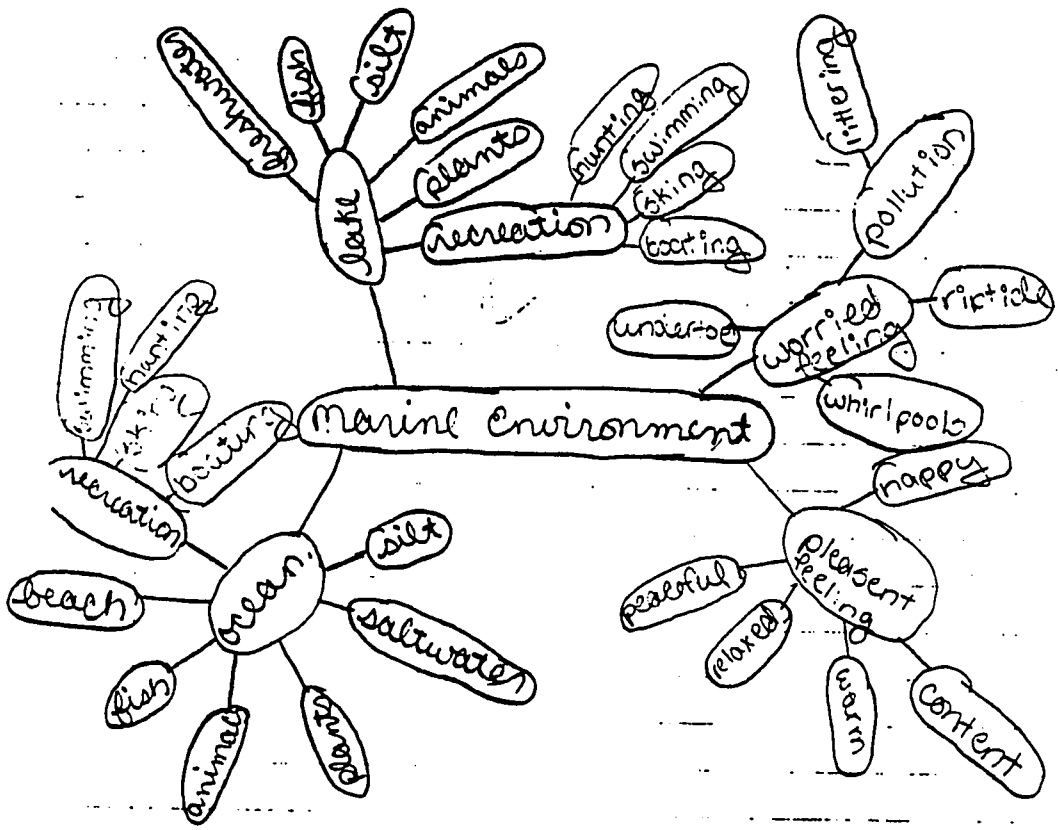

Figure 8. Christie's first "brain storming" map

Christies' second map shows a better understanding about the marine environment after her **FOR SEA** experience. In her last "brainstorming map" (refer to figure 9), she dropped these conceptions that "lake" and "recreation" are dimensions of this environment. Also, she added to her second map that the "oceans" are the biggest marine environment, and that "plants," "life," "animals," "fish," are all interconnected and "adapt to their environment." These new conceptions were covered in **FOR SEA**.

General Attitudes

Christie's attitude toward the marine environment was mixed. Her initial positive feelings reflected statements like the one from her first day of **FOR SEA**: "When I am at the beach, I love to watch the ocean" and she wrote in her first journal entry: "I love being at the beach." Both of these declarations indicate that she enjoys being at the "beach." But then she wrote on her first "brain storming" map (refer to figure 8) two major components; "pleasant feeling" and "worried feeling" in reference to her attitude towards the marine environment. The "pleasant feeling" part of her map includes concepts of "peaceful," "relaxed," "warm," "content," and "happy," whereas the "worried feeling" portion has perceptions of "undertoe [sic]," "whirlpools," "riptide," and "pollution and littering."

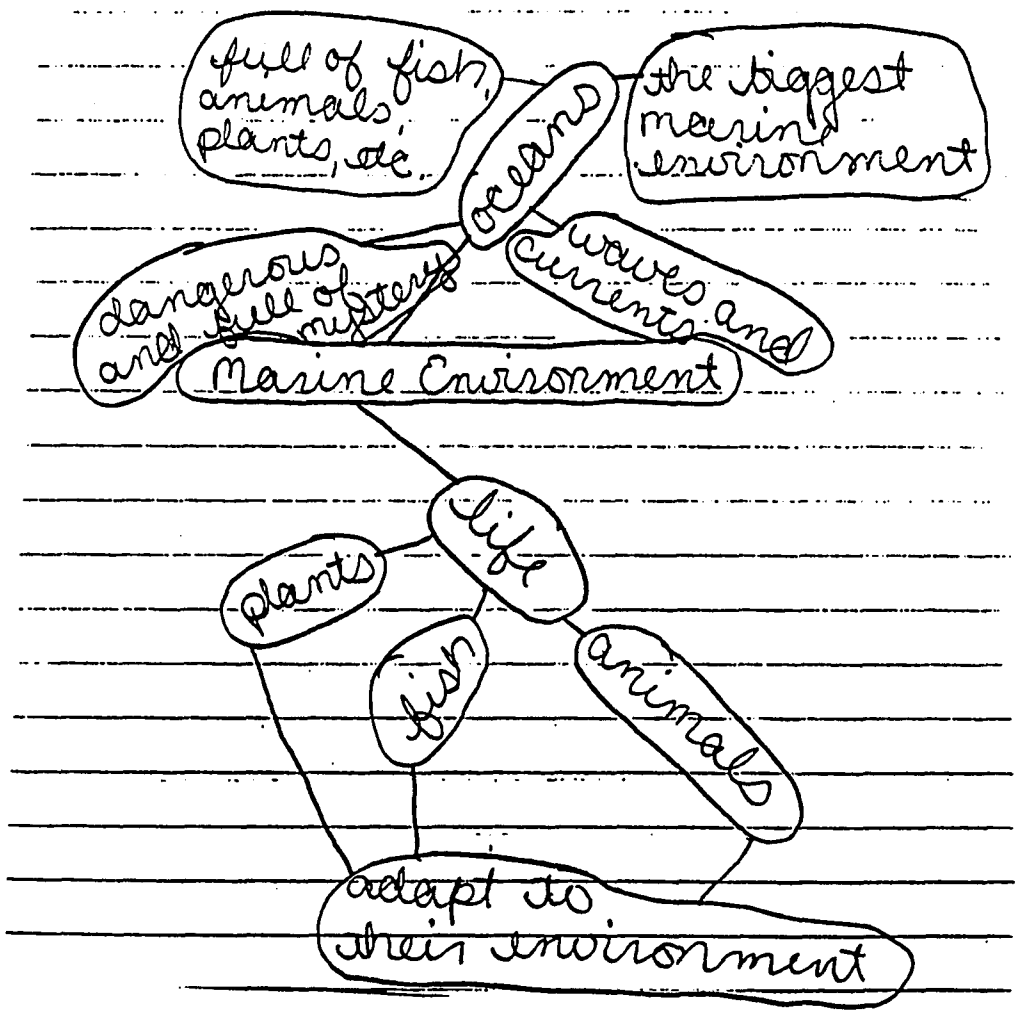

Figure 9. Christie's final "brain storming" map

Christie's positive feelings about the marine environment result from prior experiences with this environment. In our first interview, she shared with me her positive feelings: "I like being there; it's peaceful. . .I don't know I really like being there." She also shared with me an experience when her parents took her on a trip to the Bahamas. She explained her experience: "We all went snorkeling in the clear water and saw beautiful fish on a coral reef." Christie told me that her experience snorkeling in the Bahamas was fun. She wrote the following syntu in her journal about what she had seen:

Tropical Fish
Exotic
Colorful
Beautiful
Creatures of the Ocean

Christie's concerns about "whirlpools," "undertow," and other "dangerous" and "mysterious" phenomena within the ocean are phobias that she has constructed in her mind from very limited prior direct experiences with these occurrences. These phenomena of "whirlpools" and "undertow" are written on her first "brain storming" map and questionnaire. During our first interview, she told me how she would share her feelings about the marine environment to someone from another planet; she explained: "I would tell them they would have to be careful if they were going deep in the ocean." I asked, "Why would you have to be careful?" Christie responded,

"for sharks, and so they won't drown and get lost and stuff." Then she added, "whirlpools and undertow!" This fear of the unknown - sharks, whirlpools, and undertow - are clearly phobias that she has developed herself. **FOR SEA** 4 week unit does not cover any of Christie's concerns in any of the material that was presented in reference to the marine environment. Therefore, she never mentioned these concerns in her daily journal or classroom conversations. But she did refer to these concerns on her last "brain storming" map (refer to figure 9) when she wrote "dangerous and full of mystery," and "waves and currents."

Her real life fear of "undertows" is a result of Christie's recent limited experience with "huge waves" and her ordeal of the "currents" moving her while she was wading in the water at Panama City, Florida. When we had our last interview, I asked her to elaborate on what she wrote in her last "brain storming" map about "waves and currents." Christie's response was "Well, I probably wrote that because in Panama City (Florida) we went there and it was raining and the place we stayed, they always put a flag up and most of the days were red flags." I asked, "what does a red flag mean?" She replied,

> Lots of undertow, and if I went out into the ocean it was hard to get in and I was scared because one night we had a big thunderstorm and the waves got really big. Then the next day, I mean the waves were really big and it was a red flag. The waves were huge and I was scared to go out that far that day because of all the undertow.

Then I asked, "Have you ever been stuck in undertow before?" Christie responded, "Not really. Sort of. Sometimes I'll be standing there and the wave will come and move me sort of. They moved me a little bit when I was waist deep." Lastly I asked, "Have you had any more experiences with undertows or rip tides before?" She told me, "Not really because at the Bahamas there were hardly any waves, so there was not undertow." She also has the concept that "waves" produce these "undertows" because she did not witness these "currents" while she was in the calm waters of the Bahamas.

Her phobia about sharks in the marine environment is result of her trip to an aquarium and the movie JAWS. She shared with me about her visit to a sea aquarium while they were in the Bahamas.

> Well, it was like you could go up to the top and sort of look at the ocean. Then you could also go down under the water and see all the fish in the ocean. There were lots of sting rays . . . and there were sharks! You could walk around the place and see them (sharks) swim around.

I asked her how seeing the sharks made her feel. She replied, "Well, I was glad I was on the other side of the wall." I asked her to explain, and she said, "getting bitten by a shark would not be too popular." Then I asked her if she had ever been bitten by a shark. Christie responded, "No, but I have seen Jaws (movie)." I replied, "When you saw Jaws, how did that make you feel?" She replied, "scared!" She shared with me that

she had seen all of the Jaws movies a "million" times and had been "scared" every time.

Christie did not study about sharks in the **FOR SEA** unit but her fear of sharks remained with her when she wrote the following feelings in her journal about her trip to the sea aquarium:

> My family and I went to the sea aquarium. It was so much fun learning about those animals. There were all kinds of fish, sharks, sea turtles, sting rays, and other animals (fish) I no longer know the name for. Anyway here is a syntu about the sharks there:
>
> Sharks
> fierce
> sharp teeth
> beady eyes
> dogfish

When we had our last interview, I asked her to explain her feelings about the "shark" syntu that she had written in her journal. Christie's response was, "Well, even though I know that they (sharks) would not come real close to shore . . . every time I go out in the ocean at first I am a little scared at first because of sharks." I asked her to elaborate on being a "little scared at first." She continued: "Yeah, that is in my mind. That is in my imagination." I asked her if she had ever seen sharks in the ocean. "No," she replied. Her fear and conception of sharks was formed because of her direct experience with sharks at the sea aquarium in the Bahamas and her indirect experience with them by watching the Jaws movies. She has fabricated this phobia of sharks that is now lodged in her "mind" and "imagination."

Attitudes about Pollution

Christie's initial response during our first interview about the importance of the marine environment was, "Well, it is important to keep it clean." Then she wrote in her first questionnaire: "God put the marine environment there for a reason, and we should do our best to keep it clean and let it go about its own business without us interfering." This first response is a result of her strong relationship and involvement in the church. Mr. Woods told me that Christie and her family are quite active in their church.

Christie's feelings and awareness toward pollution are a result of her direct experience and exposure to this subject at the beach, on television programs, and in the FOR SEA curriculum ("We Care About Oceans"). On her first "brain storming" map (refer to figure 8) she also wrote, she had a "worried feeling" about "pollution," and"littering." Christie told me informally one day during class that she had seen "litter" on the beach while she was at Panama City, Florida, last summer. She wrote in her exit questionnaire:

> The importance is man and the marine environment help each other out. The marine environment gives us fish, we give, well nothing. When we pollute it, we're also polluting ourselves. Because when fish are in polluted water, they get polluted, and we eat those fish and pollute ourselves.

Christie has a good concept of how pollution travels through the food chain and affects us in the end. Food

chains were covered as part of the FOR SEA curriculum. In reference to our relationship Christie wrote the following: "The relationship is man eat things that are in the marine environment. Also, man pollutes the environment, which is wrong." During her exit interview, I asked her "How did you find out about that?" She responded, "In the news, on 11 ALIVE they have that earthwatch program and on the slides (We Care About Oceans) they talked about it." Then I asked her what she could do to help out with this pollution. She replied,

> Well, I guess. I wish there were more I could do to stop it. I wish I could get out there and tell everyone to stop doing that. The factories and hospitals would stop dumping all their waste into the ocean. Well, my family recycles that is one thing. I do not know much else because where I live there is not much that I could do to get involved in.

Christie is concerned about pollution in the marine environment as a result of her prior experiences and her new knowledge that she has learned from FOR SEA. But she feels that not living near the marine environment is causing her to be limited with her involvement to help stop the problem of pollution in this environment.

Tom

Tom is an 11-year-old white male who has attended this school since kindergarten. He is of average height and slightly over weight. Tom has short, sandy brown hair. At the end of the first grading period, his

science grade was an "A". He apparently did not exert much effort to get this grade because he told me that science was his best subject and that it came easily to him. He got along well with the three other boys with whom he shared a table during science class. Tom was always the spokesperson at the table, especially when the teacher was summarizing the lesson at the end of a lab activity. He loved to contribute the results that he and his lab partners had observed during the activity.

I felt that Tom was truly interested in the marine environment and loved to talk with me about his own experiences. He was always open and honest about sharing his past feelings and experiences during interviews.

Conception of the Marine Environment

Tom has lived in Georgia all of his life. Both his parents are employed with the airlines and take him on a variety of trips around the United States. He told me that when they go on vacations or weekend trips, they usually go to a "beach environment" or to some of the different Sea Worlds around the country.

Tom has had more direct prior experiences with the marine environment than any other student in his class. The beaches that he and his family have visited are in Florida, California, and Massachusetts. Tom enjoyed snorkeling on the coral reefs when he and his family were in the Florida Keys. When his family took him to Destin,

Florida, he enjoyed swimming, body boarding, collecting shells and "hanging out" on the beach. Also on one occasion he and his parents took a vacation to Massachusetts to do some whale watching and deep sea fishing for a week. He said, "It was great fun because I was amazed how large a humpback whale was when it got up close to the whale watching boat."

His experiences related to the marine environment were formed from his many vacations to the coast and from his frequent visits to the different Sea Worlds and museums (Planet Oceans). His love of the ocean is so great that he told me he wanted to study Marine Biology when he attends college. He shared that he had visited all of the Sea Worlds around the country except for the one in Ohio. Tom told me that he had loved the Sea World killer whale show and other attractions. During his exit interview, he said he also learned much about the marine environment because of a visit to Planet Oceans in Miami, Florida. He enjoyed viewing and interacting with many of the displays: an iceberg, plankton, water cycle, and ocean pollution. On several occasions he mentioned to me some of the books about the marine environment that he had read or was in the process of reading.

His broad understanding of the marine environment is directly related to his prior experience and to the curiosity that he has for this environment. According to both of his "brain storming" maps (refer to figure 10 &

11) and other information he shared with me, Tom's conceptions of the marine environment are quite diverse. He has concepts like "tides," "mammals - whales, dolphins, & porpoise," "Life - barnacles, urchins, seastars, reefs, & periwinkles" that other classmates did not mention on their "brain storming" maps. Those concepts are taken from his own experience with the marine environment and not from **FOR SEA**.

Tom's experiences with other environments have confused him with some of his conceptual understanding about the marine environment. In his exit questionnaire Tom wrote about a recent experience with a "marine environment." He wrote: "I also went to Niagara Falls Aquarium and saw many different parts of the marine environment (living or otherwise)." This statement was in reference to his experiences with the marine environment during the **FOR SEA**. When I asked him to elaborate on the above statement he replied, "That was a lot of fun. That's a big marine environment with a lot of water there and a lot of things do not live underneath the falls there." Then I asked Tom, "Do you think the falls (Niagara) are part of the marine environment?" He responded, "Well, yeah. It is an environment. It is part of the marine environment. It is not open ocean, but it finally ends up in the ocean." That reply is partially correct, but I still think that Tom is not sure what "marine" means to him. I then asked him, "In your

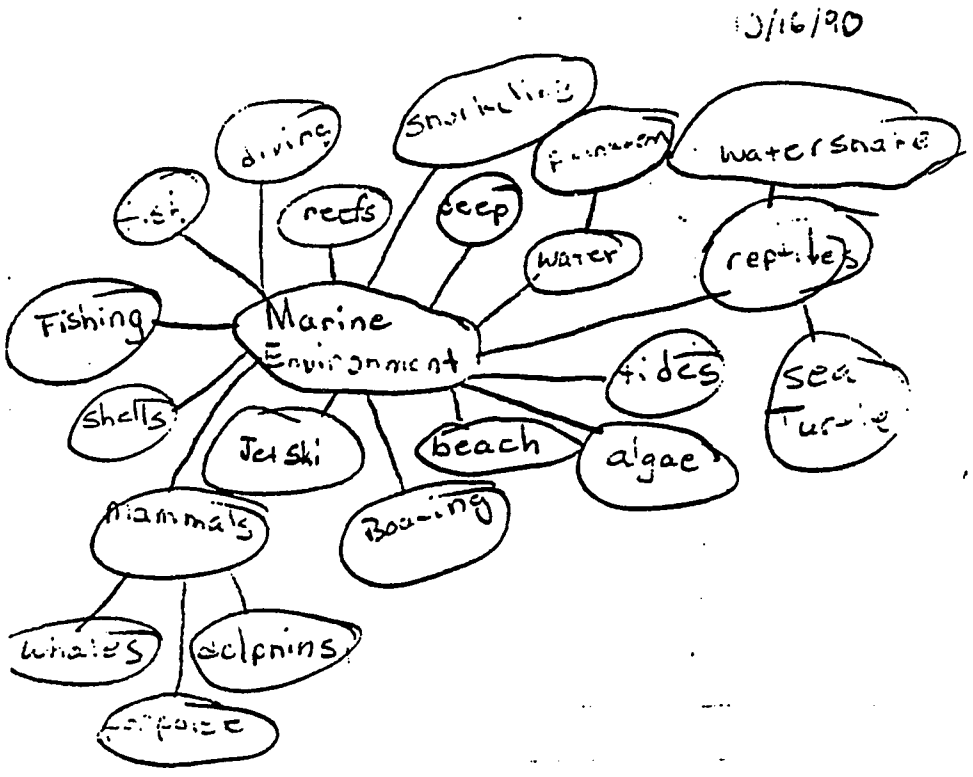

Figure 10. Tom's first "brain storming" map

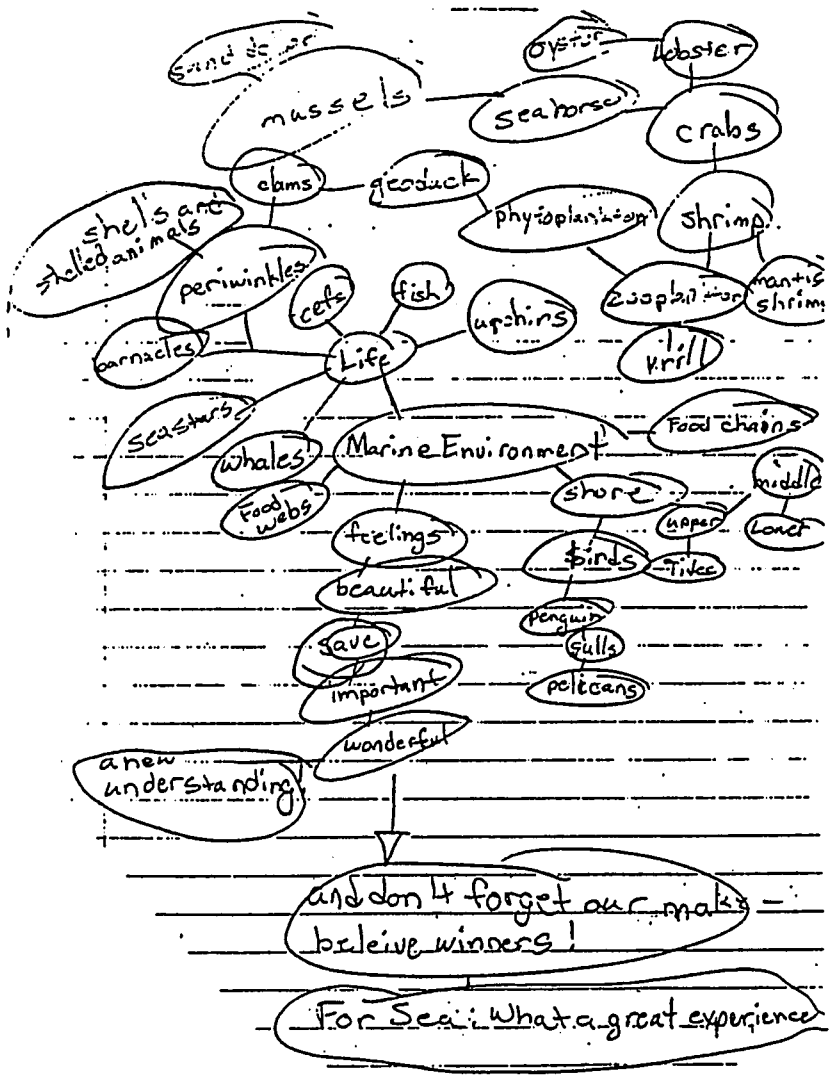

Figure 11. Tom's final "brain storming" map

mind, what do you think the marine environment is?" Tom replied: "It is an environment in a natural body of water or a water environment." Then I asked him the following: "Would Rock Eagle Lake be part of the marine environment?" "Yes," said Tom. Tom's response about the lake's being part of the marine environment is maybe a result of his recent visit with the other members of the sixth grade class earlier in the school year to study ecology. I am not sure why he has this misconception about a lake being part of the marine environment. On both of his "brain storming" maps, despite his misconception, he omitted a "lake" or any other body of water, as being a component of the marine environment.

General Attitudes

Tom's beginning attitude toward the marine environment was positive. During his first interview, he told me, "It is a lot of fun down there. I can not put it in words. It is nice. It is pretty down there. I like the way it feels. I like the smell of the ocean." During this interview, Tom did not share with me any negative feelings. Also, there was no evidence of adverse feelings on either of his first "brain storming" map or on the questionnaire.

Attitudes about Saving the Oceans

The slide show, We Care About Oceans, really made an impression on Tom; he uses the words "save" and "preserve" repeatedly throughout the remainder of his FOR SEA experience. Tom's negative and concerned feelings emerged in his first journal entry when he wrote the following:

> It (slide show) talked about things that live in the ocean, how we pollute it, and how to preserve it. The title; We Care About Oceans, is fitting for sure. We can always do more to save the oceans. Keeping the oceans clean is important. It helps us live our daily lives. There are some interesting things in our oceans, and we need to preserve them.

FOR SEA had a big impact on Tom's feelings towards the marine environment. His last "brain storming" map (refer to figure 11) reflects his feelings toward the marine environment as "beautiful," "important," "wonderful," "a new understanding," and "save." In 4 of the 6 questions in his last questionnaire, Tom wrote his belief that the marine environment needs to be "saved." In reference to his feelings resulting from his four weeks experience with FOR SEA, he wrote the following: "I feel much better about [sic] in the sense that I've learned a little bit more than I already knew. This is good (FOR SEA) because you always need to learn a little bit more about the ocean. It is a great place that should be saved." When one of the questions asked him to share his feelings about the marine environment with someone from another planet, Tom wrote: "I would tell

them it is a wonderful and beautiful place. Then I would tell them of the greatness of it and how much fun it can be and how it needs to be saved."

