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Influencing Students To Become Stewards Of The Earth's Ocean

Jenifer Trimble
University of Central Florida

INFLUENCING STUDENTS TO BECOME STEWARDS OF THE EARTH'S OCEAN
THROUGH A RESIDENTIAL MARINE CAMP EXPERIENCE

by

JENIFER L. TRIMBLE
B.S. University of Central Florida, 1983

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Major Professor: Juli K. Dixon

ABSTRACT

The purpose of this action research study was to document 8th grade students' experiences at a residential marine learning facility as they discovered the interconnections between life on Earth and its dependency on ocean health. My goal was for students to take their new knowledge and share it with others in a quest to become educated and caring stewards of the Earth's ocean. Students in this study participated in open peer and instructor discussions, performed full and guided inquiry activities, and snorkeled among the shallow water habitats that transition from mangroves toward coral reefs to discover the interconnections among shallow water marine habitats and the critical necessity of biological diversity among habitats.

The processes used to collect data for this action research study were a pre/post knowledge assessment about coral reefs, videotaped conversations among peers and instructors, photographs documenting student engagement in activities, and interviews conducted at the conclusion of the trip. The themes that emerged included a mindset of ocean stewardship, deep engagement in inquiry-driven activities while interacting among peers, the ability to clearly articulate the effects of human impact on biological diversity and the need to maintain sustainable shallow water ecosystems that are biologically diverse.

Although this study was only conducted over a three day weekend, the emergent themes highlight the value of providing students with opportunities to interact with nature. Experiential learning not only contributes to the various ways of knowing but such experiences help students

develop a stronger sense of self perception and values as they begin formulating their sense of relationship to and responsibilities toward their own communities and the larger, natural world.

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CHAPTER 1 INTRODUCTION

The case for teaching children about the importance of the world's ocean is highlighted in National Geographic's (2006) *Ocean Literacy*. Despite the fact that the ocean covers most of our planet, is the source of most life on Earth, provides food for much of the human population, regulates our weather systems and climate, and produces most of Earth's oxygen, the ocean and aquatic sciences are among the most underrepresented disciplines in K-12 educational curricula. In fact, they are rarely taught at any grade level. Ocean education is mentioned infrequently in state and national standards. To be considered "ocean literate", students should not only understand essential ocean principles and fundamental concepts; they should also be able to communicate in meaningful ways about the connection all life on Earth has with oceans and be able to make informed and responsible decisions about our ocean and its resources (*The ocean literacy: The essential principles of ocean sciences K-12.*2006).

The Next Generation State Standards (NGSS) teams, under the organizing body of the National Research Council are in the process of developing internationally benchmarked science standards that are rich in content and practice across all disciplines and grades (http://www.nextgenscience.org/development-overview). The NGSS is a collaborative effort among scientists, science educators, business, and industry and will work with these groups/teams in an advisory capacity before the standards are completed and released in early 2013 (Achieve, 2012). Craig Strang, the National Marine Educator's Association (NMEA) President-Elect asked the NGSS teams in an open letter in February 2012 to consider incorporating the most up to date knowledge our nation has regarding ocean literacy (Strang,

2012) “We have a powerful opportunity to ensure that every child gains a broad understanding of the importance of the ocean, especially its influences on the economy, climate, biodiversity, our food sources, and to the overall quality of our lives. Including ocean sciences in the NGSS is the single most important action that can be taken to alert the public to the importance of keeping our ocean healthy” (Strang, 2012).

Purpose of Study

The purpose of this study was to determine if my students' experiences at a residential marine learning facility helped them develop a deeper and personal enthusiasm for a lifetime of learning about the natural world - particularly ocean sciences. As they discovered the interconnections between life on Earth and its dependency on ocean health, my goal was that students would take the knowledge they gained from their residential marine science experience and share it with others in a quest to become educated and caring stewards of the Earth’s oceans.

Questions

In initiating this action research, my central question was “How does a residential marine facility learning experience influence students' attitudes about becoming stewards of the Earth’s ocean? During and after the field trip, I chose to analyze three essential questions:

1. In what ways did a residential learning experience at ©Seacamp influence students’ ocean stewardship?
2. In what ways did a residential learning experience at ©Seacamp influence students’ understanding of the effects of human impact on the biological diversity of shallow water ecosystems?

3. How was students' engagement in the learning process influenced during their experiences at ©Seacamp?

©Seacamp, located at Newfound Harbor Marine Institute (NHMI) on Big Pine Key, Florida is an outdoor residential facility designed for students to receive intensive, hands-on marine science education in a marine sanctuary setting. Students' experiences included snorkeling among the only living coral reefs in the United States, which are located in the Florida Keys. Additionally, during their stay students performed laboratory experiments modeling real-life environmental stresses marine organisms experience due to the negative impact of human activities. They studied symbiotic relationships among marine organisms and learned about the critical importance of stable, biologically-diverse marine populations from the patch reefs and grassy flats to sponge beds and the mangrove trees ringing the shorelines of the tiny islands around NHMI which represent the Florida Keys shallow marine ecosystems. Their "classroom" consisted of the coral reefs, mangrove islands, sea grass communities, tidal pools and open air laboratories. Students spent three days immersed in the wonders of the marine environment while sharing discoveries with peers through laboratory experiences - all while developing an awareness of the interdependence of all living things.

Data for this study were collected using a pre and post trip ocean knowledge assessment about coral reefs and biodiversity; photographs taken by students, chaperones, and I of students' experiences and examples of the animals they captured during snorkeling, transcriptions of students' conversations among peers and ©Seacamp instructors from videotaped activities, videotapes, and interviews I conducted on the return trip on the bus as well as at school..

Rationale

I designed a course called "Ecology of the Florida Keys" for an electives component at my middle school to help educate 8th grade students in their understanding of the impact of human activities as they relate to the decline of the world's ocean ecology and ultimately, the biological diversity of ocean life. The human activities adversely affecting our oceans include, but are not limited to: global warming, ocean acidification, individual and industrial pollution, over-fishing and incidental by-catch, and the destruction of marine shoreline habitats (Hughes, Bellwood, Folke, Steneck, & Wilson, 2005) However, the only marine experiences students have in my elective course are through the World Wide Web, articles I provide from scientific magazines, and DVD movies about biodiversity, coral reef symbiotic relationships, global warming, and other relevant topics. Students not enrolled in my elective course are unlikely to have any interaction with such topics unless their seventh grade teacher introduced these topics in an ecology unit. By teaching this course and concluding the school year with an opportunity to participate in a residential marine science program working with real scientists doing real scientific research, I hoped to bring awareness to students regarding how human activities impact our oceans through authentic learning experiences and provide an opportunity to explore marine science career paths for interested students. The field trip was open to all 8th grade students.

Prior to this study, I took 8th grade students from three previous school years to ©Seacamp. Because the elective course is limited by the number of students who may register, I believe the ©Seacamp experience should be open to any student interested in exploring marine science. Hence, almost half of the students attending ©Seacamp were not my assigned students and had never taken my semester-long ecology course. I wanted to see if students' awareness of the impact of human activities on our oceans – in particular, how such activities negatively impact the biological diversity of Florida's coral reefs and shallow water ecosystems – changed after their experience at ©Seacamp. My goal was to bring life to the lessons I teach in my Ecology of the Florida Keys elective (or to learn marine science for students who were not able to enroll in the elective) through authentic ocean experiences by providing a unique learning opportunity for all students fortunate- enough to have the financial means to attend the field trip.

Significance of Study

John Dewey believed students' experiential differences must be taken into account when designing curriculum and teaching scenarios if education is to be effective (Dewey, 1933). Humans are sensitive to their past experiences which in turn influence the nature of their future learning experiences. Quality education is then defined as meaningful and relevant to students. Dewey further emphasized that a primary responsibility of educators is recognizing what surroundings are conducive in contributing to learning growth: educators are responsible for developing experiences into meaningful events using the physical and social aspects of the learning environment (Dewey, 1938). Jean Piaget pioneered the documentation of the effects of inquiry science on children's learning by encouraging students to participate in experiments that they designed. Students' cognitive development could be facilitated through the processes of assimilation, accommodation and reorganization instead of simply responding to "prescribed" methods from teachers (Piaget, 1952). Piaget believed if students were to learn science to their highest potential, ample opportunities for discussing thought processes while engaging in experiments must be provided. Lev Vygotsky believed students are capable of performing at higher intellectual levels when they work in collaborative situations rather than individually

(Vygotsky, 1978). Vygotsky strongly believed that community plays a central role in the process of “making meaning” (McCleoud, 2007). Presently, the National Research Council (NRC) emphasizes the critical need for communication as part of the inquiry process (National Research Council (U.S.), 1996). The ©Seacamp experience immersed students in learning opportunities in which they examined the biological diversity of marine ecosystems, made predictions based on their observations, experimented with their predictions, recorded their results and shared their results with peers. According to the NRC inquiry involves critical thinking, the use of logic, and the willingness to consider new ideas which will generate authentic and autonomous learning (National Research Council (U.S.), 1996). Experiential learning at ©Seacamp connects excitement and socialization with intensive, novel learning opportunities which may stimulate students’ critical thinking abilities in understanding the need for ocean stewardship, marine science career paths, and protection of ocean coral reef ecosystems. Research highlighted the social nature of scientific practices, showing that scientific knowledge is co-constructed and distributed among peers (Radinsky, Oliva, & Alamar, 2010). Radinsky’s study suggested that in the real world, new knowledge is more often generated in professional communities of scientists through a process of collective, contested and negotiated communication through the mutual accommodation of ideas (Radinsky et al., 2010). ©Seacamp provided a marine experiential setting for peers to experiment, explore, and discuss the marine flora and fauna of the Florida Keys among themselves and their instructors. Recent research has challenged traditional assumptions that learning new knowledge and scientific practice are essentially individual accomplishments, highlighting instead the social nature of scientific practices and co-constructing scientific knowledge among peers (Radinsky et al., 2010). Students in this action research were provided a myriad of opportunities to "weave together many strands of meaning" running through a classroom – the artifacts, utterances, and interactions of a community of members (Roth, McGinn, Woszczyna, & Boutonne, 1999). Experiential learning facilities such as ©Seacamp provided the space and time not often afforded in a regular classroom for deeper discourse and learning. The ©Seacamp experience is centered on a constructivist approach. Instructors help students scaffold and process previous knowledge into new knowledge regarding human impact on coral reef and shallow water marine environments and global ocean ecology, guiding students toward developing answers to questions such as *How do humans negatively impact marine biodiversity through their actions of polluting, introducing exotic species into native habitats, and recreational activities? What do students currently know and what did they learn during their ©Seacamp experience about symbiotic relationships between mangroves, coral reefs and the plethora of marine organisms which live within, between, and among these two ecosystems?* ©Seacamp activities involved a total immersion into marine science learning through the use of hands-on inquiry activities that were centered on peer interaction and peer-instructor interaction. Methods such as these described more likely result in meaningful and higher intellectual conversations that may be woven into students' learning experiences. Dewey wrote of the importance of diversifying the curriculum through community connections and that true education is defined within which the social situation children learn (Dewey & Small, 1897)

Assumption

This study was conducted under the assumption that students would be willing to participate by completing the Coral Reef Knowledge Survey (Appendix H) surveys just prior to and directly after their ©Seacamp experience and that all students would be interviewed. A second assumption was students would also have access to all preplanned and advertised experiences associated with ©Seacamp's mission statement.

Limitations

One limitation in this study was the brevity of the ©Seacamp experience: The program lasted only 2.5 days. Another limitation was the cost of ©Seacamp; it prevented many students who would have liked to attend from doing so. A final limitation was the opportunities afforded to students relied directly on weather conditions with which this researcher had no control.

Summary

The primary focus of this study was to record the effects of field embedded inquiry-based learning experiences on students' attitudes and ocean stewardship by documenting the conversations students had with each other, their instructors and with me about their understanding of the impact human activities have on marine shallow water biological diversity after a three day residential experience at a marine science center - ©Seacamp. Interview questions would also be used to determine if students' understanding included the importance of sharing their new knowledge with others. I feel responsible as a marine environmental educator in helping my students develop a foundation of global ocean stewardship. Building such a foundation and attitude of ocean stewardship for protecting the biological diversity of marine ecosystems requires time for exploration, learning among peers through discussions and experiments and reflection time about the importance of the interconnections between and among marine organisms and their habitats.

Chapter two, the literature review, begins with an overview of the need for ocean literacy and the importance of biodiversity on coral reef species The major themes discussed in the literature review include the lack of ocean literacy in the K-12 science standards; student learning through inquiry which embraces environmental stewardship; the benefits of experiential learning on students' environmental stewardship; and the importance of peer interaction in student learning. Chapter three provides a detailed description of the methods used to gather data prior to and during the trip, including the methods used to select participants, the setting of the study, instruments used to collect data, and an analysis of the data. Chapter four presents the data collected and an analysis of the data including a discussion of connections between the data I collected and my original research questions. Chapter five completes the thesis and recommends further research involving effective teaching and questioning strategies I can incorporate into the science classes I teach and how ocean literacy can easily be incorporated into science curriculum.

For the purpose of this study the following terms will be used:

Terms

Autotrophs – organisms (plants, algae and certain bacteria) that undergo photosynthesis: carbon dioxide and water in the presence of sunlight produce glucose and oxygen.

Biological diversity (Biodiversity) – the degree of variation of life forms found within particular species, ecosystems, or biomes. Not only does biological diversity represent the product of thousands of years of evolution and a vital component of human society's survival through to the present day (in terms of healthy peoples, healthy communities and sustainable livelihoods), it also serves as an absorptive barrier, providing protection from environmental shocks and stresses

Cassiopeia – the genus name of the non-venomous "upside down" jellyfish.

Constructivism – a philosophy that states children can learn by constructing their own meaning.

Ecosystem – the characteristic assemblages of plants and animals and the physical environment they inhabit (Beck, 2003)

Halimeda – the genus name of a green macroalgae found in marine tropical waters; its body is made of calcified segments.

Mutual symbiosis – a relationship between two organisms in which both benefit from the relationship.

Sustainable (sustainability) – Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations. Our existence depends upon what we have and will continue to have: the water, materials, and resources to protect human health and our environment (*What is sustainability?*2012)

Swimmerets - Any of a series of paired abdomenal appendages of many crustaceans, used for swimming and egg carrying.

Symbiont – for this thesis, symbiotic algae which live in the tissues of corals and which provide through photosynthesis more than half of the food for corals.

Turtle grass – of the species *Thalassia*; also commonly called sea grass, beds of turtle grass abound in the Florida Keys shallow water habitats and act as nursery grounds or homes for many fish and invertebrate species (Diersing, 2011) .

Zooxanthellae – symbiotic unicellular algae of the species *Symbiodinium* which live in the tissues of corals. They produce food by photosynthesis for the corals as well as contribute chemicals which help the coral calcify and protect itself {{127 Carbonnière, Aurélien 2008;}}.

