January 2012

# Member Perceptions of Informal Science Institutions Graduate Certificate Program: Case Study of a Community of Practice

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# Member Perceptions of Informal Science Institution Graduate Certificate Program: Case Study of a Community of Practice

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Secondary Education
College of Education
University of South Florida

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Date of Approval:
March 26, 2012

Keywords: informal science education, ISI, ISE, informal science educator, professional development

## Dedication

I dedicate this dissertation to God and my life to his service. *Ad majorem Dei gloriam.*

## Acknowledgments

I want to thank the people who have believed in me and supported my dreams and work. Thank you, Dr. Barbara Spector, for encouraging and mentoring me as my major professor and for expertly and enthusiastically modeling the roles of educator, researcher, change agent, and social activist, roles which I aspire to perpetuate. I want to thank my other committee members: Dr. Arthur Shapiro, Dr. Paschal Strong, and Dr. Diane Te Strake for their advice, patience, and continuous support.

I want to thank the people God put in my life to believe in me and to give me hope and encouragement: my grandmother Annie R. Bouldry, Rev. James W. Martin, Dr. Eldra Solomon, Louise and Woody Hale, and the Friday Faithfuls (Debbie, Jasmine, Martha, Marion, and Susan). De colores! I am grateful for my sister, Joanne E. Duggan, for staying close to me and being my friend.

I especially want to thank the participants of my research who graciously shared their experiences during the certificate program and throughout my research. They are a talented group of science educators and dedicated professionals.

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## Abstract

This research attempted to understand the experiences of a cohort of informal and formal science educators and informal science institution (ISI) community representatives during and after completion of a pilot graduate certificate program. Informal science educators (ISEs) find limited opportunities for professional development and support which influence their contributions to America's science literacy and school science education. This emergent design nested case study described how an innovative program provided professional development and enabled growth in participants' abilities to contribute to science literacy. Data were collected through interviews, participant observations, and class artifacts. The program by design and constituency was the overarching entity that accounted for members' experiences. Three principal aspects of the ISI certificate program and cohort which influenced perceptions and reported positive outcomes were (1) the cohort's composition and their collaborative activities which established a vigorous community of practice and fostered community building, mentoring, and networking, (2) long term program design and implementation which promoted experiential learning in a generative classroom, and (3) ability of some members

who were able to be independent or autonomous learners to embrace science education reform strategies for greater self-efficacy and career advancement.

This research extends the limited literature base for professional development of informal science educators and may benefit informal science institutions, informal and formal science educators, science education reform efforts, and public education and science-technology-society understanding. The study may raise awareness of the need to establish more professional development opportunities for ISEs and to fund professional development. Further, recognizing and appreciating informal science educators as a diverse committed community of professionals who positively influence science education for everyone is essential.

# Chapter I: The Problem Statement

## Introduction

Less than five years ago I had never heard of informal science institutions (ISIs) or informal science education (ISEs). I was a scientist and had worked as an industrial meteorologist for many years. I returned to college and completed a bachelor's degree in biology in pursuit of my passion and interest in living things and the environment. I completed the course of study for a Ph.D. in microbiology and was conducting research in the field of environmental microbiology. I knew what my doctoral research would entail and was prepared to be examined for doctoral candidacy.

As part of my graduate responsibilities, I taught biology and microbiology laboratory classes to mostly pre-med, pre-vet, nursing, or biology major undergraduates. Some of these students had little pre-existing science knowledge from high school and many disliked science classes, including the laboratory classes they were currently taking. They seemed uncomfortable with inquiry-driven lessons designed to construct their own knowledge, preferring to memorize or regurgitate facts, and were annoyed when asked to do more than

follow simple instructions. Many students seemed focused on getting an “A” to get into med school or just passing the laboratory class to escape to the next level of science misery dictated by their program of study.

I learned that many fellow laboratory instructors recognized similar issues in the classes they were teaching and was surprised when some instructors admitted they had disliked many of their past science courses and “just did what it took to repeat back, or regurgitate, what the teacher said to pass”. I became concerned about the education of doctors, nurses, and dentists in my future. Who would be standing over me on the operating table with a scalpel in hand? I pondered over who would be exploring and explaining my world and generating the accompanying technology upon which my life and well being might depend. Who would be making informed science, medical, and technological decisions for this country and the global community?

As I taught and interacted with my laboratory students, I enjoyed discussing what science really is all about and shared why it is so important for our future. I liked the “aha moments” where they would understand a concept and could take an idea to the next level and was enthused when they began to imagine and anticipate what their roles could be in future science-related professions. I had anticipated a career as a research scientist and now found myself

literally walking across the street on the university campus to the College of Education. I wanted to teach.

I registered for the first education courses that caught my interest. When I sat in my first science education class, I was surprised to discover the professor, Brenda, had an education perspective similar to my own, except she had names for the concepts and philosophy she espoused. Brenda had also encountered many science education students who disliked science, were uncomfortable learning to teach science to children, and were resistant to teaching science through inquiry. She had researched this phenomenon to understand the circumstances and to generate potential solutions (Spector, Burkett, & Leard, 2007). Brenda conducted her classes at informal science institutions and avidly promoted ISIs as an integral part of her curriculum for teaching science education students.

I immediately recognized the significance of Brenda teaching science education in the stimulating, hands-on, local Museum of Science and Industry (MOSI). She had found an environment, and created a laboratory, where she could model the holistic paradigm for her education students and could foster their acceptance and enjoyment in better understanding and teaching science.

It was obvious to me that this museum, an ISI, was a more conducive natural venue to freely explore science ideas and make

conceptual connections compared to a traditional classroom setting. I came to understand the relationship ISIs have with formal education and what resources they offer to schools and the community. And I became acquainted with ISI educators. Up to this point I had perceived most informal “science people” to be paid, animal loving, ersatz teacher entertainers who parroted a canned package of superficial facts and trivia to a fast flowing audience. My perception underwent radical reconstruction after Brenda recommended I join a pilot test for a graduate certificate program in informal science education. I was immersed in a diverse ISI community of earnest professionals, novices and experts, committed to developing a four semester program for professional development. This purpose of this dissertation was to examine and to explicate their experiences.

**Science Education Reform**

I have determined from my research that modern science education has been undergoing reformation since science classes were generally accepted and promoted as a necessary part of school curriculum in the late 19$^{th}$ century. Science education was advocated for by scientists through the first part of the 20$^{th}$ century and, after exposure to advanced technology during World War II, the public came to recognize improved science and technological education would be

critical for supporting national business and security interests (DeBoer, 1997; 2000).

The post-Sputnik space race of the late 1950s and the 1960s spurred education reforms that stressed memorization and subject mastery without social context (DeBoer 1991, 1997). The status quo continued until the 1970s and 1980s as concern mounted that science education without social context was failing to equip students for a more science and technology oriented global work force (Bybee, 1997; Hurd, 1997). Schools were graduating people who had memorized the facts and main ideas of their chosen discipline but were unable to identify and apply interactions between science, technology, and society to effectively contribute to their chosen profession. Numerous reports and the publication of *A Nation at Risk* (National Commission on Excellence in Education [NCEE], 1983), voiced concern that schools were not producing a literate society to keep up with advances in science and technology (Bybee, 1997; Hurd, 1997; NCEE, 1983). This alarm stimulated the subsequent modern science education reform movement.

In the late 1980s stakeholders in science education, including educators, scientists, government representatives, and business interests developed Project 2061, an initiative led by James Rutherford under the auspices of the American Association for the Advancement

of Science (AAAS) “to help all Americans become literate in science, mathematics, and technology” (American Association for the Advancement of Science [AAAS], 2011). Project 2061 has produced cornerstone documents guiding and shaping science education reform such as *Science for All Americans* (AAAS, 1990), *Benchmarks for Science Literacy* (AAAS, 1993) and numerous more recent publications to influence curriculum, instruction, and assessment (AAAS, 2011). The National Resource Council, the operating arm of the National Academy of Sciences has developed the *National Science Education Standards* (National Resource Council [NRC], 1996) and has released many other publications guiding science education practice and promoting science education research.

**Science Literacy**

Project 2061 generated reform documents are predicated on science literacy as the focal point for science education reform goals (AAAS, 1993; DeBoer, 2000; NRC, 1996). “Scientific literacy” was first coined by Paul Hurd in the late 1950s during the concern for science reform caused by the space race (DeBoer, 2000; Hurd, 1997; Laugksch, 2000). *Science for All Americans* (AAAS, 1990) describes a science literate person as

> one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and

> principles of science; is familiar with the natural world and recognizes both its diversity and unity; and uses scientific knowledge and scientific ways of thinking for individual and social purposes. (p. xvii)

Stocklmayer, Rennie, and Gilbert (2010) add that a person who is science literate "not only knows about science and its technological and societal implications, but can use scientific evidence in everyday decision-making" (p. 5). McCallie et al. (2009) state

> Science literacy—or familiarity with basic concepts and processes in science as well as the ability to apply this knowledge in various contexts—is thought to improve individuals' personal and public decision making, increase their involvement in science, technology, engineering, and mathematics (STEM) careers, and give them an appreciation of science and technology as cultural achievements (American Association for the Advancement of Science, 1993; Falk et al., 2007; National Research Council, 1995/1996; Nepote, 2007). (p. 29)

Laugksch (2000) identifies four interest groups which share different ideas about the conceptual definition, interpretation, and audiences of scientific literacy. The fourth group includes the informal science education community which promotes scientific literacy for all the groups' audiences: children, youth, and adults.

**Rationale**

ISI's offer excellent programs and creative exhibits for children, school teachers, and the public, but few of these institutions provide sustained professional development opportunities for their own

personnel, the people who actually interact with guest learners, one question at a time. These informal science educators (ISEs) are professionals who function as science teachers for classroom students and teachers but may not have a background in formal education. Bevan and Semper (2006) determined that a professional development program is needed for ISI personnel to establish a shared knowledge base with teachers and practice skills to interface more effectively with formal educators. Tran (2008) found that

> educators in science museums do not share a professional education. This leads to the question of why are professional programmes for museum educators not readily available. While there is a range of courses in museum studies, courses in museum education are less prevalent. In addition, to what extent do existing programmes prepare educators to do the work of the profession as described above, or have shared standards of practice they might expect of individuals who are recruited to the profession? Establishing such courses, recruiting students to them, and obtaining funding to support them must be seen as priorities, if the work of museum educators is to acquire the status of other professionals working within the museum field, such as curators and scientists. (p.150)

ISI members themselves, as reported by Tran and King (2007), recognize the need for a “theoretically informed knowledge base for practice” for professional development of museum educators.

Representatives of the ISI community in the Tampa area had also identified this endemic problem in their institutions in 2005 as

part of their work in the Center for Ocean Sciences Education Excellence – Florida (COSEE-FL) during community building classes at the University of South Florida (USF). These ISI representatives, or stakeholders, subsequently initiated a pilot graduate certificate program in 2006, in collaboration with USF faculty, for local informal science educators to "update their science research knowledge, learn how people learn, learn ways to establish a network, and develop means to effectively interface this network of informal science education providers with formal education institutions" (Spector, 2009a).

The initiating group recruited the initial cohort for a pilot test of a four course graduate certificate (see Appendix A for course abstracts) and participated in the implementation of the program from 2006 to 2008 (Spector, 2009b). The combined group shared their exotic and diverse workplaces and unique perspectives that evolved into a cutting edge learning environment for their peers in this ISI professional community.

I joined the ISI pilot program as a participant observer for the third and fourth courses and was amazed by the diversity of the group's make up and the unique perspective each member contributed to the learning community. I observed interactions between people with science backgrounds and people with education expertise. I

witnessed the challenges of people being exposed to philosophies and vocabularies alien to their previous professional experiences and watched people change as they gained knowledge and insight from their experiences. I felt transformed myself as I navigated the sea of ISI and science education jargon and acronyms, discovering the potential and strengths the class members and I each brought to positively impact the Tampa Bay ISI community and science education for the public.

After the ISI pilot certificate program concluded, I conducted a case study of a single member of the ISI program cohort as a pilot study for this research (Ball, 2010). I designed the study as a qualitative analysis to understand the impact of the pilot ISI certificate program on the participant and to document his personal and professional growth during and after completion of the program.

The knowledge generated from that pilot study and the ISI pilot certificate program contributed to the development of curriculum and materials for a distance learning ISI graduate certificate program initiated by the University of South Florida in 2010. Themes and conclusions from this single member study also raised many questions about the experiences of the other program participants during the certificate program and how the program had impacted their careers

and the area ISI communities. This research attempts to answer those questions and add to the limited knowledge base.

## Theoretical Framework

This dissertation was an emergent design case study in the tradition of symbolic interactionism (Jacob, 1987) which "provides models for studying how individuals interpret objects, events, and people in their lives, and for studying how this process of interpretation leads to behavior in specific situations" (p. 31). Jacob explains that

> Symbolic interactionists assume that in order to understand behavior in situations such as classrooms one must know the cultural standards that form the context of behavior, the individuals' goals within that context, and the individuals' perceptions of the consequences of various kinds of behavior. (p. 33)

Perception is having an awareness of the environmental elements through physical sensation, or sensory images, and interpreting the events in the light of one's experiences, or external world (*Merriam-Webster.com*; *American Psychological Association Glossary of Terms*). In order to understand a person's experiences, the researcher attempts to understand how the participant perceives their reality (Leedy, 1997).

The study was also rooted in phenomenology, a part of symbolic interactionism, as the experiences of the participants constitute the

reality of what transpired and were the heart of this inquiry (Ary, Jacobs, Razavieh & Sorensen, 2006). Rudestam and Newton (2007) state

> phenomenological inquiry attempts to describe and elucidate the meanings of human experience.…Phenomenologically oriented researchers typically use interviews or extended conversations as the source of their data. Important skills for the researcher include listening, observing, and forming an empathic alliance with the subject. The investigator remains watchful of themes that are presented but resists any temptation to structure or analyze the meanings of an observation prematurely. Once the basic observations are recorded, the data may be reduced, reconstructed, and analyzed as a public document.