Tom wrote about the importance of this environment: "The marine environment gives us water. There are fish that we can eat, and it gives us rain also to water our crops. It should be saved." The above statements show that although Tom feels positive toward the marine environment, he always ends his thoughts with the belief that this environment needs to be "saved."

In reference to the relationship of man (people) to the marine environment, he wrote the following:

> Man takes a lot from the ocean. He hurts the ocean and helps it with his efforts to save it. He takes bad things from it and puts bad things in. He puts in good things and takes good things out.

This statement really summarizes how Tom feels about the marine environment. In the last interview I asked him to elaborate on the above declaration. I asked him, "What does he take from the ocean?" Tom replied, "He takes fish; when he fishes for shrimp, a lot of times they take sea turtles. They get caught in the nets. . ." "How does that make you feel?" I asked. He responded, "not very good because the population of turtles is sad and it is [sic] not very many of them left. . . and some people do not care." Then I asked him explain the following: "He hurts the ocean and helps it with efforts to save it."

Tom replied,

> Well, there are a lot of sea turtles, and when they close in their eggs with wire to keep out their enemies, that helps them. I would like to think that the money goes directly to save the animals because I saw a donation box at Niagara Falls (aquarium) to help the dolphins, so I gave a little bit to that.

Then he shared with me that he subscribed to World and National Geographic magazines and that some of his subscription money goes to research and conservation. Next, I asked him to elaborate about "He takes bad things from it and puts bad things in." He responded, "Like trying to (pause) more bad things in than bad things out [sic]. He cleans up its mess; because of oil spills they have found some kind of bacteria to take some of it away." I asked him how he knew about that, and he replied, "I read about the Valdez oil spill." Then I asked Tom how it made him feel. He continued:

> I saw that one on the news, and they were trying to save the birds and they did save a lot of the birds, animals, and otters; that was good. I do not like the oil drilling because if it ever spills, there will be a lot of oil there. I think they should leave it there because we are not that desperate and sure we are using it up but unless we get that desperate and of course this Middle East crisis does not help a whole lot.

Lastly, I asked him to explain: "He puts in good things and takes good things out." Tom told me, "When people fish they take the ones they can eat." Then I asked, "How about good things in?" He responded, "When people replenish the supply of fish (pause), they sometimes put fish eggs in there and keep the fish population up because the fish population maybe running low."

Then I asked him how his feelings toward the marine environment had changed because of FOR SEA. Tom replied,

> No it did not change because I thought that way really. I have always felt that way as long as I can remember. I watch a lot of Channel 8 (PBS) on specials on the ocean and National Geographic. We watch those a lot if there is nothing else to watch and sometimes we will watch those above anything else. My parents like to, and I don't need to be encouraged because we all sit down to watch the specials, especially the ones about the ocean. We saw one that talked about pollution and I kind of got interested and like we said in class, I will pick litter along the beach.

Then I asked, "Are there any other things that have made you more concerned about it other than picking up trash and watching TV shows?" Tom replied,

> The first time I went to the beach (pause). I was four. I saw the ocean, and I could not believe how big it was. . . I wondered where the ocean really stopped. I saw fish, and then my mom thought that I really liked it. Then we started going to aquariums to watch them a little closer.

I asked Tom in his exit interview, "Why should we save the ocean?" He replied,

> It is important, really important because it gives us so much-like fish. It wouldn't be very good if there were no more ocean, no more sea because there are so many things there. It is unthinkable to have all that there and then all of a sudden to be gone. We get rain from it to water your crops and that would mean less water for the crops.

Tom's feelings toward the marine environment are related to his direct and indirect encounters with this environment. His early exposure to the marine environment initiated Tom's wonder concerning this environment. Also, Tom's parents have a major influence on him by providing him opportunities to travel to the

beaches, aquariums, Sea Worlds, and museums. Also, he has this motivation and curiosity about the ocean that makes him want to learn more about it.

In the last entry in his journal, he wrote the following syntu:

The Ocean
huge
beautiful
unprecedented
important

Also Tom wrote, "I have learned much more about the oceans and feel they should be saved and cherished. The End. Remember to keep helping our oceans and seas!" Hopefully, Tom's prior experiences and new knowledge as a result of **FOR SEA** will keep his strong commitment to learn and protect the marine environment now and in the future.

Chapter 5

RESULTS OF THE CLASS

The purpose of my study was to investigate the students' academic achievement and attitude towards the marine environment before, during, and after the **FOR SEA** experience. In this chapter I have included descriptive and inferential statistics along with qualitative assertions and supporting data. Descriptive statistics are presented first, followed by inferential, and finally by qualitative class results.

Descriptive Statistics

Descriptive statistics provide for the quantitative measure used in the study. Table 1 provides means and standard deviations for the pretest and posttest achievement measures.

Table 2 provides information on pretest-posttest gains and establishes a comparison between the actual gain from pretest mean to posttest mean compared to possible gain and the result reported as a percent of possible gain. Possible gain was calculated by subtracting the pretest mean from the maximum number of items.

Table 1

General Descriptive Statistics for Achievement

Measure	N	Number Items	Mean	Std Dev	Std Error
FOR SEA Concepts					
Pretest	19	35	23.89	2.43	0.56
Posttest	19	35	27.68	2.49	0.57

Table 2

Gains from the Pretest-Posttest

Measure	Items	Pretest Mean	Posttest Mean	Actual Gain	Possible Gain	% Possible Gain
FOR SEA Concepts	35	23.89	27.68	3.79	11.11	34.11

Hypothesis Testing

In this section I have compared information regarding the testing of hypothesis 1 presented in Chapter 1. The hypothesis was tested using the "t-test for paired observations" procedure as described in the Basic Statistics for the Behavioral Sciences (Hopkins, et al., 1987, p. 169). This procedure produces a t statistic and probability value for the hypothesis ul - u2 = 0, where ul symbolizes the pre-treatment data and u2 symbolizes the post-treatment data. I have presented the result pertaining to the test in narrative and tabular form following the statement of the null hypothesis. The statistical criteria for significance ($p < .05$) was evidence for the rejection of the null hypothesis.

Student Achievement

Hypothesis 1 concerns the influence that FOR SEA exercises have on students' achievement regarding the marine environment. Hypothesis 1 is stated below in the null form along with the statement of the results:

> Null Hypothesis 1: There is no difference in the mean scores of students achievement after having experienced FOR SEA exercises.

The mean scores on the posttest were higher for students after having been exposed to the FOR SEA exercises (see Table 1). To determine significance, I

used the t-test procedure to perform a paired observations mean difference comparison for the before and after exposure to the FOR SEA experience. The mean differences between the pretest and posttest showed a probability equal to .001 for the FOR SEA concepts (see table 3).

Since significant effects were evident from the results of the achievement instrument used to measure FOR SEA concepts, I rejected the null hypothesis.

Qualitative Class Results

This section presents the results pertaining to the qualitative questions stated in Chapter 1 and other questions that arose during this study. The results are from verbatim transcripts of student interviews, the open-ended questionnaires, "brain storming" (concept) maps, observation field notes and personal documents such as student journals and drawings.

Class Environment

This case study was conducted with nineteen students and their teacher in a sixth grade honors science class in a private school located in Atlanta, Georgia. The nineteen students (11 boys and 8 girls) in this study represent a range of ethnic groups (12 white, 1 black, and 6 Asian [4 Indians and 2 Orientals]). The students' ages are from 11 to 12-years-old. All students are

Table 3

Paired T-Test for Dependent Variables

Achievement

Measure	N	Items	Mean Diff.	Std Dev of Diff.	Std Error	T	Prob>:T:
FOR SEA Concepts	19	35	3.8	.401	.633	6.00	.001

required to wear a school uniform. The uniform for the boys consists of a light colored oxford dress shirt with a standard tie with a monogram of the School emblem, a blue blazer, gray dress slacks, and black shoes. The girls' uniform is a light colored blouse, gray skirt, blue belt, blue blazer, and black shoes.

Mr. Woods is an 46-year-old white male who began teaching at this school in 1969. He has grayish black, straight hair and wears gold rimmed glasses. Mr. Woods is average height and slightly over weight. I observed that he wore "business-like" attire everyday to class. Daily to class, he wears a white, pressed, long-sleeve dress shirt with a cross pen & pencil set in his shirt pocket, conservative tie, and a dark colored suit or gray slacks and a blue blazer, and a pair of comfortable "dress" shoes.

Mr. Wood's classroom is a result of a conversion of four boys' dormitory rooms that were formerly used when this school was a military academy. The present room is 30 feet wide and 60 feet long. The walls are painted a light blue color. There is no carpet on the checker-board black and white linoleum tile floor. The only windows in the classroom are located near the top of the ceiling on the left side of the room.

Mr. Wood's classroom is condusive to learning science because his room is full of living plants and animals, walls covered with science related posters, and

shelves stocked with preserved specimens of different types of organisms. Also, on a daily basis, the students are responsible for feeding the animals and maintaining the aquariums and cages in the class. Mr. Woods encourages the students to explore, observe and handle most of the living and nonliving items that are in his class.

On the front wall, a white-board covers most of the wall. Mr. Woods uses this board exclusively to write, using different colored markers, and sometimes he projects images from an over-head projector and a slide projector on it. Underneath the white-board is a large dog skeleton erected on a stand housed in a glass case.

The right side of the room has bulletin boards displaying environmental posters made by students during the previous Spring quarter. Located mid-way down this wall toward the back of the room is a set of metal selves with preserved animals on the top and middle shelves and a living reddish, brown ferret in a cage on the bottom shelf. This tame ferret is a great attraction in the class. The students love to pick him up and hold him each day before the class starts. On a stand to the right of the metal shelf is a 30 gallon salt water aquaria that has fish, starfish, and hermit crabs. Next to the aquaria is a door that leads to the stockroom that Mr. Woods uses for storage of science supplies.

The back wall consists of a green chalk board on which Mr. Woods now uses to hang forest animals and tree posters. Below the chalk board is a conference table that has boxes that Mr. Woods uses to file student papers.

In the back of the class on the left hand side wall, Mr. Woods has his second desk. He uses this desk for his black, leather brief case and computer and printer. Just above his desk are shelves with field guide books of different plants and animals, curriculum guides of other science programs, videos and filmstrips, folders of old tests, and miscellaneous papers. Located to the right of his desk is a 40 gallon fresh water aquaria filled with small fish and plants that he has collected from various fresh water environments. I observed numerous times during and after class that students would pick up some earth worms from a small plastic container next to the aquaria and feed the small bass in the fresh water tank.

Next to the aquaria is a 7 foot cylindrical cage covered by chicken wire that houses two living red boas. The older, large red boa is 12 feet long, and the younger one is 5 feet long. Both snakes fascinate most of the students in class; the students love to feed them and watch them eat. The snakes' diet consists of dead squirrels and birds that students have contributed by collecting these dead animals near their homes.

On the other side of the front door, the remainder of this wall consists of wooden shelves that are located just below the windows and extend down to 4 feet off the floor. The shelves are stocked with preserved specimens of animals and plants that either Mr. Woods has collected over the years or organisms that have been ordered from catalogs from biological supply companies.

The rest of the room consists of the teacher's primary desk and student tables. Mr. Wood's primary desk, located mid-room is a conference table on which he places the materials that he and the students use that day. Located in the middle of his table is a rabbit skin. He had shot and skinned this rabbit himself. On top of skin is his grade book, pen, pencils, and coffee mug. He uses the rest of the table for materials that the students need for their **FOR SEA** activities and for student papers that he is returning. Most of the time when he was not lecturing at the white-board or visiting the students' tables he would sit behind his table in his large, brown, leather-type, high back "executive" chair. From his chair he would have the students come up to him for assistance or answer their questions from this position.

The students sit at tables that are located half way towards the front of the class. Their black top lab tables are set up in the configuration of a "T," with two tables together to form one large "table." The small end

of the "T" is against the wall. The students had the opportunity to sit wherever they wished, and they chose to segregate themselves. The 8 girls sat at 2 "tables" with 4 girls at each "table" on the right side of the class, whereas the 11 boys sat at 2 "tables" with 6 boys at one "table" and 5 boys at the other. Located at the small end of the "T" near the wall is a 25 gallon salt water aquaria containing 2 blue crabs. I observed and the students told me that they liked having the aquariums and blue crabs located on their tables.

Conceptions of the Marine Environment

The students' conceptions of the marine environment were measured by having them construct their own "brain storming" (concept) map before and after the **FOR SEA** experience. The students are familiar with this type of map because other teachers in this school sometimes used this exercise in their classes. The students also used the words "idea map" and "outlining" but the majority of the class coined the word "brain storming" to represent their concept maps.

On the first day of **FOR SEA** Mr. Woods illustrated the concept of a "brain storming" map on the board and gave them an example of how to construct this "brain storming" map. He emphasized the "tangible" (concrete) and "intangible" (feeling/attitude) components of the map. For homework that night, the students were given

blank sheets of papers on which to construct their own "brain storming" map of what they thought the marine environment meant to them. This assignment was repeated the night before the last day of **FOR SEA** for the students to construct their final "brain storming" map.

This instrument allowed the students the opportunity, without restrictions, to be open ended in writing down as many concepts and attitudes about the marine environment as they wanted to. This format was useful to me because it allowed me the opportunity to observe how the students separate, organize, and connect the concepts (refer to Appendix F for examples).

I organized the "brain storming" maps in such a manner that "marine environment" represented the core category (on all maps); "ocean" and "lake" would be examples of a category; and "Atlantic" or "Lanier" would be specific examples of a sub category. This format enabled the students to conceptualize the marine environment from the general meaning in a category, down to the very specific examples in the sub category range.

After looking over the first set of "brain storming" maps, I classified the categories and sub categories into 7 different groupings according to similar characteristics pertaining to themselves: "description," "living," "non-living," "attitude," "experience," and "resource."

On their first "brain storming" maps the majority of the students have in the "description" grouping a preconception or an alternative conception concerning what they think the marine environment is. They use words like "water," "river," "swamp," "stream," "pond," and "lake" to describe examples of the marine environment. These words are considered to be part of a fresh water environment instead of a salt water (marine) environment by experts and by me. But initially 10 students used the word "ocean" and 5 students use "sea" as a concept directly connected with the marine environment. The students' final "brain storming" maps have new concepts under the "description" grouping such as "marshes" and "barrier islands" that are covered in **FOR SEA**. They still use "ocean" and "sea" as concepts. But the students have less emphasis on "river," "swamp," and "lake" and have dropped the words "stream," "water," and "pond." Again these preconceptions are related to their prior experiences and their class trip to Rock Eagle (fresh water environment) prior to studying **FOR SEA**. Some students still maintain these preconceptions ("river," "lake," and "swamp") even though **FOR SEA** did not include these other environments as part of the marine environment.

The use of the "brain storming" maps proved very useful to determine the conceptual change that occurred over a period of 4 weeks as a direct result of **FOR SEA**.

Most of the students related to the marine environment in terms of what they do recreationally during their annual vacations to the "beach." Originally the students put considerable emphasis in the "experience" grouping as a major concept on their first "brain storming" map. Their maps reflect the "recreational" aspect as being an important component and as functioning as their connection to this environment. They use words like "fishing," "boating," "swimming," "skiing," as examples of their prior recreational activities in this environment. This theme of "recreation" appears to be not as important in their last "brain storming" maps as it was in the first maps.

The concept "pollution" under the "attitude" grouping is found on 7 of the students last "brain storming" maps. Initially "pollution" is found on only 2 of the students' maps. This concept became more numerous because of the students' **FOR SEA** experience and their exposure to "We Care About Oceans" slide show followed by class discussions on man's role in the marine environment. Some of the students had concerned feelings about pollution in the marine environment initially but did not include them on their maps. I was told informally and formally during interviews with the students that **FOR SEA** helped them enhance and develop a more elaborate understanding of the magnitude that pollution plays in the marine environment.

The students have a more diverse and elaborate set of concepts as a result of **FOR SEA**. They have added to their final "brain storming" maps concepts such as " "salinity," "blue crabs," "beach," "kelp forest," "barrier islands," "sub-littoral," "littoral," "supra-littoral," "geoducks," and "whales" as part of the marine environment. These concepts are components of the **FOR SEA** curriculum.

The students' "brain storming" maps range from a simple-type model to very complex-type model. I categorized the "brain storming" maps into three different type models based on their complexity.

The first model, a simple model, is the "bicycle wheel," which 7 students drew in the first map and 7 students in the last map. This simple map has no connections between concepts, and every category has equal value within the marine environment (refer to figure 1). This model was drawn by students who initially had concepts that were at of equal meaning to them and also at a concrete level of understanding of the marine environment. They included concepts like "sand," "fish," "shells," and "beach" as examples of some of the concepts that they knew. In their last "brain storming" maps this group of students included some of the same concepts that were in their first map and same level of meaning plus new concepts (e.g., "crabs" & "hydrometer") that were in the **FOR SEA** curriculum.

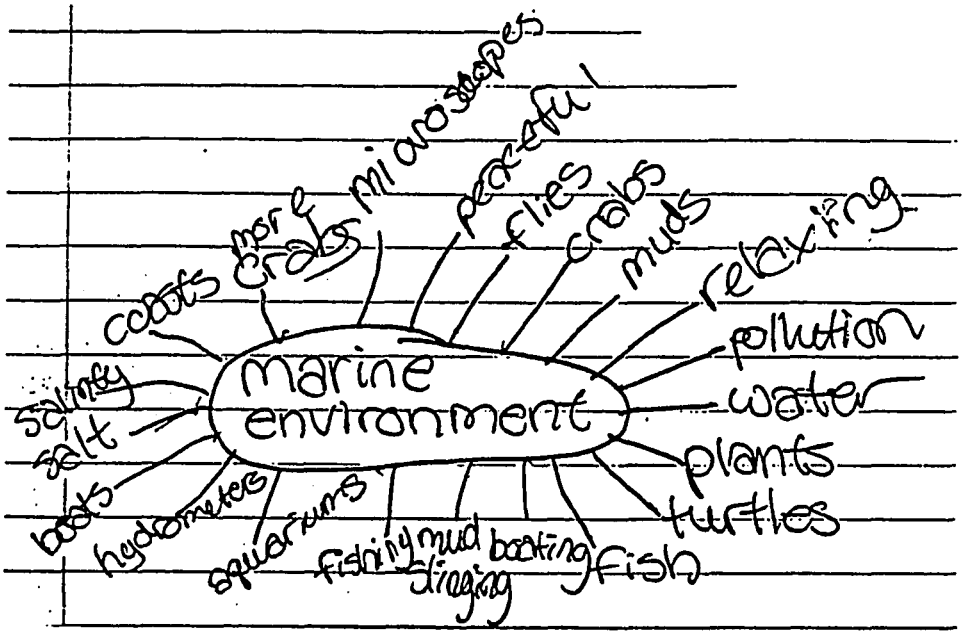

Figure 1. Simple Model - "Bicycle Wheel"

The next model is the "combo," which 4 students drew in the first map and none in the last; it represents a more balanced map (refer to figure 2). This model was set up by the students to represent a balanced representation of how these 4 students conceptualized the marine environment as the center and core category. Outside the perimeter of the marine environment the students have sub categories (e.g., "sea," "ocean,") that are connected. I observed that these parallel examples are sometimes incorrect ("lake," "pond," or "river" to "ocean") in their connection with the marine environment. But on other maps the students have a correct example to parallel another category ("sea" to "ocean"). Then from the sub categories the students have connected more concepts branching from this to give specific examples of this sub category concept.

The last model is the "solar system," which 8 students drew in the first and 12 students in the last map, that represents a more diverse map (refer to figure 3). This model is drawn by students who conceptualize a complex network that makes good linkages between the categories and presents specific examples of sub categories. However, the maps still may contain preconceptions (alternative conceptions) in both maps.

By comparing the students first "brain storming" map to their final map, I wanted to evaluate whether the students' conceptual model remained the same or changed

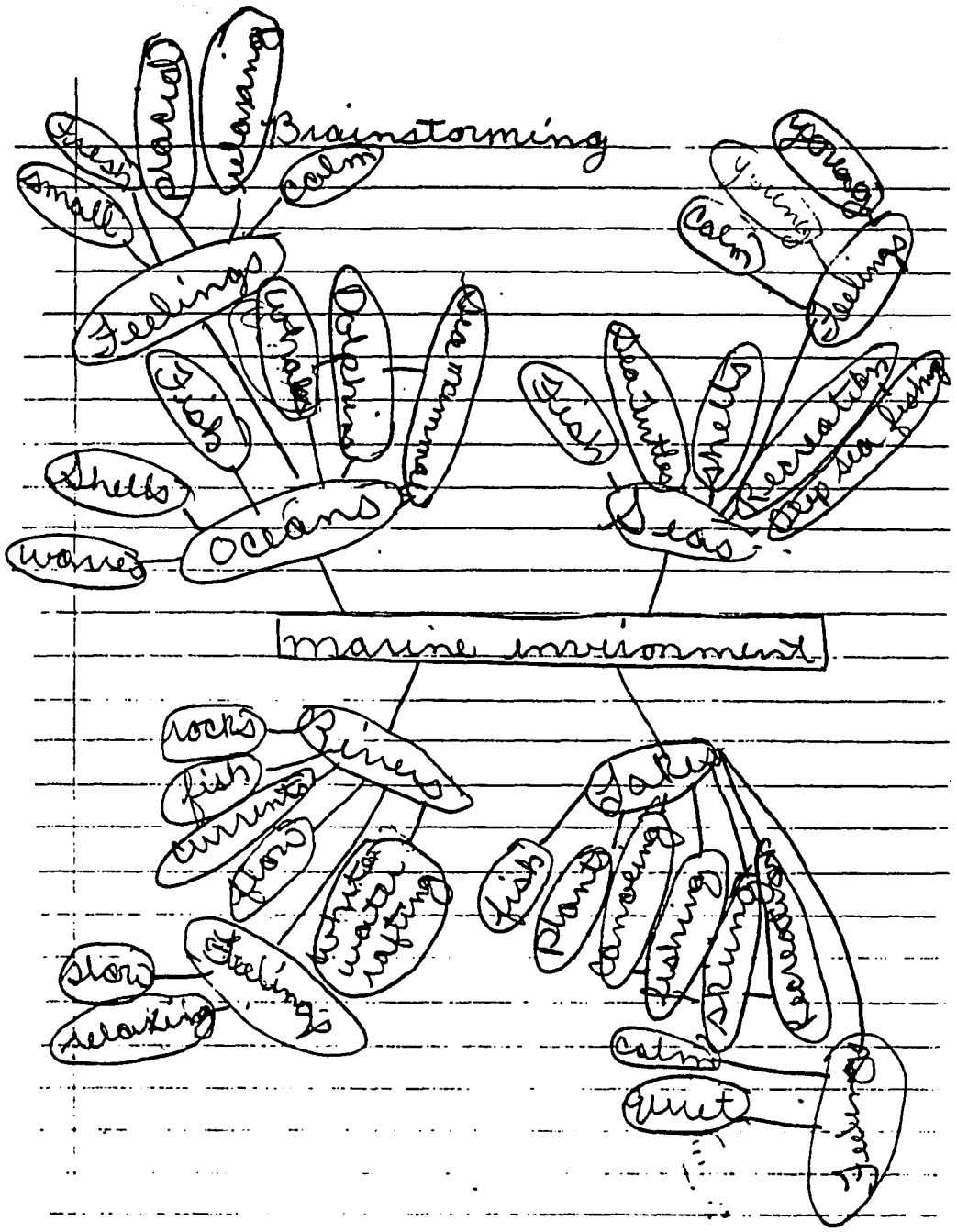

Figure 2. "Combo" Model

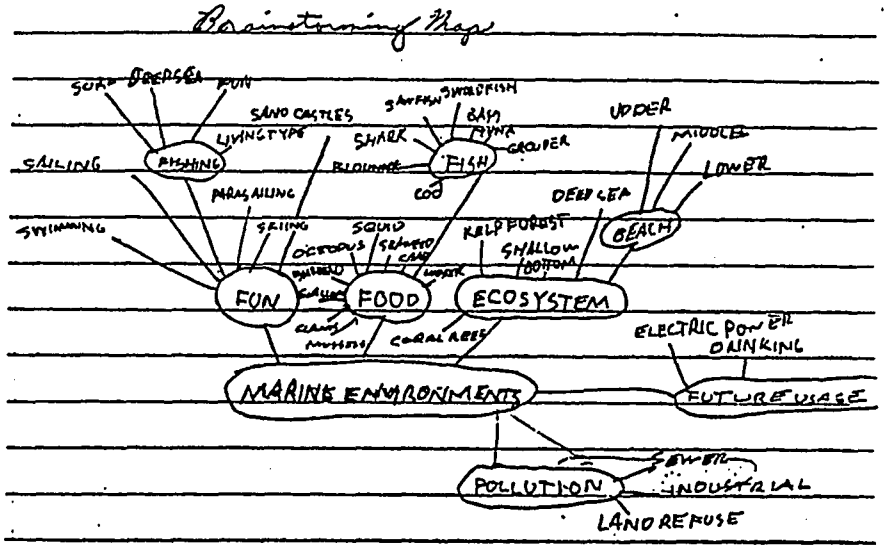

Figure 3. "Solar System" Model

as a result of the FOR SEA experience. I observed that 7 students stayed with the simple "bicycle wheel" model. This means that their conceptual elaboration remained about the same, but they have removed some preconceptions (e.g., "lakes") and included new concepts (e.g., "plankton") and attitudes (e.g. "refreshing) about the marine environment, changes resulting from the FOR SEA experience.