CHAPTER 2 LITERATURE REVIEW

Need for Ocean Literacy

In April 2004, President Bush appointed a 16 member Oceans Commission which issued a report detailing the decline and deterioration of our nation's coastal waters. Upon the report's release, Admiral James Watkins, the Commission's chairman, commented "Our oceans and coasts are in serious trouble" (Barringer, Wednesday April 21, 2004). Other studies such as the Ocean Commission's report and the Pew Oceans Commission report *America's living Oceans: Charting a Course for Sea Change*, argue for new actions and approaches in helping mitigate and correct U.S. deteriorating coastal conditions (Steel, Smith, Opsommer, Curiel, & Warner-Steel, 2005). The challenge educators face is how to link curricula and students to the marine environment through a new era of ocean literacy: providing understandable information about the structure and functioning of coastal and marine ecosystems: how these marine ecosystems affect our daily lives and how we affect marine ecosystems (Pews Oceans Commission, 2003). In the Pews 2003 report, the assumption is made that enhancing public awareness and knowledge about the importance and decline of ocean ecosystems will lead to an increase in support for ocean restoration efforts. Engaging the public is essential if we are to successfully address complex ocean and coastal-related issues, including the use and benefits of the ocean and conservation of marine resources (U.S. Commission on Ocean Policy, 2004). This sentiment is supported by Dough Daigle when he stated that "the only hope for further progress on environmental protection and sustainable development lies with a public that is not only informed but also engaged" (Daigle, 2003). Steel's (2005) study found that previous research on public knowledge concerning ocean conditions revealed a definite concern and understanding of the ecological trouble our oceans are in, but people know very little about ocean ecology. For example, in a 1999 survey conducted by The Ocean Project researchers found that Americans had only a superficial knowledge of the oceans (The Ocean Project, 2012). While the public seemed to know that oceans are essential to human survival and sentiments supported the argument for a need to protect our oceans, few people seemed to understand or realize their part in damaging our oceans' health.

In a recent study by the Ocean Project a marketing strategy and outreach initiative was undertaken to study what young people knew about the decline of coastal and shoreline ocean areas(The Ocean Project, 2012). Results showed that although most people surveyed knew very little about ocean ecological crises such as ocean acidification, even fewer knew what they could do about it. However, with a brief explanation, those interviewed quickly understood the seriousness of the issue and demonstrated an interest in learning about what they could do to help in finding solutions to this global issue. The Ocean Project gained support from a third party donor to use social networking and online search engines advertising in Houston, Texas to gather significant interest and impact data on the desire for ocean conservation efforts. They chose sea turtles to illuminate the broader problem of plastics pollution, and directed an unbranded and mission-directed advertising campaign directed at younger audiences. The Ocean Project's findings were noteworthy in that the targeted audience still held a strong sympathy about ocean health a full year after the initial campaign. The goal of a learning experience at ©Seacamp was to guide students toward a sense of ocean stewardship after discovering the fragile interconnections between shallow water marine ecosystems and the influence human activities have on such interconnections.

On March 30, 2012, the Next Generation Science Standards (NGSS) released a poll which showed voters were virtually unanimous (97%) in believing that improving the quality of science education in the United States is essential to our ability to compete globally. "Moreover, making sure American students receive a world-class education in mathematics and science is ranked second only to fixing our nation's financial health as a strategy for improving America's economic competitiveness with other countries" (*New poll shows strong support for improving science education.*). In this same poll, 87% of those surveyed supported an internationally-benchmarked set of science standards. Currently, the Centers for Oceanic Sciences Excellence In Education (COSEE) and the National Marine Educators Association (NMEA) are designated as an official Next Generation State Standards "Critical Stakeholder Team" (Strang). Each COSEE center is a consortium of ocean science research institutions, informal science education organizations and formal education entities, funded primarily by the National Science Foundation (NSF) with support from NOAA (the National Oceanic and Atmospheric Administration). COSEE's mission is to "…promote partnerships between ocean research scientists and educators, disseminating best practices in ocean sciences education, promoting ocean education as a charismatic, interdisciplinary vehicle for creating a more scientifically literate workforce and citizenry" (*The centers for oceanic sciences excellence education.*). As a critical stakeholder team, COSEE and the NMEA are carefully reviewing the draft of the NGSS and are submitting an official unified response on behalf of the Ocean Literacy Campaign. For example, COSEE and the NMEA make the point that there is an overwhelmingly terrestrial bias to almost all the K-5 Life Science standards. For example, plants have traditionally been referred to as the only photosynthetic organisms on Earth (yet ocean phytoplankton produce the majority of Earth's oxygen). The current standards state that animals need "air" to survive and describe decomposition as a process that takes place in the soil, etc. COSEE and the NMEA point out that these are factual errors resulting in incomplete or inaccurate treatment of concepts that are of fundamental importance. An example of an unintentional result is that students might never have opportunities to learn about the unique and ecologically important organisms that occupy the ocean. They also want the NGSS to reference the ocean singularly (remove the word ocean) in educating children that the world has just one ocean with many different names. COSEE and NMEA also hope that the NGSS teams will address ideas such as the fact that some of the most biologically diverse ecosystems on Earth can be found in certain marine habitats; that a myriad of unique organisms can be found only in the ocean; chemosynthesis in deep oceans should be highlighted as ecologically important as the process of photosynthesis; and the organisms inhabiting the ocean have unique adaptations for survival unlike anything seen on Earth's surface (Strang). Strang (2012) hopes the NGSS teams will consider these examples as the standards are refined. COSEE and the NMEA would like to see clarifications in our current standards made in the NGSS. For example, changing the term "air" to oxygen for what animals require to live and grow; body parts from a wider selection of animals to include such body structures as fins, gills, and antennae; looking for patterns not just in the sky and on earth but also in oceans (such as the cyclical patterns of tides and currents); when teaching about weather, mentioning the role of dunes and barrier islands in protecting shorelines; including the life cycles of marine organisms (for example, crabs, or fish); and emphasizing how the ocean regulates Earth's weather.

Recognizing the importance of suggestions such as these would ensure a greater range of ocean literacy for students in the United States if indeed the NGSS become internationally benchmarked (Strang).

Looking at the NGSS for Florida (APPENDIX F), one sees no direct reference of ocean sciences mentioned. Currently, the NGSS is under construction and fluid: the influence of previous science standards documents on the final version remains to be seen.

During their ©Seacamp experience, students in this study participated in a wide range of activities. Examples included learning about unique adaptations marine organisms have evolved for a nocturnal life style; adaptations organisms (such as the upside jellyfish *Cassiopeia)* have evolved for coping with cyclical patterns such as tides; exploring the mutual symbiotic relationship *Cassiopeia* have with the photosynthetic zooxanthellae living within their tissues; experimenting with *Cassiopeia* to test the effects of human and nature-related stresses such as salinity, temperature and pollution; water games to simulate the shelter and nursery grounds mangroves provide to hundreds of shallow water marine species; and snorkeling among the diverse habitats such as sponge and sea grass beds, mangrove roots, and coral heads. Students articulated their excitement to their peers about their discoveries of examples of a rich diversity of marine life among patch reefs and mangrove ecosystems and they talked about the mutual relationship between these ecosystems; they performed an inquiry lab to discover the biological diversity of organisms living in pioneering species of marine algae (*Halimeda*) and they discovered the unique anatomical and sensory structures of sharks and their ecological importance in marine ecosystems.

Inquiry and Deep Learning

The multifaceted activity of scientific inquiry involves making observations, posing questions, examining sources of information and planning investigations; additional inquiry skills include reviewing others' data, using tools to gather and analyze data, proposing explanations and predictions, and communicating the results of investigations (National Research Council (U.S.), 1996) . This means that students must be free to make some decisions about what they are doing and what their work means with time to think about what they are doing (Colburn, 2003). Inquiry processes are essential for children to understand and construct scientific knowledge**.** Pearce described how children use the processes of science without being taught (Pearce, 1999). He referred to behaviors of recognizing, exploring, and using logical, rigorous thought and elegant reasoning as examples of inquiry and how important it is for educators to realize the responsibility we have for leading children toward these processes. Children are natural scientists from a young age because they are curious about the world around them (Pearce, 1999). Equally important for students are opportunities for disseminating what they have learned among their peers and teacher (Braxton). Communication, discussion, and debates should be encouraged within the midst of this cycle. Pearce supports the National Science Education Standards as a framework to improve science curricula (Pearce, 1999). The NSES standards support inquiry-based science, with an emphasis on opportunities for students to learn science in personal and social perspectives (National Research Council (U.S.), 1996). Inquiry is supported as a key instructional strategy for effective science teaching enabling students to acquire knowledge and develop a rich understanding of concepts, principles, models, and theories. Good science programs require access to the world beyond the classroom.

As students formulate questions and assess and interpret evidence, research shows they develop the intellectual skills that enable them to construct new knowledge (Chan, Burtis, & Bereiter, 1997). During inquiry processes, students are ideally acquiring a set of intellectual values they would deem to be worthwhile and personally useful, providing a “tool kit” of sorts for constructing knowledge and understanding.

The National Science Teachers Association (NSTA) states that “scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. Students collect evidence ….develop explanations from the data, and communicate and defend their conclusions (National Science Teachers Association, 1999). NSTA has included science inquiry as one of their content standards (National Science Teachers Association, 1999).

Plankis and Klein (2010) described the methods their students used to study human impact on corals in their classroom as authentic inquiry because there was no expected or known outcome and students could not ask the teacher to verify their data (Plankis & Klein, 2010). With national standards in place and the research to support inquiry, science educators must become reflective practitioners to determine whether or not we are meeting the needs of our science students (Braxton).

Because one of the major goals of ocean literacy is to begin now in helping our children realize the ecological dependency upon ocean health for human survival, there is a need for a paradigm shift in education toward a holistic approach of viewing our natural world. A well-known argument among ecologists and environmental educators is that traditional forms of schooling have exacerbated the problem of isolationist thinking (Williams, 2008). This isolationist thinking is one of the central causes of what David Orr called referred to as a crisis of sustainability (Orr, 1992). Education is now compartmentalized into disciplines of various subjects and children often learn without real-life experiences to ground their learning. Philosophers and educators are now rallying for a revamping of the western models of education to a more ecologically literate one (Williams, 2008). Such champions of educational sustainability include David Orr and Capra Fritjof who postulated systems thinking and holistic learning as a means to shift our modern culture to new models and metaphors for a more sustainable world (Capra, 2002; Orr, 2004). Sustainability education would have the following understandings embedded in children's thinking and learning:

1. The whole is more than the sum of its parts-living systems are properties of the whole; this involves contextual thinking.
2. Living systems are networks at all levels: there are no hierarchies in nature, only networks nested within networks.
3. Relationships among members of an ecological community involve multiple interdependence and is essential in understanding the essence of living organisms.

In order to learn about patterns and relationships, Orr argued that developing an ecological literacy in children for sustainability occurs best when pedagogy is embedded in "place"(Orr, 2004). Orr believes there would be reciprocity between thinking and doing because landscape (or ocean-scape) would shape mindscape. The mosaic that is created between phenomena and problems would be understood only through multidisciplinary approaches in education, enveloping wonder, mystery, and delight brought forth through careful educational planning about the natural environment.

Kevin Warburton described deep learning as a key strategy by which students extract meaning and understanding from course materials and experiences (Warburton, 2003). Environmental issues, social and economic issues, and the importance of interdisciplinary thinking and holistic insight are all interconnected; the challenge for educators of students of all ages is to move away from teaching concrete facts about the environment and create opportunities for active, transformative processes of learning, allowing children to act on debate values that are meaningful to them (Warburton, 2003). Warburton’s ideas parallel descriptions of guided inquiry emphasizing that deep learning will only occur if activities are enhanced through small group discussions; teacher guidance and encouragement is provided as needed; only then will students gain insight into the interconnectedness of environmental issues and the role citizens and government play in sustainability. ©Seacamp’s philosophy is fully explained on their website: “We offer students the chance to stretch their minds and enhance their senses far beyond the scope of the classroom and to practice their cooperative skills while discovering new worlds in the company of their peers. Our staff strive to provide an atmosphere of camaraderie, as well as learning, through the fellowship of exploration, cooperative analysis, and the whole experience and challenge of residential camping. We believe in "immersion education" in that students get an opportunity to embrace the local environment by being completely surrounded by it. Through NHMI programs, participants learn by living in - and interacting with - their natural world” (*About NHMI - our philosophy.*2012)In addition to opportunities for students to explore interests in the marine sciences, NHMI has a sustainability goal interwoven throughout their programs. "From within the heart of our philosophy arise two important beliefs. The first is that an environmental ethic - an appreciation for the fragile natural world- is an essential element of good citizenship. (Some participants may indeed become the scientists of tomorrow, and others will become the informed voting citizenry who will guide the management of our marine resources in the future.) Secondly, we believe that learning must be fun"(*About NHMI - our philosophy*.2012)

Experiential Learning and Stewardship

Goodin's green theory of value (1992) suggests that all humans want some sense and pattern to their lives; nature provides the backdrop against which this can occur (Goodin, 1992) Nature enables human lives to be set in a larger context and explains why many people think of nature as sacred (Milton, 1999). Pretty suggests that spending less time in nature may result in an intrinsic disconnection with nature, leading to feelings of "biophobia" - a fear of the outdoors; nature may be perceived as being wild and unfamiliar (Pretty, 2007). Feelings of estrangement may create an inability to care for and connect with nature (Nabhan & St. Antoine, 1993; Pyle, 2003) . Such an extinction of experience may in fact result in a lost generation of children and adults, disconnected to any place in particular and unable to feel the innate relationships with nature that E.O. Wilson suggested are within us all (Kellert & Wilson, 1993). The disconnection to place and relationships in nature has been described as "nature-deficit disorder"(Louv, 2005).

According to Dewey and modern constructivism, teaching and learning have to be anchored to meaningful activities in students' lives. Knowledge and values both play a major part in students'decision-making. If educators guide learning in ways that enable students to understand the dependence and interactive relationships between humans and nature and the personal value in such learning, the willingness to act will follow {{120 Dewey, J. 1938}}

Another important matter to consider is students' feelings of being capable of doing something important in order to make a difference in their natural world. Making environmental issues an integral part of instruction designed to change action – going above and beyond awareness/knowledge of an issue is essential if students are to develop a sense of ownership and empowerment. Once these feelings are in place, students may be prompted to become responsible, active citizens who can affect the attitudes and behaviors of others (Hungerford & Volk, 1990; Palmberg & Kuru, 2000).

Environmental field studies have the implicit advantage of experiential learning (McMillan & Wilhelm, 2007). In McMillan's study, students observed phases of the moon and then wrote about their observations-both scientific observations and poetry (McMillan & Wilhelm, 2007). Some students' writing examples professed awe and gratefulness and a sense of connection to nature. Of importance is that students appeared to credit interaction with nature with providing them hope, peace and guidance in an otherwise chaotic world as seen through the eyes of an adolescent (McMillan & Wilhelm, 2007).

Experiential learning not only contributes to various ways of knowing (learning styles), it also serves to help develop and inform adolescent students' emerging personal identities. Researchers Thomashow and Comstock documented that students involved in nature study develop a stronger sense of self perception and morality as they began formulating their sense of relationship to and responsibilities toward their communities and the larger world (Comstock, 1939; Mitchell, 2001) .