**Statement of the Problem**

ISIs provide learning opportunities to contribute to the science literacy vitally needed in our society. Informal science educators, however, have limited opportunities for professional development to grow and to remain current in their field, or to be part of a community of practice. As a result, they are not able to maximize their contributions to our nation's science literacy and the reform of science education in schools. An innovative professional development program was pilot tested at USF between 2006 and 2008 to mitigate this problem locally.

## Statement of the Purpose

The purpose of this research was to describe how the ISI certificate program provided professional development and enabled growth in participants' abilities to contribute to science literacy.

A single member case study of a program member's experiences raised questions for this research about the experiences of other program participants and how the program had impacted their careers and the area ISI communities.

## Research Questions

The research questions guiding this study were:

(1) What were students' perceptions while participating in the pilot informal science institution certificate program?

(2) How did graduate students perceive their careers had been impacted during and after completion of the pilot ISI certificate program?

(3) What were the perceptions of the college professor and community representatives, or initiator/developers, during and after the pilot ISI certificate program?

## Summary

Science literacy is essential and key to the science education reform movement for an informed and functional society. Informal science institutions and their personnel support science education

reform and science literacy, but their community does not have a formal credentialed program for professional development. Most informal science educators, therefore, do not receive adequate professional development and may be unable to understand and to implement science education reform strategies as they interpret science for children, teachers, and the general public. A group of ISI professionals, educators, and community stakeholders designed and implemented a four semester pilot graduate certificate program for ISI personnel and other interested people.

The purpose of this research was to describe how the ISI certificate program provided professional development and improved scientific literacy for the participants. This emergent design qualitative research, theoretically rooted in the tradition of symbolic interactionism and phenomenology, ascertained and reported the experiences and perceptions of the majority of the members of the ISI graduate certificate cohort during the program and the perceived impact on their careers after the program was completed. The research questions guiding the study were:

(1) What were students' perceptions while participating in the pilot informal science institution certificate program?

(2) How did graduate students perceive their careers had been impacted during and after completion of the pilot ISI

certificate program?

(3) What were the perceptions of the college professor and community representatives, or initiator/developers, during and after the pilot ISI certificate program?

The study may contribute knowledge to the growing informal science education field for improving professional development and science literacy and may support the development of expanded ISI education programs for ISI professionals and stakeholders.

# Chapter II: Review of the Literature

## Introduction

The review of the literature base for the study is divided into two parts. The first part is informed by literature that defines and explains informal science institutions (ISIs) and informal science education (ISE); informal science educators (ISEs), their characteristics and functions. The term ISE is generally used interchangeably in the literature to represent informal science education or informal science educators. The limited research pertaining to the need for professional development of ISI educators is also explored. The second part of the literature defines and reviews experiential learning theory, autonomous learning, and communities of practice.

## Informal Science Institutions and Informal Science Education

Informal science institutions are places where anyone can learn about science ideas as they voluntarily explore the surrounding environment and potentially interact with ISI educators. ISIs defy simple classification. They may be permanent sites such as zoos, aquaria, parks, and nature preserves or they may be temporary special interest events such as science fairs, ecology and Earth Day

activities, government agency exhibits, and garden shows. Spector (2009a) determined

> There is no single accepted method for classifying ISIs. Varieties in categorization include non-profit; not-for-profit; for-profit; higher education based programs, including people who do outreach for research laboratories; government agencies; media; the Internet; action based public participation groups; business and industry (commercial); professional and recreational associations; and activist groups (p. 11).

In a report of the National Research Council of the National Academies, Bell, Lewenstein, Shouse, and Feder (2009) state that

> Designed settings—including museums, science centers, zoos, aquariums, and nature centers—can also support science learning. Rich with educationally framed real-world phenomena, these are places where people can pursue and develop science interests, engage in science inquiry, and reflect on their experiences through conversations (p. 293).

Informal science education includes the limitless varied encounters people have with science throughout their lives (Bell et al., 2009; Falk, Storksdieck, and Dierking, 2007). Crane, Nicholson, Chen, and Bitgood (1994) describe informal science learning as activities that are independent of schools, not developed primarily to be part of public education curriculum, and are voluntary in nature. Stocklmayer, Rennie, and Gilbert (2010) explain contexts for learning in ISIs, based on an analysis by Rennie (2007), as

> those out-of-school learning environments where: (1) both attendance and involvement are voluntary or free-choice, rather than compulsory or coercive; (2) the curriculum, if any, and whether intended or not, has an underlying

> structure which is open, offers choices to learners and tends not to be transmissive; (3) the activities in which learners can be involved are non-evaluative and non-competitive, rather than assessed and graded; and (4) the social interaction is amongst groups likely to be heterogeneous with regard to age, rather than constrained between same-age peers and formalized with the teacher as the main adult. In sum, compared to formal school environments, learning in the informal sector "is learner-led and intrinsically motivated, rather than teacher-led and extrinsically motivated" (Rennie, 2007, p. 127). (p. 10)

ISIs have long enhanced classroom and public education through informal science learning in leisure settings. They make important contributions to P-16, preschool through undergraduate, science education (Feher & Rennie, 2003; Bell et al., 2009) and many offer professional development programs, workshops, and resources for school teachers, which produce measurable benefits in teacher practice (Phillips, 2006). The National Science Education Standards (NSES) (1996) stress the value of community resources, such as ISIs, to advance science education in schools and work in partnerships with teachers.

Informal science education in ISI venues also promotes student and teacher learning experiences outside the classroom (Duran et al, 2009). Spector, Burkett, & Leard (2005, 2007) report that the use of ISI's "makes learning relevant to the world outside of schools, increases material resources for teaching, facilitates access to scientists for current information, and provides experiential learning

opportunities". For the general public ISIs encourage learning in personal, sociocultural, and physical contexts (Falk & Dierking, 2000).

Bell et al. (2009) recognize that ISI environments promote physical, emotional, and cognitive connections when people interact in learner-directed ways with exhibits and experience phenomena that are not readily accessible in every day life. People like to be entertained at ISI venues as they stroll through colorful interactive or static exhibits, watch animals in natural settings, and manipulate buttons and knobs to quiz themselves on what they know or don't know. They are naturally curious about how their world works and spend a lot of time casually learning about science and nature.

Roth and Lee found that significant science education takes place outside the classroom (Roth & Lee, 2004, 2002). Falk, Storksdieck, and Dierking (2007) found that the voting public attained more science learning from ISIs than schools and also state that informal science learning is "potentially a more holistic approach to science education, one that better integrates school, work and leisure time learning experiences" (p. 456).

The audience for informal science institutions is everyone. Spector (2009a) describes ISI targeted audiences as preK-16 students, teachers, youth, adults and all possible subsets within these groups. Bell et al states that people of all ages and cultures are

involved in informal science learning in their lives and stimulating informal science opportunities help individuals build knowledge, skills, and a positive relationship with science.

## Informal Science Educators and Personnel

Informal science educators are ambassadors of science literacy by establishing and maintaining a human link between the public and their science venue. They come from diverse backgrounds and possess a wide variety of skills, abilities, and science experience (Bell et al., 2009; Tran & King, 2007). Most informal science educators hold an undergraduate degree in a science field or education, especially if they are employed by large ISIs or government agencies. McCallie et al. (2009) maintains

> ISE professionals include all those involved in guiding, designing, implementing, researching, and evaluating learning experiences in science that take place outside of school. The ISE community includes professionals working in film and broadcast media, science centers, museums, zoos, aquariums, botanical gardens, nature centers, digital media and gaming, and youth, adult, community, and after-school programs (p. 29).

In addition to interpreting science for classroom students, teachers, and the general public, ISE professionals design and periodically update exhibits requiring communication with research scientists to keep abreast of continuous advances and changes in science and technology. They may also be responsible for training

fellow employees and volunteers, conducting teacher workshops, and developing and implementing programs for in-house summer camps, after school programs, scouting, and community outreach programs (Spector, 2009a; Tran, 2008). Some ISEs have initiated sci cafes, sponsored by their ISI, where interesting topics in science can be discussed by scientists, ISEs, and the public in a casual social environment. Bell et al. state that “front-line educators”, including ISI professionals

> influence learning experiences in a number of ways. They may model desirable science learning behaviors and help learners develop and expand scientific explanations and practice, in turn shaping how learners interact with science, with one another, and with educational materials. They may also work directly with science teachers and other education professionals, who themselves are responsible for educating others. (p. 308)

Bailey (2006) found that informal science educators generally consider themselves as educators first and enjoy learning experiences and working together in informal settings. The personnel in that study identified knowledge of learning and science content, teaching and presenting, and management as necessary for their success in their careers.

## Professional Development in ISIs

Professional development for informal science educators, the people who connect science and technology with society and educate children, teachers, and the public is limited. Few informal science organizations provide sustained professional education development opportunities for their staff members and volunteers. While ISI professionals play an increasing role as science teachers for classroom students and teachers, they may not have a background in formal education. Bevan and Xanthoudaki (2008) found that ISI educators enter the field with dissimilar backgrounds and have received limited formal professional development.

While Bevan and Semper (2006) recognize the need for informal educators to establish a shared knowledge base to interface more effectively with formal educators, Tran (2007) recommends that ISI educators need to develop their own educational agenda with its unique educational values and not model development offered by schools which do not appreciate the experience and abilities of informal educators and their institutions.

Spector (2010) learned from correspondence with Dierking that professional development for ISI personnel is “fragmented” and is not uniform in quality or content. Spector reports that some national museum and zoological associations conduct workshops and seminars,

provide pertinent literature, and hold list serves for professionals. Some universities are now offering Masters, Doctoral, and certificate programs for ISE people but Spector concludes they do not “articulate well” among themselves and have limited coordination and communication with professional ISIs. Also, many informal science educators may be isolated and unaware of existing professional development resources or may not be a member of a thriving community of practice.

## Communities of Practice

A community of practice, as defined by Wenger (1998), is usually an informal group with similar interests who interact on a regular basis to share knowledge, resources, and experiences. Wenger explains that the community becomes a self-organizing system in which the practices reflect the participants’ understandings and beliefs. Richards (2010) describes the roles and interactions of members in a community of practice.

> Expert members in a community of practice serve as mentors and facilitators. The instructor becomes a mentor or facilitator and orchestrates a balance between student-generated and instructor-generated topics. They are more experienced, active and visible and helping while novices or newcomers are those who observe experts in action and gradually obtain expertise themselves (Johnson, 2008). Communities of practice flourish when members trust one another enough to openly disclose problems, share solutions, offer sound advice, and work together to

> "deepen their knowledge and expertise" (Wenger, McDermott, & Snyder, 2002). (p. 4)

Allee (2000) states that a community of practice is self-selecting and participants contribute because they have an interest in the community's actions. Allee differentiates between communities of practice and knowledge networks

> The primary purpose of these informal networks is to collect and pass along information. They are loose and informal because there is no joint enterprise that holds them together, such as development of shared tools. They are just a set of relationships. Networking does not make for a community of practice. Communities require a sense of mission–there is something people want to accomplish or do together that arises from their shared understanding. (p. 6)

Wenger (1998) concurs that networks and communities of practice differ and states that a "community of practice exists because it produces a shared practice as members engage in a collective process of learning" (p. 4).

There is increasing evidence for stronger connections among informal science educators and development toward communities of practice within ISIs. Tran (2008) found in a study of museum professionals that, although they did not share a common education, a "shared technical language" was emerging among the group. Tran states that

> the technical language of a profession enables its practitioners to have a more functionally effective conversation about their work with colleagues and, in addition, is a means to develop their practice and identity (Clark 1999). Such a language is commonly learned and modeled in their professional education (Freidson 2001). (p.149)

Sanford, Palmquist, and Goudy (2007, ¶ 2) found that partnerships between university researchers, graduate students, and museum personnel

> are part of a larger professional development model in which graduate students and Postdocs receive their training by working with museum professionals on a daily basis. Within this model, researchers are embedded at the beginning, middle, and end of the design process alongside exhibit designers, educators, and museum administrators. Successful partnerships require that both parties learn each others language, trust each others judgment, and respect each others practice (Keller, 2005).

Sanford et al. also report that boundary crossing must happen in these relationships for successful collaboration to continue and describe the design model as

> a long-term commitment that allows trust, knowledge, mutual respect, and communication to build over time. For students, the partnership is an important professional development opportunity to learn something meaningful about museums as organizations and situate their research questions within a practical as well as theoretical framework. For the museum, the collaboration helps create leaders in the field, who use real data to inform their design decisions and are able to communicate complex theories of learning. (¶ 9)

The Sanford et al. research suggests that the reported partnership closely resembles a community of practice as described above.

Networking and partnership reports are being reported more frequently in the informal science education and museum literature. However, there is currently limited research in the field concerning true communities of practice, a more meaningful, sustained, and trusting relationship, among ISE professionals.

## Experiential Learning

**Kolb's experiential learning theory.** Experiential learning as elaborated by Kolb (1984) describes learning as a four-stage cycle: experience, reflection, abstract conceptualization, and action. The learner first encounters a concrete experience. Next, the learner uses reflective observation through reviewing the experience to understand its cognitive and emotional value and then sharing this information with others. Then, the learner connects the experience with previous experiences and knowledge by employing abstract conceptualization to generalize aspects of the experience into fixed ideas. Finally, the learner tests these new ideas in activities to assess their veracity. Kolb, Boyatzis, and Mainemelis (2000) explain that

> Experiential Learning Theory (ELT) provides a holistic model of the learning process and a multilinear model of adult development, both of which are consistent with what we know about how people learn, grow, and develop. The theory is called "Experiential Learning" to emphasize the

> central role that experience plays in the learning process, an emphasis that distinguishes ELT from other learning theories. The term “experiential” is used therefore to differentiate ELT both from cognitive learning theories, which tend to emphasize cognition over affect, and behavioral learning theories that deny any role for subjective experience in the learning process. (p. 2)

Kolb’s ELT defines learning as “the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience” (Kolb 1984). (p. 41)

Kolb et al. (2000) reports that Hickox (1991)

> reviewed the theoretical origins of ELT and qualitatively analyzed 81 studies in accounting and business education, helping professions, medical professions, post-secondary education and teacher education. She concluded that overall 61.7% of the studies supported ELT, 16.1% showed mixed support, and 22.2% did not support ELT”. (p 20)

**Novak’s learning theory.** Kolb’s experiential learning theory is espoused by Novak. Novak’s (1998) “human constructivism” theory of education, rooted in the cognitive assimilation theory of Ausubel, integrates thinking, feeling, and acting where the learner is empowered to take responsibility to construct his/her own meaning from his/her experiences. The learner takes control of his/her mind for learning to take place. At this point autonomous learning can be achieved.