None of the students drew the "combo" model at the end of the study. These students' along with 8 other students chose to draw the more complex "solar system" model. This model indicates that most of the students have added new concepts and attitudes developed during FOR SEA. The initial 8 students that used the "solar system" model have "lake" as one of their categories of the marine environment on their first "brain storming" maps. Five of the 8 students removed this "lake" preconception on their last map. This is a direct result of the FOR SEA curriculum which does not mention "lake" as being a component of the marine environment. But some students still had preconceptions on their last "brain storming" maps. This is probably due to their prior direct and indirect experiences with this environment. These preconceptions are still part of the students' conceptual framework on how they still view the

marine environment regardless of new and conflicting concepts that they might have learned as a result of their **FOR SEA** experience.

General Attitudes

The students have many opportunities to share their positive or negative feelings toward the marine environment. They use the class discussions, pre and post questionnaires, pre and post "brain storming" maps, informal and formal interviews, and daily entries in their journals to express their feelings.

As a result of their limited direct and indirect prior experiences with this environment, the students' initial attitude toward the marine environment was superficial at best. The closest marine environment is 5 hours away. With the students living so far away from this environment, their direct connection with this area is limited to summer vacations at the "beach" and indirectly through the media of television, movies, books, and science classes.

The students' attitudes at the beginning of **FOR SEA** were varied. The positive attitudes shown on the first "brain storming" maps (refer to Appendix F) by numerous students involved only one word responses. The students described their feelings as follows: "fun," "peaceful," "content," "crisp," "refreshed," "relaxed," "warm," "placid," "fresh," "relaxing," "happy," and "nice." Only

two student maps displayed negative feelings toward the marine environment. They wrote following words: "pollution," "undertoe [sic]," "riptide," and "whirlpools." These words may not be true feelings, but the students consider them as such because they connected these words with "feelings" on their "brain storming" maps.

The students' attitudes on their first questionnaire was mixed. They were asked to describe their attitudes toward the marine environment (positive and negative) to a person from another planet, a being who has not seen this environment. Their positive attitudes reflect thoughts like "beautiful," "lots of fun," "wonderful place," and "the water is nice." Their negative attitudes toward the marine environment reflect a sense of fear of the unknown to them. Lisa wrote, "I would show her the ocean and tell her about the living creatures and to be careful & warn them about the sharks, drop offs, undertows, and riptides." Susan wrote, "Sometimes things bite you if you go in the water." Jack wrote, "You could drown in it or get bitten by a fish or something." Two more students wrote ambivalent attitudes on their first questionnaire. Alan wrote, "You can be refreshed by it, and you can drown in it." When asked in an interview about this response, he told me that he had not seen or known of anyone that had ever drowned before. He could not explain to me why he had this feeling.

Mitch wrote, "I would tell them that sharks are mean. I like the marine environment because I like fish and other water animals. I'd also tell them that I don't like the marine environment because of water pollution." Mitch shared with me informally during class that he had seen "trash" on the beach during his last visit to the coast and he was familiar with the "Alaskan Oil Spill" because of news shows on TV.

None of these students when asked during interviews had experienced any of these "unknown fears" themselves while in the water at the beach. Susan, Lisa, and Mitch all shared with me that they had seen the movie JAWS. They told me that this movie might had something to do with their fear about sharks in the ocean.

These "unknown fears" can easily be the result of media hype to the extent that it causes some students to have phobias and negative attitudes about the marine environment. They can get these false impressions from multiple medias when they view movies such as; JAWS or Orca the Killer Whale, television programs; "Creatures of the Deep" (National Geographic Explorer) and "Great White Sharks," (Nova) and visit various sea aquarium attractions (Sea World, Marineland, New England Aquarium); "Shark Encounter," "Creatures of the Deep," and "Shark Exhibit."

The FOR SEA curriculum had an effect on some of the students' positive attitudes while they were taking this

unit on Marine Science. These attitudes are recorded in some of the students' journals. Susan wrote, "At first I didn't have a feeling for the marine environment. Now as we get deeper into the subject the more and more I get interested. I wish we could learn about the marine environment for the rest of year." She shared with me during an interview that "this **FOR SEA** unit is my favorite class so far this year, and I want to learn more about it (marine environment)." Some other students shared with me informally during class that they enjoyed learning about the marine environment. Jack wrote, "It has been interesting and fun to learn about sea life." He also wrote the following syntu:

Water
peaceful
waves
homes for animals
H_2O

Jack's syntu about "water" reflects his knowledge and positive attitude about the importance of water to animals.

In her journal, Lisa wrote her attitude about "waves" in the following syntu:

Waves
calm
smooth
peaceful
rapids

She shared with me during an interview that studying in class about how waves affected the beaches in **FOR SEA** reminded her of her trip to Hilton Head last summer. She

replied, "I would stay up real late to look at the ocean, and the waves looked real calm." The **FOR SEA** lesson on waves on beaches triggered Lisa's inner emotion about what she had experienced last summer.

The **FOR SEA** curriculum did have an impact on the students' attitude towards the marine environment. The students last "brain storming" maps had some of the same positive feelings toward the marine environment with the following words added: "great," "important," and "exciting." The following two students in their last journal entries have positive attitudes toward the marine environment because of **FOR SEA**. They both did not initially reflect this positive attitude in other documents. Kathy wrote:

> My feelings about the marine environment has [sic] changed completely. I think it is a lot more important than I thought before. Phytoplankton and zooplankton had a big effect on me since something living could be so tiny and still be really important. The study on marine environment has been so fun and interesting. Now the marine environment is about the same importance to me as land environment.

Kathy responded to the importance of the plankton that she had learned about in **FOR SEA** and the element of fun and interest stimulated by the study of this environment. In the last sentence she compares and elevates the marine environment to a position as important to her as the land environment with which she has had more experience and awareness. Jack wrote:

> Studying marine environment (**FOR SEA**) did a lot for me. I had never really known how interesting and fun it would be to study it. I had a great time and I learned a lot about the wonderful marine environment.

Jack's new found positive attitude was not evident until he began to write about it in his journal during and after studying **FOR SEA**.

The last questionnaires indicate that the students experienced positive changes in students attitudes as a result of **FOR SEA**. Ricky wrote: "My attitude towards the marine environment has changed in a positive way because of **FOR SEA**." His previous attitude towards the marine environment was not evident in any of his documents or discussions during class. At the conclusion of **FOR SEA** Henry wrote:

> I enjoy even better the marine environment than I used to, now that I know what is really in it. These 4 weeks have really been fun. They have told me so much about the marine environment. We couldn't live without it.

His shift in attitude results from his increased knowledge and awareness during **FOR SEA**. Henry is getting away from the "fear of the unknown" that he and some other students expressed at the beginning of **FOR SEA**. Al wrote, "My feelings about the marine environment have changed slightly over the past 4 weeks. For instance, I now know much, much more about the marine environment." Al also reflects that because he has learned more about the marine environment, his feelings have changed. During his exit interview he shared with me that his

feelings about the marine environment are slightly more positive but that his attitude about pollution is truly enhanced because of **FOR SEA**. John reflected Al's similar sentiments when he wrote, "I am more positive and understand toward marine life. [sic] I am more negative toward pollution."

Attitudes about Pollution

The classes' initial attitude about pollution in the marine environment were not as well developed as their ending attitude about this problem. Initially the majority of the students had a general idea about and had witnessed pollution directly or indirectly concerning this environment.

In their first questionnaires some of the students expressed a vague understanding of "pollution" in the marine environment. Mitch wrote: "I don't like the marine environment because of water pollution." He continued: "Water pollution is present in some water." This statement is evidence that he is not sure about the location or type of pollution that is present in this "water" environment. Pat wrote: "It (marine environment) is to [sic] polluted." These statements are mere generalizations with no explanations of what, where, or how much pollution is in this environment.

Some of the other students had a better understanding of how pollution affects the marine

environment. Susan wrote on her first questionnaire: "If man takes better care of the marine environment, such as pollution, maybe live [sic] would be better for the marine environment." I asked her in an interview, during the first week of **FOR SEA**, to tell me what that statement meant to her. She responded:

> Well, there are a lot creatures in the world that have not been discovered. Maybe some of those animals and creatures die because of pollution before we get to learn about them and discover what it looks like and its habitat and what it feeds on. So, I am saying that if we take care of the world pollution maybe we can learn more about the marine environment.

She bases her attitude on the assumption that some of these "creatures" in the world might not be discovered or learned about because pollution kills them before their time. Because her statement about pollution was still too general, I asked her, during the same interview, if she had ever seen pollution in the marine environment. She replied, "Yeah, like we learned in class today (slide show - We Care About Oceans) that the upper beach on the shore has cans drifting up to it sometime. Sometimes there are plastic bags there also. I have seen this at the beach when I was there the last time."

To enhance her attitude about pollution in the marine environment, Susan took her own prior experience of seeing pollution on the beach and related it to what she had learned in the slide show. Then I asked her how seeing beach pollution made her feel. Susan replied,

> Well, first of all I talked my parents into helping me pick some of it up and put it in a garbage can. It hurts to see that people are really doing that to the environment because it is our world and it is everyone's home and we should take really good care of it. It is a sign that shows that people really do not care about the environment and what happens to it.

Some students have strong initial feelings about the marine environment and have an attitude that it would be better off if we did not bother it. Three students have the attitude that we eat fish and other things in the ocean and "we also pollute their environment."

But one black female student really had strong feelings about the marine environment. Lisa expressed this feeling in her first questionnaire: "It serves as a dumping ground for trash. Man kills, eats, destroys and pollutes the ocean. The ocean would be perfectly fine without man." During an interview, the first week of FOR SEA, I asked her to elaborate on this statement. She responded: "It is true. If we did not put toxic waste in it, the whole world would be a happy place. We eat lots of stuff in it and cause it to be endangered and that is basically it." I asked her if she had seen pollution before and she replied, "Yeah, cups and junk but nothing big." Then I asked Lisa how seeing this pollution made her feel. She responded: "Well, I do not see it in big quantities so it does not make me feel real bad. But when crabs run over that stuff it makes me feel sick because the crab could eat it and die."

Lisa's attitude about pollution in the marine environment intensified because of **FOR SEA**. Responding to the exit questionnaire, "What is the importance of the marine environment?" she wrote: "All humans do is pollute it. Humans would be perfectly fine without it, but we feel we have to control everything. The marine environment would be perfectly fine without us." I asked her informally during class if **FOR SEA** had made any changes in her attitude about the marine environment. Lisa replied, "Yeah, I feel a lot stronger now because of the film (We Care About Oceans) and our class discussion on man's role in the environment."

The slide show "We Care About Oceans" had a big impact on most of the students' feelings toward pollution in the marine environment. This presentation included slides and narrative that discussed dumping of sewage sludge, oil spills, dredgings, and acid in the ocean and showed and discussed the consequences of litter and garbage washing up onto our beaches. Also, after the slide show, the class had a discussion on pollution and man's role with pollution in his environment.

There is strong evidence in some of the journal entries and interviews (formal and informal) that this slide show made a difference in their attitudes about pollution. Some of the journal entries that the students wrote following the slide show indicate their strong emotions:

> Susan: It showed and explained how the marine environment is polluted.
>
> Pat: I feel that people should not pollute our waters with oil spills, and dredgings from the bottom of the oceans.
>
> Jack: Don't Pollute!! Our Oceans!!

Adam wrote the following syntu in his journal:

> Pollution
> smells bad
> nasty
> feels sick
> waste dumping

During an interview I asked Adam to explain his syntu.

He responded:

> Well, like what we saw on that filmstrip (We Care About Oceans). It told a lot about why they dump the raw sewage and all that. Down in Savannah is where my cousins live. My cousins said that they (city) had dumped a 1,000 gallons of raw sewage in the ocean near the places where the people are going to play. I do not think it would feel very nice if they were swimming along and saw something come up and hit them and you did not know what it was.

Adam's feelings about pollution in the marine environment may have resulted from his indirect experience of the slides (We Care About Oceans) in class and from his cousin's story about pollution in the Savannah area. Also he told me that he had not seen any type of pollution himself while visiting the beach.

Ming, an Oriental female, wrote a strong response to the slide show in her journal that day:

> I don't like the way some companies dump their chemical waste into ocean & seas. If I were the company manager I would fire any employee that brought up the idea!
>
> I don't like the way people dump wastes in our oceans.

Dumping of waste
dangerous to animals
uncaring
harmful to environment
polluting

The following day, I had an interview with Ming to ask her to elaborate on her feelings and to explain her syntu about ocean pollution. She explained:

> I think people ought to think what they are doing before they do it (pollute). Because since last year I have been involved with an endangered species, and I have adopted a manatee in Florida. Also, I wrote a letter to the manatee club and joined.

She elaborated that she had learned information in the Atlanta Journal and Constitution and the manatee club's newsletter about how pollution affects the manatee population in Florida. Ming also told me that she saw on the slide show, "We Care About Oceans," that they (chemical companies) were putting acids in the ocean and that "really made me mad." Then she shared with me her feelings for writing the syntu.

> Well, I got really mad because I am involved with the manatees. So, I wrote 'dangerous to animals.' I said it was 'uncaring' because I thought that they (people) do not care about the marine environment and I thought that they should speak more about it. Then it is 'harmful to the environment,' so I picked that.

Ming's active role in joining the Manatee club to help that endangered species and her participation in picking up litter on the beach is evident in her concerned feelings about the marine environment. She also told me that whales, seals, and fish could be endangered in the ocean because of ocean pollution.

Ming told me that she had seen "plastic bags, paper cups, and plastic rings in the ocean" on some of her visits to the beach. When I asked her how seeing pollution made her feel. She responded: "Well, I got angry at that too, and I tried to go out there and pick it up."

The students' feelings about the marine environment became more intensified and more numerous as result of their experience with **FOR SEA**. Also, three more students that had not previously expressed their concerned feelings toward the marine environment took the opportunity to write their feelings on their exit questionnaires. Kathy wrote: "We are dependent on it and it is dependent on us. We depend on it for a supply of food and it depends on us for not killing and polluting it." Pat wrote, "Man's relationship is that we eat, study and pollute the things in the water." Then, Mitch added a similar feeling on his questionnaire: "The people eat and pollute the marine environment." This theme that "we eat food from the ocean and in return we pollute it" was a common feeling held by most of the students (12 out of 19 students) by the end of their **FOR SEA** experience.

Three students expressed that their feelings toward the marine environment had changed because of the slide show, "We Care About Oceans," and other discussions related to pollution during the **FOR SEA** curriculum.

Susan wrote in her exit questionnaire:

> My feelings toward the marine environment has changed. Whenever I go to the beach, I will ask my parents to help me collect litter on the shore. It really hurts to see pollution. It is our world and we should protect it.

Mitch expressed his feelings:

> I didn't like seeing the video (slides) about the ocean because it talked about the destruction of the marine environment. I think the marine environment is special. People shouldn't pollute the environment and I'm sad that they do.

Then Ming wrote her thoughts:

> I feel bad even more than I did before about pollution because I am now aware of the dangerous hazards of dumping wastes in our waters. Many companies have allowed themselves to do that. I also realize the importance of the marine environment especially to the animals and plants living in it. However, my thoughts that the marine environment is interesting and beautiful has not changed because of **FOR SEA**.

All three students expressed a change in awareness and concern about the marine environment, changed awareness that arose from their **FOR SEA** experience. Also, Ming shared in her questionnaire that all of the negative things about pollution did not preclude her initial feelings of interest and her appreciation for the beauty of this environment.

Chapter 6

DISCUSSION, CONCLUSIONS, IMPLICATIONS, LIMITATIONS, AND RECOMMENDATIONS

The purpose of my study was to investigate students' academic achievement and attitude towards the marine environment before, during, and after the **FOR SEA** experience. This chapter presents a discussion of research questions, conclusions, implications, and recommendations of my study.

Discussion of Research Questions

I have arranged the discussion of results around the research questions stated in Chapter 1 and restated each research question at the opening of the discussion.

Question Number 1. What knowledge do the students have about the marine environment before and after the **FOR SEA** experience?

I measured the students' knowledge about the marine environment before and after their **FOR SEA** experience was measured by the use of a pretest/posttest and "brain storming" maps.

The students were administered a pretest/posttest instrument to measure their knowledge of the marine

environment before and after the **FOR SEA** experience. Statistical analysis of data from the pre- and posttest instrument covering **FOR SEA** concepts indicated a significant difference in mean scores before and after the students experienced **FOR SEA**.

An item analysis of the questions in the posttest compared to the pretest reflected that the students' knowledge of the **FOR SEA** concepts after the 4 week study of marine science improved significantly. The students' pretest score on the concept of salinity showed that 73% of the students got that question wrong initially as compared 0% of the students on the posttest. This concept was taught by Mr. Woods, and the students were given two **FOR SEA** activities ("Constructing a Soda Straw Hydrometer" and "Using a Hydrometer to Determine Salinity") that dealt with this concept. Another example of a positive shift in knowledge was a concept dealing with food pyramids that had 84% students initially missing this question on the pretest but had only 5% of the students not knowing this concept on the posttest. The students learned this food pyramid concept was covered in **FOR SEA**'s "Who's for Dinner" (food chain/pyramid) activity.

The marine science concepts not covered by the teacher in the posttest were reflected in low scores for those questions after the 4 week study. The concept of how fast a sound wave travels through water was missed by

100% of the students on the pretest and 100% of the students on the posttest. This concept was supposed to be taught by Mr. Woods and learned by the students in a class discussion on a **FOR SEA** reading assignment titled "What's that Sound." Due to lack of time this concept was not covered at all. Therefore, their lack of understanding about how fast a sound wave travels through the water remained the same.

After examination of the item analysis of each question on the pretest/posttest I determined (by the % of students who missed that question) that one question was invalid in measuring the appropriate concept intended. Although that concept, the energy flow through a food chain/web, was taught by the teacher and discussed in their **FOR SEA** student packet, 94% of the students missed this concept on the pretest and 84% of the students on the posttest. This high percentage was a result of the misleading nature of the pretest/posttest choice of the answers to this question (refer to Appendix B and see question # 14). An analysis of the distribution of students choosing each answer indicated that 75% of the students related "energy flow" and "nutrient flow" together and selected answer "c" for this question. Therefore, the choices of answers were confusing, and the question was invalid in terms of measuring knowledge of this concept on the pretest/posttest.

Students also recorded knowledge of the marine environment before and after **FOR SEA** on their first and final "brain storming" maps. "Brain storming" maps allowed the students the opportunity, without restrictions, to be open ended, to write down as many concepts about the marine environment as they wanted to. This format, developed by Novak (1977), was useful to me because it allowed me the opportunity to observe how the students separated, organized, and connected the concepts (refer to Appendix F for examples).

On the first "brain storming" maps the majority of the students had some preconceptions concerning the description of the marine environment. They use words like "river," "swamp," "stream," "pond," and "lake" to describe examples of the marine environment. (I agree with the experts that these examples are be part of a fresh water environment.) Initially 10 students used the word "ocean" and 5 students used "sea" as a concept directly connected with the marine environment. Their sources of knowledge about the marine environment were limited to their prior experiences directly (vacations to the "beach") and indirect knowledge learned through multiple media (e. g., books, museum and sea aquarium visits, movies, TV specials [National Geographic]).

These preconceptions may also be a result of their prior experiences with these environments and their class trip to Rock Eagle (fresh water environment) prior to

studying **FOR SEA**. They were working on the basis of these preconceptions because they had limited knowledge and experiences with the marine environment. Therefore, their preconceptions of the marine environment conflicted with the true conception of this environment.

The students' knowledge of the marine environment increased as a result of their **FOR SEA** experience. The evidence of this increase in knowledge is evident in their final "brain storming" maps (refer to Appendix G). On their final maps that were included in the **FOR SEA** curriculum the students have included more concepts. Therefore, the students have taken what they knew initially before **FOR SEA** and have added new knowledge as a result of their **FOR SEA** experience.

The use of the "brain storming" maps proved very effective to determine the conceptual change that occurred over a period of 4 weeks as a direct result of FOR SEA. Posner, Strike, Hewson & Gertzog (1982) looked at how to effect conceptual change in students. They identified conditions that need to exist. First, a student must be dissatisfied with his existing concept. Second, any new concept must by comprehensible to the student. Third, a new concept must appear as plausible as the student's own misconception (preconception). Fourth, a new concept has to be more useful than the previously held theory.

By comparing the students first "brain storming" map to their final map, I evaluated whether there was conceptual change as a result of the **FOR SEA** experience. According to some of the final "brain storming" maps, there was evidence that conceptual change did occur in some students. Sixty percent of the students' final "brain storming" maps (refer to Appendix G) had new concepts to describe the marine environment like "marshes" and "barrier islands" that were covered in **FOR SEA**. Some students still used "ocean" and "sea" as concepts. But the students had less emphasis on "river," "swamp," and "lake" and have dropped the words "stream," "water," and "pond." Therefore, conceptual change did occur because some of the students did comply with some of criteria (Posner et al.) stated above in the paragraph.

John (informant) did not exhibit any conceptual change. On his final map he still had the preconception that "lakes," "rivers," and "bodies of water" were part of the marine environment. Information that he shared with me during his exit interview indicated that his prior experience and his limited knowledge about the marine environment were the reason for his preconceptions. John conceptions about the marine environment remained about the same in spite of **FOR SEA**.

The final "brain storming" maps reflected new concepts related to the marine environment, concepts that

the students learned as a result of **FOR SEA**. They added concepts such as "salinity," "blue crabs," "beach," "kelp forest," "sub-littoral," "littoral", "supra-littoral," "geoducks," and "whales" as part of the marine environment. These concepts are components of the **FOR SEA** curriculum.

Question Number 2. What attitudes do the students have about the marine environment before and after the **FOR SEA** experience?

The students' attitudes toward the marine environment before and after their **FOR SEA** experience were measured by the use of questionnaires, "brain storming" maps, interviews, and journals.

As a result of their limited direct and indirect prior experiences, the students' initial attitudes toward the marine environment were shallow at best. The closest marine environment to these students is 5 hours away. Since "attitudes are learned in many ways. . ." (Shrigley, Koballa, & Simpson, 1988, p. 667), the students developed their initial attitudes toward the marine environment from their prior visits to the "beach" and indirectly through the media of television, movies, books, and science classes.

The students' attitudes at the beginning of **FOR SEA** were varied. The positive attitudes reflected on their first "brain storming" maps (refer to Appendix F) were described as "peaceful," "content," "relaxed," "happy," and "refreshed." The students also showed their positive

attitudes on their first questionnaire when they wrote thoughts like "beautiful," "lots of fun," and "wonderful place." These attitudes reflect the students favorable encounters with this environment. They have learned that the marine environment is one that they can feel good about because of satisfying prior experiences with it.

Initially some of the students expressed a fear of the unknown and had negative feelings towards the marine environment because they lacked understanding of the unknown. Christie recorded concerned feelings when she wrote on her first "brain storming" map the words "undertoe [sic]," "riptide," and "whirlpools." She based her perceived fears of these phenomena on no direct experience but purely on the basis that she feared that she would be caught in these if she ventured out into the ocean. Five other students on their first questionnaire wrote negative reflections because of a sense of fear of the unknown. Some of the fears they described were "sharks," "drop offs," ". . . things bite you if you go in the water," and "you could drown in it." None of these students, when asked during interviews, had experienced any of these "unknown fears" themselves while in the water at the beach.

Three students shared with me that they had seen some of these "unknown fears" in movies like JAWS and in TV programs about the ocean. Their exposure to these media may give them false impressions; they are unable to

discern what is real from what is fabricated by the producers in order to make an exciting and entertaining story about animals and phenomena in the marine environment. Lack of knowledge of the marine environment caused some of the students to have negative feelings about this environment because they were working on their own fears and preconceptions rather than fact.