Environmental impact from human activities is challenging the very fabric of our planet's ecosystems. Thomashow asked the question "How do we assess our own actions and practices, or those of our neighbors, or those of our species?" (Mitchell, 2001) His research revealed that if students are to become budding naturalists, they will need to acquire a range of facilities: the willingness to be a part of the living land or ocean surroundings; the ability and opportunities to ask good, scientific questions and develop approaches for finding empirical answers; opportunities for using their imaginations; immersion in the natural world as inspiration for artwork, photography, stories, essays, music, and poetry; and, opportunities for open-mindedness and reflection, engaging in the wonder, insight, and meaning derived from nature explorations (Mitchell, 2001).

It is only natural that people's perspectives may change over time as a result of their personal behavior and external influences when it comes to environmentally responsible behavior (Bogner, 1998). Psychological processes underlie attitudes and their changes. Developing a sense of ocean stewardship (or any environmental citizenry) is time consuming and complex. Bogner's study revealed that environmentally responsible behavior is rewarding for the individual only when majorities within the society also behave responsibly. There is a delay from reasoning to action; quantity of time is required and a long-lasting approach is needed for such a paradigm shift from nature exploitation to nature conservation and thus make a statistical difference (Bogner, 1998). Immersing students in constructive outdoor ecology programs is a first approach and becomes the beginning of a journey of a "life-long mosaic of actual commitment." Providing students with the tools to make responsible environmental decisions through first-hand experience, participatory interaction among peers and subsequent reinforcement provides the first step of the journey.

In an environmental education (EE) experience for a group of students staying in a residential facility in the Great Smokey Mountains National Park (GSMNP), an analysis of 3-month follow-up surveys revealed that students showed an increase in commitment to environmental stewardship and an increase in their knowledge and awareness of the biodiversity of the GSMNP (Stern, Powell, & Ardoin, 2008). However, students' interest in learning, discovery, and their connection to nature faded over time. Stern suggested that EE experiences may achieve desired effects in the short term, but long term influences need to be further studied. They suggest follow up activities and reinforcement of newly acquired interests should be incorporated by field trip leaders as suggested by other researchers, e.g. (Bogner, 1998; Dettman-Easler & Pease, 1999; Smith-Sebasto & Cavern, 2006).

Novelty and Peer Interaction

There is a significant amount of evidence in brain research that suggests humans are hardwired for meaning, having a built-in capacity for searching for meaning and reflection. Human brains are centers for processing, storage, and recall. Hawkins defined human intelligence as the ability to make predictions based on processing and storing sequences of patterns and then recalling such patterns to make predictions (Hawkins & Blakeslee, 2004). One of the ways our brain can store all the information we process each day prioritizing information through the idea of novelty – thus attracting the attention of the brain (Berns, Cohen, & Mintun, 1997)

Field trips have the power to stimulate interest and motivation in science, helping students develop scientific and social skills (Michie, 1998). Additional research by Radinsky, Olivia, and Alamar highlighted the social nature of scientific practices, showing that scientific knowledge is co-constructed and distributed among peers (Radinsky et al., 2010). In the real world, new knowledge is more often generated in professional communities of scientists through a process of collective, contested and negotiated communication through the mutual accommodation of ideas. Experiential learning opportunities in an outdoor facility provide the space and time not often afforded in a regular classroom for peers to explore and "weave together many strands of meaning running through [an outdoor] classroom – the artifacts, utterances, and interactions of the community of members" for deeper discourse and learning (Radinsky et al., 2010) .

Summary

In initiating this action research, my central question was "How does a residential marine facility learning experience influence students' attitudes about becoming stewards of the Earth's ocean? During and after the field trip, I chose to analyze three essential questions:

1. In what ways did a residential learning experience at ©Seacamp influence students' ocean stewardship?
2. In what ways did a residential learning experience at ©Seacamp influence students' understanding of the effects of human impact on the biological diversity of shallow water ecosystems?

3. How was students' engagement in the learning process influenced during their experiences at ©Seacamp?

My strategy for documenting the effects of inquiry-based field-embedded learning experiences and how they influenced students' attitudes and ocean stewardship was by transcribing students' conversations with each other, their instructors and me during their two and a half day stay at ©Seacamp about their understanding of how humans negatively impact marine shallow water biological diversity. As evidenced through the literature review, there is a growing need for national benchmarks to ensure ocean literacy and a need for teaching students with an educational focus on environmental sustainability. Ocean literacy may still not be a priority even with the implementation of the NGSS. For students to develop a sense of stewardship toward the natural world, they must be provided the opportunities for meaningful learning using inquiry processes. Learning science through inquiry and peer interaction is essential for students to construct scientific knowledge – opportunities in which they make observations, pose questions and form explanations and predictions while immersed within the natural world. The experiential learning opportunities among peers at ©Seacamp provided opportunities for open-mindedness and reflective thought about the fragile nature of the ocean.

CHAPTER 3 METHODS

Introduction

The primary focus of this study was to record the effects of field embedded inquiry-based learning experiences on students' attitudes and ocean stewardship by documenting the conversations students had with each other, their instructors and with me about their understanding of the impact human activities have on marine shallow water biological diversity after a three day residential experience at a marine science center - ©Seacamp. During and after the field trip, I chose to analyze three essential questions:

1. In what ways did a residential learning experience at ©Seacamp influence students' ocean stewardship?
2. In what ways did a residential learning experience at ©Seacamp field influence students' understanding of the effects of human impact on the biological diversity of shallow water ecosystems?
3. How was students' engagement in the learning process influenced during their experiences at ©Seacamp?

This study examined the effects of authentic, field-embeded inquiry learning on students' understanding of the research questions. Permissions were obtained first through the Institutional Review Board of the University of Central Florida (Appendix A), the county's Deputy Superintendent (Appendix B), and my school principal (Appendix C); parent consent (Appendix D) and student assent (Appendix E) were then secured. The setting, subject, design, instruments, data collection, and analysis of the study are reported in this chapter. Data obtained in this study were gathered through qualitative and quantitative methods. Qualitative data were gathered using transcripts from videotapes, field notes and student interviews. Quantitative data were collected through a Pre/Post trip assessment *Knowledge About Coral Reefs* (Appendix H) which focused on coral reefs and general ocean knowledge.

Design of Study

This action research concentrated on authentic, field-embedded inquiry learning by middle school students who participated in a three day residential field trip to Newfound Harbor Marine Institute (©Seacamp). "Action research seeks to bring together action and reflection, theory and practice, and in participation with others, the pursuit of practical solutions to issues of pressing concern to people…" (*Handbook of action research*: *Participative inquiry and practice*. 2001). Qualitative studies and action research also afford researchers opportunities to reflect deeply about their impact on participants and to collect and analyze visual data using rich narrative language(Gay, Mills, & Airasian, 2006) Qualitative methods in this action research were essential to accurately portray the experiences of the students throughout their field trip experience. Continual interactions and observations during the three day trip enabled me to record detailed descriptions of students' thoughts, actions, and understanding about topics including the impact of human activities on ocean marine organisms and their habitats, the importance of biologically diverse marine ecosystems, and the importance of peer interaction as children are making meaning out of new ideas.

Data were collected and triangulated from numerous sources for establishing credibility and trustworthiness (Mills, 2003; Thrift, 2007). For data triangulation, Oliver-Hoyo and Allen (2006) suggested that an accurate picture of a situation is best represented when obtained from several sources. Data were collected using a pre and post Coral Reef Knowledge survey (Appendix H), researcher observations, photographs taken by students, chaperons and the researcher, transcripts of videotapes of student conversations with peers and ©Seacamp instructors during guided and full inquiry scientific experiments, and individual interviews with students about their ©Seacamp experience. The data collected helped me in discovering a rich and diverse tapestry representative of students' experiences.

Settings Of This Study

School Setting

Students attending ©Seacamp were in the eighth grade at a middle school suburb in central Florida. The school population was 1304, of which 406 students were 8th graders. Approximately 28% of the student body at this school qualified for free/reduced lunch. The school maintained an "A" rating for five consecutive years based on the Florida Comprehensive Assessment Test for mathematics and reading. Eleven boys and 31 girls attended the field trip. Fifteen of the 42 students participated in the Coral Reef and Ocean Knowledge assessment and the interview questions. Of these 15 students, 7 were currently enrolled or had been enrolled the previous semester in my elective course "Ecology of the Florida Keys"

©*Seacamp Setting*

©Seacamp is a non-profit, marine science education facility located on Big Pine Key in the Florida Keys adjacent to Looe Key and Florida's fragile coral reefs. Florida Keys reefs are part of the Florida Keys National Marine Sanctuary (FKNMS). ©Seacamp was founded in 1966.

The educational facility is the result of a cooperative effort of parents, scientists, businessmen, camp leaders and others dedicated to the education of youth in marine science. ©Seacamp's mission statement is "… to create awareness of the complex and fragile marine world and to foster critical thinking and informed decision making about man's use of natural resources" (©Seacamp.org). It is one of the few organizations in the United States providing experiential education in marine studies to students between the ages of 8 to 21 years old. As a residential facility ©Seacamp Association offers extended sessions of hands-on, interactive education, taking advantage of the variety of marine environments surrounding the campus (©Seacamp.org). The NHMI program was started in 1970 for the purpose of complementing ©Seacamp Association's mission in providing experiential marine science education opportunities. The NHMI program extends these opportunities into the school year, from early September through late May for students from 4th grade through college level, as well as teacher workshops. Approximately 8,000 participants enjoy the workshops and residential programs at the NHMI field studies center each year, including students from international locations (©Seacamp.org). In this study ©Seacamp offered students the opportunity to explore waters of the Atlantic and Gulf of Mexico which surround the Florida Keys. Students snorkeled coral heads, sponge beds, and turtle grass flats next to mangrove islands. Wind conditions prevented snorkeling full reefs. Students waded to Horseshoe Island at low tide and were taught lessons about the delicate balance between mangroves and coral reefs. They participated in studying nocturnal animal behaviors, examined marine symbiotic relationships through hands –on experiences, and explored the biodiversity of pioneering species of a marine algae ecosystem. Each experience offered opportunities to interact among peers with a rich diversity of flora and fauna basic to the study of marine science and to discover how biodiversity ensures the continuation of the tropical marine species of the Florida Keys.

Camp facilities for this particular study included a dining and recreation hall, three science laboratories, harbor for 25 foot pontoon boats, arts and crafts building, infirmary, teaching shelter, and commercial kitchen; students were housed in dormitories. A timeline for the activities for the ©Seacamp experience is shown in Table 1.

Table 1 Timeline of ©Seacamp Field Trip

Time period and Date	**Student Activities**	**©Seacamp Instructor's Actions**
5/11/2012 Friday evening	• Interactive discussion: daily time niches for marine organisms (diurnal, crepuscular, nocturnal). • *(Full Inquiry):* Used flashlights and nets to capture marine organisms exhibiting bioluminescence • Interaction among peers to discover/discuss what each found; • organisms released at end of activity	• Discussed nocuturnal behaviors and adaptations • Discussed benefits of nocturnal lifestyle. • Instructed students about safety during capturing activities • Distributed nets and flashlights • Praised and celebrated capture successes with students • Answered questions students had, pointing out unique features of each student's findings
5/12/2012 Saturday morning	• Swim test and snorkeling practice • *(Full Inquiry):* Snorkeling of patch reefs, sea grass beds and among mangrove roots of Bird Island • Students placed captured organisms into pans of sea water to observe after students were all back aboard the boat • Students snorkeled to other groups to celebrate "catches" peers made	• Modeled safety rules and hand signals; • Modeled hand signals used to indicate dangerous Lionfish (invasive species) if sighted. • Distributed nets to snorkelers for capturing marine organisms during snorkeling activities. • Conversed with students to bring forth rich descriptions of locations and behaviors of the organisms doing prior to being captured. • Handled marine organisms with care, modeling how to hold without harming, pointing out unique adaptations each organism had for its habitat • Modeled gentle treatment and

Time period and Date	Student Activities	©Seacamp Instructor's Actions
		emphasized importance of returning all organisms to the ocean at the trip's conclusion (many organisms were brought back to the "touch tank" and released on our second day snorkel trip
Saturday Afternoon:	• Low tide wade to Horseshoe Island and collecting organisms of interest along way • Observed and compared mangrove species • Licked salt off and the back of black mangrove leaves and examined Red mangroves' "sacrificial leaves" to learn how mangroves survive salty environment • Searched for ants which have symbiotic relationship with white mangroves • Captured *Cassiopeia* for study; • Played predator/prey water games with peers simulating the shelter and protection mangroves provide for hundreds of other marine species (mangroves represented "safe zones") • Waded back to NHMI and observed captured bonnet head sharks and the teamwork instructors modeled to ensure the sharks did not perish • *(Guided Inquiry): Cassiopeia* lab performed: students chose which stress factors to subject jellyfish to affect their pulse rates • Recorded observations of pulse rates of *Cassiopeia* after being exposed to stress factor (students caused changes in temperature, introduced a pollutant, or changed the salinity levels in the pans containing *Cassiopeia* (See Appendix K) • Questioned instructor and peers about the plant-like structures	• Interactive discussion about ecological role between mangrove islands and coral reef • Interactive discussion about symbiotic relationships between insects and black mangroves, the requirement of hurricanes and storms for mangrove propagule distribution • Directed students to "build" miniature mangrove islands that could withstand a "storm" (bucket of water tossed at it multiple times) to simulate mangrove role in holding sand together to create islands. • Collected *Cassiopeia* jellyfish for afternoon lab; • Created, modeled, and participated in water games about mangrove ecological importance as nursery grounds and protection from predators for a plethora of shallow water marine organisms • Interactive discussions with students about instructors' behaviors to ensure survival of captured bonnethead sharks (students subtly guided to realization these sharks would be put in "Shark Lagoon" for them to swim with Sunday) • Instructors set out materials, providing students choices for stress test of collected *Cassiopeia* jellyfish • Interactive discussion of symbiotic relationship between *Cassiopeia* and zooxanthellae • Interactive discussion about why one tray of *Cassiopeia* were set aside and not tested (control group)

<table>
<tr><th>Time period and Date</th><th>Student Activities</th><th>©Seacamp Instructor's Actions</th></tr>
<tr><td></td><td>(zooxanthellae)
Expressed concern about "killing" jellyfish from introduced stresses
Observations of three bonnet head sharks captured and placed in holding tank to de-stress</td><td></td></tr>
<tr><td>Saturday Evening:

Exploration of coralline algae (Halimeda)</td><td>Students shook large bunches of Halimeda algae and lights were turned off to observe bioluminescence from organisms living within the algae
(Full Inquiry): Students used their hands, assorted dissection tools to locate and carefully remove wide variety of marine organisms found among the stalks of Halimeda algae.
Students placed organisms into dishes and observed behaviors, celebrating successes among peers about discoveries
Students set themselves immediately into task masters (directors, collectors, cheerleaders, reporter - with others at tables around them, etc)
Students used several small containers provided and made decisions to separate organisms if they proved to be aggressive toward newly introduced species placed in the container
Student groups entered data on communal whiteboard of numbers of species of each classification category.</td><td>Interactive discussion of pioneering species and pioneering communities
Interactive discussion about classification of marine species
Instructors distributed pans of Halimeda (coralline algae), probes, forceps, dishes/containers of sea water and "rinse" pitchers of sea water on students tables
Guided students to search through algae carefully and separate organisms into dishes in ways they thought organisms were most similar</td></tr>
<tr><td>5/13/2012

Sunday morning:</td><td>(Full Inquiry): Students snorkeled around small coral-head, patch reefs, sponge flats, and mangrove roots
Some students collected and photographed organisms such as lobster and sea hares</td><td>Some group instructors were able to demonstrate and discuss the mini-ecosystems found within sponges
Interactive discussions about organisms captured by students</td></tr>
<tr><td>Sunday afternoon:</td><td>Interactive discussions with peers and instructor about shark facts
Shark anatomy lesson
Interactive game about sharks' seven senses</td><td>Interactive game in some teaching groups: 10 Least likely ways to die (shark bites ranked last among examples)
All groups: interactive discussion about shark structures</td></tr>
</table>

Time period and Date	Student Activities	©Seacamp Instructor's Actions
	• *(Guided Inquiry):* Dissection of squid (anatomy and adaptations of these marine organisms) • Examined frozen bonnet head shark to examine anatomical features and senses • *(Full Inquiry):* Snorkeled among small bonnet head sharks in "Shark Pond"	• Encouraged students to examine bonnet head's mouth to understand this animal must "suck to bite" (in hopes of 100% participation for swimming in shark lagoon) • Instructed students how to lay on kickboard with fee out of water to lessen turbidity

Subjects

The participants chosen in this study were 8th grade students. Because enrollment in the elective "Ecology of the Florida Keys" is limited to only 30 students per semester, the field trip was an opportunity extended to all eighth grade students who could afford the trip price of $605. Eleven boys and 31 girls attended the trip.