**Autonomous learning.** Autonomous learning, as defined by Spector (2006) “is the ability to identify learning needed at any point in time, and pursue it in a productive way without depending on a teacher or other authority to direct thinking and acting”. (p. 24) Spector (2009a) explains that when learning follows Kolb’s experiential learning cycle and learners integrate thinking, feeling, and acting, then they can incorporate their new knowledge into their existing cognitive frameworks if they take time for reflection.

> If we think of reflection as “slowing down our thinking processes to become more aware of how we form our mental models” (Senge, Kleiner, Roberts, Ross & Smith, 1994, p. 237), then it follows that “changes in short term everyday mental models, accumulating overtime will gradually be reflected in changes in long term, deep-seated beliefs (Senge, et al., p. 237.) Changes in beliefs often bring about changes in behaviors. These changes lead to questioning, collecting more data, and evaluating. Learners then become autonomous learners having the ability to “undertake all or most of the design of (one’s) own learning, to evaluate performance, and to make adjustments accordingly” (Moore & Kearsly, 1996, p. 205). (p. 4)

**Constructivism.** Autonomous learning is facilitated by teachers in an experiential learning environment where students can freely construct their own meanings from their experiences. Hein (1991) states that constructivism is a term that “refers to the idea that learners construct knowledge for themselves---each learner individually (and socially) constructs

meaning---as he or she learns. Constructing meaning is learning; there is no other kind." Constructivist teachers according to Grennon Brooks and Brooks (1993) are those who act "as mediators of students and environments, not simply as givers of information" and who "encourage student inquiry by asking thoughtful, open-ended questions and encourg[e] students to ask questions of each other." Shapiro (2000) describes the design elements of a constructivist classroom as "focused on both content and process" as "learner- and problem-centered, discovery-based, experiential and small group based" and uses Maslow's hierarchy of human needs and as one of several motivational strategies for creating a classroom culture for constructivist learning. Hein confirms that "motivation is a key component in learning" and is a guiding principle of constructivist thinking.

**Summary**

A policy statement of the Informal Science Education Ad Hoc Committee of the Board of the National Association for Research in Science Teaching (NARST) published in 2003 about learning science in informal contexts provides an overarching context for this literature review

> Learning rarely if ever occurs and develops from a single experience. Rather, learning in general, and science learning in particular, is cumulative, emerging over time through myriad human experiences, including but not limited to experiences in museums and schools; while watching television, reading newspapers and books, conversing with friends and family; and increasingly frequently, through interactions with the Internet. The experiences children and adults have in these various situations dynamically interact to influence the ways individuals construct scientific knowledge, attitudes, behaviors, and understanding. In this view, learning is an organic, dynamic, never-ending, and holistic phenomenon of constructing personal meaning. This broad view of learning recognizes that much of what people come to know about the world, including the world of science content and process, derives from real-world experiences within a diversity of appropriate physical and social contexts, motivated by an intrinsic desire to learn. (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003, p. 109)

Informal learning is a constant for all people in their every day lives and informal science institutions provide a stimulating environment where independent learning can take place. Informal science educators are ambassadors of science literacy by establishing and maintaining a human link between the public and their science venue, by interpreting science and technology concepts. Because adequate professional development is limited and the field does not appear to have well established communities of practice, many ISI educators do not have the support to sustain, or advance, their careers and may not be able to educate the public effectively. The

reviewed formal learning literature describes experiential learning theory in which people construct their own knowledge in a repeating cycle and integrate thinking, feeling, and acting. Autonomous learning, fostered by reflective thinking can empower people and foster change. These concepts can frame education strategies for sustained ISE professional development. Independent thinking and acting ISI professionals who have been educated in such a constructivist perspective and constructivist classroom culture have potential to enhance the learning experience for all people, advance their careers, and support vigorous communities of practice.

# Chapter III: Methodology

## Introduction

The purpose of this research was to understand the experiences of a cohort of informal and formal science educators, which included the initiating ISI community representative graduate students and the college professor, during and after their completion of a pilot graduate certificate program in informal science education and to report their personal and professional experiences and growth to the informal science education community and science education interests in general.

This research was conducted using qualitative methodologies grounded in the constructivist perspective. Lincoln (2005) defines the constructivist perspective as a position attending to meaning making actions of active agents and thinking humans in which people make meaning from actual situations and their individual mental perspective which assigns meaning to events and conditions they experience.

The research questions guiding this emergent design qualitative study were:

(1) What were the graduate students' perceptions while participating in the pilot informal science institution graduate certificate program?

(2) How did the graduate students perceive their careers had been impacted during and after completion of the pilot ISI certificate program?

(3) What were the perceptions of the college professor and initiator/developer community representatives during the pilot ISI certificate program?

## Research Methodology

**Participants.** Participants for this research were members of the cohort from the pilot face to face informal science education graduate certificate program which was conducted over four semesters from 2006 to 2008. There were 11 participants in the study, a subgroup of 15 pilot program members. The participants were those who (1) completed the four semester ISI pilot certificate program, (2) were enrolled in at least one semester of the program, (3) were the program initiators and developers, or (4) was the college professor in charge of the ISI certificate program. The study participants who completed the certificate consisted of 3 females (including participant observer) and 3 males ranging in age from mid-twenties to mid-

forties. They were employed in informal science education, were graduate students, or belonged to both categories. The four program initiator/developers were 3 females and 1 male ranging in age from mid thirties to mid-forties. None of the initiator/developers completed the entire four semester program due to time constraints and job responsibilities. The university professor in charge of the ISI certificate program was female. Three members of the pilot ISI program who were not part of this research did not want to participate or did not respond to be interviewed. There was no contact information available for the fourth nonparticipant.

**Context of the research.** The context of the research was the pilot informal science institutions graduate certificate program which included scheduled classes, discussion groups, and times spent with the program professor and fellow members. Participants met for classes at and toured numerous ISIs throughout the Tampa Bay area including zoos, aquaria, science museums, and science research facilities. Guest speakers in the classes included ISI professionals, scientists, educators, government agency representatives, and community resource members (see Appendix B for partial list of venues and guest speakers).

The class accessed a Web site set up for the program which included learning resources and links, directions for activities, completed class projects, and discussion opportunities.

**Data collection.** This study protocol received expedited approval from the University of South Florida Division of Research Integrity and Compliance, IRB# Pro00004865. A consent form for the participant research was also approved for the participant interviews (see Appendix C for consent form).

I contacted potential participants by internet or telephone to request their participation. Before each interview I read the consent form with the participant, answered any questions they had, obtained their signature, and gave them a copy with my signature. I stored all consent forms, interview tapes, and collected materials in a locked file at my home office. I stored all electronic files pertaining to this research in my home computer with password protection enabled.

The face to face audio taped interviews were conducted individually at a place suggested by the participant, generally the participant's workplace or a nearby neutral location such as a restaurant or coffee shop. The interviews were generally open-ended in nature but were guided by themes that emerged from the single person case study (Ball, 2010) I previously conducted. These emergent themes included the participant's growth in self-efficacy, his

career advancement, his enhanced professional standing, and contributions he made to the ISI field during and after completion of the ISI certificate program. Specifically I concluded the ISI certificate program provided the participant, Jerry, with a stimulating nurturing environment which enabled him to assimilate and model the holistic education philosophy in his work, understand the diversities and inside operations of ISI's, and recognize and utilize networking through the development of professional and personal relationships within his community of practice. Further, the self-efficacy Jerry achieved from the ISI program enhanced his career and made him a voice and model in his community of practice.

I generated some potential questions rooted in the themes from the pilot research and referred to them during participant interviews to enhance data collection. Some additional questions were added to the list as they became apparent to me as the schedule of interviews progressed (see Appendix D for list of questions). For each interview I led with these open-ended questions and conversation to encourage spontaneity and only asked more specific questions to clarify what was already being discussed by the interviewee. Because my research was grounded in phenomenology, it was essential that the participants' experiences reflected what they had actually lived.

I made notes before each interview to record my thoughts about the interviewee. Occasionally I made brief notes of my impressions (Sanjek, 1990) while interviewing but maintained focus on the interviewee. I also kept a log of my observer's comments post interview for comparison with the interview transcripts during the analyses. I transcribed all interview tapes myself for accuracy and to enhance my analyses. Participants received a copy of their interview electronically after I transcribed their tape and they were asked to check it for accuracy and add any notes or changes. I employed telephone and email correspondence to follow up on questions, responses, and to obtain further clarification. In addition to interviews, I collected class notes, materials, and other artifacts about participants and included my recollections, observations, notes, and reflections and as data sources. Class members had been encouraged to journal, document, and participate in the online discussion board throughout the program but most people did not find time to carry out these activities along with the many projects and activities they were already engaged in.

**Data analyses.** I transcribed the audio tape of each interview while comparing it with my notes and observations made during the taping session. I examined all data collected from each participant line by line and paragraph by paragraph looking for emerging patterns and

themes within that individual respondent's experience. I reviewed the overlapping categories and themes through an iterative process of documenting and comparing the participant's experiences and perspectives until a saturation point was recognized and triangulated among the interviews, my observations and notes, and class artifacts (notebooks, projects, presentations, and the course web site).

The data were then compared across the board with all respondents and included the participant from my earlier study, Jerry, to confirm emergent key points that were dominant and obvious until all categories became saturated (Corbin and Strauss, 1990). As a participant observer my notes, memories, and other artifacts were also documented, examined, and compared with my fellow participants.

Interviews and other associated materials were member checked continuously (Gall, Gall, & Borg, 2007) with the participants throughout the analysis phase of the research to further enhance credibility and dependability of the research. I described and grouped each student's perceptions of the ISI classes and their perceptions of career impact during and after the certificate program. I then described and grouped the perceptions of the initiator/developers, the program professor, and my own perceptions as a participant/observer during and after the ISI program. I then identified the major themes from the groups, or threads, of entire cohort's perceptions.

## Summary

This research was an emergent design study conducted using qualitative methodologies grounded in the constructivist perspective. The pilot ISI graduate certificate program cohort members' experiences, including my own as a participant observer, were ascertained in the tradition of symbolic interactionism and phenomenology through face to face audio taped interview, collected class materials, and other artifacts. The audio data were analyzed line by line and compared with other data and were triangulated with observations and artifacts until all categories became saturated. As a participant observer my notes, memories, and other artifacts were also be documented, examined, and compared with fellow participants. Interviews and other associated materials were member checked continuously with the participants throughout the analysis and major themes were discerned about the cohort's perceptions of the pilot ISI certificate program.

# Chapter IV: Analyses and Findings

## Introduction

The purpose of this research was to understand the experiences of the cohort of formal and informal science educators, ISI community representatives, and the college professor during and after completion of the pilot ISI graduate certificate program and to report their personal and professional experiences and development to the informal science education community and science education interests in general. In this chapter I have presented my findings framed by the research questions:

(1) What were the students' perceptions while participating in the pilot informal science institution certificate program?

(2) How did the graduate students perceive their careers had been impacted during and after completion of the pilot ISI certificate program?

(3) What were the perceptions of the college professor and community representatives, the initiators and developers, during the pilot ISI certificate program?

## Findings

Here I have provided a brief depiction of each cohort member from self-reported data and class records followed by results of my analysis of the interview transcripts and associated materials, or artifacts. In the first part of the chapter I have described each student's perceptions of the ISI classes and their perceptions of career impact during and after the certificate program. In the second part of the chapter, I have reported the perceptions of the ISI community representatives, the initiators and/or developers, during and after the ISI program. In the third part of the chapter, I have described the ISI program professor and her perceptions during and after the courses. In the fourth part of the chapter, I have described myself, the participant/observer, and reported my perceptions of the ISI certificate program experience during and after the courses. And in the final section I have summarized the analysis and findings of the research.

**Student perceptions.** Bob. Bob's educational background was in environmental science but he described himself as an educator. He was employed by a marine laboratory and aquarium as a school programs coordinator. Bob had some knowledge of ISIs and education from his participation in marine science education meetings connected with his work. He enrolled in the program because he wanted to learn

additional teaching skills and attended the four semesters of the certificate program.

Bob found the information about other ISIs, their people, and how they relay science education interesting because each place has their own system with different roles and diverse structures. He stated that the teaching methods discussed and modeled in class ”opened my eyes more to some of the pieces that the science teachers and the classroom teachers deal with” and helped his career. After completing the certificate program, Bob was promoted to senior programs director.

Bob indicated that his professional connections with other ISIs and networking with fellow ISI people improved during the program. He maintains his relationships with cohort members and feels the area ISI network is stronger. Bob sees himself as a bridge between scientists and educators, not just at his ISI now, but for outside teachers “to help them talk to the scientists, interpret the research.”

Terri. Terri’s educational background was in biology and marine science and she described herself as an educator. She was an instructor in her second year of employment at an aquarium at the onset of the ISI program and was in charge of the sleepover program, assisting with summer camp, teaching programs and helping with animal care. Terri was made aware of the program by her supervisor,

who was an initiator/developer of the courses, and felt it would be an opportunity to grow her knowledge base on ISIs and informal education. Terri attended the four semesters of the ISI certificate program.

ISIs and ISEs were a “totally new concept” to Terri. Terri came to realize “Oh, there’s other people out there like me! And it’s not like Oh, it’s just our facility that does that, there are a lot of other places that have that available as well.” She found ISI site visits, guest speakers, and group discussions to be beneficial and recognized the diversity within the cohort and in the greater ISI community.

Terri had little pre-existing knowledge of reform philosophy in science education or education vocabulary. Science education reform “just sounded like a big mess” to her. She found the class education materials and assigned research papers were sometimes difficult to read and comprehend. Terri initially felt there was a lack of direction and instructions with class assignments and was not accustomed to being in charge of her learning.