The **FOR SEA** curriculum did have an impact on the students' attitude towards the marine environment. The students last "brain storming" maps (refer to Appendix G) reflected some additional positive feelings that were not present on their first maps. They added words like "great," "important," and "exciting." Also two students in their final journal entry wrote of positive feelings as a result of **FOR SEA**. Kathy wrote: "My feelings about the marine environment has [sic] changed completely. I think it is more important than I thought before." Jack wrote:

> Studying marine environment (**FOR SEA**) did a lot for me. I had never really known how interesting and fun it would be to study it. I had a great time and I learned a lot about the wonderful marine environment.

Neither of these students demonstrated positive attitudes until they experienced **FOR SEA**.

Attitudes can be altered by experience. The students took their initial attitudes and built on them from the new experiences that they received as a result of **FOR SEA**. These newly acquired attitudes resulted

directly from the **FOR SEA** curriculum and class discussions of man's role in the marine environment.

Question number 3. How does the **FOR SEA** experience affect students' attitudes towards the marine environment during the unit?

The students' attitudes towards the marine environment during **FOR SEA** were monitored by the use of student journals, participant observation, and informal and formal interviews.

The **FOR SEA** curriculum had an effect on some of the students' attitudes. During day 2 of the study the students viewed a slide show, "We Care About Oceans." The presentation included slides and a narrative discussing dumping of sewage sludge, oil spills, dredgings, litter, garbage, and acid in the ocean. Also, after the slide show, the class had discussions on pollution and man's role with pollution in this environment.

This slide show had a big impact on most of the students' feelings toward pollution in the marine environment, and it was quite an emotional issue for most of the students in the class. There is strong evidence in some of the journal entries and interviews that the program "We Care About Oceans" enhanced their awareness about pollution in the marine environment.
Adam wrote the following syntu in his journal that night after the slide show:

Pollution
smells bad
nasty
feels sick
waste dumping

During an interview I asked Adam to explain his syntu. He responded: "Well, like what we saw on that filmstrip (slides). It told a lot about why they dump the raw sewage and all that. . ." Ming also wrote a strong response and syntu about the slide show in her journal that day:

I don't like the way people dump wastes in our oceans.

Dumping of waste
dangerous to animals
uncaring
harmful to environment
polluting

These are examples of how some of the students reacted as a result of learning about pollution in the marine environment. This slide show informed the students about the problem of pollution in our oceans and also enhanced prior direct experiences with those who have witnessed different types of pollution while at the beach on vacations.

The **FOR SEA** curriculum had an effect on some of the students' attitudes while they were studying about the marine environment. They expressed these attitudes in some of their journal entries. On the 5th day of FOR SEA, Susan wrote, "At first I didn't have a feeling for the marine environment. Now as we get deeper into the

subject the more and more I get interested. I wish we could learn about the marine environment for the rest of year." After reading her journal entry, she shared with me during an interview that "this FOR SEA unit is my favorite class so far this year, and I want to learn more about it."

The FOR SEA lesson on the effect of waves on beaches enhanced an inner emotion that Lisa had about waves, a feeling based on an experience of the previous summer while visiting Hilton Head. She wrote the following syntu that night after this lesson:

Waves
calm
smooth
peaceful
rapids

She shared with me during an interview that studying in class about how waves affected the beaches reminded her of that trip to the beach. "I would stay up real late to look at the ocean, and the waves looked real calm."

Based on the assumption that attitudes are learned. I conclude that students' prior direct experience (visits to the beach) combined with their indirect experience (FOR SEA) did broaden and deepen their attitudes toward the marine environment. They were more conscious of man's responsibility because of their FOR SEA experience.

Conclusions

Based on the results presented in Chapter 4, Chapter 5, and the discussion of results presented in this chapter, I offer the following conclusions:

1. There is significant positive gain in students' knowledge and a better understanding of the marine environment as a result of **FOR SEA**. The students' posttest scores reflected a increase in knowledge of the marine concepts that were covered. The students' final "brain storming" maps indicated a better general understanding of the marine environment than their initial maps.

2. After experiencing **FOR SEA**, students were less likely to consider lakes, rivers, ponds, or swamps as concepts of the marine environment. These preconceptions were not included on the majority of the students' final "brain storming" maps.

3. Conceptual change did occur over a period of 4 weeks as a direct result of **FOR SEA**. Sixty percent of the students' final "brain storming" maps had new concepts to describe the marine environment such as "marshes" and "barrier islands."

4. The **FOR SEA** curriculum did have a positive impact on students' attitudes towards the marine environment. The students' last "brain storming" maps reflected some additional positive feelings that were not

present on their first maps. They added words like "great," "important," and "exciting."

5. While they were taking this unit on marine science, the **FOR SEA** curriculum had an effect on the majority of the students' attitudes toward pollution in the marine environment. The students viewed a slide show, "We Care About Oceans, which informed them about the problem of pollution in our oceans and also enhanced prior direct experiences with pollution in the marine environment. Afterwards they consistently readdressed the issue in their journals, interviews, and their final "brain storming" maps.

6. During their study of the marine environment, the **FOR SEA** curriculum had an effect on some of the students' positive attitudes. Many students' took their prior direct experience (visits to the beach) and combined their indirect experience (**FOR SEA**) to help broaden and deepen their attitudes toward the marine environment.

Implications

Results of this study indicate that the **FOR SEA: Investigating Marine Science** curriculum offered knowledge and an indirect experience that effected changes in students' attitudes towards the marine environment. The **FOR SEA** curriculum gave the students the opportunity to encounter the nonliving and living concepts of the marine environment by using a lab activity approach.

Students constructed this newly acquired knowledge from **FOR SEA** and applied it to their prior knowledge and experiences to gain a more meaningful understanding of the marine environment. Teachers and curriculum coordinators could use this program to enrich their students' knowledge and attitudes towards the marine environment.

The use of "brain storming" (concept) maps and syntus in the students' journals allowed them the opportunity to express their own ideas and feelings about the marine environment without restrictions. This approach was very useful for me because I felt that the students were quite creative with their syntus and "brain storming" maps as well as honest and open ended in their journals. More novel approaches such as these should be used to assess the students' conceptual understanding and attitudes toward a subject. These approaches provide multi-dimensional information originating from a student perspective rather than a quantitative instrument designed from the researcher perspective.

The results of this study probably would be different if my sample were coastal or inner city students. I would expect that the coastal students would have more prior experiences and less preconceptions because they would have the opportunity to interact with this environment more frequently. On the other hand the inner city school students would have the most difficulty

relating to the new concepts and I suspect they would have more preconceptions than any other sample. The inner city students would not have the opportunity to experience the marine environment directly because of lack of assess. Therefore, they would have to rely on indirect experiences (book, TV shows, public aquariums) to learn about this environment.

This study took a novel approach in assessing knowledge and attitudes in science education. The use of participant observation, "brain storming" (concept) maps, open-ended questionnaires, interviews (informal and formal), personal documents (student journals and syntus) helped triangulate data sources. In the long run the results of this case study were more conclusive than if I had only used one instrument to measure knowledge and another to measure attitudes. Thus a need exists for more qualitative studies in science education, such as this one, to help to contribute more comprehensive findings to literature rather than relying on the quantitative studies.

Limitations

Based on the findings of this study, I propose the following limitations:

1. Researcher Bias. I approached this study with an open mind and an "emic" approach of collecting data from the students' perspective rather than mine.

However, I know I was not able to get eliminate all of my subjectivity. I pursued my subjectivity by keeping a daily journal, in which I tried to record anything that would affect the results of this case study. I sought to obtain truth from the data with this study rather than to judge or make value statements from what I observed (Peshkin, 1988).

2. I was the only person collecting and analyzing the data. This leaves open the possibility that interpretation of results is limited. Goetz and LeCompte (1984) "believe that enthnographers must consider lack of reliability and validity to be serious threats to the value of their results" (p. 209). Therefore, to make an attempt to enhance the validity and reliability of this study I used a triangulation design of different data sources and methodologies.

3. I did not use multiple investigators or a team approach to collect and analyze the data. I had an overwhelming amount of data to collect, code and compare. In future studies the help of other investigators would facilitate the study because each investigator could use his/her own strengths to overcome the others deficiencies. The use of multiple investigators would also be important in order to see if each investigator came up with similar conclusions after the data was analyzed.

4. Students' previous experience and background with the marine environment affected the study. This study sample had a range of prior experiences, the closest marine environment being hours away. Most students had very limited direct experiences (visits to the "beach," and annual one week vacations) and indirect experiences (TV programs, books, and movies) with this environment. Therefore, their initial knowledge base was limited before the FOR SEA experience. However, since most came from upper middle income families, their opportunities to experience the marine environment were more enhanced than would be in a low income student sample.

5. Preconceptions. The students' had very few preconceptions about the marine environment before and after their FOR SEA experience. There could be numerous reasons why they did not present as many preconceptions as I anticipated. Perhaps not every student was open and honest with me about their preconceptions because of lack of trust towards the teacher and me or the fear of embarrassment in front of their peers. Also the teacher in this study showed more favoritism towards the boys than the girls. I observed numerous occasions when the teacher would "put down" or ignore a female student, and this may have had an effect on how the girls perceived the male teacher and me.

6. Teacher's knowledge base. This was the first time that the teacher had taught this material. He had to rely on the **FOR SEA** teacher background information and me for consultation before presenting the marine science concepts to his students.

Recommendations

Based on the findings of this study, I propose the following recommendations:

1. Future studies should include a female researcher to help triangulate data from female participants. I felt that on some occasions the girls (e.g., Fran) were not as open and honest with me as the boys were. The additional help from a female co-researcher might help verify the validity and reliability of the information received from the girls as well as cross check the data from the boys.

2. Future studies should allow time at the end of each class period to ensure that students make journal entries. The students were supposed to have five minutes at the end of each class to write in their journals, but most days the time was not available. Daily time would give the students the opportunity to make regular entries instead of haphazard entries before their Friday deadline.

3. Future studies should include information regarding conceptual change during the **FOR SEA**

experience. My focus was on conceptual change after the FOR SEA unit. Analyzing conceptual change during the study would help determine what type of teaching strategy (lecture, reading assignment, hands-on activity) was successful in helping the students effectively understand that particular concept. The concept of salinity is a good example. The majority of students did not understand this concept initially, but posttest results showed increased conceptual knowledge after several activities ("Constructing a Soda Straw Hydrometer" and "Using a Hydrometer to Determine Salinity" [refer to Appendix A]) and class discussion.

4. Pretests and Posttests should be followed up by interviews. This would enable students to understand what they missed and provide the researcher information about the question interpretation. The researcher can then assess whether or not the question accurately reflected what was intended.

5. Techniques to allow the students to eliminate their preconceptions (misconceptions). The teacher should allow the students an opportunity in class to express their initial concepts by a class discussion and/or a concept map before the new concept is introduced. The teacher should have a clear understanding and be able to express the concept in articulate manner and with correct information to the students. The teacher should use multiple teaching

strategies (brain storming sessions, concept mapping, lecture, class discussions, reading assignments, audio visual materials, activities, and labs) to teach the concept to the students.

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Appendix A

Sample FOR SEA Exercise

CONSTRUCTING A SODA STRAW HYDROMETER

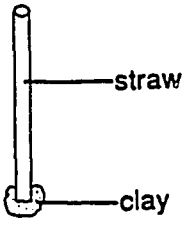
You may have observed that the saltier the water, the higher an object floats in it. Scientists use a weighted glass cylinder to determine salinity. This instrument is called a hydrometer (hi-dram-a-ter). In the following activity, you will make your own hydrometer and use it to measure salinity.

Materials:

plastic soda straw
100 ml graduated cylinder or similar container
permanent marking pen
plasticine clay
salt
spoon to measure
water
unknown salt solution

Procedure:

1. Press a small ball of plasticine clay into one end of a straw. The clay should act as a plug so water cannot get into the straw.



2. Add fresh water to your cylinder until the water is about 1" from the top.

3. Put the hydrometer in the fresh water. Remove or add clay until the hydrometer just rests on the bottom of the container.

4. Mark the water level on the straw with a permanent marker and label it zero (meaning no salt added).

5. Remove the hydrometer. Add 2 teaspoons of salt to the water (NOTE: If this is not enough salt to raise the hydrometer from the bottom, add more salt but keep track of how many teaspoons you added). Dissolve all the salt in the water. Put the hydrometer into the water.

6. Use the marking pen to mark the water line. Label the line with the number of teaspoons of salt that you added.

7. Remove the hydrometer. Add the same number of teaspoons of salt to the water that you added in #5. Put the hydrometer into the water.

8. Mark the water line. Label the line with the total number of teaspoons of salt that you added.

9. Examine the calibrations on the straw. Write a statement about the scale created on the soda straw.

10. Use your hydrometer to test the unknown salt solution:
    a. Put the hydrometer in the solution.

    b. Mark the water line with a letter "U".

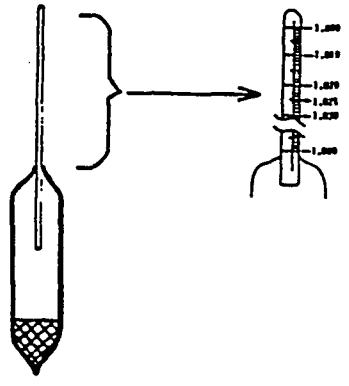
    c. Look at the U mark and your numbers indicating how many teaspoons of salt you added.

    d. Estimate the number of teaspoons of salt that were dissolved in the unknown sample.

    e. Write your estimate here: _____teaspoons of salt

USING A HYDROMETER TO DETERMINE SALINITY

The hydrometer scientists use to determine salinity is a bit fancier than your straw hydrometer. The cylinder has a thin glass tube at the top with a scale printed inside (see diagram). The higher the salinity, the higher the tube floats and the larger the number that lines up with the water's surface.



In the next activity, you will use a hydrometer to determine the salinity of two salt water samples. One sample comes from the ocean surface, the other from the bottom. Your results will let you infer which sample comes from the surface and which comes from the bottom.

1. Based on what you already know, predict which sample will be the saltiest. Circle your prediction: **surface or bottom**

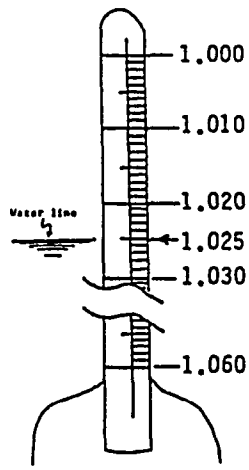
Materials:

2 salt water solutions, "A" and "B"
Celsius thermometer
hydrometer
100 ml graduated cylinder or similar container
correction graph - temperature/salinity

Procedure:

1. Fill the graduated cylinder with sea water sample "A".

3. Put the hydrometer in the sample. Use the diagram to help you read the measurement.



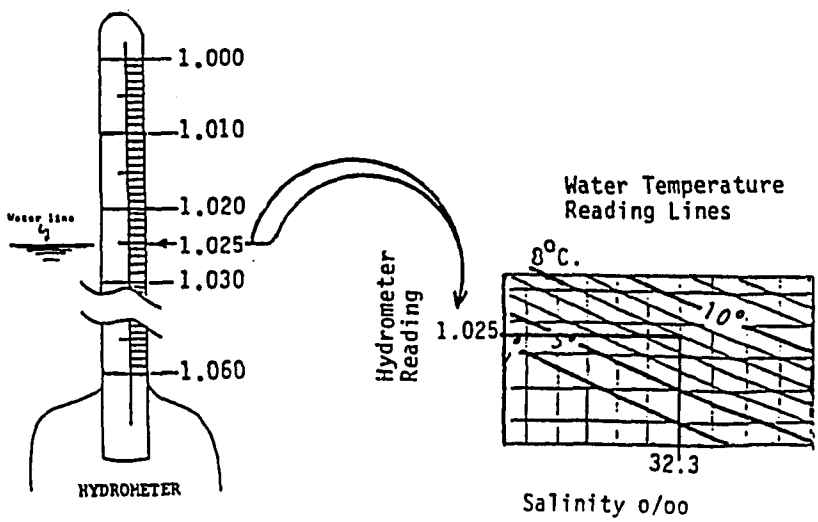
4. The hydrometer reading is _____
Using the graph to determine salinity:

   a. On the graph, find the diagonal line that matches your water temperature reading.

   b. Find your hydrometer reading on the graph.

   c. Follow hydrometer reading line over until you meet the correct temperature line.

   d. From this meeting point, move straight down and read the salinity of your sample in parts per thousand (o/oo).



5. Repeat the above procedure with water sample "B".

6. a. The salinity for water sample A is _____o/oo.

   b. The salinity for water sample B is _____o/oo.

7. Water sample A is the **surface/bottom** sample. (Circle one)

   Water sample B is the **surface/bottom** sample. (Circle one)

Interpretation:

1. Which solution was the saltiest? _____

2. The salinity of sea water ranges from about 25 parts salt per thousand parts of water (25ppt) to about 34 parts per thousand. Did either or both solutions fall in this range? If yes, which ones?

   _____

3. What are two conditions that might help account for this range (from 25 ppt to 34 ppt) in ocean salinities rather than a single uniform salinity?

   a. _____

   b. _____

4. Where would you expect the lowest salinities to be found? Explain.

   _____

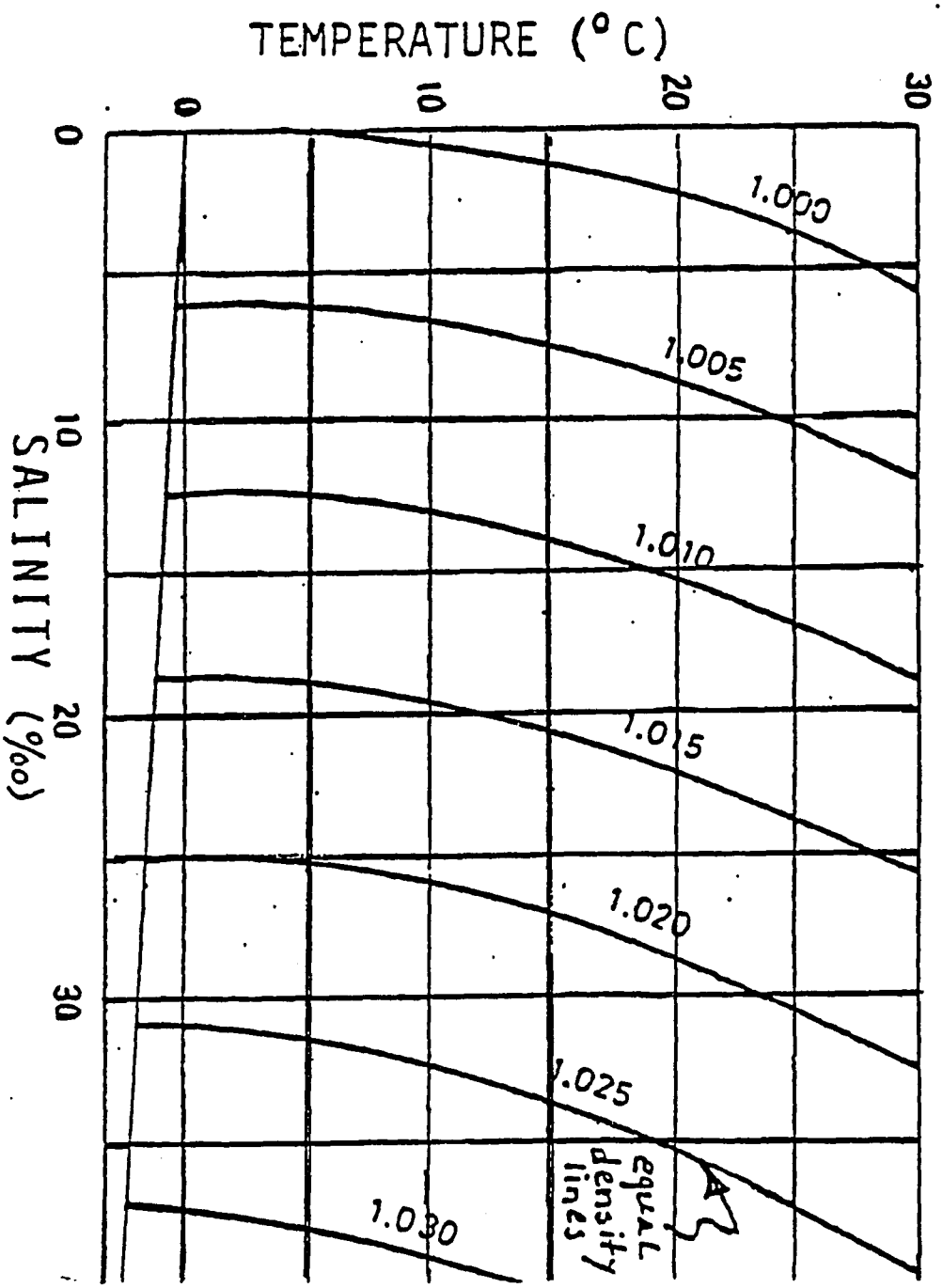
   _____

5. Where would you expect the highest salinities to be found? Explain.

   _____

   _____

Salinity Graph



Appendix B

FOR SEA Pretest/Posttest

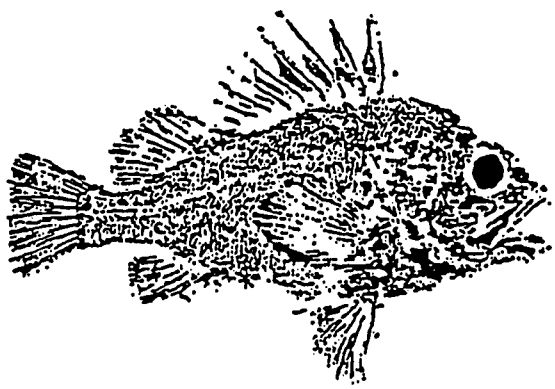
5-6

TEST BOOKLET

THE MARINE SCIENCE TEST

Grades 5-6

Investigating the Marine Environment



Mark all of your answers on the Answer Sheet only.
Do not write in this test booklet.

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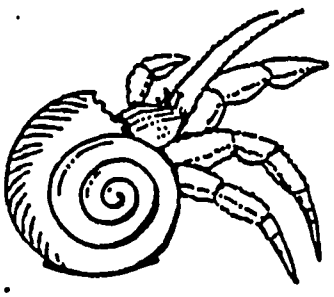
INVESTIGATING THE MARINE ENVIRONMENT - Grades 5-6

1. Which of the following is a part of the non-living environment affecting a crab?
   a) seaweed
   b) clams
   c) tides
   d) man

2. All of the following are aquatic environments except:
   a) estuary
   b) seawater
   c) tundra
   d) swamps

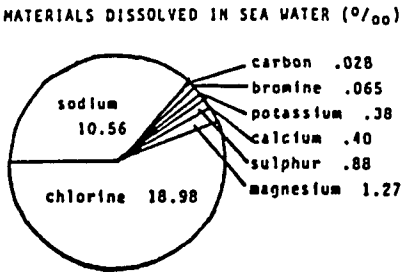
3. The study of environment is called
   a) biology
   b) ecology
   c) enology
   d) oceanology

This is a picture of a marine animal.



4. How does this animal protect itself?
   a) rapid swimming
   b) hard covering on tail
   c) many sharp teeth
   d) borrowed shell

Use the following graph to answer questions 5 and 6.



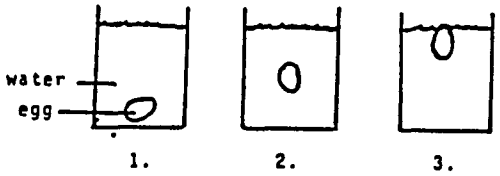
5. Which element is least abundant?

a) bromine b) carbon c) calcium d) potassium

6. The numbers show the amounts of materials in:

a) pounds b) grams c) parts per thousand d) percent

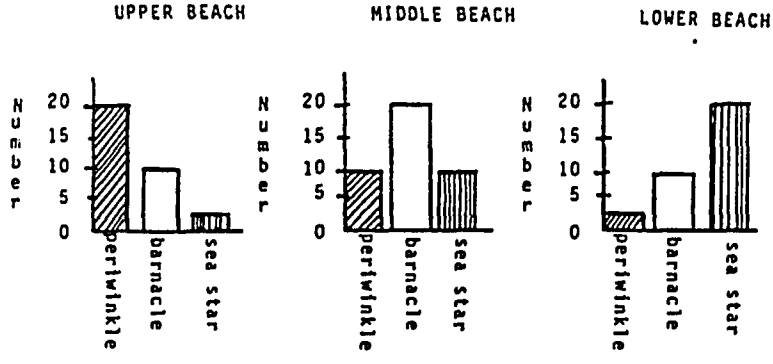
Use this drawing to answer question # 7.