Subjects chosen for this action research were 15 students (four boys and 11 girls) who completed both the pre and post survey of Coral Reef Knowledge and the interviews. For these two instruments, 7 students were currently enrolled (or had previously been enrolled) in the elective course. This may indicate a predisposition toward ocean stewardship. It should also be noted that students were to complete the survey during the bus ride to and from ©Seacamp using their cell phones. This did not turn out to be a good choice as there were not enough smart phones on the bus, some students complained of motion sickness when trying to complete the survey on the phones, and many students preferred to socialize with friends rather than complete the survey. Video transcripts and photographic data were used from all participants.

Instruments

The purpose for this study was to examine the effects of authentic, experiential and inquiry-based learning on students' understanding of the effects of human impact on Earth's ocean and to examine how students' feelings about the ocean (ocean stewardship) changed during their field trip experience. An additional purpose was to observe the engagement levels of students as they interacted among peers and their instructors during their residential field trip.

The instruments in this action research study were selected and developed to the extent of which each would aid the gathering of data to answer the research questions. Instruments utilized in this research initially included two surveys and a quiz which were given to students twice: just prior to and again after the field trip. The surveys and assessment paralleled Florida's NGSSS (see Appendix F). However, the documentation which most supported my questions were through the transcripts of my videos while students participated in all field trip activities, photographic evidence of students' learning taken by me, other chaperones, and the students themselves and the post trip interviews.

Video Transcripts and Accompanying Field Notes

Students were videotaped using either Flip devices or i-phones. I transcribed each video and matched the filmed activity with field notes taken throughout the trip. Field notes described ©Seacamp instructors' actions, the words student used to describe their learning, and my perception of enthusiasm exhibited by students as they participated in the experiences.

Photographs

Students photographed specimens they collected as well as their experiences during laboratory experiments. Additional photographs were taken by other chaperones and me. The three chaperones are educational instructors (a teaching colleague, an assistant principal, and a parent who is a college professor).

Interviews

Interviews were needed to gain a full perspective of students' understanding of new knowledge and their levels of interest and excitement while doing inquiry experiments. Formal and informal interviews gave me insight into students' depth of understanding of the meaning and importance of biodiversity and whether students believed human activities adversely affected coral reef biodiversity. The use of continuous communication with students in their respective study groups by other teachers acting as chaperones afforded me the possibility of including as many students as possible for a rich and broad view of their ©Seacamp experiences. Informal interviews were conducted before, during, and after inquiry experiences. The formal interview after the trip's conclusion re-addressed students' understanding of the importance of biodiversity and sought to determine whether students felt empowered and knowledgeable enough to make a difference in protecting the ocean for future generations of students. The formal interview consisted of six questions (Appendix I) and was conducted during homeroom times, class time (if those students were enrolled in the my elective course), before school or via email.

Methodology and Data Collection

In April 2012 an Internal Review Board (IRB) Committee form (Appendix A) was submitted and approved by the Office of Research of the University of Central Florida. Upon receipt of IRB approval, county and principal approvals were granted (Appendix B and C). Parent consent (Appendix D) and student assent forms (Appendix E) were then distributed. I emphasized on both consent and assent forms that students would not be penalized in any way if they chose not to participate. All signed and collected data, field notes, photographs that were on CDs, and interview sheets were kept in a locked filing cabinet. All videotapes were downloaded onto a password protected flash drive along with other downloaded photographs and videotapes.

Data were collected using three pre-trip surveys. Students were asked to take the pre-trip surveys on the bus ride to ©Seacamp using their smart phones (or pencil/paper for the Career Interest survey; Additional data were collected through field notes, photographs, and audiotapes during students' experiences as outlined in the ©Seacamp Activities Timeline (Table 1). Content taught to students by ©Seacamp Instructors was closely aligned with both the NGSSS (See Appendix F) and the Ocean Literacy Project's Framework. All activities (instructional, guided and/or full inquiry activities) were recorded using Flips, i-phones and digital cameras. I asked students questions during and after each activity according to the ©Seacamp Activities Timeline and then transcribed the videotapes to determine themes represented in the responses that were consistent with themes evident in other data. Other teachers acting as chaperones contributed to videotaping students' interactions and responses during their group's activities. Students were requested to take the surveys again upon return from ©Seacamp (some students used smart phones on the bus; others waited until they returned home and took the post trip surveys from computers). A post trip interview was conducted face to face and students' responses were recorded by hand. The face-to-face interview responses were from students who participated in the surveys.

Summary

The purpose of this study was to determine if a residential marine facility learning experience influenced students to become stewards of the Earth's oceans. From this action research study three sub-questions were developed. During and after the field trip, I chose to analyze three essential questions:

1. Did a residential learning experience at ©Seacamp influence students' ocean stewardship?
2. Did a residential learning experience at ©Seacamp field influence students' understanding of the effects of human impact on the biological diversity of shallow water ecosystems?
3. How was students' engagement in the learning process influenced during their experiences at ©Seacamp?

Chapter three describes the design of this action research study. The school and marine facility settings are described; how subjects in this study were chosen and grouped were explained and the methods employed to accurately gather data were described. In depth conclusions from the analysis of triangulated data are discussed in Chapter four.

CHAPTER 4 DATA ANALYSIS

This chapter provides a systematic description and analysis of the information collected during this action research study, "Influencing Students to Become Stewards of the Earth's Oceans" during and after students participated in a residential marine facility learning experience. The questions addressed during this study were:

1. In what ways did a residential learning experience at ©Seacamp influence students' ocean stewardship?
2. In what ways did a residential learning experience at ©Seacamp influence students' understanding of the effects of human impact on the biological diversity of shallow water ecosystems?
3. How was students' engagement in the learning process influenced during their experiences at ©Seacamp?

<u>Data Analysis of Coral Reef Knowledge Assessment</u>

I created a Coral Reef Knowledge assessment based on Carl Stepath's 2006 instrument (See Appendices G and H) to compare students' baseline knowledge prior to the ©Seacamp field trip as compared to after their ©Seacamp experiences. The 10 questions in the Coral Reef Knowledge assessment are found in Appendix H. Questions ranged in content from knowing the name of the ocean zone where corals thrive, whether corals are plants or animals, how they feed, how corals get their coloration, why corals exist only off the coastlines of Florida in the continental United States, causes of good water clarity, how biodiversity is measured, and how humans and exotic species can harm corals.

Fifteen students (10 girls and 5 boys) participated in this assessment. Results are shown below in Table 2. Learning gains were shown in all questions except for questions 5 and 10. Question 5 states "The reason why corals grow only in Florida" is… The correct answer is because the water is clear and low in nutrients. No student answered this question correctly. There was no change in learning gains for question 10 (The harm caused by non-native species of animals to coral reefs). Thirteen students answered this question correctly both before and after the trip. The greatest learning gains were obtained from questions 3 and 7 ("How corals feed" and "How biodiversity is measured". Both of these questions showed a learning gain of +4.

Table 2: Results of Knowledge Assessment of Coral Reefs and Biodiversity

Knowledge Assessment Results			
Question	Pre	Post	Difference
1. The reefs of Florida's Keys are found in which ocean zone?	2	4	+2
2. Corals are __.	9	11	+2
3. Corals feed by __.	4	8	+4
4. Corals have color due to __.	5	7	+2
5. Coral reefs grow off the coasts of the Florida Keys because __.	0	0	0
6. The clarity (clearness) of the water around a reef is __.	12	14	+2

Knowledge Assessment Results			
7. The biodiversity of a coral reef is measured by:	7	11	+4
8. The beautiful colors corals have may be due to light hitting the microscopic plants (zooxanthellae) found in coral tissues. When corals lose their zooxanthellae they turn white. (T/F)	12	14	+2
9. Humans can cause harm to coral reefs by __.	13	14	+1
10. If an exotic (non-native) fish is introduced by humans into a coral reef ecosystem, it could __.	1	1	0

<u>Evidences of Student Engagement During Peer and Instructor Interactions:</u>

Nocturnal Adaptations Activity:

The following are video transcripts and field notes representing evidences of student engagement and the excitement in learning through peer interaction. Also evidenced are the methods instructors used in helping students scaffold new information to prior knowledge during the Friday night activity: “Adaptations of Marine Organisms to a Nocturnal Lifestyle”. During this activity, the ©Seacamp instructors were Deana, Nathan, Bryan, and Monique.

Example 1: Students were all engaged as evidenced by participating in whole group discussions with their instructors. Students were talking to each other and bantering back and forth with instructors. Students were trying to pronounce the word “crepuscular” (the term used for those organisms feeding during twilight hours). Nathan hinted that mosquitos were examples in an attempt to guide students to associate the new term with creatures that feed just before sunset. Nathan again related the lesson about nocturnal animals to students' prior knowledge when he mentioned the Electromagnetic Spectrum to explain why most nocturnal and crepuscular animals are red (red is absorbed first in the water layers so red animals are not as easily seen). A student exclaimed, *"Oh, this is where we were supposed to be paying attention in class* [during school] *and I wasn't!"*

Example 2: Instructor Monique asked students what an advantage might be if an organism is a crepuscular feeder. Monique: "What is happening to your daytime feeders at the end of the day?" Students: *The daytime feeders are tired and getting ready to rest*. Monique: "Right! The diurnal (daylight feeding animals) are getting tired, so what does this mean for a crepuscular feeder?" *Students call out "They get more food!".*

Example 3: When Monique pulled out "props" of stalked eyes (See Figures 1 and 2) and mentioned the term "camouflage", students were laughing as they took turns trying on the glasses representing unusually large or stalked eyes - adaptations many nocturnal animals have. They called out examples of familiar animals having such structures such as stalked eyes *"Oh, yeah! Crabs have them!"*

Figure 1 Stalked eyes for seeing all around

Figure 2 Large eyes for capturing light

Example 4: Instructor Deana was breaking down the meaning of the term bioluminescence and students were identifying what they knew of the word parts. She probed students understanding by asking for possible advantages bioluminescence might have for certain marine organisms. *Some students shouted out that it was like "fireflies"*. Nathan eventually guided them into guessing that it might be a signal for finding a mate.

Example 5: "Hallie" and "John" readily placed their hands into a bucket of seawater that held the ink expelled by the Rose Sea Hare (See Figures 3 and Figure 4). Despite the fact the bucket had just contained the slimy sea creature, they wanted to smell the water because the ink of this sea hare is said to smell like roses. Their peers gathered around and queried them as to the smell; soon other students were plunging their hands into the bucket. A few seconds later, someone caught a large hermit crab and Ariana and several others clamored to be the first to hold it.

Figure 3 Rose Sea Hare

Figure 4 Hanna smells Rose Hare's ink

Example 6: "Lydia" was actively involved in hunting for nocturnal and/or bioluminescent marine organisms when she suddenly noticed the night sky and the clarity with which she could see the constellations. She laid down on the sea wall platform and began pointing to stars/constellations she knew: "*Oh! That's the North Star and that's the Big Dipper and that's the Little Dipper…"* Another student asked her how she knew these examples and she responded *"Because we learned about them in history class when we read about the Underground Railroad in history class…only we don't see stars in [her hometown] because of light pollution."*

Snorkeling trips:

Example 7: On both snorkeling trips, students were engaged in discussions with the instructor about the habitats and organisms they might encounter while snorkeling. Despite expressing some nervousness of encountering sharks, all students "buddied up" with a snorkel partner and actively pursued fish and other creatures with nets in the hopes of bringing examples back to the "catch trays" on board the pontoon boats. Students snorkeled to each other throughout their time in the water to show each other the spots where they found fish or conch or hermit crabs (See Figure 5). There was a great deal of sharing and squealing as students made their discoveries. Upon return to the harbor, students from each teaching group sought one another out to show what they had captured for the "Touchy Feely" tank or other holding tanks (See Figures 6 and 7).

Figure 5 Snorkeling the Patch Reefs

Figure 6 Marine organisms discovered by students

Figure 7 Marine animals caught by students for the touch tank

Example 8: Students created coral polyps from playdough just prior to snorkeling to demonstrate the tiny animals from which coral are actually composed. They took their time to perfect their models and expressed concern when their instructor crushed their models to demonstrate that the same would happen to real coral if they accidently stepped on them if they stood up while snorkeling or crushed the living animals with their flippers. Students reminded one another of this as they were entering and exiting the water to snorkel: the times when it was most likely that students might stand.

Water games:

Example 9*:* Many students expressed curiosity about how a plant (mangrove tree) could live in salt water. Students carefully examined the leaves of each type of mangrove pointed out by Instructor Nathan and readily licked the backs of the black mangrove leaves to test for salt excretion. They seemed intrigued about the “sacrificial” leaves red mangroves used to excrete salt and actively searched for the ants Nathan mentioned that protected the white mangroves from nibbling Key Deer and the ants are rewarded with sugar excreted at the base of each leaf. Students became excited after seeing *Cassiopeia* floating by as this was one of the reasons for wading to Horseshoe Island: to collect the jellyfish for their lab.