Terri was promoted to education camp coordinator during the certificate program and had more opportunities to practice inquiry based learning during summer camp programs where she had more time to work with her audience and incorporate more hands on

activities. A big “take away” idea for Terri included characteristics of learning and her potential impact as she recognized

> Oh, I definitely was exposed to a lot of stuff I didn’t know about or kind of knew about but got more details and information. You know, there are so many people out there doing studies about how much you can learn. I mean, one of the things that really stuck out for me, and I can’t remember the exact percentage now but, close to 80 percent of what you learn doesn’t happen in school. It happens in your outside activities, going with family type things, and things like that. I think that was really enlightening for me and like “Oh wow, so what I do does make a difference.” Hopefully, when people come here they don’t realize they’re learning, but they take away a lot more than they may think.

Terri felt she and other class members shared many similar ideas and experiences although their education, employment, and experiences were diverse. She felt the ISI program helped her and the group network and connect with people locally to understand that “other places faced the same difficulties that we were facing as well”. Terri also sees herself as a bridge between the aquarium biologists and school children to facilitate interactions and disseminate science information

Edie. Edie’s educational background was in biology and had been employed in aquaculture and microbiology. She described herself as a scientist working as an educator and felt comfortable in both worlds. At the beginning of the ISI program, Edie was employed as a teacher by an outdoor adventure education organization for children and was

enrolled in a master's degree program. She met Brenda, Jerry, and me while attending a graduate course we were teaching and had no prior knowledge of ISIs/ISEs and science education reform. Edie was invited to join the ISI program at the beginning of the fourth semester and subsequently enrolled in independent study with Brenda and completed the first three ISI courses she had missed.

Edie did not realize she was employed by an ISI and was an informal science educator at the beginning of her attendance in the ISI certificate course. She had many preconceptions of ISIs/ISEs

> I didn't believe that the body of knowledge really existed. I thought that people who were successful working in ISIs were people who were successful in classrooms and brought it over. I didn't even know there was a delineation between the types of teaching and learning that goes on….I didn't make the connection [between science educators, scientists, and ISI personnel] because you work in an aquarium you know what's going on with the latest and greatest things in marine research. I wasn't necessarily under the impression that ISI institutions were always connected to a body of research scientists or to anything that's current. I always thought that, you know, an aquarium is just a place where you go to see pretty fish. So it was not apparent to me that there was an undercurrent of, you know, of current scientific research.

As Edie was exposed to the ISI cohort, explored resources, and participated in learning activities, she recognized the diversity and depth of ISIs and ISEs and was surprised to find *she worked at an ISI and was an informal science educator*

> One of the really neat things that occurred to me is …the vast variety of informal science institutions and informal science educators. And I find myself as one of those actually. But I would say that's one of the largest learnings that I got … science is everywhere and there's a potential experience using an understanding of informal science education in many practice fields.

Edie reported she had always been engaged and responsible for her own learning and decided to use her newly acquired knowledge about science education reform as an experiment in her work. She was soon writing the science education portion of the curriculum and was training her coworkers by modeling holistic science education ideas.

As the fourth semester of the ISI program concluded, Edie enrolled in the first three courses she had missed and worked one on one with Brenda over three semesters to help develop the ISI curriculum as a distance learning certificate program. She realized she was modeling and practicing with her work and learning what Brenda had been modeling for her. She understood and embraced experiential learning and was an autonomous learner who used herself to explore and try on ideas about holistic education philosophy

> You know, I think once you understand that you're teaching a whole person, you're not just teaching back….it's not about content. It's really not. It's not about…me encoding my understanding and knowledge onto somebody. It's about allowing them to know the opportunity to understand something properly. That's probably the biggest thing of the ISI program.

Edie had no professional connections with ISIs prior to her course participation and no knowledge of communities of practice. She felt the ISI cohort was a creative group where members did not mind asking questions or sharing ideas. Edie saw her classmates as professional ISI people and was somewhat reserved initially because she did not recognize she was an ISI member too. She did not believe she bonded with most of the cohort because she “came in after the classroom culture was established” and “everybody had their role”.

Edie has benefited from the ISI community in her career. After the ISI program concluded, Edie was hired by Terri to work as a summer instructor at the aquarium and felt accepted as a fellow professional. When Edie investigated employment with a regional fisheries management council, she used her ISI network to secure information and recommendations from fellow ISI program members. She was hired by the fisheries management council and created her position as a “Fisheries Outreach Specialist”.

Edie now applies her knowledge as a science educator to help fisheries scientists explain their current research which impacts fishing laws and regulations. She acts as a facilitator, or bridge, between the fishing public and the scientists to interpret and connect both groups to work together to establish and maintain sustainable fish

populations. Edie has a fuller understanding of how the ISI program was beneficial to her

> …while I may not be accepted as a [Ph. D] scientist…I think I am respected as an educator….I give a lot of presentations and people tend to really respond to the way I interact….being in the program [has] given me the confidence to say "You're right, I'm not a Ph. D in fisheries biology." And I know why that works to my advantage because my specialty is not science, it is conveying a translat[ion] of science into meaningful stuff for people who don't understand it….program gave me the confidence to say "I am this other type of intelligence which is fulfilling my role here."

Edie perceives she has greater awareness of what she sees and experiences when visiting ISIs now

> I'm far more critical…normally I would just have taken it as this experience where the aquarium is a money-making venture….And now [I see] the missed opportunity…that could have been a teachable moment....I'm far more critical of informal science education than I ever have been….by and large, ISI is not a profession yet….I am still appalled at the lack of professionalism in the field.

Tom. Tom's educational background was in wildlife and fisheries science but he described himself as an educator. He was employed by a marine laboratory and aquarium as public programs coordinator. Tom was somewhat knowledgeable about ISIs, having worked several years in the ISI field, and had some exposure to science education through participation in marine science education meetings. He was made aware of the ISI program through his employer, who knew

Brenda professionally, and enrolled in the program because he wanted more exposure to ISIs and to advance his career. Tom also thought it would be a good opportunity to learn about pedagogy in informal education, education research, and teaching strategies. He attended the four semesters of the certificate program.

Tom was initially frustrated and confused at the onset of the ISI program and felt other class members shared his view

> …I think quite honestly common conversations were "What are we doing?" I think there was some confusion that carried through the …certificate. Are we designing this program or are we part of this program? Or a combination of both?

Tom was concerned he had entered the program "blind" and figured

> because of the people that were in the program, that we were partly designing. But then also, there were facets of the program where we were also learning while designing. So there was a combination that kind of continued throughout the program….I didn't feel we had a kind of direction and outlined goals and objectives…I'm pretty methodical, pretty logical thinking. And not having that goal down the line was a little disconcerting for me….I know there were others of similar mind.

Tom realized Brenda approached the program with a "very free form [of] thinking and a "just letting it kind of unfold as it happened" philosophy which was not always aligned with his perception of what the class should be doing. He did believe, however, that he and Brenda had "a very open honest respect for one another in terms of how we perceived things".

Tom knew the words “ISI” and “ISE” at the onset of the certificate program but

> I guess I didn’t really think about them collectively. I knew they were, that there were zoos and aquariums. I didn’t know that they had kind of an overarching title. And I think that’s a lot of the perceptions. Not a lot of people consider all these institutions, whether it’s a zoo or an aquarium or museum, as an informal science institution where they can come for free form learning.

Tom did not initially realize he was an informal science educator. He thought, “I just have a fun job.”

During the program Tom was introduced to science education reform philosophy, vocabulary, and learning strategies that were new to him. He thought some of the literature and articles presented early in the program were “eye opening.”

> Things that come to mind like “blank slates” was a new concept to me that no [one] really is a blank slate. Everyone has misconceptions and preconceptions and different learning backgrounds that really kind of shapes how they take in subject matter….definitely some new things introduced to me.

Tom felt he could make sense of the materials easier through group discussions as the courses progressed. He benefited from joining in the group discussion board on line. “It made me think and gather my thoughts and put them [together to] send a paper into the site.” Tom recognized that he was taking responsibility for his own learning and “helped get his mind right for going back to school”. Consequently he

enrolled and completed an MBA program and was hired as a community education manager for an extremely large ISI.

Tom reported he had developed a better understanding of the ISI industry throughout the certificate program, particularly connections between science educators, scientists, and ISI personnel

> I think it has changed both in my perception and in practice. I think everyone's trying to advance the profession. Everyone's trying to, quite honestly, compete for the dollar, more students, more audiences. And in order to improve, we've got to get better connections between educators and scientists.

At his ISI Tom was promoted to a director position half way through the certificate program. He believed the ISI program improved his networking and assisted him in developing more connections between formal and informal professionals

> the network was very, very beneficial for me in terms of the mix of informal educators, managers, as well as formal classroom teachers and professionals. It really opened my eyes to not just the network but the fact that we're all kind of trying to achieve the same goal and trying to bridge the gap between informal and formal. It was exciting to see that there were people out there that were, somehow, someway, trying to develop a program that kind of bridges those things. The idea was that we were trying to find an academic home for it.

Tom recognized he was an active member in the ISI community and considered himself a mentor in his profession.

Jerry. Jerry's educational background was in environmental studies with a concentration in the humanities. He was an environment

and conservation educator and was employed by a state agency as an outreach coordinator. Jerry had worked at ISIs for several years and had knowledge about the ISI field and some exposure to science education ideas through attendance at marine science education conferences. He was introduced to Brenda and heard her speak about the pilot ISI certificate program when he attended a professional conference with Harry. Harry and Dawn were working with Brenda to develop the ISI program and recruit people for the pilot courses. Jerry was actively seeking additional professional development to advance in his informal science career and was encouraged to enroll in the ISI program. He attended the four semesters of the certificate program.

Jerry quickly became frustrated in the first semester of the ISI program because he had no previous knowledge of science education reform philosophy or vocabulary. He felt he “couldn’t ground it in anything….It had its own different language…the nature of science, what’s that? The five E’s, what’s that”? Jerry heard the words “paradigm shift” and “constructivist learning” but did not understand what they meant. He had no experience with “open-ended inquiry” and “use yourself as a learning laboratory” that Brenda modeled for the class. Jerry believed other members of the cohort shared his concern about lack of direction and Brenda

> [Her role] was no where really made clear. I think that was a big issue for all. Here was this lady who has been here at the university for 25 years. She's been doing this type of community-based education….what do you mean you're not an expert? Why can't you tell me what the right answer is? What do you mean it's an open discussion? My point of view is just as valid as your point of view…? It was a shock for a lot of us.

Jerry reported he was able to put aside his frustration and move forward after speaking with Harry who told him the courses were "in the pilot phase" and

> you are basically an architect of this program…as you're going through this, what you're working on and …your involvement…how you deal with this learning opportunity…it's going to create a foundation for what we can do for the next go around.

At that point Jerry visualized the program

> [as a] puzzle frame and I have the pieces. I wasn't…nervous about not knowing what things we were going to do…whatever it was, these big topics were going to fall in there somewhere. The puzzle pieces were different things I wanted to work on and I knew that, at some point, they were going to be there.

Jerry felt he began to comprehend science education reform ideas better after he enrolled in independent study with Brenda, concurrent with the second semester of the ISI program, and had the opportunity to explore and model science education activities and discuss reform topics and philosophy with Brenda. He took the role of program facilitator for many of the ISI classes, walking the group

through science activities, encouraging them to report about their work and conferences they had attended, and encouraging them to discuss work issues. He could see that some class members still did not understand emergent curriculum design and constructivist education philosophy. Jerry realized he now understood and was modeling the education reform philosophy and course design ideas Brenda had been promoting.

Jerry continued to work with Brenda in the third and fourth semesters of the program. As he collaborated on national presentations about the ISI program with cohort members, planned class activities with Brenda, and helped arrange site visits for the group using his developing connections with classmates and the community, he recognized that through his networking he now had access to the class members' resources and, in turn, their networks.

Jerry reflected that his expanding connections with active networks, site visits, and conversations with fellow professionals helped him understand there was much greater diversity in ISIs than he had previously thought. He had a "totally new idea and concept about what ISIs were". Jerry perceived some ISIs "were looking for good actors, performers…wanting friendly people who could entertain but not necessarily those with science content or over-thinkers". He

had also visited ISIs where current science knowledge and independent thinking were essential.

Jerry's involvement with the ISI program and professional career networking resulted in a career change in the fourth semester of the certificate program. He was hired as a program coordinator by a national organization promoting improvement of the environment and communities through youth education and felt his learning about inquiry, education vocabulary, and school science standards gave him "a lot more grounding and …common vocabulary" to do service learning projects, connect in the classroom, and do teacher training. He recognized the benefits of his vast ISI and professional network and became expert at pairing his resources with those of the ISI community noting "it is a 'dog eat dog' world in the not for profit ISIs, so working together expands minimal resources such as funding, staffing, and expertise". Jerry was later promoted to state director and became expert in writing curriculum, grant applications, and teacher training programs for the organization.

**Initiator/developer perceptions.** Dawn. Dawn was an experienced informal science educator who had risen through the education department at a large aquarium from instructor to vice president of education over several years. She had dual bachelor degrees in music and a M.S. Degree in Science Education with focus on

Biology and had been a formal education teacher before entering the informal science education field. Dawn was responsible for hiring and training ISE personnel at the aquarium and had encountered many applicants and trainees with diverse science backgrounds who had no formal or informal education experience. Dawn was an active member of the ISI community and COSEE-FL. She was an initiator and developer of the ISI certificate program and present in the classes during the first and second semesters.

In the ISI classes Dawn saw herself as

> an active participant, making sure that if Brenda asked anyone questions or comments, …I tuned in. …any time you're in a collaborative type of learning environment, everybody's role is to be an active participant. I think, specifically because Harry and I probably had a little bit more experience, I tried to add experience from my own background. But everybody did that regardless of what level of experience they had.

Dawn already knew several of the student class members and was aware most had strong science backgrounds and little formal training in education, pedagogy, and education philosophy much like her employee, Terri

> …she's a great educator…she has a science degree…. I thought she was the perfect example of somebody who could benefit from this program because she is a very talented and skilled individual and could definitely benefit from some of the more formalized training.