7. Which jar has the most salt dissolved in the water?

a) 1 b) 2 c) 3 d) cannot tell from this information

Mr. Goalot took his class to the beach. He divided the class into three groups. Each group counted periwinkles, barnacles and sea stars. The groups collected data in three different areas of the beach. Their findings are graphed below. Use these graphs to answer questions # 8-11.



8. Where were the most barnacles found?

a) upper beach
b) middle beach
c) lower beach
d) upper or lower beach

9. If you wanted to see sea stars, you should look on the:

a) upper beach
b) middle beach
c) lower beach
d) any part of the beach is equally good

10. Which animal can probably best tolerate dry periods?

a) periwinkle
b) barnacle
c) sea star
d) not enough information to tell

11. Barnacles were found in the same numbers on:

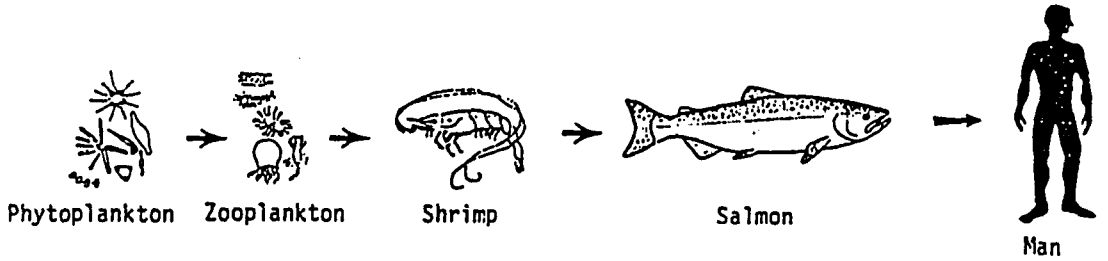
a) the upper and lower beaches
b) the upper and middle beaches
c) the middle and lower beaches
d) no two beaches

.....

12. Freely drifting plants found in the water are called:

a) photometers
b) zooplankton
c) phytozoa
d) phytoplankton

Use the following diagram to answer questions # 13-18.



13. We call this diagram a:

a) food chain
b) food web
c) food pyramid
d) web chain

14. The arrows represent:

a) energy flow
b) nutrient flow
c) both a and b
d) increase in numbers

15. Phytoplankton may be called a:

a) producer
b) first order consumer
c) second order consumer
d) third order consumer

16. In this food chain, man is a:

a) producer
b) first order consumer
c) third order consumer
d) fourth order consumer

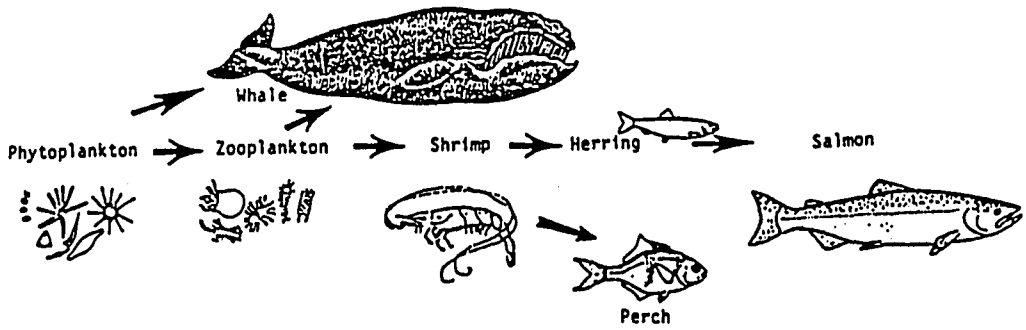
17. If the man ate the shrimp, he would be a:

a) producer
b) first order consumer
c) third order consumer
d) fourth order consumer

18. If the phytoplankton all disappeared, which organisms would die first?

a) man
b) shrimp
c) salmon
d) zooplankton

Use the following food web to answer # 19-23.



19. Which animals in this food web are first order consumers?
   a) herring and perch
   b) zooplankton and whales
   c) salmon and whales
   d) phytoplankton and zooplankton

20. Which animal is both a first and second order consumer?
   a) whale b) shrimp c) zooplankton d) perch

21. If the plankton disappeared, which groups would be affected first?
   a) herring and perch
   b) salmon and perch
   c) shrimp and herring
   d) shrimp and whales

22. If the salmon disappeared, the number of herring would probably:
   a) decrease c) remain the same
   b) increase d) not enough information to tell

23. If the whales disappeared, the number of shrimp would probably:
   a) decrease c) remain the same
   b) increase d) not enough information to tell

.....

24. It takes about how many pounds of phytoplankton to produce one pound of zooplankton?
   a) 1 b) 10 c) 25 d) 100

Two identical aquaria were set up in a classroom window. Both were filled with water to the same level. Fertilizer was added to one of the tanks. The number of phytoplankton in a drop of water from each tank was recorded every day. Use the results shown in Table II to answer questions #25-27.

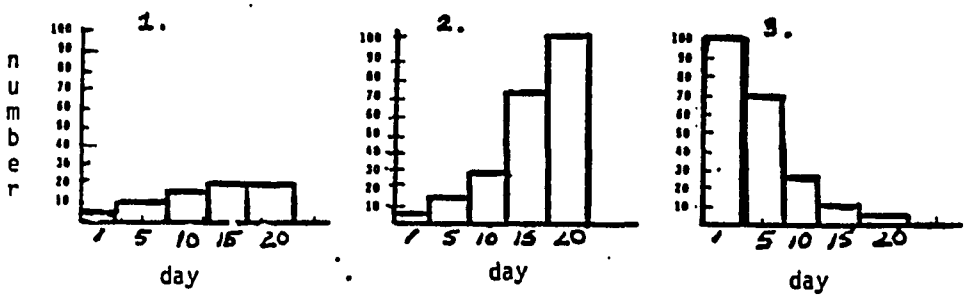
Table II

Number of Phytoplankton

Day	Tank A	Tank B
1	3	3
5	8	14
10	14	28
15	20	65
20	20	100

25. Which tank most likely had the fertilizer added?

a) Tank A
b) Tank B
c) Tank A and Tank B
d) not enough information to answer



26. A bar graph of Tank B would look like:

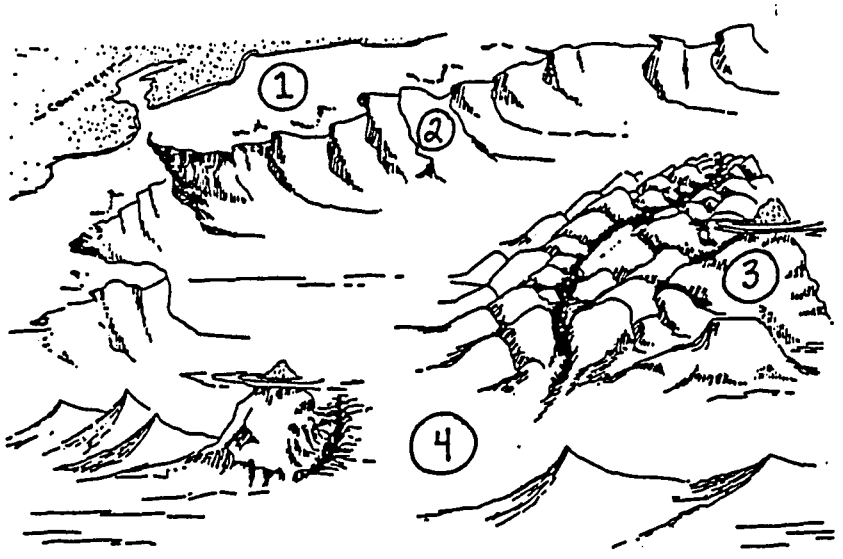
a) 1 b) 2 c) 3 d) none of these

27. The oxygen level in Tank B probably:

a) increased
b) decreased
c) increased, then decreased
d) decreased, then increased

.....

Use the ocean floor drawing below to answer questions # 28-31.



28. Number 1 shows:

a) a seamount
b) the abyssal plain
c) continental slope
d) continental shelf

29. Number 2 shows:

a) a seamount
b) the abyssal plain
c) continental slope
d) continental shelf

30. Number 4 shows:

a) a seamount
b) the abyssal plain
c) continental slope
d) continental shelf

31. The information to make the drawing probably came from:

a) mountings
b) soundings
c) depthing
d) listening

.....

The R/V Explorer is charting the ocean bottom. It gathers the data given in Table I. Use this information to answer questions # 32-35.

Soundings	Time down and back (sec)	Depth (meters)
A	1.0	750
B	1.0	750
C	2.67	2000
D	4.0	3000
E	2.67	2000

32. The deepest spot found was at Soundings:

a) A b) C c) D d) E

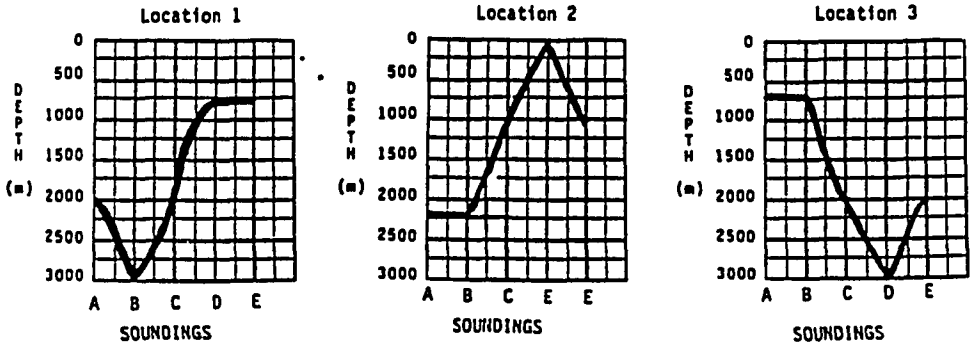
33. How fast is the sound wave traveling beneath the R/V Explorer?

a) 750 meters per second
b) 1500 meters per second
c) 2000 meters per second
d) not enough information to tell

34. Sunlight was present to the depth of Soundings:

a) B b) C c) D d) not enough information to tell

Use these pictures and table above to answer # 35.



35. Which one of the above shows what the bottom looks like under the R/V Explorer?

a) 1 b) 2 c) 3 d) not enough information to tell

.....

Appendix C

Pre-Interview Outline of Questions on Attitudes

Pre-Interview Outline of Questions on Attitudes

1. Tell me some of the places (states) you have lived?

2. What are some of your experiences with the marine environment?

3. When your family takes vacations where do you all go?

4. Tell me things you do when you go to the beach?

5. Tell me your feelings (thoughts) when you are at the beach?

6. Suppose you met someone from a different planet that never saw or knew anything about the marine environment (coast, beach, ocean). What would you tell them about your own feelings (thoughts) about this environment?

   How would you describe that environment?

7. What is the importance of marine environment?

8. What is the relationship of man (people) to the marine environment?

Appendix D

Questionnaire Before the FOR SEA Study

Name_____Date_____

Questionnaire Before the FOR SEA Study

1. What are some of your experiences with the marine environment?

2. Suppose you met someone from a different planet that never saw or knew anything about the marine environment. What would you tell them about your own feelings (positive and negative) about this environment?

How would you describe the marine environment to that person?

3. What is the importance of the marine environment?

4. What is the relationship of man (people) to the marine environment?

Appendix E

Student Journal Instructions

FOR SEA Student Journal

1. When?

Try to put an entry in your journal everyday.
(Please date every new entry.)

2. What?

Write about your feelings (attitudes) about the marine environment after your experience with the class that day.

OR

Write a syntu about the marine environment expressing your feelings (attitudes).

A syntu is a Japanese poem consisting of five lines which do not have to rhyme. The lines are as follows:

In line 1	use one word - the name of a marine animal, object, event or experience.
In line 2	write an observation of the item you named in line 1 using one of the five senses.
In line 3	write a feeling about the item in line 1.
In line 4	write another observation of line 1 using another of the senses (not the one used in line 2.)
In line 5	write a one word synonym for line 1.

Two examples

Whales	Loggerhead Sea Turtle
huge	brown
peaceful	endangered
great swimmers	crusty
leviathans	reptile

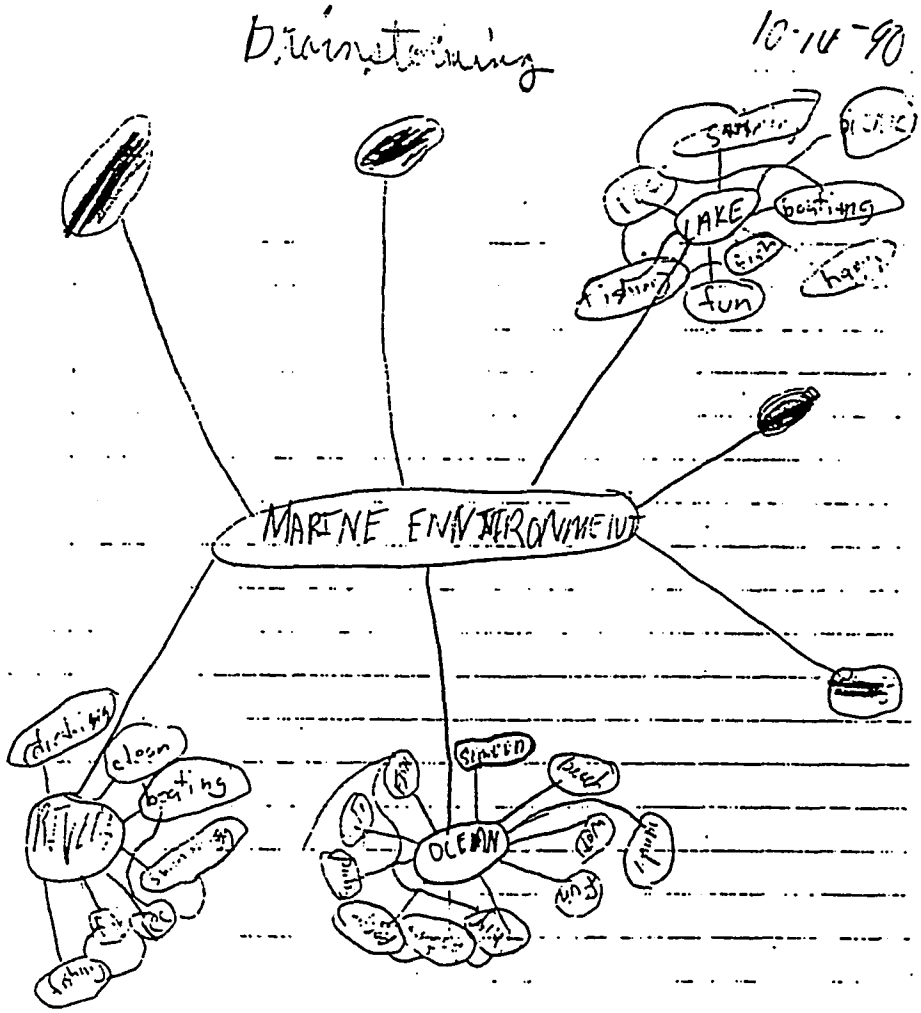
OR

Drawings. Draw or sketch anything you want about the marine environment.