Example 10: Students were assuming the roles of young fish, predators, or were linked arm in arm to represent mangrove “safe zones”. They had to mimic a chomping gesture with their hands if they were a predator and race to hide in the safety of the “mangrove roots” if they were young fish. When tagged, they switched roles. All students exhibited excitement through laughter and play and raced to explain their game to me after I returned on a search for the video camera to document their games (Figure 8 below)

Figure 8 Water Games about Predator/Prey

Halimeda lab:

Example 11: From the moment the tray of coralline algae (*Halimeda*) was placed on each table, students were completely engaged because they were told prior to getting the tray that there were many (but very small) living organisms hiding in the algae. Engagement was also quickly documented when instructors turned out the lights and told students to gently shake the trays: the result was a shower of sparks and brief glowing of the organisms able to emit bioluminescence. From that point on, students all took turns (or often all at once) gently poking through the algae and even more carefully extracting the brittle stars, tiny crustaceans, fish, shrimp, and many different types of marine worms. The behavior of the worms, in particular, captured and held the attention of the students as the worms shimmied or writhed in the holding containers. Students all talked at once and demanded the attention of their peers or passing instructors and chaperones to show them what they found. Students could not resist the squeals of excitement from their peers and moved quickly to other tables to see what their peers captured. Just as frequently, students were dragging their friends back to their own table to show off their group's cache. Even at the conclusion of the lab, many students tried digging through the algae - as the tray was being removed from the table (See Figures 9 and 10). Students shared their data on a white board which represented whole class findings and students all participated in trying to classify the animals they caught and describe their behavior.

Figure 9 Finding out about the biodiversity in *Halimedia*

Figure 10 Separating all the invertebrates into trays

Shark Anatomy and Squid Dissections

Students congregated into a tight and focused group to take turns touching a frozen bonnet head shark that was used as an instructional aide for teaching shark anatomy, share senses, and the shape of its mouth (to assuage any fears of snorkeling with live bonnet heads later that afternoon). Students were fascinated to touch the "toothed" skin and to see the ampullae of Lorenzini (tiny jelly-filled pits around the shark's snout which pick up electric signals). They also expressed concern about how the shark died and then laughed when told the shark had been frozen for a decade (See Figure 11). By the end of the lesson, students were excited (and a few were a bit nervous but very willing) to snorkel "Shark Pond" (See Figure 12).

Figure 11 Shark Anatomy Lesson

Figure 12 Snorkeling Shark Pond

Example 12*:* During the dissection of the squid, Susan was so engaged in locating the squid's beak that she asked the chaperone videotaping her to leave her alone so she could focus on what she was doing (See Figure 13).

Figure 13 Squid dissection

Evidences of Ocean Stewardship and Concerns about Human Impact on Ocean Ecosystems through Video Transcripts, Field Notes, and Photographs

Snorkeling Trips:

Example 13: Instructor Nathan pointed out "Little Palm Island" which students could see housed a luxurious resort. Nathan told the students how the developers removed all the mangroves from the island edges and replaced them with palms not native to the Florida Keys to give the resort a "Caribbean look". These trees are incapable of holding sands together like mangrove roots. As a result, the artificial beach the developers created was washing away daily and spreading out from the island. Because students had been taught about the progression of habitats (mangroves to sponge beds and sea grass meadows to patch reefs, coral heads and reefs), several students stood up to see the white fan-like spread of human-introduced sand. One student Gia called out to Nathan *"It's smothering the sponge beds and corals, isn't it? Is it going to kill the reefs?"*

Example 14*:* Students wanted to make sure that the creatures they captured while snorkeling were placed into the catch trays properly by their peers if Nathan did not directly take their net. They were concerned their hermit crabs, snails, sea hare, and sea cucumber were not killed and would survive the trip back to NHMI.

Example 15*:* Just prior to the snorkel practice activity, Monique taught the group about the tiny coral animal. She explained about the importance mangroves in holding sands together to form the Key islands; she told students they were about to see examples of hermatypic corals while snorkeling and that the animal itself (the soft part) was on 2% of the coral mound itself.

Monique also explained that corals typically grew only 40 cm per year and stated "Don't kick over the coral or you will have wiped out 200 years of growth!" (See Figure 14). On this first snorkel expedition, students' flippers did touch the sandy bottom numerous times, but once students were confident their vests would hold them up, many began shouting at each other to *"Keep your feet up! You'll kill the coral!"*

Figure 14 The boat is a classroom

Wade to Horseshoe Island:

Example 16: Students flocked to Instructor Nathan after he captured a large female horseshoe crab and seemed awestruck by the mass of eggs she was carrying on her swimmerets. They also expressed concern that he had her out of the water too long for them to see her: "*Quick! Put her back in the water before she dies!"*

Halimeda Lab:

Example 17: Throughout this lab, students could be heard loudly admonishing their peers to *"Be careful!"* or *"Don't kill it!"* as they discovered the dozens of invertebrate species and a few vertebrate (fish) species. They showed great concern about the marine worms' aggressive behaviors and quickly set about to separate the more fragile animals from the marine worms. Some students were very protective of their holding containers and would not let peers poke or "harass" the creatures within the containers. When instructors announced that they would be returning the Halimeda to the exact spot from which it was collected the next day, several students asked if they [the instructors] were sure their creatures would be put back with the algae that night so "they have a safe place to hide"

Cassiopeia Lab:

Example 18: Students were initially hesitant to perform this lab for fear of killing the jellyfish (See Figure 15). They were very clear in stating that they "do NOT want to kill it". Some even accused one another of doing so, although the jellyfish did resume normal behaviors when removed from their stress factor (temperature, salinity changes, or pollutants.)

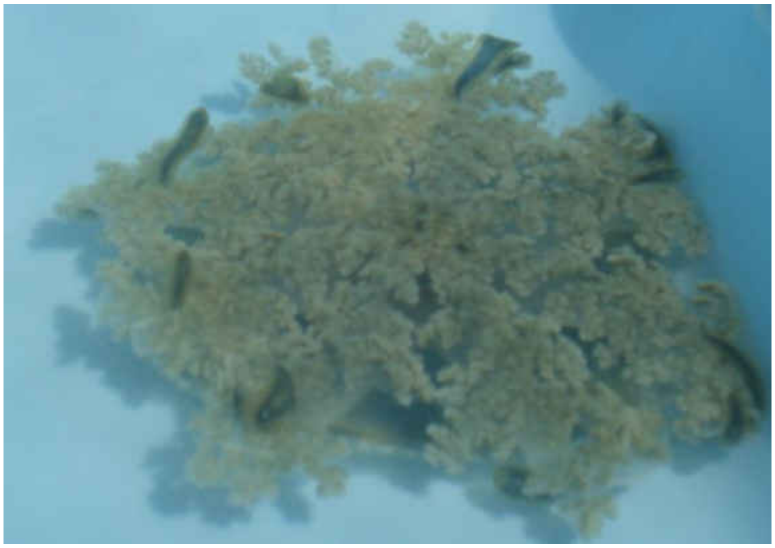

Figure 15 *Cassiopeia,* the “Upside Down” Jellyfish

Example 19: Tom and Mary anxiously counted the pulses their jellyfish emitted. Despite being assured that no jellyfish would meet its death, students conversed back and forth in concern about the excessive pulsating behavior or the lack of pulses their jellyfish were exhibiting. (See Figure 16).

Figure 16 Testing stress factors on Cassiopeia

Shark Lesson Activities

Example 20: Students learned about the anatomy and behaviors of the little bonnet head shark (*Sphyrna tiburdo*). Several students in instructor Nathan's group came to realize on Saturday while wading back from Horseshoe Island that these sharks were being captured for their benefit for the Sunday swim in "Shark Pond". The students witnessed the stress of instructors trying to save three bonnet heads caught on a hook line and watched as they rushed the little sharks to the shark tank. They observed the instructors holding the sharks, moving them back and forth so as to pass water over the gills (the sharks were too weak to swim on their own). Students' voices were hushed as they queried the instructors about why they were holding the sharks, "swimming" for them and why they wouldn't put them in the pond. Students seemed to sense the gravity of the situation - the sharks were possibly dying (See Figure 17). Students did not want to leave the holding tankto perform the jellyfish lab because they were worried about the sharks dying.

Figure 17 Casey worries about injured bonnet head

Example 21: “Tom” and “Larry” noted that there were two dead bonnet heads in Shark Pond after their swim and expressed remorse: *“I guess those were two of the three from yesterday that didn’t make it in the tank – that’s sad.”*

<u>Data Analysis of Student Interviews</u>

Table 3 represents students’ responses to the first question of the post trip interview: *“Why did you want to attend this field trip to ©Seacamp?”* Of the 15 students participating in the interviews, most indicated a love of the ocean and that it seemed like a fun thing to do with their friends. “Laura” indicated she attended the trip because she had an interest in pursuing a career in marine science. She also indicated she still planned on doing so. Eight of the students directly indicated they wanted to "learn new things" or "do the activities".

Table 3: Why did you want to attend this field trip to ©Seacamp?

Why did you want to attend this field trip to ©Seacamp?	
Larry	*I love the ocean and I wanted to learn more about it.*
Evan	*I really wanted a vacation away from my parents and I wanted to do experiments about the ocean!*
Nicolette	*I'm really interested in marine life and I wanted to learn more about the Florida Keys.*
Laura	*I was thinking about becoming a marine biologist and I wanted to see what it was like. I'm still considering it*
Anna	*It sounded like a lot of fun and my friends are going and I really like sea turtles.*
Jourdan	*I wanted to learn more about sea life. Also, I've never been snorkeling and I wanted to do that*
Ariana	*I wanted to learn and explore and be happy and have fun and live my life the best I can*
Cindy	*I wanted to have fun with my friends overnight and see new things*
Gia	*I went snorkeling with my family on vacation once, but I really wanted to do it again with my friends this time*
Becca	*I love the ocean*
Grace	*I enjoy everything about the ocean and I wanted to learn more about it with my friend.*
Bette	*It seemed like it would be fun!*
Amanda	*Because I heard it was a cool trip*
Tom	*It sounded cool to stay in dorms and do all the activities. Also missing school*
Rick	*I wanted to be with my friends because it sounded like it would be really fun and I love the ocean. I knew someone who went before and they said they really liked it.*

Table 4 represents students' responses to the question *"What activity did you enjoy the most on the field trip and why?"* Eleven of 15 students mentioned "snorkeling" either directly (or indirectly when they described "swimming [snorkeling] with the sharks"). All students indicated they learned new things during their favorite activity or that they had fun.

Table 4: What activity did you enjoy this most and why?

What activity did you enjoy this most and why?	
Larry	*I loved learning about sharks and then getting to swim with them*
Evan	*The Friday night bioluminescent and nocturnal animal activity – I didn't know marine worms glowed. It's not every day you get to see stuff like that*
Nicolette	*The [Halimeda} algae lab –there were so many little tiny animals like the spider crab and I didn't know its organs were carried on its legs*
Laura	*Snorkeling – I saw a big blue crab and a lot of fish by the mangrove roots*
Anna	*Wading to Horseshoe Island – seeing the mangroves up close and then a giant horseshoe crab swam past us. The water games there were fun, too*
Jourdan	*Snorkeling – I caught a hermit crab, lobster, and a sea urchin. But, I liked swimming with the sharks activity, also*
Ariana	*I liked snorkeling the best because I could do it and I found stuff without that much assistance*
Cindy	*Dissecting the squid. I liked seeing what it was made of. I didn't know they had that many senses[enlarged eyes, specialized tentacles, beak]*
Gia	*Snorkeling around all the mangrove roots and around Bird Island.*
Becca	*Snorkeling because it was cool to see how many animals were in the shallow water*
Grace	*A tie between wading to Horseshoe island and the snorkeling. I didn't know so many things lived in the mangrove. and the I liked seeing how different the fish were here than in Australia*
Bette	*I liked snorkeling because I saw so many fish and even a lobster, but I really liked swimming with the sharks, too*
Amanda	*The snorkeling in general was the best because it was really fun and cool*
Tom	*Swimming with the sharks even though some were dead. It was nerve-recking [sic]but it was funny, too*
Rick	*The snorkeling was my favorite because we caught hermit crabs and a sea hare. Fish were everywhere by the mangrove roots.*

Table 5 represents students' responses to the request *"Describe 2 or more things you learned about the ocean that you didn't know before this field trip."* Ten of 15 students indirectly related their learning experiences to the concept of biological diversity. They indicated a new understanding of how many different organisms depend on shallow marine habitats to survive and expressed concern about their activities causing harm to the marine organisms they encountered.

Table 5 What are two or more things you learned about the ocean that you didn't know until this field trip?

What are two or more things you learned about the ocean you didn't know until this field trip?	
Larry	*I didn't know sponges were living and things lived in them. Now I'm afraid of stepping on them. I didn't know brittle stars could bioluminesce.*
Evan	*That red mangroves have sacrificial leaves [for salt elimination] and that sharks have 7 senses*
Nicolette	*I didn't know sharks had 7 senses. I didn't know certain shrimp can make a snapping sound so loud [the pistol shrimp]. I didn't know about the tapetum lucidum that nocturnal animals have on their eyes.*
Laura	*I had no idea jellyfish were so sensitive – I didn't know there were sea hares or that so many animals glowed [during the nocturnal and algae activities]*
Anna	*I never heard the word "crepuscular" before – that those are the animals that come out at twilight. There were so many! I didn't know some marine worms come out at night and glow*
Jourdan	*I didn't know how fragile coral is and that I can damage them with just my flippers*
Ariana	*I thought seaweed [Halimeda] was just a bunch of mushy stuff but it was FULL of stuff and if you squish it there's so much in it that could die. There were some really vicious marine worms trying to kill the other stuff [in the container]*
Cindy	*I had no idea sharks have 7 senses and I didn't know how sensitive jellyfish are. We almost killed ours with just a little soap*
Gia	*I didn't know about the progression of life from the seagrass beds to the mangroves and if something goes wrong, they are all affected. I didn't know a sea hare would ink me*
Becca	*I didn't know about all the different mangroves that live near the ocean edge and there were so many random animals living in them*

What are two or more things you learned about the ocean you didn't know until this field trip?	
Grace	*I didn't know that the mangroves pull and hold the sand together and all those animals lived around their roots and I didn't know bonnet head sharks have to suck to bite*
Bette	*I didn't know sharks can taste with their skin and I thought algae was just a clump of weeds but it was full of living things*
Amanda	*Sharks have teeth on their skin and a lot of fish depend on mangroves for shelter*
Tom	*That fish have white bellies for camouflage and that sharks taste things by bumping into people*
Rick	*I didn't know that we are stepping on so many little animals with our flippers when we put our feet down. I didn't know that all those worms and brittle stars and stuff were in the algae.*

Table 6 represents students' responses to the question *"What did you learn about the term "biodiversity?"* from your field trip experience?" Thirteen of 15 students responded to this question and these students used phrases such as *"so many"* or *"it's good"* or *"dependency/depends"* and *"strengthens"* in their responses indicating an essential understanding that biological diversity in ecological habitats is essential for organisms to thrive.

Table 6: What did you learn about the term "biodiversity" from your field experience?