Dawn viewed most of the student members as very engaged in their learning. She felt Tom

> was incredibly enthusiastic and willing to learn…and he's not afraid to ask questions. But he is the kind of person that gets the most out of programs like this because I saw him as someone who came in without having a lot of knowledge but not afraid to ask questions and work with other people. I still get emails from him asking questions…. He's definitely somebody who is like a sponge.

And Dawn saw Sandy (not a participant in this research) as an avid learner

> …one of my favorites because she's…so smart, so talented. Again, a very strong science background and hadn't really taught kids too much until she came here….ideal because she needed more. [She] had very little training and experience with kids but soaked up everything and learned whatever she could. So an opportunity like this is really beneficial to someone like her.

Dawn had difficulty determining what Amy (not a participant in this research) was trying to get out of the program.

> …I couldn't figure out if she wanted to be an educator or a scientist. I do have strong memories of her because a lot of times, when we would be involved in conversations, I would just kind of think she seemed to have an impression like she already knew a lot of the information. But I didn't quite understand why she was involved if she felt like she couldn't get that much out of it.

Dawn recognized that the ISI program had helped Terri "to think about education as a process" and to see that informal science

education has “its own kind of skill set and methodology”. She saw changes reflected in Terri’s work at the aquarium

> I think she is a lot more methodical now...when she writes lesson plans and she teaches…. A lot of times people think education is just about imparting knowledge and facts. You know, you want to go teach at the aquarium? Okay, I’m going to list all the adaptations an alligator has and you’re going to run it. It’s not really what it’s all about. So I think before, I would say she wasn’t that basic but I think after the program she thinks a little bit more about the standards. What are they [children] learning back in the classroom? There is more of a thought process than just “Oh, you know what’s cool? It’s cool if we did a class on locomotion. Kids would love it.” But what’s your end goal there? What’s the point of that? I think she does tend to think of … a more realistic view of the educational process and what her role is here.

Dawn perceived she had most benefited from the ISI program by being exposed to the ideas other members brought to the classes

> I think hearing what people, myself included, what we did and didn’t know was always helpful. I learned as much about other peoples’ questions and comments as I do about my own knowledge. So it was interesting to hear what people wanted to talk about or needed to talk about and kind of compare it to my background. I think that I kind of got out of it that there is no set formula in doing what we do. We all bring different things to the table.

She also found some of the readings selected for the program to be beneficial noting that she might not have been made aware of them otherwise.

Dawn believed the regional ISI community of practice had become more cohesive due to participation in the certificate program

> …I think all collaborations were strengthened as a result of being more involved. Even though I have known Harry for a while, and Jerry too, and some other folks who were involved, I think seeing them on a regular basis really only helped to strengthen our kind of already existing collaboration. I think before the certificate, there were loose collaborations. I think after everyone participated, there were a little more concrete relationships developed and everybody understood each others' roles a lot better….I think a little bit more cohesive community ISI region.

Hannah. Hannah was an experienced educator, library media specialist, and administrator in K-12 through university education and distance learning. She held a B.S. Degree in Education and MSLS Degree in Library and Information Sciences and worked online in virtual environments to deliver environmental education programs for government agencies. Hannah was invited by Brenda, who she had worked with in COSEE-FL, to help with the development and delivery of the pilot ISI certificate program courses. She was present in the classes in the first and second semesters.

Hannah perceived from the onset of the courses the student members were "dedicated to their jobs but didn't have much of a background that would help them with the classes". She felt there were only a few students who contributed to conversations while most

of the members “seemed unable to respond to questions most of the time and didn’t contribute much”.

Hannah reported the most beneficial aspect of the ISI program for her was the “opportunity to network with other ISI people”. She also felt she benefited from attending site visits to other ISIs where she got “behind the scene tours of their facilities”.

Harry. Harry was an experienced informal science educator who, over a decade, had advanced from education coordinator to president and CEO of a private, not-for-profit aquarium and marine science education center. He held a B.S. Degree in Chemistry and had graduate research experience in chemical oceanography before entering the informal science field. Harry was an active member of the ISI community, COSEE-FL member, and had participated in Brenda’s community building courses where he voiced the need for professional development for area ISEs. Harry was an initiator and developer of the ISI certificate program and present in the classes during the first and second semesters. He recruited several members of the pilot cohort, including Jerry, Sandy, Erin, and Amy, whom he had worked with in informal science programs and activities.

Harry recognized the ISI certificate program had a positive impact on Erin, the public relations and marketing director for his aquarium operations, as she had become a “great mentor for the

educators [who] see her a little bit differently because PR and marketing [are] a totally different enterprise from education". He pointed out the necessity of different operations within each ISI to communicate with each other and "understand the other cultures within" had been a beneficial part of the program curriculum.

Harry reported he and Dawn had shared community partnering ideas from the ISI certificate program with an executive of a large ISI in the area and "he gets it….It's not about being competitive …it's not… [although] we're doing similar activities'. He mentioned that he and other ISI professionals reciprocate in attending their respective sci cafes and

> since they've started theirs, we go over to theirs and feel bad, actually, when we can't go to each others. All this is going on most of the time. And we have Facebook pages, or fan pages, that we [use to] push our traffic back and forth".

Harry also pointed out that many ISIs in the area now "leverage resources beyond just what we would normally think of". He described a "bartering system", or reciprocal agreements, that

> we use for summer camps that our groups are allowed to go to the [X] aquarium or the [Y] aquarium and they send theirs to us [with] no fee. Transportation is a huge expense of summer camp so we partner with [another ISI]. Why not give them some earned income for vehicles that they already own? And that's been widely successful the last two years….we have limited space here so we partner with the larger institutions who provide us space.

Cathy. Cathy was a scientist and an experienced educator in formal and informal K-12 and university education. She held a B.S. Degree in Marine Biology, M.Ed. Degree in Curriculum and Instruction, and a Ph.D. Degree in Science Education. At the time this research was conducted Cathy was director of a county science center. She worked as an education specialist for COSEE-FL and attended doctoral courses where she first met Brenda (professor and mentor). Cathy participated in Brenda's community building courses and voiced the need for a graduate program in informal science education. She was an initiator and developer of the pilot ISI certificate program. Cathy attended some of the first and second semester classes and the entire third semester course.

Cathy perceived herself as a "semi-expert" in the ISI classes and "kind of guided a lot of the conversation for the people who really didn't know anything". She felt she was "more or less analyzing" the cohort and observed a contrast early in the pilot ISI program between the experienced educators and some of the less experienced members

> Paula was great because she was a more mature person and she could see that she could benefit from the things we were doing, open up her mind to the informal ed. But the other two, being younger and not having a lot of experience and just kind of starting out, really just wanted to, you know, kind of get what they could get out of it and just be finished with it.

She noted the pilot ISI program was designed to bring together people from formal and informal settings to learn from each other to foster professional development and felt “they learned from their peers but I don’t think they bonded through what they were supposed to have learned”.

Cathy recognized her role as an experential learner in the class and grew her knowledge base of area ISIs and dif different facets of their operations

> For me as a learner, I always look for something new to learn, so I can’t say I didn’t learn anything because I know that I did. What I found interesting, I think, was the structure of the different organizations, the hierarchy, where they got their money from. And it isn’t necessarily that I didn’t know that. It was just interesting to listen to the people that sell within those organizations talk about it and describe it and to see that variety. So there were some similarities but there [were] a lot of differences. I think for me that was what I took away. As far as the education, what goes on, the informal educators and their types of jobs, I was well aware of that and what we were trying to deal with.

She felt trips to various ISIs were the most helpful part of the program for her and “personally liked the visits to the different places the most because you’re hearing from the people involved with it and you’re seeing that in action. You’re able to ask them questions and gain your information that way.”

Cathy perceived the certificate class cohort was probably a more cohesive community of practice after completion of the program

> I think they are more willing to talk to each other and try to work on things. They think about “hey, I can call Jerry now for this project”. So you know … I think they are. I also think they might be thinking about or moving toward “hey, how can we work together” because I know we have these conversations … at the Science Center. … And we go over and over again … why can’t we pool our resources? None of us can afford grant writers. Could we come up with some kind of organization to where we can combine and we have maybe … one or two people, but they kind of work for all of us? So those conversations have gone on and I see people just are thinking about it by the nature of their business and the economy. You know, we have to figure out how we can make the most effective use of our resources.

Cathy described how she currently uses her connections in her work and recognized the reciprocity in the community

> …Harry needs a van to drive the kids around so he calls the Science Center…. And if we want somebody to come out and look at a fish tank, or whatever, we can call Harry. … I called Tom a couple of times to see if he wants to …do a project, or something like that. …I definitely keep those people in the back of my mind in my little Rolodex. Like if I’m working on a project and I think, hey, we might be able to do something with them. Or we might be able to do something for them. …it’s like anybody you meet. You kind of keep them in the back of your mind for the future.

**Program professor perceptions.** Brenda had been a tenured university professor for over twenty five years in the field of science education at the onset of the ISI pilot certificate program. She held a B. S. Degree in Biology and had taught high school biology. She had a

M. S. degree in Combined Science and a Ph. D. Degree in Science Education. She was an experienced state, federal, professional education consultant and expert in social issues and community building. She described herself as a “creative thinker who is a change agent.”

Brenda had brought together marine and environmental science stakeholders in the Tampa Bay area to work on a COSEE Florida grant but perceived from the onset the teachers, scientists, and other people there

> were talking right past each other. Even when they thought they were saying the same thing, it was obvious that they were not. They were using the same words but they didn’t [have] the same meanings for them. And they were loaded with misperceptions about what was required by the state and what was required by the county and what wasn’t required in terms of education. And scientists had all sorts of weird ideas about standards. And teachers had even weirder ideas….

Brenda offered a series of community building courses for the group with “the idea that people would learn about each others’ cultures and develop some sort of common [ground] and then be able to develop some sort of mission and goal with COSEE Florida”. In the fifth community building course “Harry brought up the idea that people needed formal…professional [development and] it became a collective conversation about the idea….” Brenda and Harry spearheaded focus groups and surveys with Florida ISEs and, with the assistance of

Dawn, Cathy, and Hannah, developed initial materials and syllabi for the pilot ISI graduate certificate program courses and recruited students.

Initiator/developers. Brenda was director, or facilitator, for the entire four semester ISI certificate program. She knew none of the student members at the onset of the program other than Paula, an experienced formal educator she had previously met through Cathy. Brenda believed Paula and the initiator/developers (Dawn, Cathy, Harry, and Hannah) had greatly contributed to the success of the program through their participation and guidance in group discussions and their previous formal and informal science education backgrounds and professional experiences they shared with the cohort.

> During the courses Dawn served as both a learner and an instructor and she shared a lot. For example, when she went for a National Science Foundation workshop for principle investigators...she came back and she shared her experiences and then we would discuss the information [in class]. And she was very helpful in providing her experience as an experiential base for what went on in the course, as was Howard…. While his job was being the education person [at his ISI], he was participating completely and helping to generate new projects and analyzing other projects. He was very active in [it] all…. …my interaction with them was not just classes, my interaction with them was all the projects and all the dimensions of it. We were all interacting around [their] projects. And I spent an enormous amount of time with most of the individuals and it was not formal class time. It was meetings about different projects that overlapped into the ISI program.

Brenda believed the experienced educators, through numerous collaborations within the cohort and greater exposure to the area ISI community, had developed larger professional networks during and after the certificate program. She perceived they had also expanded their knowledge bases by exploring new literature and sharing with the group

> …she [Dawn] appreciated like everybody else. Everybody was contributing their knowledge base and the literature they were coming across. And she was appreciating having a group to be a sounding board to discuss the literature with, and to get the perspectives on what the literature was saying, and the perspective on what she was doing.

Brenda did not remember in which semesters some of the less experienced students were enrolled but had detailed perceptions of each participant. She considered many members had “got all there was” from the certificate program and, through using what they had learned, had advanced in their careers and expanded the ISI community of practice.

Erin. Brenda did not know Erin when she first came to the classes but was aware Erin was a public relations specialist at an aquarium and had been invited by Harry, her supervisor.

> She was very outspoken and very able to identify her cultural behaviors and Asian cultural background. And she was very able to take anything that we said in class and discuss and give another perspective on it, a different perspective … all through the course of her job which was public relations person….

Tom. Brenda had not met Tom prior to the first ISI class. She perceived Tom took “a while to understand where I was coming from and to respond [to] where I was coming from” regarding science education reform philosophy. She recognized she “was modeling something different than what he was expecting regarding straight input from a professor” but felt he eventually accepted what she demonstrated and came to understand how people learn. She described Tom as

> very willing to do a lot of the intellectual work…. He was really pushing hard to keep the journals going but the other people really didn’t want to especially. But he was doing some really good stuff there, questioning, thinking. Part way through he realized that he [would] go on to get the MBA.

Brenda felt Tom took from the ISI program “pretty much everything that was there to get.” She recalled Tom was bothered by what he called “teacher bashing” and he felt “we were always bashing schools or bashing teachers. And it was really hard for him to swallow the idea that it wasn’t bashing schools. It wasn’t bashing teacher. It was just telling it like it is.”

Terri. Brenda had not met Terri prior to the ISI courses but knew Dawn was her supervisor in the aquarium education program. She described Terri as “very mousy at first” and perceived she was “very

much intimidated by the fact that her boss, Dawn, was in the classroom."

> And she didn't say much of anything at all. Even towards the end, it was very hard to get a whole lot of conversation out of her. So I never really had any sense of how much she was learning or not learning or what she did or didn't. The only thing I did know was that Dawn made a comment to me about the fact that, as time passed, Terri was participating to a significant degree in staff meetings.

Bob. Brenda did not know Bob before the ISI courses. She mentioned that "Bob described himself very well when he said in class that he was a formal teacher in an informal setting". She remembered he had no "idea that he should be doing something else … the informal setting was new to him. And he seemed to pick up on it. He seemed to like the idea." Brenda recalled Bob, Tom, and other members had enjoyed talking and planning a potential ISI certificate program for an education group coming to Florida where they "could go to the various organizations and various ISIs and get educated. And that each one would be using their own [ISI] …." Brenda felt they all saw the community as "an ideal target place for people who wanted to get interested about marine education. They could come to the Tampa Bay area for real hands on experiences."