3. Mr. Howick wants to see you journal once a week (on Fridays)

Appendix F

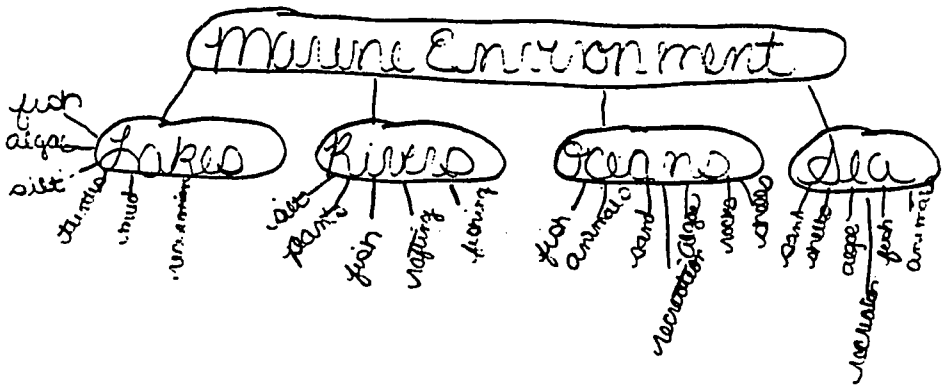
Initial Class "Brain Storming" Maps



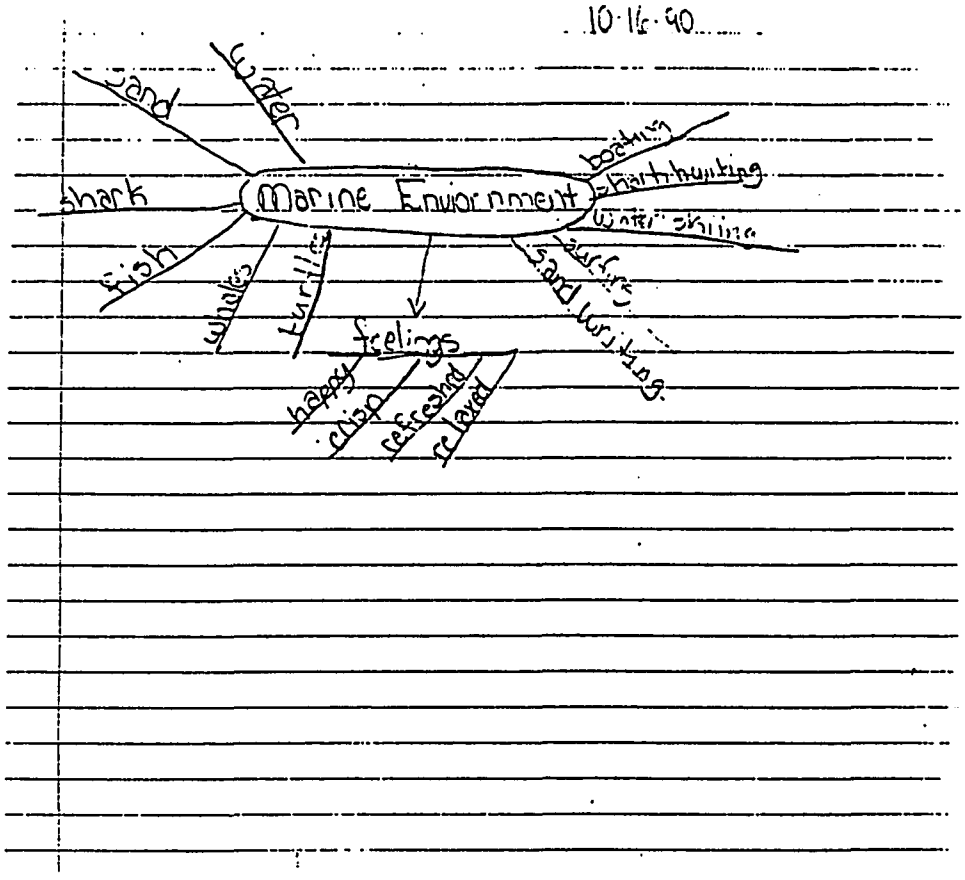
Alan's first "brain storming" map

Oct. 16, 1998

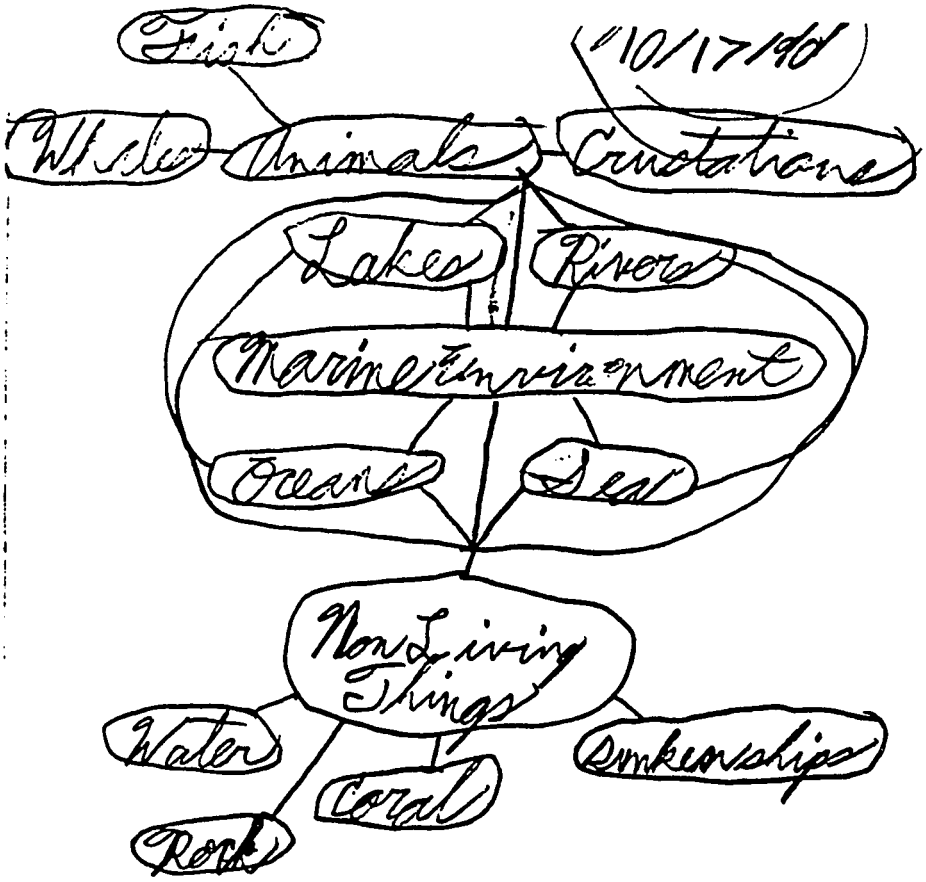
study—pollution



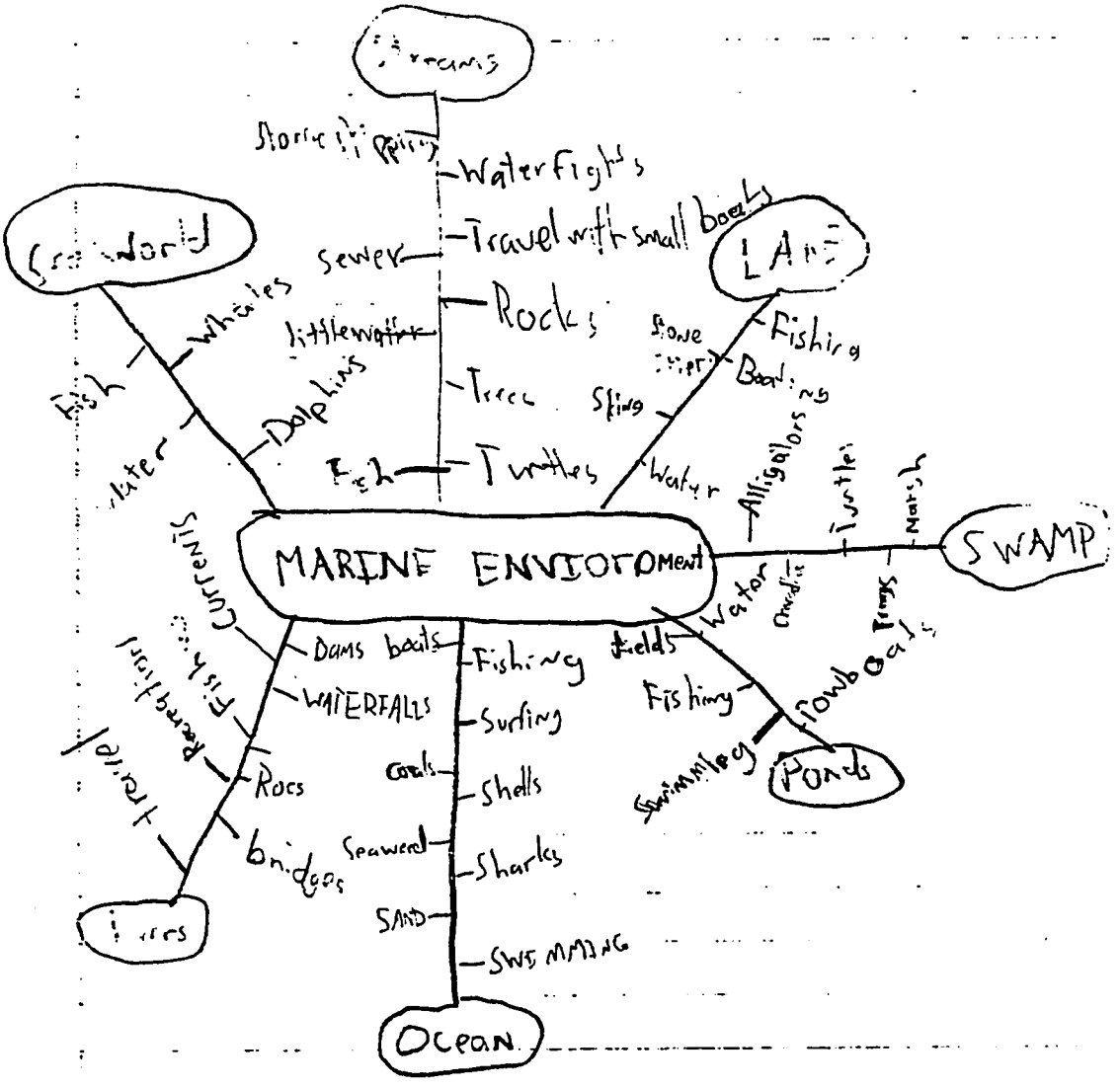
Kathy's first "brain storming" map



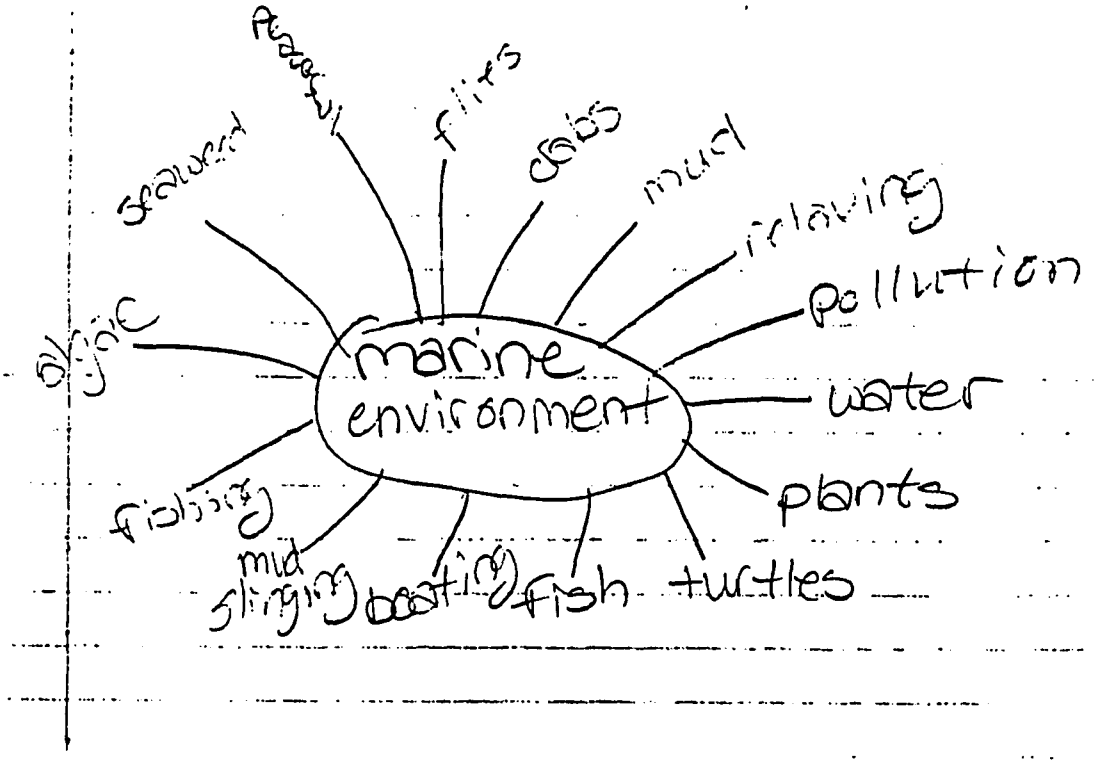
Lisa's first "brain storming" map



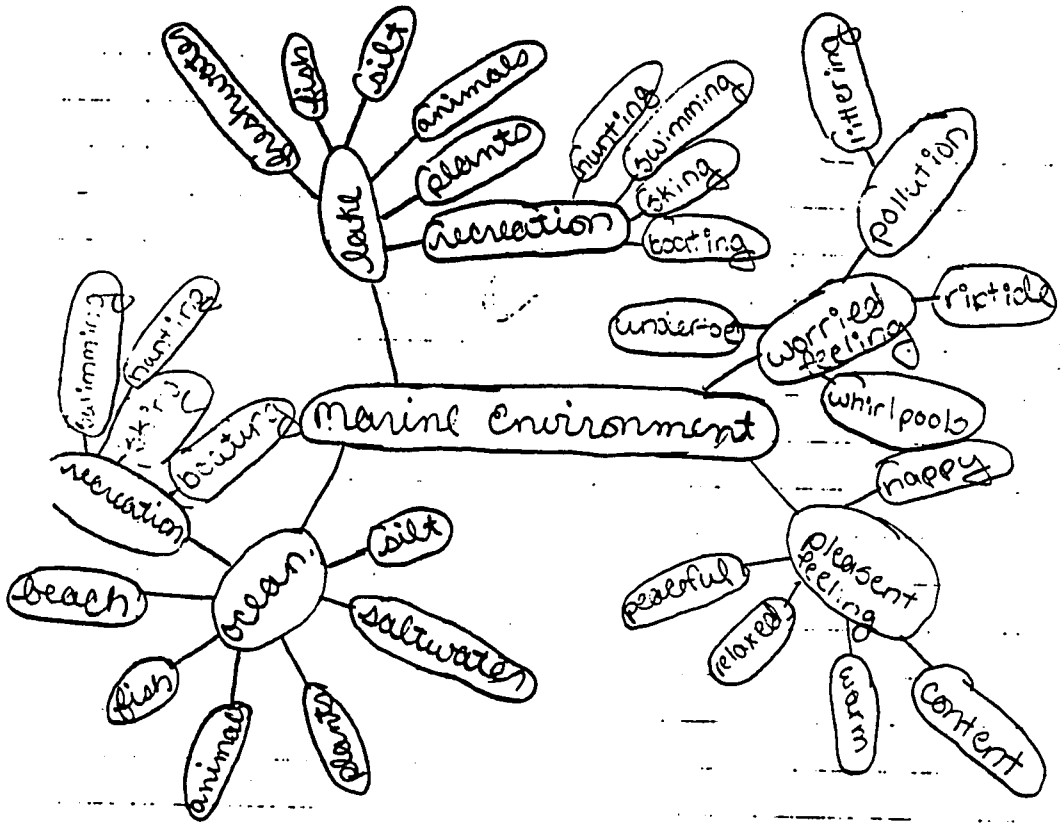
John's first "brain storming" map



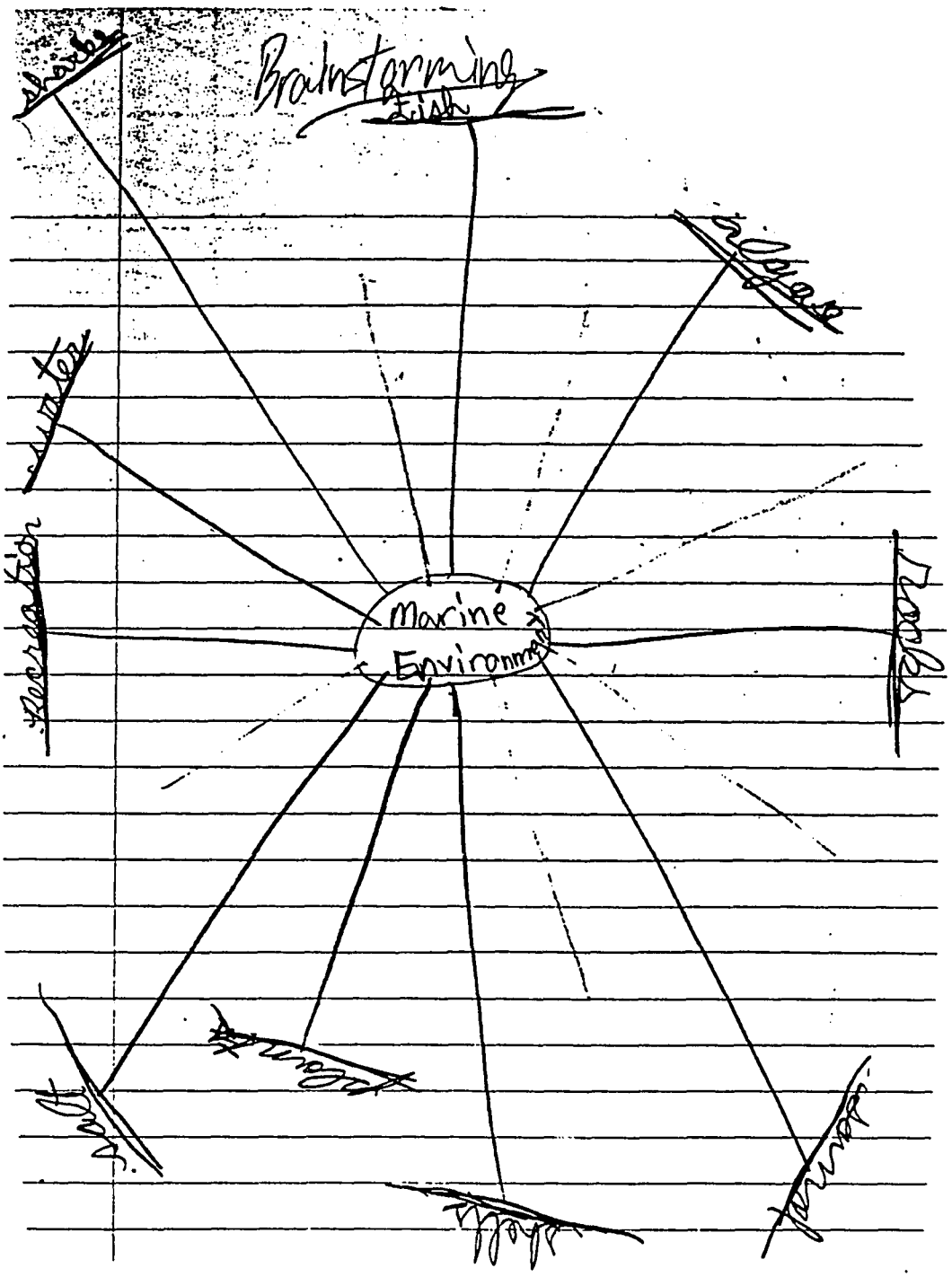
Henry's first "brain storming" map



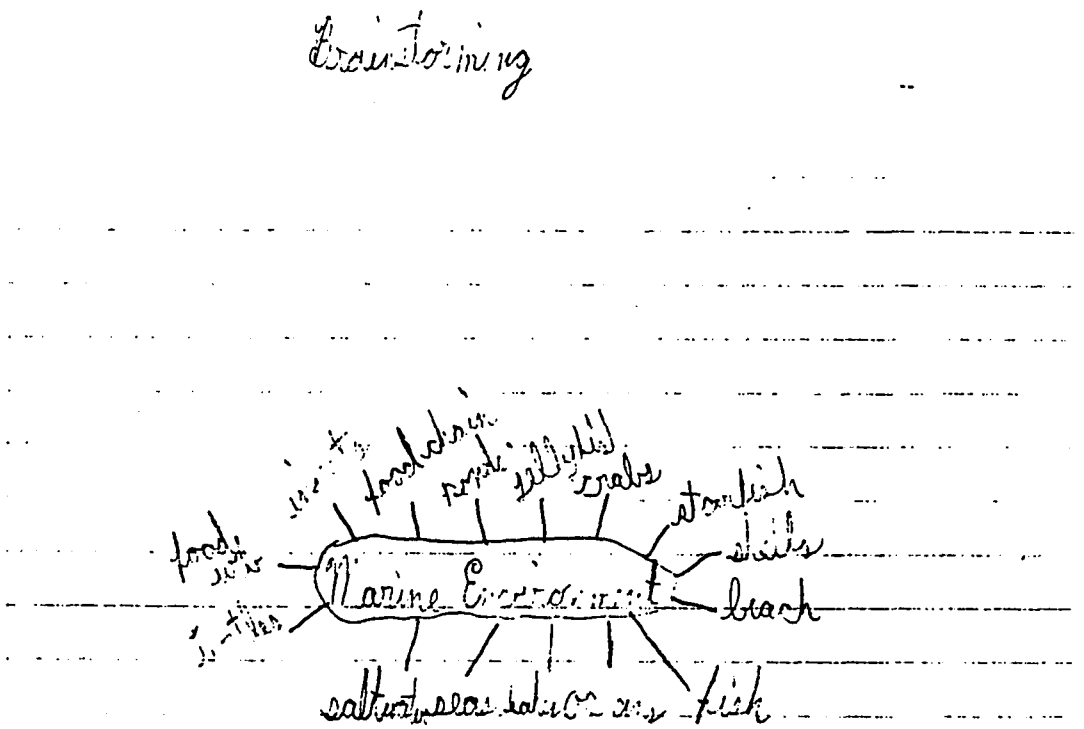
Sally's first "brain storming" map



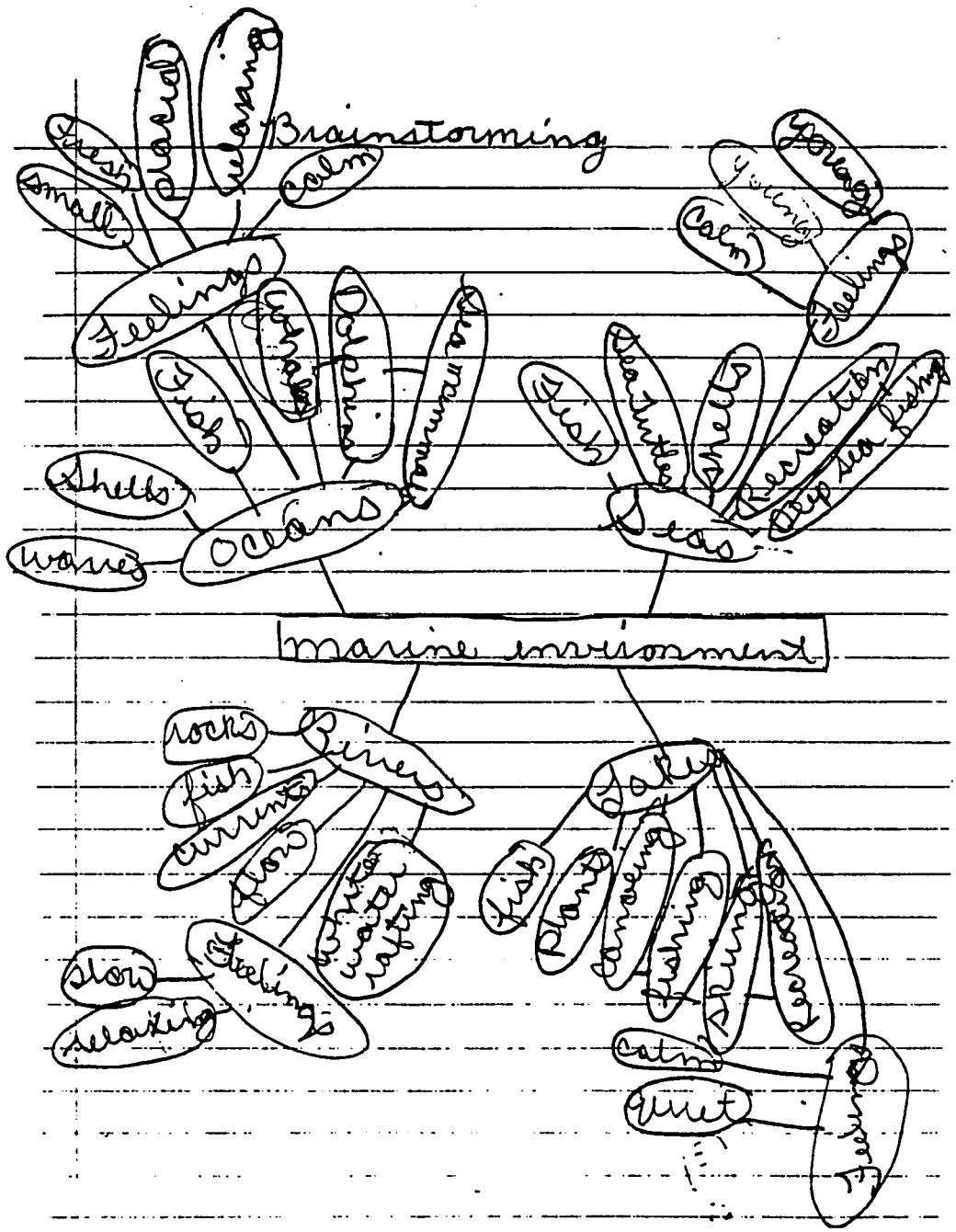
Christie's first "brain storming" map



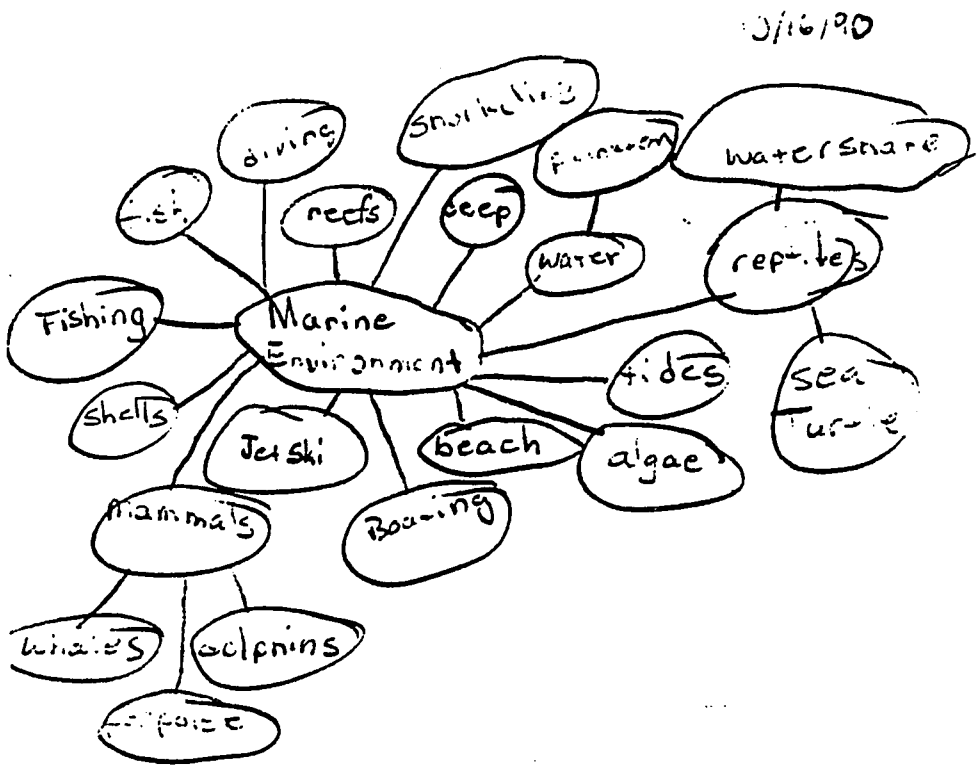
Fran's first "brain storming" map



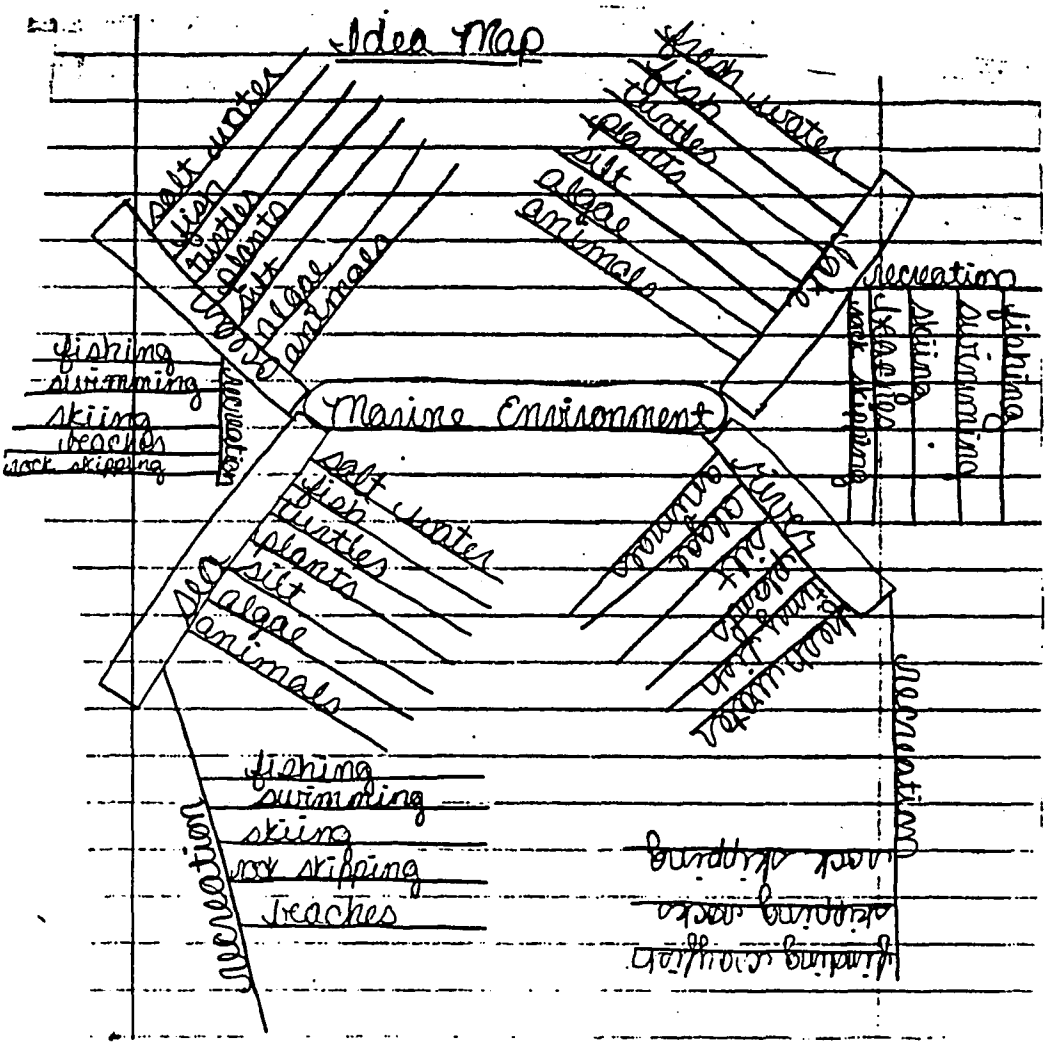
Adam's first "brain storming" map



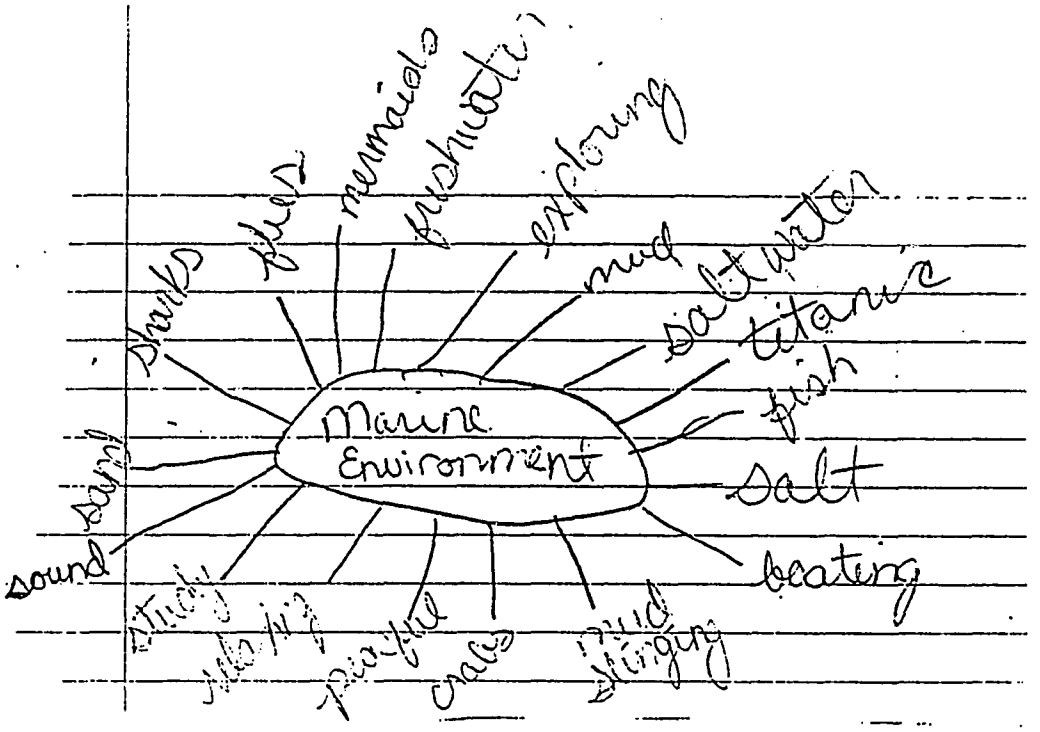
Ming's first "brain storming" map



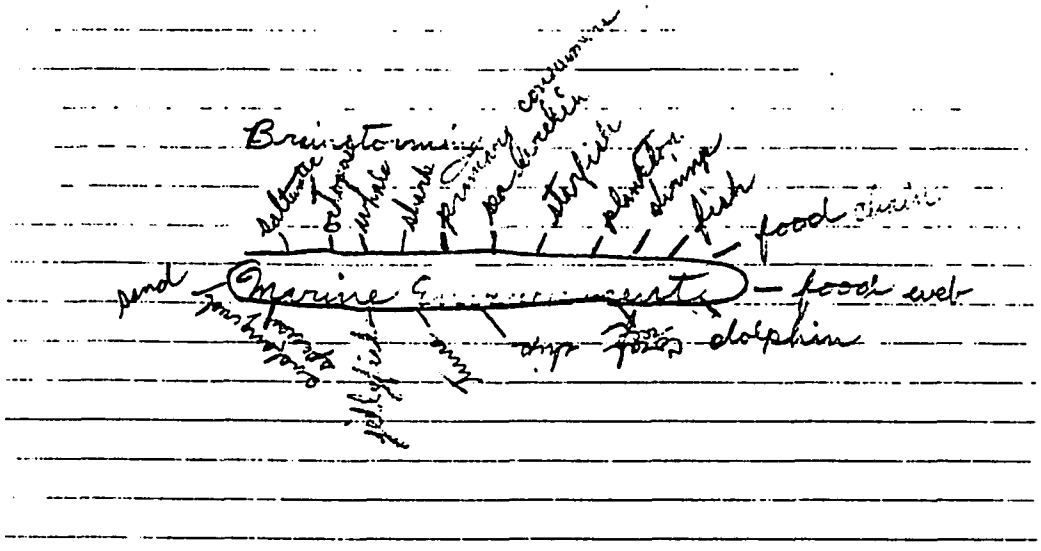
Tom's first "brain storming" map



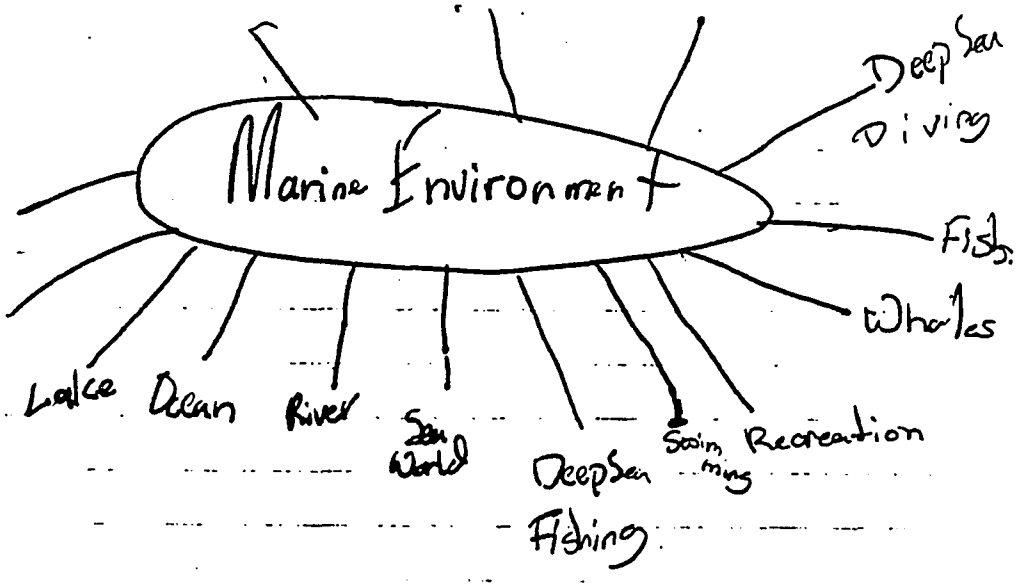
Susan's first "brain storming" map



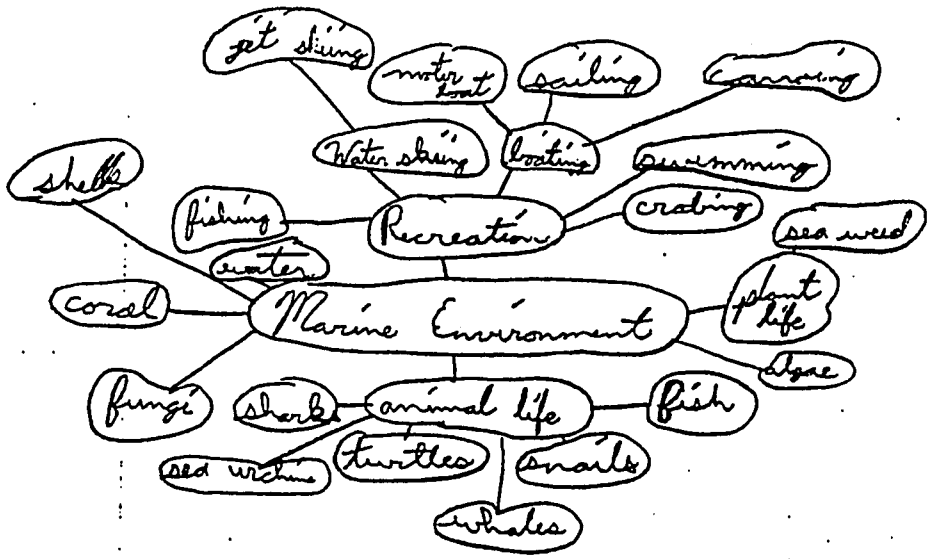
Sooky's first "brain storming" map