What did you learn about the term "biodiversity" from your field experience?	
Larry	*That so many animals live in an area and that is a good thing*
Evan	This student chose not to respond
Nicolette	*There are lots of different species but they don't bother each other and they depend on each other*
Laura	*Like the algae [Halimeda]is a home to so many things*
Anna	*The [Halimeda]algae is really one big home for so many and I was so surprised about all the worms in it*
Jourdan	*I was so surprised by how many creatures were living in that algae[Halimeda]- that it has such an important purpose for so many animals*
Ariana	*There are so many different living things and we need to be really careful to protect them*
Cindy	*There were a whole bunch of shrimp and worms and brittle stars and they all called that algae "home"*
Gia	*It's really important [in nature]to have a lot of different types of stuff in case one thing dies off. Like a sponge has a bunch of things living inside it*
Becca	*I wasn't expecting to find all those worms and brittle stars in that Halimeda*
Grace	*I think it means that it strengthens ecosystems*
Bette	This student did not remember
Amanda	*That everything depends on things that depend on marine life*
Tom	*The more biodiverse some place is, the more healthy[sic] and lively an ecosystem is*
Rick	*I think it means there is [sic] a lot of different things and they all need each other. We need to be a lot more careful because biodiversity makes a place stronger.*

Table 7 represents students' responses to the question "Has your ©Seacamp experience made you think differently about how human activities affect coral reefs (or the ocean in general)?" Thirteen of 15 students responded to this question, but Larry and Tom indicated they did not think any differently about human activities. Nicolette, Cindy, and Becca said they were worried about the effects of trash on marine life after seeing trash in the water. Gia indicated it made her "feel more protective" about caring about oceans. Some examples of students' concerns included being careful about stepping on or throwing anchors on top of coral; wasteful behaviors of people; the importance of talking to others; and the importance of "the small [living] things". Bette and Amanda directly stated they now thought more deeply about the impact of human activities on the oceans. Anna indicated she now realized why laws were in place to protect mangroves. Rick's answer referenced the impact of a speech given by instructors Nathan and Collins just before we departed from ©Seacamp. They told the students to "get off the couch, the computer, the cell phones" and to go outside and "live nature" – that true meaning and caring would be found only if students went outdoors and lived it. They told the students to "spread the word" about the plight of our ocean.

Table 7 Has your ©Seacamp experience made you think differently about how human activities affect coral reefs (or the ocean in general)?

Has your ©Seacamp experience made you think differently about how human activities affect coral reefs (or the ocean in general)?	
Larry	This student responded "No" - He said he felt he was already "pretty thoughtful about protecting our oceans"
Evan	This student had a difficult time articulating his feelings, which is also true in the typical classroom due to his disability
Nicolette	*I noticed when we were snorkeling there was trash – and I saw this floating balloon and worried that a sea turtle might swallow it and die*
Laura	*I didn't know I could smash coral to death with just my feet when snorkeling*
Anna	*I thought about how mangroves are so helpful to people and animals especially during a storm and that's why it's against the law to cut them down*
Jourdan	*Just something like dropping an anchor can cause so much damage [to coral]. [This trip]made me care a lot more about other creatures' feelings*
Ariana	*I think I need to get out and talk to other kids to think about what they do - like buying smart cars*
Cindy	*I saw trash in the water [while snorkeling] and it made me think how precious clean water is. It made me consider taking shorter showers – but probably not*
Gia	*They [©Seacamp's brochure] make it [the animal abundance] seem like a bigger deal and I was actually expecting more stuff. Maybe there are fewer fish because of pollution and stuff*
Becca	*It made me feel a lot more protective of stuff in the ocean and I was really disappointed when I saw a piece of trash*
Grace	*I just didn't realize how important the little species are to each other*
Bette	*Yes – There's a lot more harm being done [to the oceans] than we think. Harming one animal harms so many others*
Amanda	*Yes – I never really thought about this before ©Seacamp: now I realize that humans polluting can destroy the environment and all the things in it*
Tom	No – I learned a lot from the Florida Keys class –maybe a little [change in thinking] but not a lot
Rick	*I think telling people why it's important not to pollute might help – maybe more people ought to get outside like Nathan said [the parting speech an instructor gave to students on the bus].*

Table 8 represents students' responses to the question "Has your ©Seacamp experience given you any ideas about what you can do to protect oceans for the next generation of kids?" Fourteen of 15 students responded to the question. Seven of the 15 students used phrases such as "talk to others", "tell my friends", or "educate the public" as a solution in helping protect our oceans for future children. Evan and Anna suggested people stop taking things from the ocean (overfishing of sharks was one example). Grace and Amanda stressed the influence laws might have in helping our oceans. Gia initially indicated that she could not think of anything to protect our oceans for future generations but then changed her mind: *"Then I listened to Nathan and Collins' [©Seacamp instructors' parting speech about getting up off the couch and spreading the word about stewardship to others] and that really made me think differently that maybe I can make a difference."*

Table 8: Has your ©Seacamp experience given you any ideas about what you can do to protect the Earth's ocean for the next generation of kids?

Has your ©Seacamp experience given you any ideas about what you can do to protect the Earth's ocean for the next generation of kids?	
Larry	*It really opened my eyes about what I want to do* [This student gave no specific example]
Evan	*We must stop overfishing sharks because they are really important for the ocean* [did not elaborate]
Nicolette	*We need to talk to other people and tell them about the [importance of the] ocean*
Laura	*Educate the public*
Anna	*We need to clean up trash from beaches and we need to stop taking things from the ocean. We should try to recycle more*
Jourdan	*Tell whoever is driving the boat to be really careful where they drop the anchor. Spread the word about protecting the ocean –tell people to be more aware of what they do*

Has your ©Seacamp experience given you any ideas about what you can do to protect the Earth's ocean for the next generation of kids?	
Ariana	*Yes, definitely I think I can pick up plastic when we go sailing and tell other kids [about the importance of not littering]. I really hate motorized boats*
Cindy	*I can tell my friends about what I saw [at ©Seacamp]. I think some people might listen.*
Gia	*At first I thought "No", but then I listened to Nathan and Collins' [instructors' parting speech about getting up off the couch and spreading the word about stewardship to others] and that really made me think differently that maybe I can make a difference*.
Becca	No response
Grace	*Maybe more stricter* [sic] *laws ought to be in place.*
Bette	*I need to tell my friends about things we can do*
Amanda	*Following boating laws is important because they are there for a reason*
Tom	*Yes, I can do a beach cleanup [whenever I go] and I can tell people not to dump the exotic animals from their aquariums into the ocean*
Rick	*If more people got in the ocean, maybe they would see things differently, like all the different things need our help.*

Summary

Influencing students to become stewards of the Earth's ocean was the purpose of this study. Supporting evidences included a pre and post knowledge survey about coral reefs and biological diversity, videotaped transcripts and field notes of students' conversations and activities among peers and instructors, student interviews, and photographs.

In evaluations of the outcome of my first question "In what ways did a field experience at ©Seacamp influence ocean stewardship?" I discovered many examples of student behaviors which exhibited caring about marine organisms' welfare – from the tiny invertebrates discovered in the algae lab to larger organisms found during snorkeling trips and ultimately a caring attitude about whether the sharks captured for their swimming activity would survive. Students discovered stewardship behaviors within themselves as well by expressing concerns of stepping on corals and thus killing them, causing harm to the jellyfish they used to test stress factors, and the realization they could do positive things to help the health of our ocean by telling friends about their discoveries.

In evaluating the outcome of my second question "In what ways did a field experience at ©Seacamp influence students' understanding of the effects of human impact on the biological diversity of shallow water ecosystems?" I discovered that students' greatest revelations about biological diversity occurred during the Halimeda (algae) lab. Most students expressed wonderment about the abundance and number of so many different organisms living in a clump of marine algae. They also expressed wonderment that so many different organisms would find a safe haven inside a single, small sponge when they cut one open on their second snorkeling trip. Their instructor emphasized in a lesson on the white floor of the pontoon boat how important it was that there were many different species of (for example, sponges) because if one species disappeared due to disease, predation, or pollution, others existed to support the ecosystem through the crisis. Students remembered these lessons as evidenced in their interviews and they were recorded multiple times talking about variety and sheer numbers of organisms observed during snorkeling and during the algae lab.

In evaluations of the outcome of my third question "How was students' engagement in the learning process influenced by their experiences at ©Seacamp?" I discovered there is no indoor classroom experience that can match the level of engagement students exhibited during their ©Seacamp activities. The socialization among peers while discussing their learning was paramount in understanding the concept of biological diversity and its importance. Sharing their excitement of discoveries with their friends - as documented through photographs, interviews, and video transcripts revealed the stewardship behaviors students were developing during their short stay, immersed in meaningful activities and grounded in "place". During the interviews, I realized that some of the students I taught in the classroom were suddenly demonstrating a stronger sense of self-perception: they were developing a sense responsibility toward the global ocean and they listened keenly to the parting message of their instructors to "go forth and make a difference".

CHAPTER 5 CONCLUSION

Introduction

In initiating this action research, the purpose of this study was to determine the influence a residential marine learning experience had on students' ocean stewardship. The questions investigated in this study were:

1. In what ways did a residential learning experience at ©Seacamp influence students' ocean stewardship?

2. In what ways did a residential learning experience at ©Seacamp influence students' understanding of the effects human impact has on the biological diversity of shallow water ecosystems?

3. How was students' engagement in the learning process influenced during their experiences at ©Seacamp?

My essential question for this action research was to determine the influence a residential marine learning experience had on students' ocean stewardship behaviors. Specifically, would students come to understand from their field experiences at ©Seacamp that organisms inhabiting our oceans are part of a vast interconnected ecological web and that marine organisms each have a specific role within this web? Would they learn that biological diversity is essential to sustain marine ecosystems and that the Earth's ocean is not so infinite as to be unaffected by the impact of human activities? My focus was to document the instances where students articulated care and concern about the ecological importance of smaller ocean inhabitants they may never have encountered through common experiences such as trips to the beach or local theme parks and television/media sources. Interviews, videotapes, field notes and photographs were the methods I used to document student evidences: recording the conversations and actions of the students while they were engaged in discussions among peers and ©Seacamp instructors that centered on the themes of ocean stewardship, the impact of human activities on Earth's ocean, and the importance of biological diversity.

Connections from Practice to Literature

It is recognized today that Earth's ocean is in serious ecological decline (Steel et al., 2005) The challenge educators face is how to link curricula and students to the marine environment through a new era of ocean literacy: providing comprehensible information about the structure and functioning of coastal and marine ecosystems and clearly representing how humans and the ocean are interconnected (Pews Oceans Commission, 2003) Undeniably, further progress on environmental protection and creating sustainable marine environments relies on an informed and engaged public (Daigle, 2003) There has been a tremendous interest and effort to reform science education so that students are not only engaged, but engaged in authentic scientific inquiry (Sandoval & Millwood, 2005).

Pearce described inquiry as recognizing, exploring and using logical, rigorous thought and elegant reasoning, emphasizing the importance of encouraging communication and discussion among peers as part of the inquiry processes (Pearce, 1999). The National Science and Education Standards (NSES) underscore the necessity of opportunities for students to learn science in personal and social perspectives (National Committee on Science Education Standards and Assessment, National Research Council, 1996).

Throughout their ©Seacamp experience, students were engaged in animated conversations among peers and instructors while performing authentic scientific inquiry. From the first night of their arrival, students were involved in both full and guided inquiry. Berns, Cohen and Mintun highlighted the concept of introducing novel activities to children in addition to the regular indoor classroom - while interacting with peers - would likely lead to high levels of engagement (Berns et al., 1997). Radinsky's revealed the importance of new knowledge being generated through a process of collective, contested and negotiated communication while co-constructing new understandings just as it is in the real world (Radinsky et al., 2010). After brief, interactive lessons, students then transitioned into authentic inquiry activities such as capturing (and later releasing) nocturnal marine animals (a connection of living examples to their discussion prior to the activity); learning on board a "floating classroom" pontoon boat about the transition of one marine habitat into another and the critical necessity of biological diversity - then snorkeling turtle grass and sponge beds. Students captured (and later released) a diverse selection of organisms that depended on turtle grass and sponge bed habitats for survival, all while engaged in discussion with peers. Students watched intently as an instructor cut apart a sponge and observed an entire, separate, "microhabitat" of invertebrates that found shelter and safe harbor inside this single sponge; students swam with peers beside mangrove roots and observed innumerable species of young fish and invertebrates that use the mangrove habitats as nursery grounds or permanent shelter. Once on board the boat, they had rich, animated discussions about all the marine organisms they encountered. ©Seacamp instructors incorporated play through water games to simulate the ecological importance of mangrove habitats. Students gently pulled apart clumps of coralline algae (Halimeda) to discover a diverse and rich population of mostly invertebrates while learning from their instructors that these invertebrates and the *Halimeda* represent a pioneering community to the establishment of corals. Plankis and Klein's research described inquiry as authentic when an activity or experiment had no expected known outcome and students would not be able to ask the teacher to verify their data (Plankis & Klein, 2010). Using this definition authentic inquiry learning was exemplified when students tested human-generated stress factors (pollutants, salinity changes, or temperature) on jellyfish and observed the changes in the jellyfish pulse rates; Students exhibited keen interest and engagement while dissecting a squid to learn about unique adaptations of this marine invertebrate. Most students expressed a desire to examine and touch a frozen bonnet head shark as their instructors talked to them about the evolution of unique features sharks have which make them unique, apex predators. Finally, almost all students put aside fears of small sharks and paddled around a small, man-made lagoon in hopes of observing bonnet head sharks "in the wild".

In order to learn about patterns and relationships in sustainability education, David Orr emphasized that developing children's ecological literacy occurs best when pedagogy is embedded within "place" (Orr, 2004). He believed there would be reciprocity between thinking and doing because students' experiences in nature shape their mindscape. Orr believed to create an ecologically-literate mindscape requires opportunities for enveloping wonder, mystery and delight and such opportunities must be carefully designed to bring forth such emotions. This philosophy is embraced at ©Seacamp and is part of their mission statement.

Dewey and modern constructivists underscore the ideas that teaching and learning have to be anchored to meaningful activities. ©Seacamp instructors guided students through each activity to help them understand the dependence and interactive relationships between humans and nature. Students' answers in the interviews were evidence they were making these connections. One student described how biological diversity strengthened an ecosystem; another expressed wonder that so many living things could be living within a single sponge. One student said "I just didn't realize how important the little species are to each. Almost all students expressed amazement that so many different invertebrates could live within the algae and they demonstrated protective behaviors towards the tiny invertebrates they removed and put in small holding trays: students were observed removing marine invertebrates to other trays if other marine organisms within the same container acted aggressively toward them. Students encouraged peers to "be careful" and to "watch out" during the same lab as well as while snorkeling so as not to harm the coral. Other researchers emphasize the necessity of providing opportunities for students to go above and beyond simple awareness or knowledge of an issue if educators want students to develop a sense of ownership and empowerment; when these feelings are in place students may be prompted to become responsible, active citizens who can affect the attitudes and behaviors of others (Hungerford & Volk, 1990; Palmberg & Kuru, 2000). Evidence to support this idea was strong in my last interview question "Has your ©Seacamp experience given you any ideas about what you can do to protect the Earth's ocean for the next generation of kids?" Seven of the 15 students responded using expressions indicating that they planned on telling others about the importance of protecting our oceans; two expressed personal actions (such as not taking things from the ocean or overfishing). The strongest evidence came from Gia

(Table 8) who carefully contemplated the question. She indicated at first that she didn't think there was anything she could do, but hearing an inspirational parting speech by ©Seacamp instructors Nathan and Collins changed her way of thinking. *"Then I listened to Nathan and Collins' [©Seacamp instructors]' parting speech about getting up off the couch and spreading the word about ocean stewardship to others] and that really made me think differently - that maybe I can make a difference."*

Implications for Classroom Teaching

I did not expect the depth of thinking 8th grade students were capable of until I began coordinating the trips to ©Seacamp four years ago. Documenting conversations and transcribing videos highlighted many examples of student learning that I was unaware of until this 2012 ©Seacamp experience: the critical importance of peer interaction for discussing scientific knowledge; the influence guest speakers or other instructors have on student learning – particularly young, educated role models in the science field (as evidenced by several students moved by Nathan and Collin's parting speech); giving students opportunities and time to practice new ideas; keeping lessons brief but making experiences longer.