Sandy. Brenda met Sandy at the beginning of the ISI program and thought she was initially "very quiet". Sandy was a formal

educator, a marine specialist at a marine magnet elementary school. Brenda's initially perceived Sandy as "operating in a very traditional teacher mode even though she was not a classroom teacher …. And she was still operating in the traditional paradigm. And the school was pretty much operating in the traditional paradigm." A school marine project had been developed and supported by an aquarium, the university, and a federal agency to provide student data collection opportunities and corresponding curriculum for marine classes. Brenda learned Sandy was experiencing communications breakdowns within the project and guided the ISI class to use the experiences at this school as a case study to learn about collaboration among various community organizations and interfaces between ISIs and formal schools. (Several members of the ISI cohort had been or currently were involved in the school marine education project.) Brenda recalled Sandy was increasingly frustrated with addressing the issue in class

> after about the third or fourth week of dissecting this, Sandy sent me an exit memo in which she said she had to live with this every day, all day long in the school, and that she really didn't want to be living with it in graduate work. And would we please cut it off. So we did.

Brenda believed Sandy "learned a lot about the education things about what could be better in terms of how people learn" and recalled experiences Sandy had shared with her

> she frequently came into class and said “Oh, I did ‘x’ in school today and this is what the outcome was” and she was very pleased by the outcome. … she started to do something different and she was ecstatic over the fact that how the students picked up on it and came back to her and what a great interaction this created. And she did that very frequently during the program. [However] at the end of the program, she was personally as a learner … still operating in the dominant paradigm And she would do whatever was asked of her and do it in a respectable manner within the confines of what was going on but not with any…not bringing in any degree of diversity in terms of the way she was approaching or extending anything.

Brenda perceived Sandy had established a network and resources in the ISI community and was using them by the conclusion of the program

> …she did make a point of saying that because of the program that she had these great relationships with all the people in the different organizations and how great it was that it made her job so much easier. She could now call these people and set up all things for her school that she liked and wanted to have happen. So that was a great advantage to her.

Amy. Amy was a scientist who expressed a desire to get into education. Brenda did not know her before the beginning of the ISI courses. She described Amy as “very bright and …very motivated and really jumped in on everything that was going on [in the classes]….she got all gung ho in the first course with all the readings and all the things She really did a great job with it.” Brenda supported Amy in entering a master’s of education program and accepted her in

independent study courses she was teaching. As the ISI courses progressed, however, Brenda realized

> Amy was not particularly interested in the organizational career part of the ISIs. She was very explicit that she was not interested in that. She was interested in developing curriculum. And as it turned out when she went to work for Harry [at the aquarium after the ISI program concluded], her downfall and why she ultimately got fired ended up being the fact that she did not….I can't say that she didn't know what to do, but she just didn't really learn what there was to learn about being a professional ISI person in a professional ISI organization. And so she put her foot in her mouth once too often and got herself fired.

Jerry. Brenda had not met Jerry before the start of the ISI certificate program and "didn't know a whole lot about him" when the first semester ended. By the end of the certificate program, Brenda described Jerry as "a sponge" who "would take every single thing and interpret it in his own cognitive framework and put it to use in every aspect of whatever he was doing." Brenda observed Jerry modeling science education reform ideas in the ISI classes and in his work. She was excited as he advanced professionally during the ISI program and enthusiastically supported his academic achievements (M. Ed. and doctoral course work) post certificate program. Brenda enjoyed mentoring Jerry and collaborating with him on mutual projects. She described Jerry numerous times as "a poster child for the ISI certificate program."

Edie. Brenda had taught Edie in a graduate middle school science methods course during the time the ISI pilot program was being conducted. She recognized Edie was dissatisfied and wanted to learn more than her traditional graduate classes offered so she invited her to join the cohort for the fourth semester. Brenda stated that Edie was also “a poster child for the program.”

> I think she pretty much got everything out of it that there was to get out of the program. She learned everything that needed to be learned and used a lot of it while she was working at [her ISI] and that put her in a position at [her ISI] where she was looked to then as a program development person.

Brenda mentored Edie and supported her independent study of the first three ISI courses and her remaining master’s degree work. She was excited about Edie’s professional growth and capacity to utilize her expanding ISI network and resources

> And then when the job became available over at fisheries, it was ideal and …I knew what she knew and [had] the connection with Cathy and Cathy’s husband. It was very easy to say that she was the perfect person for that job…. when Emily called me and asked if I knew anything about that job, I said “hold on a minute” and I put her on hold and I called Cathy. “Hey,Cathy. Is that your husband’s place?” She says “Yeah” and I said “Hey, Edie. Guess what?”

Participant Observer. Brenda met the participant observer while teaching a graduate science education methods course and perceived she was “the only one in the class who seemed to understand anything

I was saying [about idea of paradigm shift in science education].” Brenda became the participant observer’s major professor for her M. Ed. and Ph. D degree pursuits and invited her to join the ISI pilot certificate cohort at the beginning of the third semester. Brenda recognized the participant observer was “learning what I call organizational development kinds of stuff about group interactions and group dynamics and group growth and … learning all of that by actually living it firsthand within the group as well as learning what was happening with the ISIs.” Brenda realized the participant observer was

> able to analyze what was going on in the courses while it was going on and analyze, not only the interactions among the people and how that was promoting or inhibiting the learning that was going on, but also able to make suggestions for ways to make program …. And giving me your perceptions of all that and making suggestions as a learner…to make it work better.

By the end of the certificate program, Brenda recognized the participant observer was reorganizing her plans for a future in educating teachers and the public to understand and embrace science education reform and professional development for informal science educators

> And then, my perception was that the light kind of went on with “yes, I want to teach. But why in the world would I want to be locked into the kind of aggravation that the teachers are talking about if there’s another way that I can teach, where I can capitalize on all of my background not just a little bit of it? And

> bring it together to a larger population than just a single classroom of kids."

Brenda's Perceptions of Herself. Brenda reflected on the ISI pilot certificate program experience and believed it gave her

> an outlet … to use what I've learned throughout my career in a totally different environment in a totally different way. …And so, the fact that I could take what I knew and put it into an entirely different construct was very exciting. And I really liked the people in the ISI program. They were exciting to work with because I could pick their brains. And as much as I can contribute to what they were learning, I could pick their brains about the world in which they lived and then make the adaptation of what I knew to serve them in the world in which they lived. And so that gave me a challenge of how to use what I know differently and that was very exciting.

Brenda felt she was invested in the success of the program and the ISI community

> It was something we had all invested very heavily in and it was fun to keep investing in it because the people were fun to work with. And the work was interesting. I said to other people, "I do for my job what other people do for recreation" and that is go to museums, or outdoor whatevers, or go to places where things are happening in the community.

She also perceived the expanded network of ISEs and sense of community fostered by the pilot certificate program was beneficial post program when she participated in an NSF education grant writing proposal

> …it turned out that they were trying to design community-wise activities and NSF said that there had to be informal partners in

> it. I immediately said that I had a network, a well developed functioning network of people who could be part of this. And that Dawn, as the vice president at the aquarium, was the ideal person to lead a selection for the informal. And we could capitalize on the network that she and I and others had built together. …and [I] explicitly pushed the idea that one institution wasn't good enough, that it really needed to be a whole lot of institutions in order to get the money. And this style of our network that we had created was the ideal connection.

Brenda considered the ISI pilot certificate program had positively impacted the next generation distance learning ISI certificate program she later initiated

> All the topics that emerged during … conversation in the pilot project were used as information for the development of the on line program. … And so everything that emerged through the … pilot class was chronicled and all of that information was then reconfigured into something that would make a sequential sense for on line courses. …from looking at the way people responded in the live pilot, it gave me the clues as to how we would mesh things together in a more viable way for the on line [courses].

**Participant observer perceptions.** I was a scientist. I had been an industrial meteorologist and later earned a B.S. Degree in Biology. I had completed the coursework for a doctorate in microbiology before changing my studies to science education. I had met Brenda as a professor of the first education class I enrolled in, Teaching Methods in Middle Grade Science. She introduced me to science education reform philosophy, education vocabulary and literature, the constructivist philosophy, and informal science

education. As I became involved in her classes and research, Brenda invited me to enroll in the ISI pilot certificate program she was facilitating at the beginning of its third semester.

Perceptions during program. I knew only Brenda at the first class meeting and my initial perceptions of the pilot ISI program and people were colored by my unfamiliarity with the jargon the cohort used, the numerous abbreviations of organizations and societies they referred to, and their individual backgrounds and careers. As I attended the site visits to various ISIs and participated each week in group discussions and projects, I perceived the cohort consisted of several subgroups with different purposes.

Brenda and Jerry were generally upbeat and encouraged everyone to work on their ISI projects, report on their work and activities, and let new ideas emerge. Cathy and Paula actively contributed opinions in various discussions and seemed aligned with Brenda and Jerry. Sandy and Amy seemed irritated as the class dissected and discussed their problems with their school project each week and were most interested in formal teaching strategies and curriculum ideas. Tom seemed frustrated because he wanted more direction and support to develop an overarching end product from the four ISI courses. Bob was very quiet but seemed to support Tom (they worked together and shared transportation to class). Terri attended

every class but I never heard her speak more than a few words and I was never sure of what she was doing in the courses. Edie joined the cohort in the fourth semester and was reserved at first, but soon became more confident and injected enthusiasm into the group as she actively participated in discussions, career reporting, and projects.

I never met Dawn, Hannah, Harry, or Erin in the third and fourth semester classes of the program. I realized late in the fourth semester that Hannah was taking the courses on line. I eventually met Harry at an ISI function but still have not met the others face to face.

As I came to understand the class culture (vocabulary, personalities, and methods of operation), I perceived I was philosophically aligned and most connected with Brenda, Jerry, Cathy, Paula, and Edie. I was comfortable with Brenda's method of acting as facilitator and modeler in the classes. I sensed several class members seemed frustrated with less direction from Brenda and did not seem to change their dominant paradigm mindsets. Tom, Bob, Terri, Sandy, and Amy, in my opinion, did not seem to be interested in getting to know me or include me in their interests. They were polite but I perceived they had previously established their personal class connections and I was not part of them. I did, however, feel like an accepted and contributing member of the former group.

I believe the ISI certificate program advanced my knowledge in several ways. I began the certificate program in the third semester when the cohort was exploring regional ISIs and meeting ISEs and administrators at those sites. I grew to appreciate the differences in each place and their diverse personnel but also learned to recognize where they overlapped in what the ISIs offered the public and the commonalities the educators shared. I came to understand most ISIs were organized and committed to provide entertainment and education, at varying degrees, for numerous audiences. When it came to the educators they employed, however, commitment to long term employee growth and professional development was rarely evident.

I learned from ISEs that they generally moved laterally from one ISI to another, picked up some skills through on the job training in house, but seldom advanced to better paying, higher level positions because they had little opportunity for professional development at their ISIs. The ISEs considered themselves to be professionals and wanted more education, support, and recognition from education foundations and ISI communities. Throughout the program I observed they reported successes as they connected with other ISIs and ISEs and strengthened their resource base and community through reaching out and supporting each other. I felt the ISI program helped me to understand the major barrier to professional development for

most informal science educators was lack of financial commitment for professional development and inexperience on their part to empower themselves personally and act as a cohesive community of practice.

I ended the fourth semester of the program and studied the first two semesters independently with Brenda to attain the ISI certificate but still did not fully comprehend and questioned why professional development was not being invested in and financed by ISIs and state and national science education stakeholders.

Perceptions after program. As I interviewed members of the ISI cohort and gathered associated materials from them, I analyzed and reflected on my perceptions of the ISI certificate program's impact on their careers and the ISI community post program. I perceived from the interviews with the initiator/developers of the program that those who were still actively involved in science education, formal and informal, had and used large networks and resources in their work at their various ISIs. They seemed to be active strong members and mentors in their local and regional communities of practice and were involved with national ISI/ISE issues. These members expressed frustration about lack of funding for professional development at their venues and stressed it was important that ISEs be viewed as professionals and have a supportive community.

The student members had all advanced vertically in their

careers, either within their ISI or to a larger organization post certificate program. I perceived most of them were involved with their ISE community and continued using and enlarging their networks and resources. Some of us from the former cohort helped Brenda prepare the curriculum and materials for the on line ISI graduate certificate courses immediately after the pilot program concluded. All of the people I interviewed and communicated with during my research seemed more confident and some appeared to be taking more of a leadership role in the ISE field and greater responsibility for their careers.

Brenda was involved in planning and then facilitating the on line ISI graduate certificate courses immediately after the pilot program concluded. She was actively engaged with the ISI community and informal science educators. I perceived Brenda to be proud of the accomplishments of the ISI cohort members and satisfied with herself that her work positively impacted so many people and furthered reform science education and professional development for the ISI community. She was engaged in generating research papers about the ISI certificate program and seemed enthusiastic about new projects and collaborations in which she could capitalize on her ISI connections and network.

After the ISI certificate program ended I have reflected on what I learned about my experience and, through member interviews and materials, what I understand about their experiences. I believe the most benefit I received when all was said and done was the confirmation that people who take charge of their own learning and are open to exploring new ideas tend to attain greatest success. Also, those people who reach out to understand and help others reap the greatest rewards in personal satisfaction.