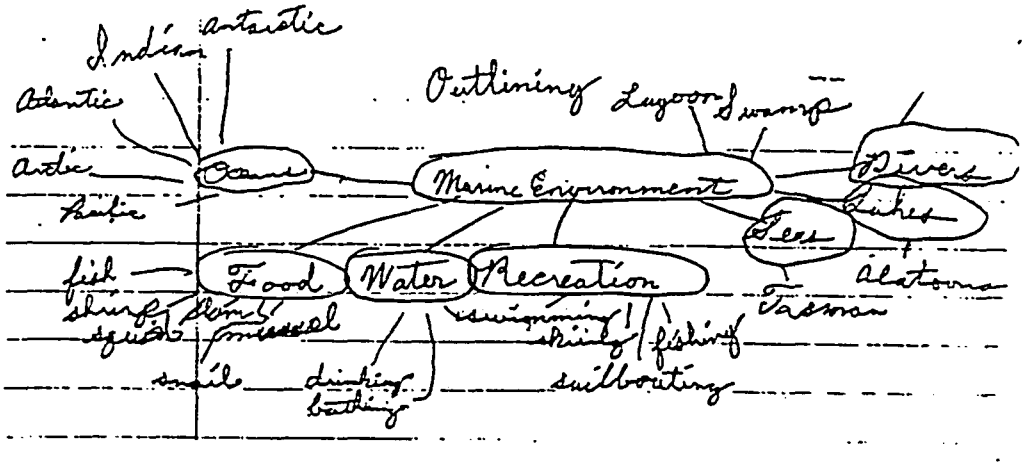
Ed's first "brain storming" map



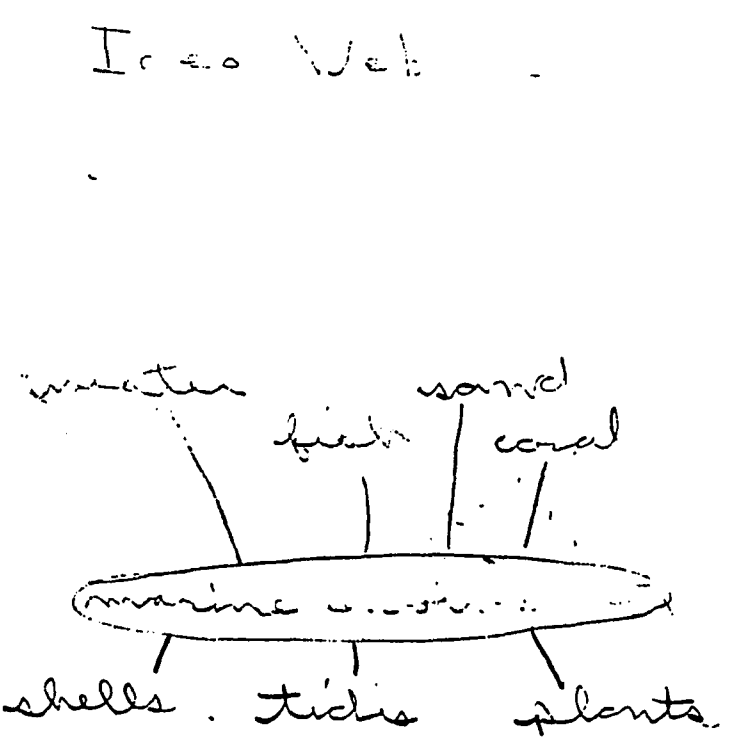
Art's first "brain storming" map



Mitch's first "brain storming" map



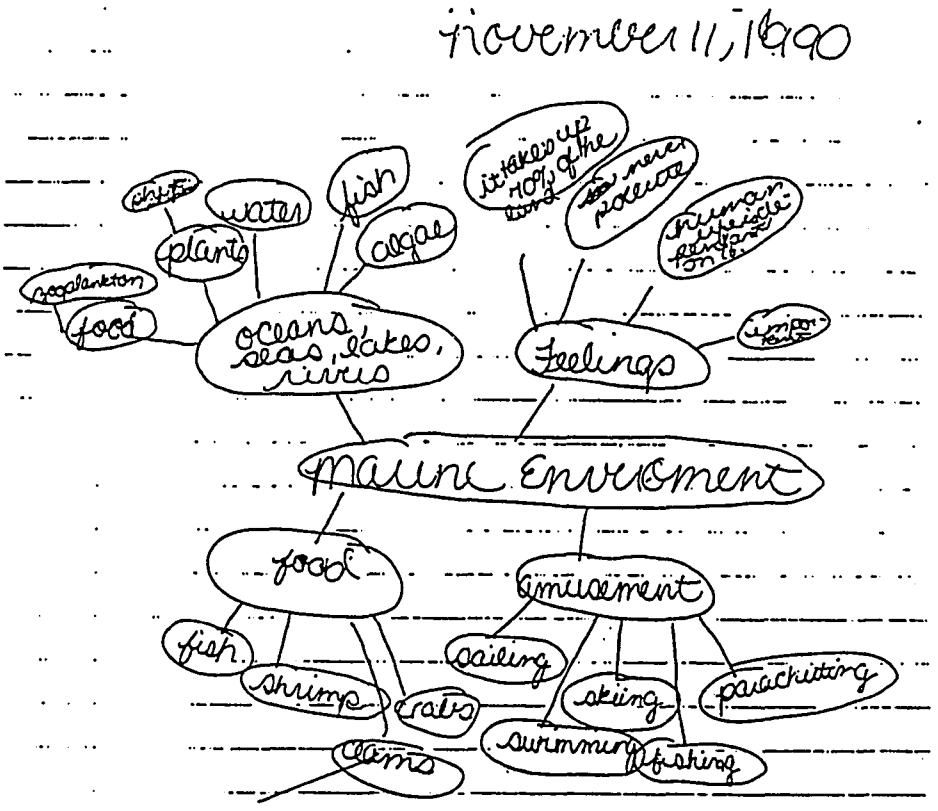
Al's first "brain storming" map



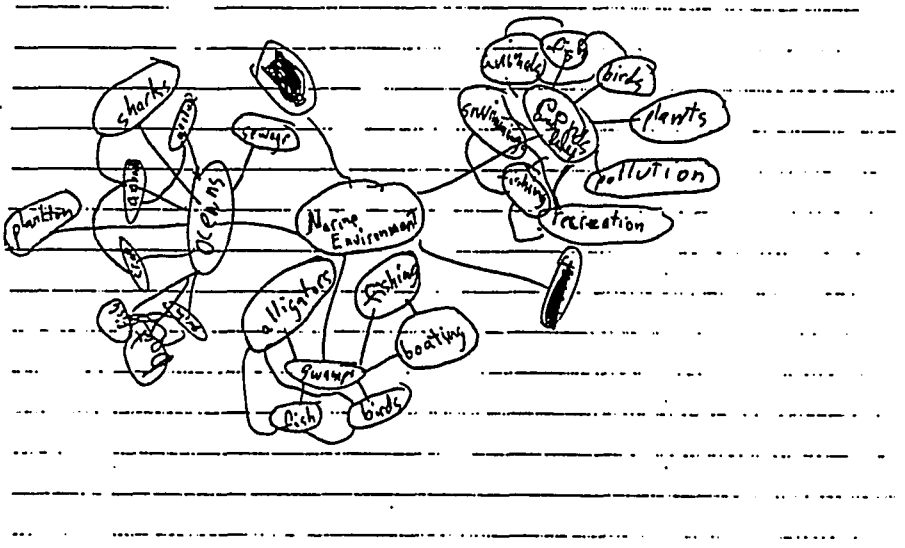
Pat's first "brain storming" map

Appendix G

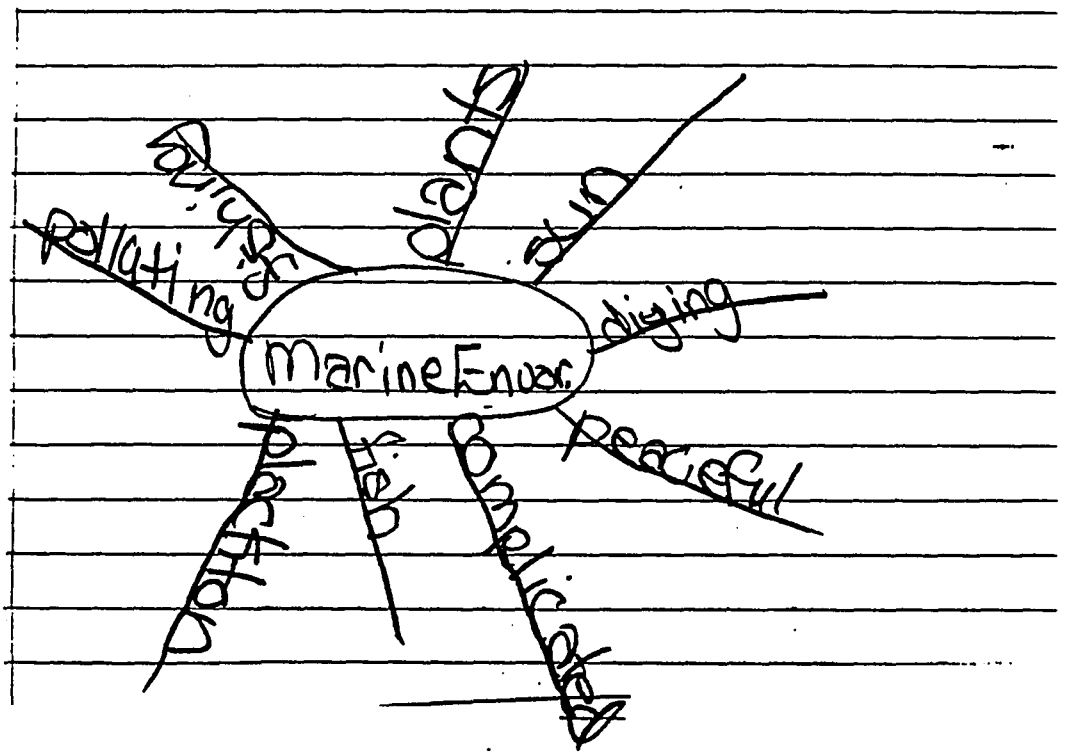
Final Class "Brain Storming" Maps



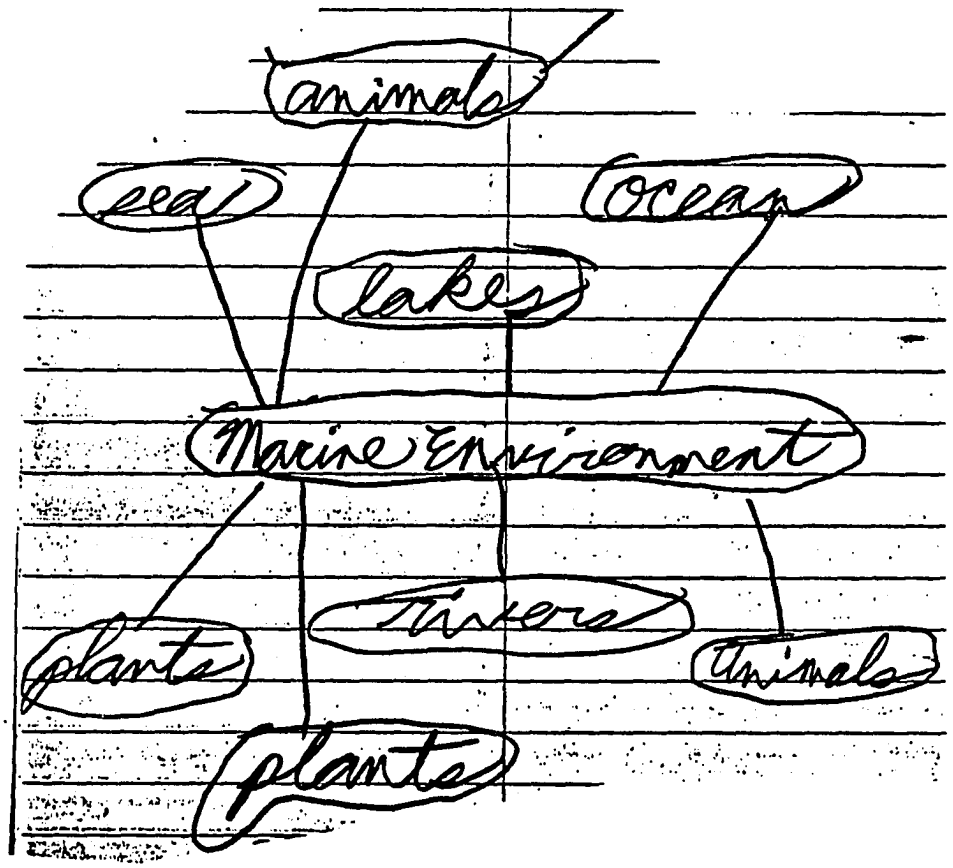
Kathy's final "brain storming" map



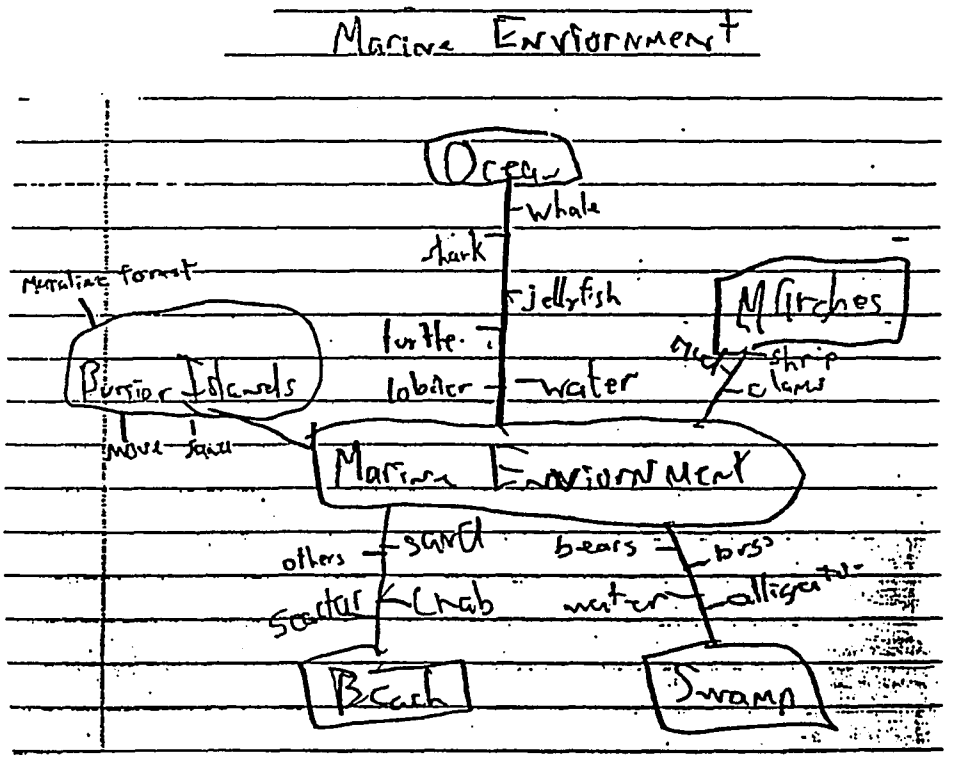
Adam's final "brain storming" map



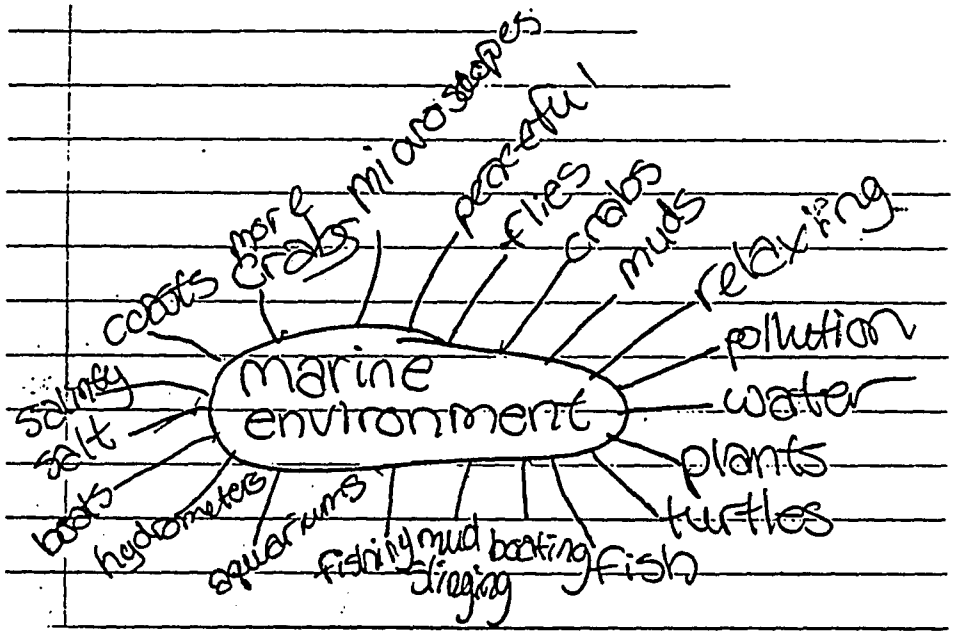
Lisa's final "brain storming" map



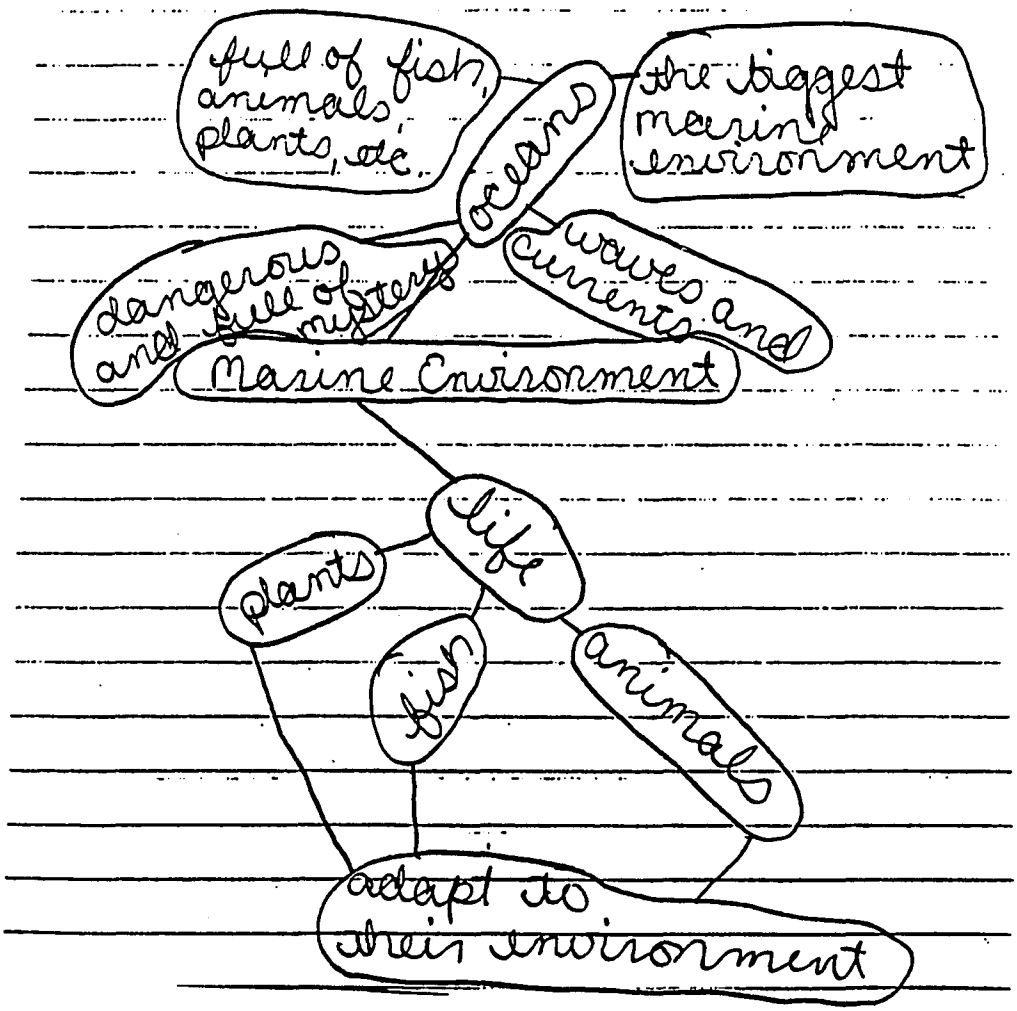
John's final "brain storming" map



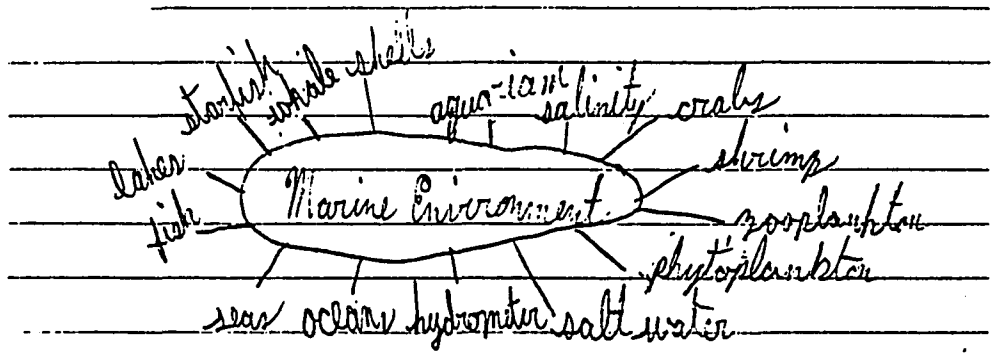
Henry's final "brain storming" map



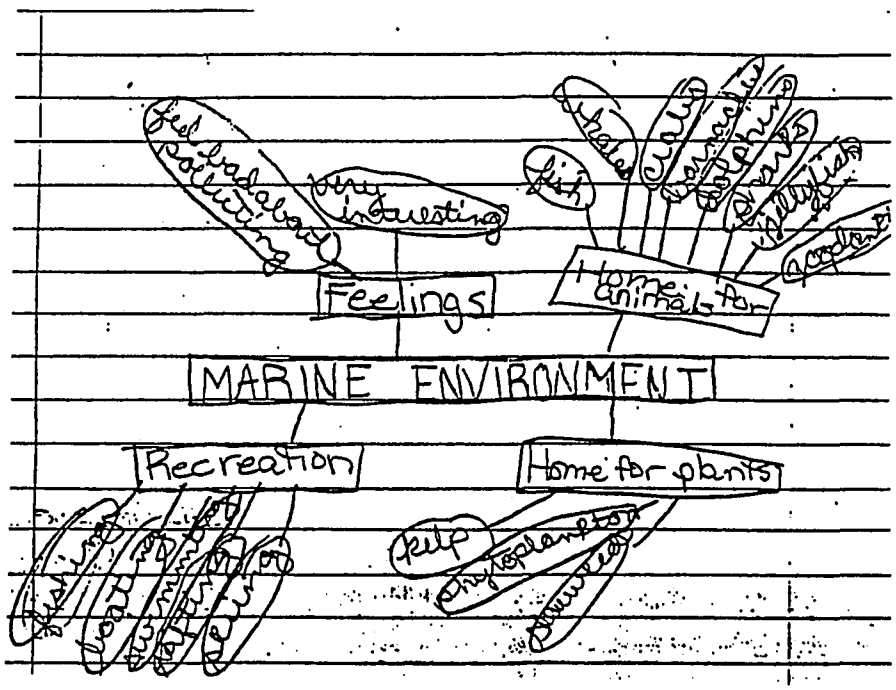
Sally's final "brain storming" map



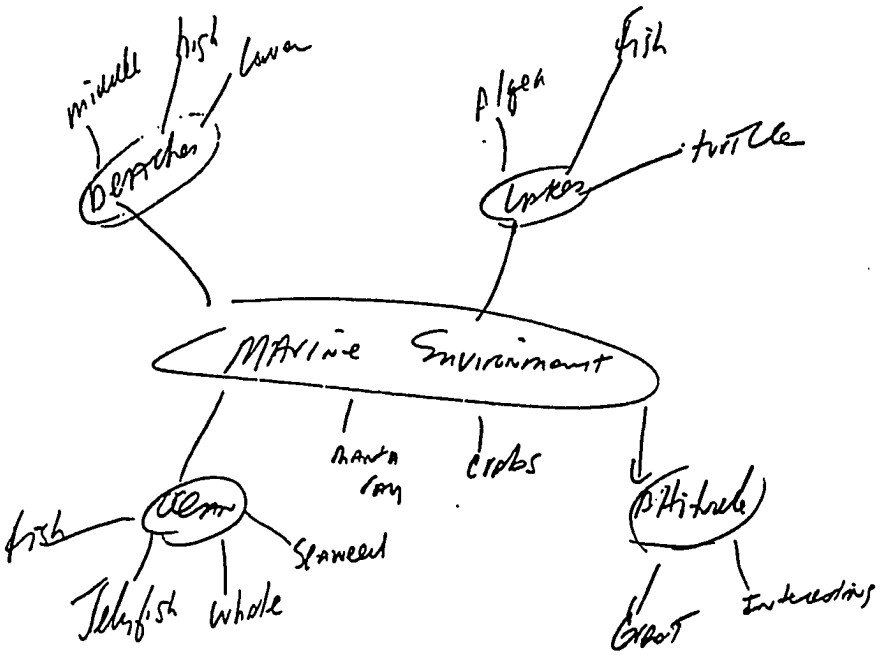
Christie's final "brain storming" map



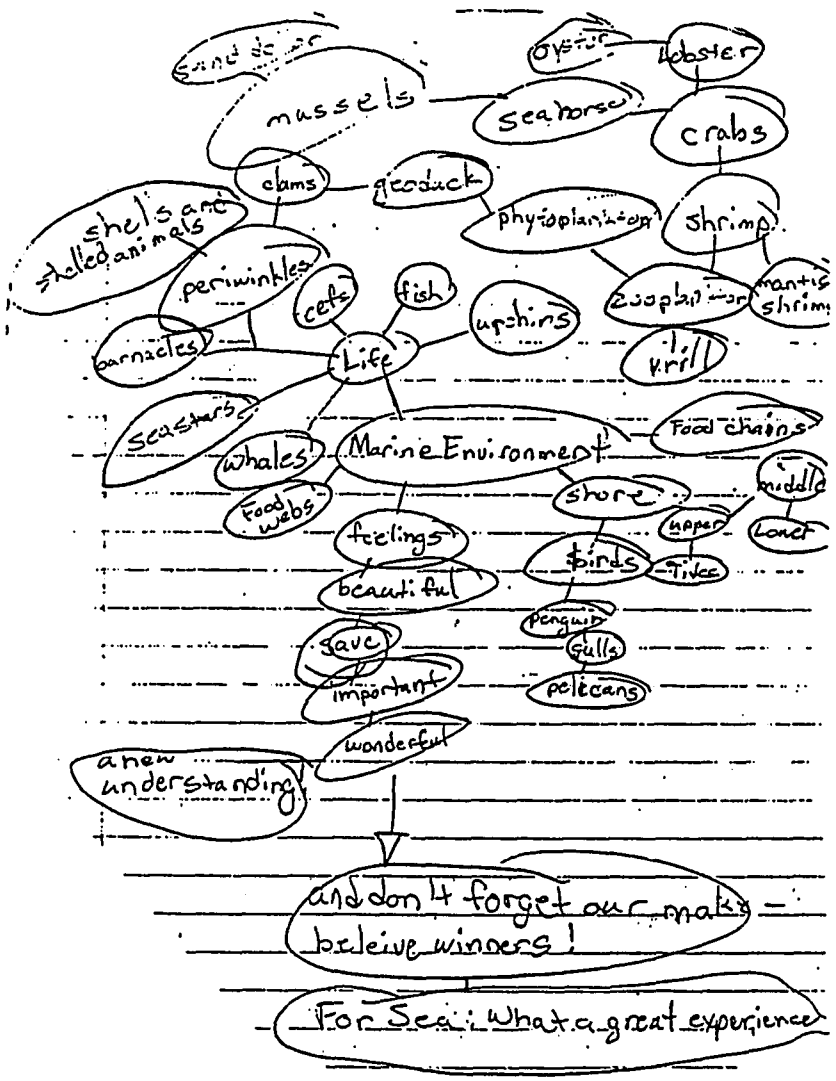
Adam's final "brain storming" map



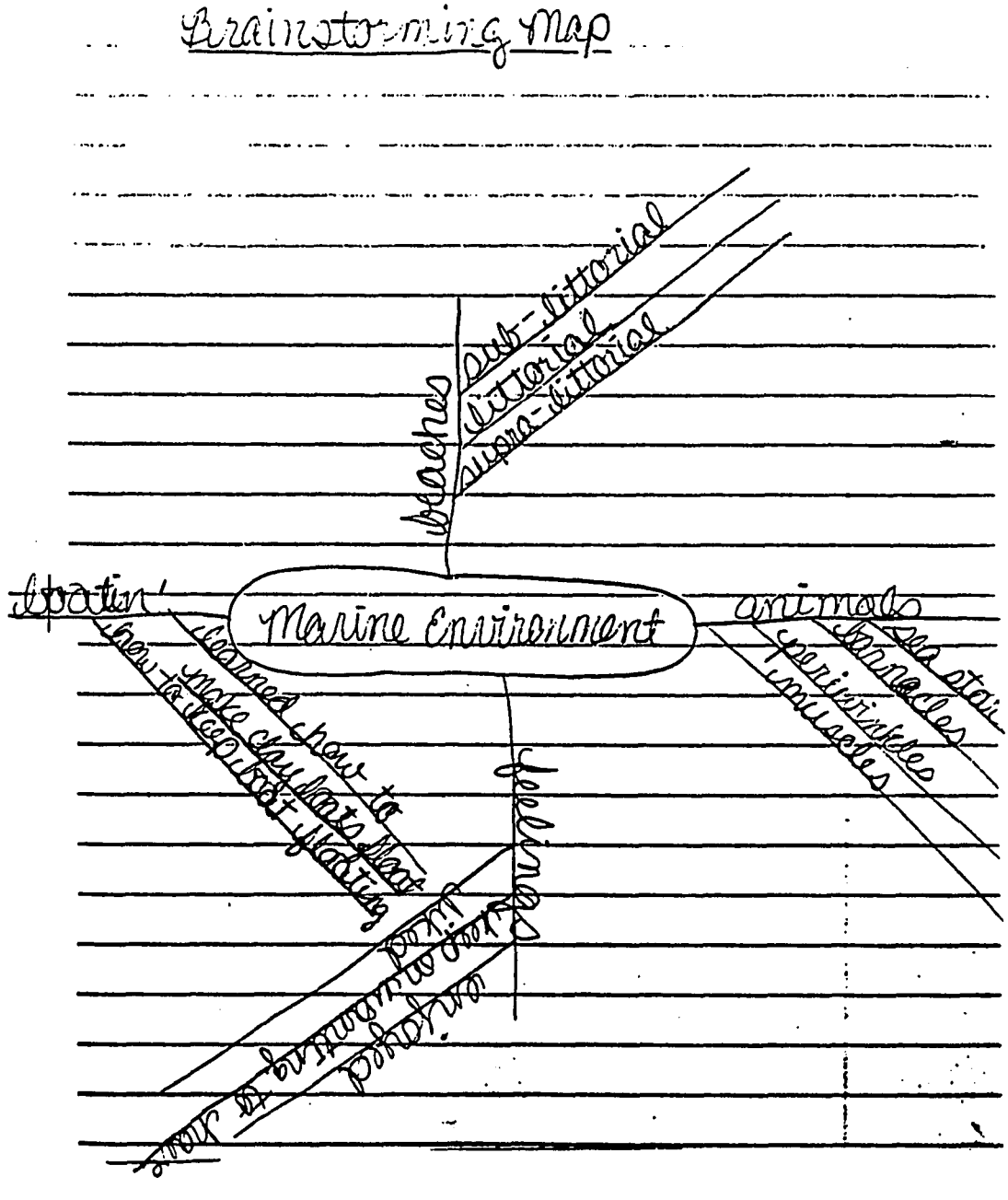
Ming's final "brain storming" map



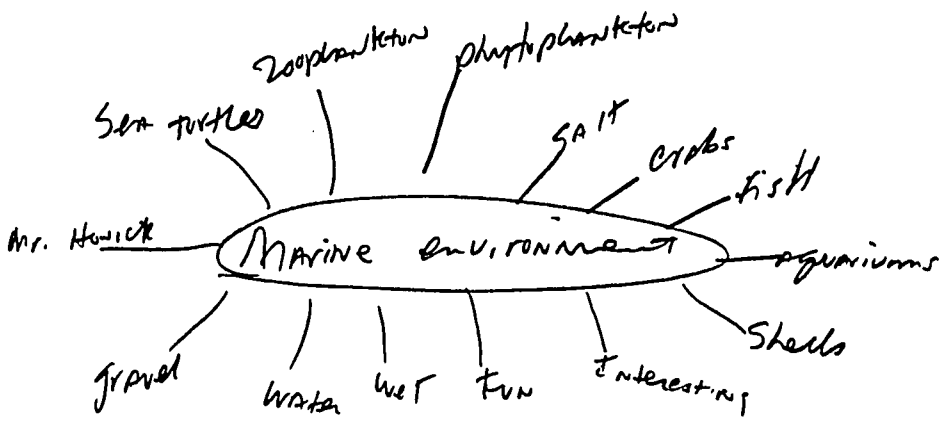
Jack's final "brain storming" map