Regarding my own teaching practices, what I learned from the ©Seacamp experience is that lessons should be chunked and students need time to discuss, practice, and experience meaningful activities for them to understand new knowledge. Novel situations stimulate thinking. Instead of "covering" material in a chapter, I need to focus on the standards and keep lessons brief and meaningful – to surrender the concept of a "sage on a stage".

The evidences documented from the ©Seacamp 2012 field trip support what I read in the literature: that "place" is critical; peer interaction is essential; and ecological literacy takes time and careful lesson planning. Field trips should continue to be part of the public school curriculum if they are evaluated to stand on their own merit. Sometimes learning has to take place in alternate settings.

Limitations

There were several limitations to this study: The first is that the residential field experience is only 2 nights and 2.5 days. While abundant learning opportunities abounded throughout students ©Seacamp experiences, reflection time was limited because the pace of the program was very fast. A second limitation is that I devised 2 surveys and 1 assessment for students to take on the bus ride down to the Florida Keys, but this proved to be unsuccessful in answering my research questions: The survey answer choices were lengthy and I did not take into account that some students may have had trouble interpreting what the questions were asking or that they might get motion sickness trying to take the surveys on the bus. I did not provide adequate time for students to take the pre-surveys. I assumed students would like the "novelty" of using their smart phones and willingly use the long bus ride to ©Seacamp to take the surveys. In hindsight, I should have realized that the bus ride was, to them, strictly social time and most students were not motivated to take the surveys prior to their ©Seacamp experience. Many students did not have a smart phone to take the surveys and thus only a small number of students took all three. A third limitation was that high, prevailing winds prevented students from snorkeling the actual coral reefs; instead, snorkeling was restricted to patch reefs and a coral head. Therefore, students did not have the true coral reef experience they witnessed in many of the DVD's they observed during the "Ecology of the Florida Keys" course and some students expressed disappointment in this situation. Also of importance to note is that of the 15 students participating in the coral reef and ocean knowledge assessment and interviews, 7 students currently enrolled or had been enrolled the previous semester in my elective course "Ecology of the Florida Keys" and this may have had possible predispositions toward ocean stewardship.

Summary

If I were to replicate this study or expand on this research question, I would take greater care in generating a survey more conducive to 8^{th} grade students' response abilities (simple agree or disagree instead of employing the emotive word "strongly" when agreeing or disagreeing). I would email the questions to students two weeks prior to the trip so they would have time to take them in a more comfortable setting and perhaps reflect more deeply about the questions. I would like to have had the time to have post trip activities with students to review and discuss their learning, but my school administration and district will not allow residential trips until after the Florida's Comprehensive Assessment Test (FCAT). Much research confirms the need for follow-up activities and reinforcement of newly acquired interests to prevent the fading of new knowledge and discoveries over time.

I am very concerned about the lack of ocean literacy in Florida's current standards and the NGSS. I am concerned about the disconnection between today's youth and the outdoors. Research has shown that developing any type of environmental citizenry is time consuming and complex (Bogner, 1998). Bogner's reseach showed a delay from reasoning (about caring for the environment) to action which requires a quantity of time and a long-lasting approach for such a paradigm shift from nature exploitation to nature conservation. I would like to see further studies that focus on influencing ocean stewardship in our nation's children based on longer learning experiences such summer programs.

Conclusion

The purpose of this action research study was to determine the influence a residential marine learning experience had on students' ocean stewardship. As a teacher, I learned that an experiential learning encounter at ©Seacamp fostered within my students the beginning of thinking deeply about their actions and the actions of others on coastal marine ecosystems. I was awed about their compassion for even the tiniest invertebrates while engaged in each activity and that they realized the importance of how each habitat was connected to and depended upon another. I was inspired by my students with social or physical disabilities who willingly immersed themselves in the activities and who spoke about their learning with joy and excitement. It is my hope that my school district and those across this state and nation will recognize the importance of experiential learning in fostering ocean (and all) environmental literacy.

APPENDIX A:
IRB APPROVAL FORM

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Revised letter 4/4/2012

From : **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To : **Jenifer L. Rembert**

Date : **November 02, 2010**

Dear Researcher:

On 11/2/2010 the IRB determined that the following proposed activity is not human research as defined by DHHS regulations at 45 CFR 46 or FDA regulations at 21 CFR 50/56:

Type of Review:	Initial Review
Project Title:	.How Does a Residential Marine Facility Learning Experience Affect Middle School Students' Ability to Describe Human Impact on Coral Reef Biodiversity and Their Interest in Considering Careers in Science?
Investigator:	Jenifer L Rembert
IRB ID:	SBE-10-07214
Funding Agency:	None

University of Central Florida IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are to be made and there are questions about whether these activities are research involving human subjects, please contact the IRB office to discuss the proposed changes.

On behalf of the IRB Chair, Joseph Bielitzki, DVM, this letter is signed by:

Signature applied by Janice Turchin on 11/02/2010 08:41:30 AM EST

Janice M Turchin

IRB Coordinator

APPENDIX B:
COUNTY PERMISSION

[redacted]

April 23, 2012

[redacted]

Dear Ms. Rembert,

I am in receipt of the proposal and supplemental information that you submitted for permission to conduct research in the [redacted] Schools. After review of these documents, it has been determined that you are granted permission to conduct the study described in these documents under the conditions described herein with students from [redacted] School at Seacamp on Big Pine Key, Florida.

[redacted] has the authority to decide if she wishes to approve your study. Therefore, your first order of business is to contact her to explain your project and seek permission to conduct the research. You are expected to make appointments in advance to accommodate the administration and/or staff for research time.

Please forward a summary of your project to my office upon completion.
Good Luck!

Sincerely,

[redacted]
Deputy Superintendent
Instructional Excellence and Equity

[redacted]

[redacted]

APPENDIX C:
PRINCIPAL CONSENT

[redacted]

[redacted]

April 17, 2012

Department of Teaching and Learning Principles
College of Education
University of Central Florida
Orlando, Florida

Dear Committee Member:

Ms. Jenifer Rembert has permission to conduct her studies, "How Does a Residential Marine Facility Learning Experience Affect Middle School Students' Ability to Describe Human Impact on Coral Reef Biodiversity?" and Does Student Interest in Considering a Science Career Change After Their Residential Marine Facility Learning Experience?" on the campus of [redacted] and at Sea Camp in the Florida Keys.

If you have any questions, feel free to contact me. I look forward to the results of her study.

Sincerely,

[redacted]

[redacted]

[redacted]

APPENDIX D:
PARENT CONSENT

Consent from a Parent for a Child in a Non-Medical Research Study

Purpose of the research study: National Geographic's (2006) brochure *Ocean Literacy* presents the case for teaching children about the importance of the worlds' oceans (*Ocean literacy*.2006). Despite the fact that the ocean covers most of our planet, is the source of most life on Earth, provides food for much of the human population, regulates our weather systems and climate, and produces most of Earth's oxygen, ocean and aquatic sciences are among the most underrepresented disciplines in K-12 educational curricula and they are rarely taught at any level. Ocean education is mentioned infrequently in state and national standards. To be considered "Ocean Literate", students should understand not only essential ocean principles and fundamental concepts but be able to communicate in meaningful ways as well about the connection all life on Earth has with oceans and know how to make informed and responsible decisions about our ocean and its resources.

One purpose of this study is to determine how a field trip to Seacamp affects students' understanding of human impact on coral reef biodiversity. A second purpose is to determine if interacting with marine scientists at Seacamp affects students' interest in science/marine science careers.

Principal Investigator(s): Ms. Jenifer L. Rembert, [redacted]th grade Physical Science Teacher and Seacamp Coordinator for [redacted]

Sub-Investigator(s): [redacted] Principal - [redacted]

Faculty Supervisor: [redacted], Principal - [redacted]

Investigational Site(s): Seacamp Association, Inc.
1300 Big Pine Avenue
Big Pine Key, FL 33043
and
[redacted]

What your child will be asked to do during the study:
Ms. Rembert may audiotape, videotape, or photograph students as they learn about coral reefs and ocean stewardship while performing laboratory experiments and discovery activities following the Seacamp curriculum. Students may be asked to be interviewed or to provide comments about what they learn or are learning during the taping/interviews. Additionally, they will be asked to fill out a pre and post survey about their learning and about science careers.

Ms. Rembert will transcribe all audio/videotapes to determine what learning (and depth of learning) occurs as a result of their Seacamp experience.

Audio or Video Taping: Both types of taping will occur during this study. Only those participants who have parental permission will be audio or video taped and thus participate in the study. Students will always wear shirts over bathing suits while at Seacamp so this will cause not concerns for videotaping. ***Your child will not be penalized in any way if you choose not to allow him or her to participate in this study.***

If you grant permission for audio and/or video taping, the tapes will be kept in a locked, safe place on the [redacted] campus. The tapes will be destroyed by August 2012 at the completion of Ms. Rembert's thesis.

Please indicate below if you do or do not give permission for student interviews and surveys:

☐ I give my permission for my child to participate in videotaped sessions with other participants.

☐ I DO NOT give my permission for my child to be videotaped during the Seacamp field trip.

How to Return this Consent Form: Please have your child return this form with your signature on or before *MONDAY APRIL 30, 2012. THANK YOU!!*

Sincerely,
Jenifer L. Rembert,
8th Physical Science and Ecology of the Florida Keys Teacher,
[redacted]

APPENDIX E:
STUDENT ASSENT

University of Central Florida

I am doing a research study about 8th graders who are attending Seacamp May 11-13, 2012. I would like to know what you learn about the diversity of life found in the coral reefs around Big Pine Key as well as the kinds of careers one might investigate as they relate to the Earth's oceans. I am completing thesis research as part of my classes at the University of Central Florida.

If you participate in the study while on the field trip, you will answer a short questionnaire about marine science careers while you ride on the bus to Seacamp. You will then answer the same short questionnaire after field trip while riding home. While at Seacamp, I would like to audio and video record you as you collect marine animals, perform the laboratory activities and prepare to snorkel or wade. Only Dr. Jeanpierre, my professor at UCF and I will hear the audiotapes or watch the videotapes. I will not use your full names when I talk to you or film you and the tapes will be destroyed at the end of my study. It will not affect your grade if you decide you do not want me to film audiotape your voice but you cannot be in the study. You can stop taking part in the study at any time. You will not be paid for doing this. Would you like to take part in this research project?

☐ I want to take part in Ms. Rembert's research project.

☐ I do not want to take part in Ms. Rembert's research project.

__________________________ _________

Student's signature Date

____

Student's printed name

APPENDIX F:
NEXT GENERATION STATE STANDARDS

NGSSS (Next Generation Sunshine State Standards) Grades 7 and 8
<u>The Practice of Science</u>
SC.7.N.1.A (and SC.8.N.1.A): Scientific inquiry is a multifaceted activity; The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation
SC.7.N.1.B (and SC.8.N.1.B): The processes of science frequently do not correspond to the traditional portrayal of "the scientific method."
SC.8.N.1.2: Design and conduct a study using repeated trials and replication.
SC.8.N.1.C: Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge
<u>Interdependence</u>
SC.7.L.17.2: Compare and contrast the relationships among organisms such as mutualism, predation, parasitism, competition, and commensalism.
SC.7.L.17.3: Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.
SC.7.E.6.6: Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.
SC.7.L.17.B: Both human activities and natural events can have major impacts on the environment.
SC.7.L.17.C: Energy flows from the sun through producers to consumers.
SC.7.L.17.2: Compare and contrast the relationships among organisms such as mutualism, predation, parasitism, competition, and commensalism.
<u>Diversity and Evolution of Living Organisms</u>
SC.7.L.15.C: Natural Selection is a primary mechanism leading to change over time in organisms
<u>Matter and Energy Transformations</u>
SC.8.L.18.1: Describe and investigate the process of photosynthesis, such as the roles of light, carbon dioxide, water and chlorophyll; production of food; release of oxygen.

APPENDIX G:
PERMISSION FOR USE OF CONTENT FOR PRE AND POST CORAL REEF KNOWLEDGE ASSESSMENT

STATEMENT OF ACCESS

I, the undersigned, the author of this thesis, understand that James Cook University will make it available for use within the university library or, by other means, allow access to users in other approved libraries.

All users consulting this thesis will have to sign the following statement:

In consulting this thesis, I agree not to copy or closely paraphrase it in whole or in part without proper written acknowledgement for any assistance I may have obtained from it.

Beyond this, I do not wish to place any restriction on access to this thesis.

Signature 6/25/12

Date

APPENDIX H: KNOWLEDGE ABOUT CORAL REEFS SURVEY

Knowledge About Coral Reefs Survey

1. The reefs of Florida's Keys are found in which ocean zone?
A. Pelagic
B. Mesopelagic
C. Abyssopelagic
D. Photic

2. Corals are __.
A. thin layers of living animals, which secrete a limestone skeleton as they grow. (Coral colonies grow, divide and multiply in a process known as budding.)
B. thin layers of plants, which secrete a limestone skeleton as they grow. (Coral colonies grow, divide and multiply in a process known as budding.)

3. Corals feed by:
A. eating plankton
B. producing their own food by photosynthesis
C. eating plankton AND food is produced for them by photosynthesis from zooxanthellae living in their tissues.

4. Corals have color due to:
A. the algae that live on the outside of their polyps, like clothing.
B. the presence of a brown algae (zooxanthellae) that live in their tissues.
C. the various organisms that live around the reef.
D. the presence of a unique animal that lives within their tissues.

5. Coral reefs grow off the coast of the Florida Keys because:
A. corals need dirty water which is high in nutrients.
B. corals need clear water which is low in nutrients.
C. corals need clear water which is high in nutrients.
D. corals do not require clear water to grow.

6. The clarity (clearness) of the water around a reef is __.
A. determined by the amount of phytoplankton, NOT by the sediment in the water.
B. determined by the amount of sediment AND phytoplankton in the water.
C. the angle with which the sunlight hits the water.
D.

7. The biodiversity of a coral reef is measured by:

A. the number of coral species in a reef.
B. the number of all animal and plant species in a reef.
C. the number of fish species found in a reef.
D. the number of algae species in a reef.

8. The beautiful colors corals have may be due to light hitting the microscopic plants (zooxanthellae) found in coral tissues. When corals lose their zooxanthellae they turn white.