## Major Themes and Summation

I noticed repeating and concurring perceptions within and across the member groups as I categorized major themes from various threads in my data analyses. I have identified several major themes from the entire cohort's perceptions and additional major themes from the perceptions of the initiator/developers, program director, and participant/observer. The cohorts' major themes were

- Increased understanding and implementation of science education reform strategies in the workplace
- Deeper understanding of connections and increased communications between formal educators, scientists, and ISIs/ISEs

- Increased awareness of diversity and resources in ISI community and expanded use of ISI community people and other resources
- Expanded ISI/ISE professional networks and increased awareness and participation in community of practice
- ISI graduate certificate program contributed to career advancement

Additional major themes from the initiator/developer perceptions were

- Strengthened ISI community of practice
- Recognized that Brenda was an experienced change agent and educator who brought the ISI community and resources together under one umbrella

Major additional themes from Brenda were

- Most class members came together as a learning community and displayed greater self-efficacy in the workplace
- Some students became strong proponents and models for science education reform at work and in ISI community of practice

Other major themes from my perceptions as participant/observer were

- ISEs love their work and want to be recognized as professionals who contribute to and influence science education for all people

- Class members benefited from Brenda modeling science education reform, mentoring, and supporting career advancement

I also noted several minor themes from perceptions of some of the individual class members. A few class members were initially frustrated with student directed classes and with Brenda not acting as the “teacher”. A few students were also frustrated about the emergent design concept of the courses and the perceived lack of goals and discernable projects. These voiced frustrations appeared to disappear over the course of the semesters as most of the people came to understand more about experiential learning and constructing their own knowledge.

# Chapter V: Discussion

## Introduction

The purpose of this research was to describe how the ISI certificate program provided professional development and enabled growth in participants' abilities to contribute to science literacy. The questions guiding the research were:

(1) What were the students' perceptions while participating in the pilot informal science institution certificate program?

(2) How did the graduate students perceive their careers had been impacted during and after completion of the pilot ISI certificate program?

(3) What were the perceptions of the college professor and community representatives, the initiators and developers, during the pilot ISI certificate program?

In the previous chapter I provided a brief depiction of each cohort member from self-reported data, interviews, and class records followed by the findings and analyses of the interview transcripts and associated materials. I described each student's perceptions of the ISI classes and their perceptions of career impact during and after the

certificate program. I reported the perceptions of the initiator/developers, the program professor, and my own as a participant/observer during and after the ISI program.

**Assertions**

I iteratively reviewed the findings and data analyses of my research and reflected on the program experiences that generated the various major and minor themes of individual members, the cohort subgroups, and the entire cohort. I questioned the underlying reasons for the groups' perceptions and for the positive impact of the certificate program evidenced by their reported perceptions and collected artifacts.

As I mentally connected these experiences and outcomes, I spontaneously brought them together as one massive diagram, or concept-map, to illustrate and explicate my understanding of the research findings. I realized the program itself, by design and constituency, was the overarching entity that accounted for the members' experiences. I identified three principal aspects of the ISI certificate program and cohort which influenced the perceptions and the reported positive outcomes of the class members and underpin this assertion:

- the composition of the cohort and their collaborative activities established a vigorous community of practice

which fostered community building, mentoring, and networking

- the design and implementation of the long term program promoted experiential learning in a generative classroom
- the members who were able to be independent or autonomous learners and who embraced science education reform strategies evidenced greater benefit

Constituency, or Make-up, of Cohort and Activities. The make up of the ISI certificate program cohort and their collaborative activities established a vigorous community of practice as previously defined and described in the literature (Wenger, 1998; Allee, 2000; Richards, 2010). This ISI community of practice fostered community building, mentoring, and networking. The learning and exploration occurred within a professionally diverse community made up of individuals with similar goals. The courses were intentionally designed from the onset to exploit this diversity among members by nature of their varied histories and occupations and by their different levels of professional experience.

The ISI cohort consisted of a broad spectrum of people: experienced and novice professionals, formal and informal teachers, and educators and scientists. All members had joined the program

with a common goal to “update their science research knowledge, learn how people learn, learn ways to establish a network, and develop means to effectively interface this network of informal science education providers with formal education institutions” (Spector, 2009a). The initiator/developers of the ISI certificate program were experienced professional formal and informal science educators, most of them stakeholders in the area ISI community. Harry and Dawn were experienced informal science educator executives who had risen through the ranks at local aquaria. Cathy was an experienced formal and informal science education teacher. Hannah was a university media specialist and worked online in virtual environments to deliver environmental education programs for government agencies. The initiator/developers had over one hundred combined years of formal teaching and informal science education experience.

Several of the less experienced class members held science degrees and had become informal science educators at zoos, aquaria, government agencies, and private education venues (Bob, Terri, Edie, Tom, and Jerry). Amy was a novice scientist with an interest in education. Sandy was a school science coordinator with an interest in informal science education. Erin was a public relations director at an aquarium. I was an experienced scientist who had become a graduate

student in science education and was a neophyte in regard to informal science education.

Brenda was a university professor with over forty years in the field of science education, first as a high school biology teacher, then as a federal grants program officer, and finally in science teacher education development and research. She was a pioneer in science education reform and the science-technology-society movement and had considerable experience in community building and advocating for social issues regionally and nationally.

The weekly class activities, group discussions, and collaborations experienced within the community of practice over four semesters fostered professional relationships and professional development through community building, networking, and mentoring. Stoll (2010) states that “professional learning based on self-development, reflective practice, and work-based learning supported by peers” is generally considered “more effective” than traditional short term professional development which does “little more than raise awareness of issues”.

Class members collaboratively explored and discussed science education reform and ISI/ISE literature, visited each others’ ISIs, shared their workplace successes and problems, and brainstormed ideas for subsequent class activities and projects. Experienced members, for example, shared grant writing processes and strategies

with the class. Novice members who collaborated with, or were mentored by, senior classmates to present papers at professional meetings reported their successes and growing networks back to the class. Subsequently, members shared a common occupational vocabulary, expanded their understanding of their profession, grew networks as they were introduced to new people and resources, and developed trust and confidence in each other.

The iterative actions by the ISI cohort generated a cycle of self-efficacy in the individuals leading to career advancement (see Appendix E for career advancement of novices), greater participation in their community of practice, and additional perceptions of self-efficacy.

Bandura (1994) defines perceived self-efficacy “as people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives.” Mentoring relationships between experienced and novice members in this collegial setting also contributed to class member self-efficacy and enhanced professional and career development. Day and Allen (2004) described a positive relationship between mentoring and career self-efficacy in addition to career motivation and career success of protégés in a survey study of perceptions of municipality employees.

The achievement/self-efficacy cycle in the ISI cohort was recognized to varying degrees with different class members. Edie, for example, had no prior professional ISI connections or knowledge of communities of practice. She became involved with class activities and was hired by Terri to work at the aquarium and “felt accepted as a fellow professional”.

Edie continued her ISI course work and was mentored by Brenda. When Edie, who happened to be an avid sport fisher, later sought employment with a fisheries management council, she used her ISI network (Brenda and Cathy) to secure information and recommendations and was hired. She demonstrated greater self-efficacy and increased professional development by creating her position as a “Fisheries Outreach Specialist” and applied her knowledge as a science educator to facilitate communication between the fishing public and scientists. At the time Edie was interviewed for this research, she had created and continued to build new professional relationships and networks. I perceived she was extremely proud of her successes and appeared confident in her career and future.

Jerry reflected that community building class activities, supportive experienced members, and time spent being mentored by Brenda significantly contributed to his increased self-efficacy evidenced by his greatly expanded networking skills, career advancement, and

self-confidence in modeling science reform strategies at work. Each time Jerry encountered someone outside the class with whom he could interact using the knowledge from the ISI program, his self-efficacy and confidence increased.

When Jerry talked back with Brenda after each new networking incident, he was beginning to recognize how potent he was becoming. It happened many times before he recognized the extensiveness of what he was doing was networking. Once he recognized this, he started to do it deliberately. Because he had become so reflective, he was beginning to become conscious of how he could use his newly constructed knowledge in different settings with new people and people that he had previously encountered.

By being a presenter at national meetings, Jerry was recognized as an authority so people approached him and he had ideas to contribute when he approached other people. Brenda commented: "Jerry was seeing on the national scene that he had already studied things that people were presenting as new and wonderful and this contributed significantly to his self-efficacy."

Design and Implementation of Program. The design and implementation of the four semester ISI certificate program promoted and encouraged experiential learning in a generative environment as a process for professional development. The pilot program was designed

by Brenda and the initiators with “structures of learning opportunities consistent with those recommended by the National Science Education Standards (NRC, 1996), Benchmarks for Science Literacy (AAAS, 1993), Kolb’s experiential learning theory (Kolb, 1984), and Novak’s (1977) theory of education guide course design” (Spector, 2009b).

The course abstracts summarize areas of study for a curriculum that was open-ended and flexible to induce the cohort to explore and question science education reform philosophy and vocabulary, construct their own knowledge, and then model science education reform strategies. The members’ professional tasks and job activities provided learner driven opportunities as cases for study and discussion with the “timing of the learning opportunities based on learners’ expressed need to know” (Spector, 2009b).

The instruction design and curriculum were deliberately planned to encourage

- observation and awareness of diversity, operations, and resources in ISIs and ISEs
- personal development of reflection and metacognition
- common language for cohort in community of practice
- networking and community building

These outcomes or benefits evidenced in various degrees by cohort members resulted in self-efficacy, career advancement, and modeling/using science education reform strategies in workplaces and transmission to public audiences. For example, Dawn recognized the ISI program had helped Terri “to think about education as a process” and to see that informal science education has “its own kind of skill set and methodology”.

Dawn saw changes reflected in Terri’s lesson plans and teaching and realized “she does tend to think of … a more realistic view of the educational process and what her role is here.” Terri’s professional development resulted in her career advancement at the aquarium and according to Dawn “with this kind of training and thoughtful approach to this field, she’s a shoe-in for future managerial work, whether here or somewhere else”.

For Tom, who began the ISI certificate program with “no schooling in educational research, pedagogy, or teaching strategies”, the ISI certificate program provided a scaffold for his knowledge and professional growth over the four semesters of classes. He experienced additional vertical career movement shortly after the ISI program ended and was hired as a community education manager for an exceptionally large ISI. He now works in concert with science

educators, research scientists, and public programs personnel reminiscent of his experience in the ISI program.

Autonomous Learners and Science Reform Modelers. Edie, Tom, and Jerry, as shown in Table 1, stood out among the novice members of the cohort as receiving greater benefit from the ISI certificate program based on their reported perceptions, experienced member reports, and collected artifacts demonstrating increased self-efficacy and professional growth. They were the predominant class members who were able to be independent autonomous learners and who embraced science education reform strategies and used them in their occupations.

**Table 1**

*Perceived Knowledge and Growth Change of Novice ISI Program Members*

| | | |
|---|---|---|
| Amy | | Edie |
| Erin | Terri | Jerry |
| Sandy | Bob | Tom |

———————————————————————————————

| | | |
|---|---|---|
| Minor | Moderate | Major |

Perceived Knowledge and Growth Change after ISI Program

More rich and detailed data was collected about Edie, Tom, and Jerry compared with some members. Erin, Amy, and Sandy, for example, were unavailable for interview and data concerning them was collected from other members and class artifacts. Edie and Jerry took responsibility for their own knowledge construction and learning by modeling science education reform strategies at their workplaces and taking the initiative to test these new ideas by changing existing curriculum to inquiry-based products. Tom recognized that he was responsible for his own learning and enrolled in an MBA program during the course of the ISI certificate program to further develop his administrative education. Jerry and Edie enrolled in additional science education and independent study classes under Brenda's tutelage and were mentored by her. Ultimately they both earned M. Ed. degrees. Jerry has continued his education by pursuing a Ph. D. in science education. For Jerry, Edie, and Tom, Kolb's experiential learning cycle describes their learning experiences in the ISI program. Through Kolb's (1984) iterative cycle of experience, reflection, abstract conceptualization, and action and in accordance with Novak's theory of education (1998), Edie, Jerry, and Tom were empowered to take charge of their own learning by integrating thinking, feeling, and acting and became autonomous learners. As they recognized their empowerment and increased self-efficacy, they further advanced their

science education careers and were positioned to transmit those holistic reform strategies to new associates and to a larger general population. New research on professional development for informal science educators lends support to my findings.

Kisiel et al (2012) reported the following findings from three ISE professional development projects conducted as extended workshops or classes: informal science educators perceived a stronger sense of community and greater resource sharing within and between ISIs after participant collaborations; members reported their programs and training practices had benefited from being introduced to science education reform instructional strategies; participants perceived increased self-confidence and self-efficacy in teaching post projects.

Kisiel et al further reported participants reported the workshops provided “a professional way to speak about what their professions required” and they sensed “a growing awareness of informal science education as a discipline in itself”.

Kisiel et al’s findings are comparable to many of the findings of my study. However, because the ISI program extended over four semesters, this study resulted in a deeper richer understanding of the long term interactions in a community of practice and the discovery of a professional development cycle that generated self-efficacy and

career growth through the use of science education reform strategies, community building, and mentoring.

It is interesting to note that Kisiel et al's ISE projects and the ISI certificate program were both conceived and implemented independent of each other, on opposite sides of the U. S., in response to the recognized need in their respective informal science communities for strengthening the interface with formal education and advancing professional development for ISEs.

**Limitations of the Research**

Generalizations from this research cannot be made to the entire informal science education community. Observer bias must be considered, as it is difficult to separate the researcher from the research when the researcher is also an observer in a study. The mentoring professor in the pilot program was also the committee chairperson for this dissertation research. As a scientist I formerly held a post-positive perspective and have less experience in designing and implementing qualitative research.

Sample size was small for this study but is acceptable for qualitative research of this type. Most of the program members who completed the four semester ISI pilot certificate program were interviewed, as well as all of the program initiators and the college professor. Limitations on the part of the respondents must also be

considered. The interviews were conducted after the certificate program was completed and this passage of time influences one's memory and description of past events (Plummer, 2001). To mitigate this potential problem, I took care to match events related in the interviews by constructing a timeline and member checked throughout the analyses.

Hermeneutics was also a limitation to this study such that "prior understandings and prejudices shape the interpretive process" causing each person who reads the research to make their own interpretation" (Denzin & Lincoln, 2005, p. 27).