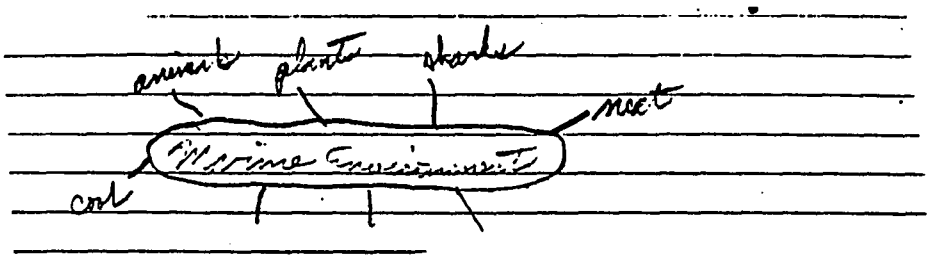
Tom's final "brain storming" map



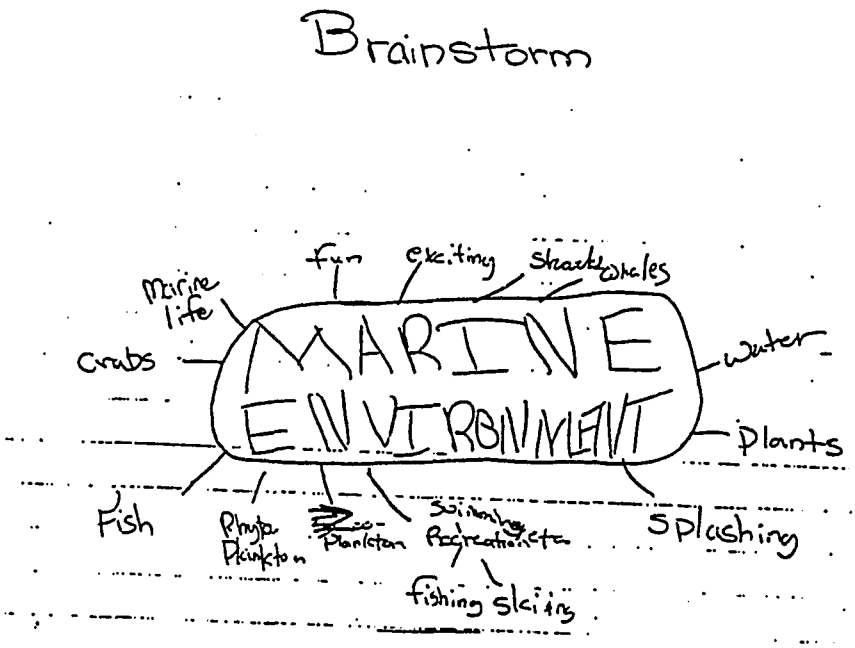
Susan's final "brain storming" map



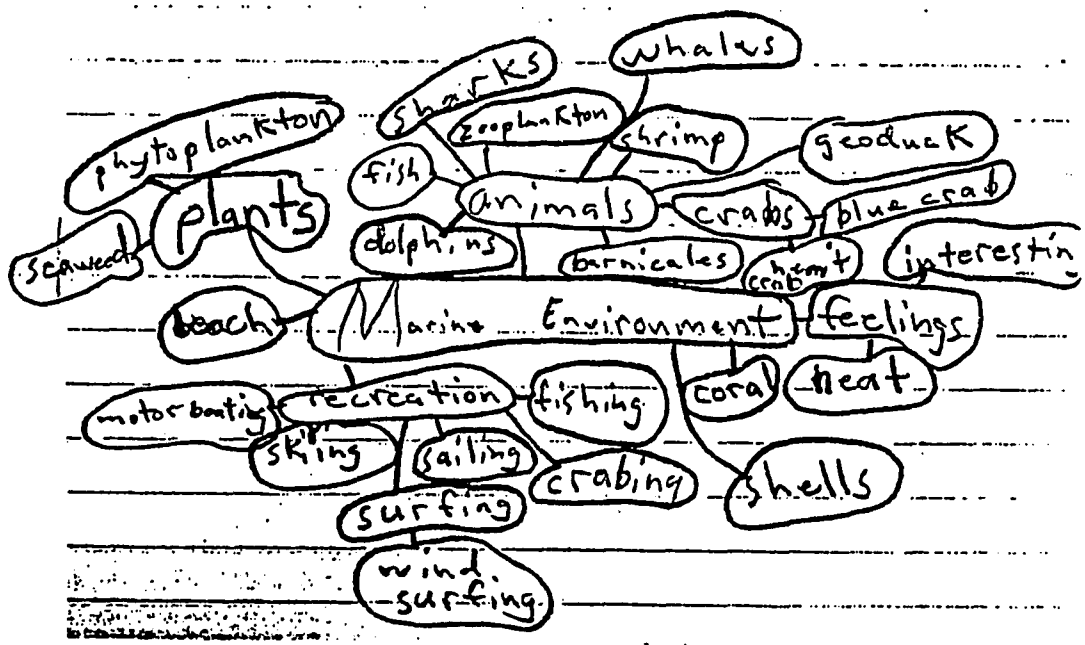
Sooky's final "brain storming" map



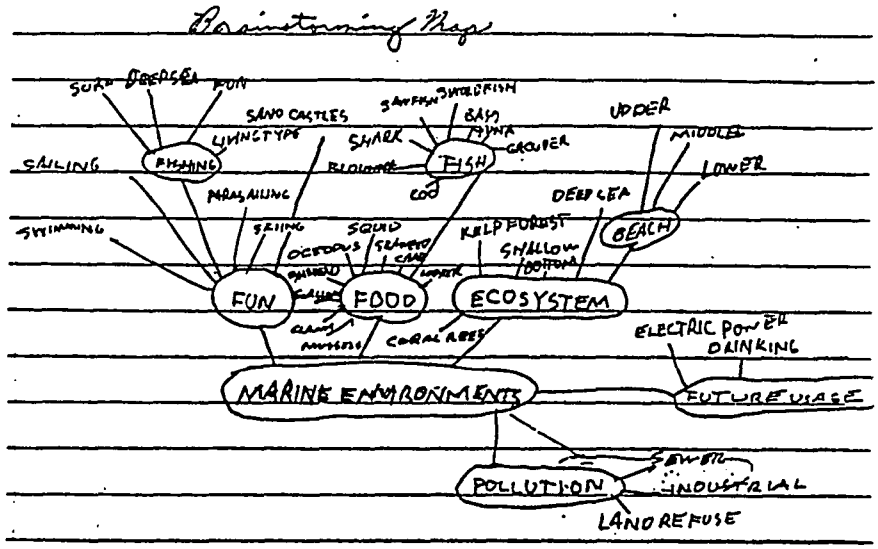
Ed's final "brain storming" map



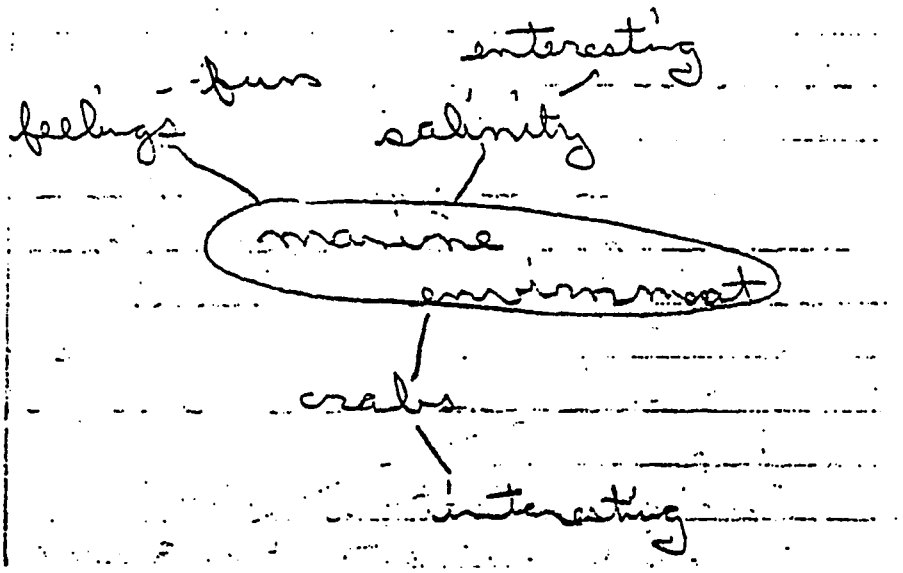
Art's final "brain storming" map



Mitch's final "brain storming" map



Al's final "brain storming" map



Pat's final "brain storming" map

Appendix H

Questionnaire After the FOR SEA Study

Name_____Date_____

Questionnaire After FOR SEA Study

1. Discuss some of your experiences (positive and negative) about the marine environment that happened during the last 4 weeks.

2. Discuss your feelings (positive and negative) about the marine environment because of the last 4 weeks experience with **FOR SEA.**

3. Suppose you met someone from a different planet that never saw or knew anything about the marine environment.
What would you tell them about your own feelings (positive and negative) about this environment?

How would you describe the marine environment to that person?

4. What is the importance of the marine environment?

5. What is the relationship of man (people) to the marine environment?