A. True
B. False

9. Humans can cause harm to coral reefs by

A. clearing mangrove plants near the shoreline.
B. directing runoff of pollutants and nutrients from roads and land to enter oceans.
C. dropping anchor chains from their boats onto the reefs.
D. All of the above.

10. If an exotic (non-native) fish is introduced by humans into a coral reef ecosystem, it could __.

A. eat native fish.
B. eat the corals.
C. eat the algae corals depend on.
D. All of the above.

REFERENCES

Retrieved 01/25, 2012, from http://www.nhmi.org/about.htm

About NHMI - our philosophy. (2012). Retrieved 06/15, 2012, from http://nhmi.org/phil.htm

Achieve, I. (2012). Next generation science standards. Retrieved October 9, 2012, from http://www.nextgenscience.org/development-overview

America and the ocean Annual update 2011. (2011). Retrieved October 3, 2012, from http://theoceanproject.org/wp-content/uploads/2011/12/TOP_AmericaOceansUpdate2011_online.pdf

America, the ocean, and climate change (2009). Retrieved June 21, 2012, from http://theoceanproject.org/

Barringer, F. (Wednesday April 21, 2004,). Federal oceans commission finds decline along coasts. *New York Times*, pp. A15.

Beck, M. W. (2003). *The role of nearshore ecosystems as fish and shellfish nurseries.* . *Issues in Ecology, 11*, October 6, 2012-1-12.

Berns, G. S., Cohen, J. D., & Mintun, M. A. (1997). Brain regions responsive to novelty in the absence of awareness. *Science, 276* doi: DOI: 10.1126/science.276.5316.1272

Bogner, F. X. (1998). The influence of short-term outdoor ecology education on long-term variables of environmental perspective. *Journal of Environmental Education, 29*(4), 17-29.

Bransford, J. D., Brown, A. L., & Cocking, R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school.*. Washington, D.C.: National Academy Press.

Braxton, E.*The implementation of interactive science notebooks and the effect it has on students' writing*. (Master of Education in K-8 Math and Science, University of Central Florida). (2010)

Bressers, H. T. A., & Rosenbaum, W. A. (2000). Learning, and environmental policy: Overcoming “A plague of uncertainties”’. *Policy Studies Journal, 20*(3), 523-39.

Capra, F. (1996). *The web of life: A new scientifi c understanding of living systems.* . New York: Anchor Books.

Capra, F. (2002). *The hidden connection: Integrating the biological, cognitive, and socialdimensions of life into a science of sustainability.*. New York: Doubleday.

Carbonnière, A. (2008). Hermatypic coral: The role of the zooxanthellae. Retrieved 06/29, 2012, from http://www.com.univ-mrs.fr/IRD/atollpol/glossaire/ukzooxan.htm

Center for Applied Biodiversity Science. (2008). *Economic values of coral reefs, mangroves, and seagrasses: A global compilation.* . (). Arlington, VA: Conservation International.

The centers for oceanic sciences excellence education. Retrieved June 13, 2012, from http://www.cosee.net/

Chan, C., Burtis, J., & Bereiter, C. (1997).
Knowledge-building as a mediator of conflict in conceptual change. *Cognition and Instruction, 15*, 1-40.

Chin, C. (2007). Teacher questioning in science classrooms: Approaches that stimulate productive thinking. *Journal of Research in Science Teaching, 44*(6), 815-843. doi: 10.1002/tea.20171

Colburn, A. (2003). *The lingo of learning: 88 educational terms every science teacher should know.* . Arlington, VA: NSTA Press.

Comstock, A. B. (1939). *Handbook of nature study*. New York: Cornell University Press.

Cudaback, C. (2012). College students' attitudes about the science and stewardship of the ocean. unpublished manuscript.

Daigle, D. (2003). Involving the public in coastal conservation. In D. Dallmeyer (Ed.), *Values at sea* (pp. 230-238). Athens, GA: University of Georgia Press.

Dettman-Easler, D., & Pease, J. (1999). Evaluating the effectiveness of residential environmental education programs in
fostering positive attitudes toward wildlife. *The Journal of Environmental Education, 31*(1), 33-39.

Dewey, J. (1910).
Science as subject-matter and as method. *Science,* , 121-127.

Dewey, J. (1933). *How we think*. Boston: D.C. Heath.

Dewey, J. (1938). Logic: The theory of inquiry. (pp. 40). New York: Holt, Rinehart, and Winston.

Dewey, J., & Small, A. W. (1897). *My pedagogic creed* EL Kellogg & Company.

Diersing, N. (2011). Seagrass meadows and nutrients. Message posted to http://floridakeys.noaa.gov/scisummaries/seagrassnut.pdf

Driver, R., & Others, A. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher, 23*(7), 5-12. Retrieved from http://edr.sagepub.com

Fischer, K. A. (2011). *Cultivating environmental stewardship in middle school students.* (M.S., Portland State University). *ProQuest Dissertations and Theses,* Retrieved from http://search.proquest.com/docview/905306473?accountid=10003. (905306473).

Furtak, E. (2005). The problem with answers: An exploration of guided scientific inquiry teaching. *Science Education, 90*(3)

Gay, L. R., Mills, G. E., & Airasian, P. (2006). *Educational research: Competencies for analysis and applications.* . New Jersey: Pearson Education, Inc.

Goodin, R. E. (1992). *Green political theory*. Cambridge: Polity Press.

Handbook of action research: *Participative inquiry and practice*. (2001). In P. Reason, & H. Bradbury (Eds.), (pp. 1). London: Sage Publications.

Hawkins, J., & Blakeslee, S. (2004). *On intelligence* . New York: Times Books.

Hughes, T. P., Bellwood, D. R., Folke, C., Steneck, R. S., & Wilson, J. (2005). New paradigms for supporting the resilience of marine ecosystems. *Trends in Ecology & Evolution, 20*(7), 380-386. doi: 10.1016/j.tree.2005.03.022

Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *The Journal of Environmental Education, 21*(3), 8-21.

Jones, G., McCormick, M., Srinvasan, M., & Eagle, J. (2004). Coral decline threatens fish biodiversity in marine reserves. *Proceedings of the National Academy of Sciences of the United States of America, 101*(21), 8251-8253. doi: DO 10.1073/pnas.0401277101

Kellert, S. R., & Wilson, E. O. (1993). *The biophilia hypothesis.* Washington, D.C.: Island Press.

Louv, R. (2005). *Last child in the woods.* . Chapel Hill: Alonquin Press.

McBeth, W., & Volk, T. L. (2010). The national environmental literacy project: A baseline study of middle grade students in the united states. *Journal of Environmental Education, 41*(1), 55-67. doi: 10.1080/00958960903210031

McCleoud, S. (2007). Lev vygotsky. Retrieved October 3, 2012, from http://www.simplypsychology.org/vygotsky.html

McMillan, S., & Wilhelm, J. (2007). Students' stories: Adolescents constructing multiple literacies through nature journaling. *Journal of Adolescent & Adult Literacy, 50*(5), 370-377. Retrieved from www.reading.org/General/Publications/Journals/JAAL.aspx

Michie, M. (1998). Factors influencing secondary science teachers to organise and conduct field trips. *Australian Science Teachers Journal, 44*(4), 43. Retrieved from http://asta.edu.au/resources/teachingscience

Mills, G. (2003). *Action research: A guide for the teacher researcher.* Upper Saddle River: Pearson Education.

Milton, K. (1999). Nature is already sacred. *Environmental Values, 8*(4), 437-449.

Mitchell, T. (2001). A biospheric natural history
Orion: People and Nature, 20(4), 24-26-28, 31, 33, 35-37.

Nabhan, G. P., & St. Antoine, S. (1993).
The loss of floral and faunal story: The extinction of experience. in: S.R. kellert and E.O. wilson (eds) *the biophilia hypothesis.* Island press, washington, DC, pp.229-250.

National Committee on Science Education Standards and Assessment, National Research Council. (1996). *National science education standards*. Washington, DC: The National Academies Press.

National Research Council (U.S.). (1996). National science education standards : Observe, interact, change, learn. (pp. 3). Washington, DC: National Academy Press.

National Science Teachers Association. (1999). *NSTA position statement: informal science education.*. Arlington, VA:

New poll shows strong support for improving science education. Retrieved June 13, 2012, from http://www.nextgenscience.org/new-poll-shows-strong-support-improving-science-education

Nuthall, G. (2000). The role of memory in the acquisition and retention of knowledge in science andsocial studies units. *Cognition and Instruction, 18*(1), 83-139.

An ocean blueprint for the 21st century final report of the U.S. commission on ocean policy. Retrieved 04/14, 2012, from http://www.oceancommission.gov/documents/full_color_rpt/01_chapter1.pdf

The ocean literacy: The essential principles of ocean sciences K-12. (2006). Retrieved 03/20, 2012, from http://www.coexploration.org/oceanliteracy/documents/OceanLitChart.pdf

Oliver-Hoyo, M., & Allen, D.The use of triangulation methods in qualitative educational research. *Journal of College Science Teaching, 35*(4), 42-47.

Orr, D. (1992). *Ecological literacy: Education and the transition to a postmodern world.* New York: Suny Press.

Orr, D. (2004). *Earth in mind: On education, environment, and the human prospect..* Washington: Island Press.

Palmberg, I. (1995). Pupils as environmental actors and informants. *IF MacDermott (Ed.), Proceedings of the Conference on the Exchange of Promising Experiences in Environmental Education in Great Britain and the Nordic Countries,* Great Britain and the Nordic Countries. 75-80.

Palmberg, I. E., & Kuru, J. (2000). Outdoor activities as a basis for environmental responsibility. *Journal of Environmental Education, 31*(4), 32-36. Retrieved from http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ613694&site=ehost-live

Pearce, C. R. (1999). *Nurturing inquiry: Real science for the elementary classroom* Retrieved from http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=ED468806&site=ehost-live

Pews Oceans Commission. (2003). *Commission. America's living oceans: Charting a course for sea change. A report to the nation. arlington, VA: Pew oceans commission; 2003 144pp.* (Arlington, VA:

Piaget, J. (1952). *The origin of intelligence in children.* New York: International University Press.

Plankis, B., & Klein, C. (2010). The CORALS connection-building personal connections to environmental issues. *The Science Teacher, 77*(2), 47-51.

Pretty, J. (2004). How nature contributes to mental and physical health. *Spirituality and Health International, 5*(2), 68-78.

Pretty, J. (2007). *The earth only endures: On reconnecting with nature and our place in it.* London: Earthscan.

Pretty, J., Hine, R., & Peacock, J. (2006). Green exercise: The benefits of activities in green places. *The Biologist, 53*(3), 143-148.

Pretty, J., Peacock, J., Sellens, M., & Griffin, M. (2005). The mental and physical health outcomes of green exercise. *International Journal of Environmental Health Research, 15*(5), 319-337.

Pretty, J. N., Adams, W. M., Berkes, F., Derreira de Athayde, S., Dudley, N., Hunn, E., . . . Pilgrim, S. (2008). How do biodiversity and culture intersect? *Conference on Sustaining Cultural and Biological Diversity in a Rapidly Changing World: Lessons for Global Policy.*

Pyle, R. M. (2003). Nature matrix: Reconnecting people and nature. *Oryx, 37*, 206-214.

Radinsky, J., Oliva, S., & Alamar, K. (2010). Camila, the earth, and the sun: Constructing an idea as shared intellectual property. *Journal of Research in Science Teaching, 47*(6), 619-642. Retrieved from http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ895888&site=ehost-live; http://dx.doi.org/10.1002/tea.20354

Roth, W., McGinn, M. K., Woszczyna, C., & Boutonne, S. (1999). Differential participation during science conversations: The interaction of focal artifacts, social configurations, and physical arrangements. *Journal of the Learning Sciences, 8*(3-4), 293-347. doi: http://dx.doi.org/10.1080/10508406.1999.9672073

Sandoval, W. A., & Millwood, K. A. (2005). The quality of students' use of evidence in written explanations. *Cognition and Instruction, 23*(1), 23-55.

Schoedinger, S., Cava, F., & Jewell, B. (2006). The need for ocean literacy in the classroom: Part I. *Science Teacher, 73*(6), 44-47. Retrieved from http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ758657&site=ehost-live; http://www.nsta.org/main/news/stories/journal_archive_date_list.php?category_ID=88&issue_ID=985

Smith-Sebasto, N. J., & Cavern, L. (2006). Effects of pre- and posttrip activities associated with a residential environmental education experience on students' attitudes toward the environment. *The Journal of Environmental Education, 37*(4), 3-17.

Steel, B. S., Smith, C., Opsommer, L., Curiel, S., & Warner-Steel, R. (2005). Public ocean literacy in the united states. *Ocean & Coastal Management, 48*(2), 97-114. doi: 10.1016/j.ocecoaman.2005.01.002

Stepath, C. M. (2006). *Coral Reefs as Sites for Experiential Environmental Education: Learning with Australian students–a Foundational Study,*

Stepath, C. M. (2006). *Coral reefs as sites for experiential environmental education: Learning with australian students–a foundational study.* James Cook University).

Stern, M. J., Powell, R. B., & Ardoin, N. M. (2008). What difference does it make? assessing outcomes from participation in a residential environmental education program. *Journal of Environmental Education, 39*(4), 31-43. Retrieved from http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ811967&site=ehost-live; http://heldref.metapress.com/openurl.asp?genre=article&id=doi:10.3200/JOEE.39.4.31-43

Strang, C.COSEE/NMEA critical stakeholder comments to the first draft of NGSS. Retrieved June 14, 2012, from http://www.oceanliteracy.net

Strang, C. (2012). Open letter to next generation science standards state teams. Retrieved October 7, 2012, from http://oceanliteracy.wp2.coexploration.org/?p=3657

The Ocean Project. (2012). America, the ocean, and climate change, 2009. Retrieved June 21, 2012, from http://theoceanproject.org/download-reports/

The Ocean Project. (2012). Http://theoceanproject.org/wp-content/uploads/2012/05/TOP_Update_Summer_20121.pdf. Retrieved 6/10, 2012,

Thomashow, M. (2001). A biospheric natural history. *Orion: People and Nature, 20*(4), 24-37.

Thrift, M.*A case study of the effects of inquiry based professional development through the use of a mentor on an alternatively certified elementary teacher's science teaching self-efficacy.* (Unpublished M.Ed). University of Central Florida, 2007,

U.S. Commission on Ocean Policy. (2004). *An ocean blueprint for the 21st century. report of the US commission on ocean policy Governor's draft.* (). Washington, D.C.:

United Nations. (2012). United nations: International day of biological diversity. Retrieved 10/28, 2012, from http://www.un.org/en/events/biodiversityday/biodiversity.shtml

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Warburton, K. (2003). Deep learning and education for sustainability. *International Journal of Sustainability in Higher Education, 4*(1), 44-56. doi: http://dx.doi.org/10.1108/14676370310455332

What is sustainability? (2012). Retrieved 10/28, 2012, from http://www.epa.gov/sustainability/basicinfo.htm

Williams, D. (2008). Sustainability education's gift: Learning patterns and relationships. *Journal of Education for Sustainable Development, 2*(1), 41-49. doi: http://dx.doi.org/10.1177/097340820800200110.