**Conclusions**

I identified the following major themes from the entire cohort's perceptions

- Increased understanding and implementation of science education reform strategies in the workplace
- Deeper understanding of connections and increased communications between formal educators, scientists, and ISIs/ISEs
- Increased awareness of diversity and resources in ISI community and expanded use of ISI community people and other resources

- Expanded ISI/ISE professional networks and increased awareness and participation in community of practice
- Enhanced professional development and career growth

Additional major themes from the initiator/developer perceptions were

- Strengthened ISI community of practice
- Recognized that Brenda was an experienced change agent and educator who brought the ISI community and resources together under one umbrella

Major additional themes from Brenda were

- Class members came together as a learning community and displayed greater self-efficacy in the workplace
- Most students became strong proponents and models for science education reform at work and in ISI community of practice

Other major themes from my perceptions as participant/observer were

- ISEs love their work and want to be recognized as professionals who contribute to and influence science education for all people

- Class members benefited from Brenda modeling science education reform, mentoring, and supporting their career advancement

## Implications

Findings extend the limited literature base for professional development of informal science educators and may benefit ISIs/ISEs, formal science education teachers, and education researchers. Long term graduate education programs for ISI employees in a community of practice can advance their science education careers and can create a pool of science education executives, a level of middle management and infrastructure, which does not generally exist in most ISIs.

Such expert informal science educators could effectively interface with and train school teachers to develop and to implement programs that promote holistic K-12 science education at their venue and incorporate NSES in curriculum and learning activities. ISEs who have had extended professional development are also poised to transmit science education reform strategies to the public and their staff by incorporating their learning into their exhibit plans, staff training, and mentoring.

ISIs with experienced well-connected ISEs can make greater contributions to communities and can integrate science with art,

music, and other creative media. ISIs can also benefit financially from strong networks with other ISIs/ISEs to share resources, collaborate on grant writing projects, and further strengthen their community of practice through collegial cooperative ventures. Additionally, ISEs with advanced education can gain employment with science, medical, or engineering research facilities and government agencies to be effective bridges between scientists and society to facilitate understanding of science and technology issues that impact public decision-making, politics, economics, and safety.

Perceptions of the ISI certificate program cohort may be useful for creating additional ISE professional development programs by universities and in ISI communities of practice in general. These findings may stimulate interest in additional research of informal science education professional development, understanding the dynamics of communities of practice, benefits of mentoring relationships, value of change agents, and successful experiential learning and science education reform strategies.

**Future Research**

While this research has described and explained the perceptions and experiences of the ISI program cohort, it generates many questions for future research. It could be informative to track and to periodically interview the former novice and experienced members of

the ISI cohort as a longitudinal study to learn how they are impacting their ISIs, what leadership and mentoring roles they are taking, and how their careers are advancing given the professional development they received. Are they instituting professional development programs in their ISIs and, if so, are they using strategies learned in the ISI program? Are they still active in their community of practice? What causes a community of practice to continue to thrive or, conversely, to die?

Research about whether the design and implementation of the ISI certificate program is transferable to formal teacher development, other professions, or other communities of practice could yield interesting findings as well. Additionally, exploration of the awareness and problems of funding professional development and the availability of education grants for ISEs could be elucidated.

**Conclusive Summary**

The purpose of this emergent design qualitative research was to understand the experiences of a cohort of informal and formal science educators, the initial ISI community representatives, and the college professor during and after completion of a pilot graduate certificate program for informal science institutions and to report their personal and professional experiences and growth to the informal science education community and science education interests in general.

My study described and explained the perceptions and experiences of a cohort of science educators during and after they participated in the professional development program. The program by design and constituency was the overarching entity that emerged from the analysis of data and accounted for the members' experiences. The three principal aspects of the ISI certificate program and cohort which influenced the perceptions and the reported positive outcomes of the class members were

(1) the composition of the cohort and their collaborative activities which established a vigorous community of practice and in turn fostered community building, mentoring, and networking

(2) the design and implementation of the long term program which promoted experiential learning in a generative classroom

(3) the ability of some members who were able to be independent or autonomous learners to embrace science education reform strategies for greater self-efficacy and career advancement

The research extends the limited literature base for professional development of informal science educators and may benefit informal science institutions, informal science educators, formal science

educators, science education reform efforts, and public education and science-technology-society understanding. Hopefully, this study may raise the awareness of the need to establish more professional development opportunities for currently employed ISEs and to fund professional development for these people. Further, it is essential to recognize and to appreciate informal science educators as a diverse committed community of professions who positively influence science education for many.

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# Appendices

## Appendix A: ISI Course Abstracts

*Community Resources for Environmental Education*

Identify, access, and acquire community resources to incorporate into learning opportunities for diverse audiences at all school levels. Instruction and assessment strategies to incorporate resources from media, business and industry, professional natural science, engineering, and social science societies, governmental agencies, non governmental agencies, civic groups, research institutions, and academic institutions are addressed.

*Methods for Interpretive and Transformative Standards Based Education*

Current theories from research in brain physiology, cognitive psychology, and science education explaining how humans of all ages learn to make meaning from experiences are translated into practice to bridge the gap between information and understanding (meaning making).

*Environmental Site Explorations*

On-site experiences at informal science institutions (ISI) provide first hand opportunity to construct a holistic view of the informal education industry, its organization, career paths, management concerns, unique

niches, and the nature and relationships among programs and partnerships.

*Update of Environmental Research and Management Policies* Current and future scientific research topics of long term importance are explored providing an integrated update in science. Complex connections among the various natural, mathematical, and social sciences; agriculture; psychology; and engineering are emphasized.

## Appendix B: Site Visit and Guest Speaker List

| Site Visited | Frequency |
|---|---|
| Busch Gardens in Tampa, FL | once |
| Florida Aquarium in Tampa, FL | 25+ |
| Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute in St. Petersburg, FL | once |
| Hands On! (Museum exhibit design and construction) in St. Petersburg, FL | once |
| Museum of Science and Industry in Tampa, Florida | 12+ |
| Mote Marine Laboratory and Research Center in Sarasota, FL | once |
| The Pier Aquarium in St. Petersburg, FL | once |

Guest Speaker and/or Affiliation and Topic

Earth Force Florida, Service Learning

Florida State Parks Education Program

Marine Science Technologies, University of South Florida - St. Petersburg, College of Marine Science

Manatee County Keep America Beautiful, Conservation Education

Pathfinder, Inc., Experiential Outdoor Education

**Appendix B (Continued)**

Dr. Paschal Strong, University of South Florida, Professor Emeritus, Human Brain and Learning

U. S. Sea Grant Program

Note: Some site visits were one-time explorations of site operations, education programs, personnel, hierarchy, financial operations, etc. Florida Aquarium and Museum of Science and Industry were site visits and class meeting places.

## Appendix C: Informed Consent Form


# Informed Consent to Participate in Research Information to Consider Before Taking Part in this Research Study

**IRB Study # 00004865**

You are being asked to take part in a research study. Research studies include only people who choose to take part. This document is called an informed consent form. Please read this information carefully and take your time making your decision. Ask the researcher or study staff to discuss this consent form with you, please ask him/her to explain any words or information you do not clearly understand. We encourage you to talk with your family and friends before you decide to take part in this research study. The nature of the study, risks, inconveniences, discomforts, and other important information about the study are listed below.

Please tell the study doctor or study staff if you are taking part in another research study.

We are asking you to take part in a research study called:

Impact of Pilot Graduate Certificate Program on Informal Science Educators

The person who is in charge of this research study is Lois A. Ball**.** This person is called the Principal Investigator. However, other research staff may be involved and can act on behalf of the person in charge. She is being guided in this research by Dr. Barbara S. Spector.

The research will be conducted at the office/conference room where interviewee works or at a neutral site near the interviewee place of work. These places, which are not affiliated with USF, may be at the Florida Aquarium, Mote Marine Laboratory, Sea World, and other places mutually agreed upon that are acceptable, convenient, and comfortable for the interviewee.

## Purpose of the study

The purpose of this study is to understand the impact of the pilot USF Informal Science Institutions Graduate Certificate program on class members during and after the completion of the program. You are being asked to participate in this study because you were a member, or contributor, to the program.

- This study is being conducted by a student for a dissertation.

## Study Procedures

If you take part in this study, you will be asked to:

- Participate in one face to face 1 to 2 hour audio taped interview which will be conducted individually at a mutually agreed upon site in a neutral setting. You will receive a copy of the interview after transcription and will be asked to check it for accuracy and add any notes or changes. You may be contacted by telephone and email correspondence to follow up on questions, responses, and to obtain further clarification within three months after the interview.
- Be available for the interview which will be conducted at, or near, your place of work at a location you decide is comfortable and convenient between July 2011 and October 2011.
- You have the option to agree to recording of the interview. The principal investigator will have exclusive access to the interview tape. Your name will be replaced by a pseudonym on all transcripts and notes. The interview tape will be stored in a secure locked file and after five years will be erased.

## Total Number of Participants

About fourteen individuals will take part in this study at all sites.

## Alternatives

You do not have to participate in this research study.

## Benefits

We are unsure if you will receive any benefits by taking part in this research study.

## Risks or Discomfort

This research is considered to be minimal risk. That means that the risks associated with this study are the same as what you face every day. There are no known additional risks to those who take part in this study.

## Compensation

You will receive no payment or other compensation for taking part in this study.

## Cost

There will be no costs to you as a result of being in this study.

## Privacy and Confidentiality

We will keep your study records private and confidential. Certain people may need to see your study records. By law, anyone who looks at your records must keep them completely confidential. The only people who will be allowed to see these records are:

- The research team, including the Principal Investigator and study coordinator.
- Certain government and university people who need to know more about the study. For example, individuals who provide oversight on this study may need to look at your records. This is done to make sure that we are doing the study in the right way. They also need to make sure that we are protecting your rights and your safety.
- Any agency of the federal, state, or local government that regulates this research. This includes the Food and Drug Administration (FDA), Florida Department of Health, and the Department of Health and Human Services (DHHS) and the Office for Human Research Protection (OHRP).
- The USF Institutional Review Board (IRB) and its related staff who have oversight responsibilities for this study, staff in the USF Office of Research and Innovation, USF Division of Research Integrity and Compliance, and other USF offices who oversee this research.

We may publish what we learn from this study. If we do, we will not include your name. We will not publish anything that would let people know who you are.

## Voluntary Participation / Withdrawal

You should only take part in this study if you want to volunteer. You should not feel that there is any pressure to take part in the study. You are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study.

### You can get the answers to your questions, concerns, or complaints

If you have any questions, concerns or complaints about this study, or experience an adverse event or unanticipated problem, call Lois A. Ball at (813) 767-2175.

If you have questions about your rights as a participant in this study, general questions, or have complaints, concerns or issues you want to discuss with someone outside the research, call the USF IRB at (813) 974-5638.

## Consent to Take Part in this Research Study

It is up to you to decide whether you want to take part in this study. If you want to take part, please sign the form, if the following statements are true.

**I freely give my consent to take part in this study and authorize that my health information as agreed above, be collected/disclosed in this study.** I understand that by signing this form I am agreeing to take part in research. I have received a copy of this form to take with me.

_____ _____

Signature of Person Taking Part in Study Date

_____

Printed Name of Person Taking Part in Study

## Statement of Person Obtaining Informed Consent

I have carefully explained to the person taking part in the study what he or she can expect from their participation. I hereby certify that when this person signs this form, to the best of my knowledge, he/ she understands:

- What the study is about;
- What procedures/interventions/investigational drugs or devices will be used;
- What the potential benefits might be; and
- What the known risks might be.

I can confirm that this research subject speaks the language that was used to explain this research and is receiving an informed consent form in the appropriate language. Additionally, this subject reads well enough to understand this document or, if not, this person is able to hear and understand when the form is read to him or her. This subject does not have a medical/psychological problem that would compromise comprehension and therefore makes it hard to understand what is being explained and can, therefore, give legally effective informed consent. This subject is not under any type of anesthesia or analgesic that may cloud their judgment or make it hard to understand what is being explained and, therefore, can be considered competent to give informed consent.

_____ _____

Signature of Person Obtaining Informed Consent / Research Authorization Date

_____

Printed Name of Person Obtaining Informed Consent / Research Authorization

## Appendix D: Potential Questions for Interviews

Potential Questions for Dissertation Interviews

Why did you sign up for the ISI certificate program?

At the beginning of the ISI certificate program, did you define yourself more as a scientist or educator?

What was your professional background?

Has the ISI certificate program impacted your career?

Has the ISI certificate program influenced your professional relationships?

How did you describe your career before the program?

How do you describe your career now?

Did experiences in the ISI program influence your employment during the program? After the program?

Do you apply ISI program ideas in your work?

Tell about your professional ISI connections before the ISI program? After?

What did you know about communities of practice prior to the ISI program? Now?

Are you an active member in a community of practice now?

Describe your professional network prior to ISI program? Now?

What meaning did you make from the resources you were exposed to in the program? COSIA, education literature, ISI site visits, speakers, etc.

How did you understand ISIs before the program? ISEs?

How do you understand ISIs after completion of the program? ISEs?

**Appendix D (Continued)**

Describe your learning strategies before the ISI program? After?

What did you understand about science education reform before the program? After?

What meaning did you make from the program education materials?

Tell about interactions with and perceptions of fellow ISI members?

Do you communicate with any of these people now?

Tell about your experiences with the program professor, Dr. Spector.

Did anyone contribute to your understanding or help you make meaning of the materials in the ISI program?

How did you make meaning of the materials in the ISI program as it progressed from first through fourth semester?

How did you understand the connections between science educators, scientists, and ISI personnel prior to the ISI program? Now?

What about the ISI program was most helpful or beneficial to you?

What was least helpful?

What would you change for future ISI courses?

## Appendix E: Career Advancement of Novice ISI Program Members

| Novice Member | Occupation Pre ISI Program | Occupation Post ISI Program |
|---|---|---|
| **Amy** | science research asst. | unknown |
| **Bob** | school programs coordinator, for marine laboratory/aquarium | senior programs director for marine laboratory/aquarium |
| **Edie** | teacher, outdoor education program | fisheries outreach specialist for regional fisheries council and earned M.Ed. |
| **Erin** | public relations and marketing director for aquarium | same |
| **Jerry** | outreach coordinator of environmental/conservation education for state agency | state director of national organization for youth environmental education and earned M. Ed. |
| **Sandy** | marine specialist for elementary school | same |
| **Terri** | instructor, coordinator of sleepover program for aquarium | education camp coordinator for aquarium |
| **Tom** | public programs coordinator for marine laboratory/aquarium | community education manager for extremely large ISI and earned MBA |