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Evaluating a Graduate Professional Development Program for Informal Science Educators

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Evaluating a Graduate Professional Development Program for Informal Science Educators

by

Jeremy Paul Lake

A dissertation submitted in partial fulfillment
of the requirement for the degree of
Doctor of Philosophy
in Curriculum and Instruction with an emphasis in
Science Education
Department of Teaching Learning
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Dedication

I dedicate this work to my son Ashton. Your birth and your smile everyday gave me the push to reach inside and finish telling this story.

Katrina Adams, you have been so important to me since you walked into my life so long ago. I'm blessed to love you and to have our beautiful son Ashton together. To Dakota and Bane Adams; thank you for accepting me into your family and letting me be your daddy.

Without my family, I don't know where I would be. My mother, Patricia Lake and my brother Colin Lake; thank you. Thank you for everything you've done to encourage and support me over the years. Thank you for believing in me when I'm not sure I even believed in myself. Without you both, I wouldn't be writing these words to complete this doctorate. To my father Paul Lake, you have indelibly made me the man I am today. I know you can't read these words, but I hope you would be proud of who I have grown up to become.

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Abstract

This study is an examination and evaluation of the outcomes of a series of courses that I helped build to create a graduate certificate. Specifically, I wanted to evaluate whether or not the online iteration of the *Informal Science Institutions Environmental Education Graduate Certificate Program* truly provided the long term professional development needed to enhance the skills of the formal and informal educators participating so that they could contribute meaningfully to the improvement of science literacy in their respective communities.

My role as an internal evaluator provided an extraordinary opportunity to know the intent of the learning opportunities and why they were constructed in a particular fashion. Through the combination of my skills, personal experiences both within the certificate's predecessor and as an educator, I was uniquely qualified to explore the outcomes of this program and evaluate its effectiveness in providing a long-term professional development for participants.

After conducting a literature review that emphasized a need for greater scientific literacy in communities across America, it was evident that the formal education enterprise needs the support of informal educators working on the ground in myriad different settings in ways that provide science as both content and process, *learning science facts and doing real science*. Through a bridging of informal science educators with formal teachers, it was thought each could learn the culture of the other, making each more fluent in accessing community resources to help make these educators more collaborative and able to bridge the classroom with the

outside world. This bridge promotes ongoing, lifelong learning, which in turn can help the national goal of greater scientific literacy.

This study provided insight into the thinking involved in the learners' growth as they converted theory presented in course materials into practice. Through an iterative process of reviewing the course generated content, I was able to piece through the many layers of this two year long program to examine the growth of these individuals over time.

While all participants showed growth completing the certificate program, those who could fully invest themselves in the experiences seemed to have gained the most. These cases indicate the *Informal Science Institutions Environmental Education Graduate Certificate Program* was effective at enhancing the careers of formal and informal science educators. Additionally, it suggests informal science educators, although busy with their professional obligations and personal lives, can be successful in a formal graduate program designed to meet ISE needs as explicated in *Learning Science in Informal Environments: People, Places, and Pursuits* (Bell, Lewenstein, Shouse, & Feder, 2009). The emergent model indicating connections among a person's personal life, professional life, and graduate study may also have implications for other professionals desiring to enroll in graduate school. For example, science teachers in university graduate programs may also benefit from applying this model to their lives.

Chapter One: The Problem Statement

Development of the Investigator's Perceptual Screen- Who I Am

I came to education in a roundabout way, driven by an innate desire to learn about science and nature. Some of my first memories come from going fishing with my father and running along the beach as a small child. I was exposed very early to the natural world and was challenged to find answers to my questions that naturally grew from my curiosity. This growth continued through more opportunities to engage my curiosity at zoos, aquaria, and museums. Informal learning environments became a staple that supplemented my school work.

Formal schooling was, for the most part, easy for me even though I had to overcome a hearing deficit leading to specific disabilities in learning from a setting that only provided auditory instruction. Fortunately, I was able to combat this with minor surgery and escaped special education classes in elementary school. I learned how to figure out what was in the teachers' head and play the game of formal education parroting back what I knew the teacher wanted me to answer. I didn't have to truly apply myself in many of my classes and could get away with bare minimum effort to achieve the high grades I expected. When a subject mattered to me, I went above and beyond what I needed to do. This was especially so in my science classes where I connected my interest from the outdoors with the in-class learning opportunities school afforded me, which in turn made my learning meaningful to me.

I went to Eckerd College to study marine biology, because I wanted to work with marine mammals. I soon learned that this cliché tract had very limited opportunities and was driven

more by looking like Ken and Barbie rather than by abilities to conduct research, train animals, or even educate the public. I turned back to my interests in the natural world and went to the great outdoors. I changed my major to Environmental Studies with a tract in Humanities. This allowed me to take the hardcore sciences I enjoyed as well as classes in fine arts, psychology, and literature that appealed to me in the liberal arts tract. This educational setting taught me to look at things from many different perspectives and brought me to learning through firsthand experiences with a heavy emphasis on project and problem based learning in real world settings.

All students at Eckerd were required to work with an organization improving their community and report back on their service at a school wide event for their senior project. In addition, Environmental Studies majors were required to complete a semester long internship with an environmental organization as a capstone requirement. I found myself working as a volunteer in nonprofit organizations that focused on animal conservation at Wildlife on Easy Street (now known as Big Cat Rescue) and Lowry Park Zoo for each of these assignments. The formal school assignment required reflecting back on my experiences and making meaning I could share with others via a public fair and presentation. This volunteer work led to my first job in environmental education at Lowry Park Zoo in their summer camp programs when I graduated.

I worked for Lowry Park Zoo's Education Department. I began as a seasonal summer camp instructor, then was a full time education instructor, and finally became a coordinator running all camp opportunities for hundreds of children weekly. The camps combined learning with animal encounters that children could receive nowhere else. I tried to infuse hands-on minds-on experiences in a way that taught kids while providing the fun "edu-tainment" that the parents expected of a "camp."

The Museum of Science and Industry served as a brief stop on my resume' before I went to work for the State of Florida's Fish and Wildlife Conservation Commission's (FWC) Fish and Wildlife Research Institute (FWRI). Working for a government research science laboratory was a very distinct cultural experience. I clearly saw the differences between scientists, educators, the media, and separate stakeholder groups who all had vested interests in the animal inhabitants of Florida. In essence, I served as a translator in my role as education and outreach coordinator. The scientists provided me with the science on which they were working. I turned it into something digestible to a wide variety of audiences while still being deemed accurate by the scientists and the management side of this government agency. I produced various curricula and other materials for educators, wrote press releases and news articles for popular media and journalists, and met the public first hand at fishing shows, the Florida State Fair, and other events at which there were exhibits I designed.

FWRI also served as my first real immersion into professional associations, and I became a participant in the first *Informal Science Institutions Environmental Education Graduate Certificate Program* offered through the University of South Florida. I was looking for a professional development opportunity of my own where I could learn more about the formal education enterprise and how better to work with educators throughout the community. This graduate certificate accomplished that for me as well as kick started me on my way toward my long term goal of a master's degree and a doctorate.

Through my involvement with the national professional association, the *National Marine Educators Association* (NMEA) and its state chapter the *Florida Marine Educators Association* (FMSEA), I was introduced to a group of educators working to create a graduate certificate to bridge the gap between formal and informal education. This matched closely with my goal of

making myself more fluent in the culture of the K12 educational world and helped motivate me to go back to school for a master's degree. I found degrees were more critical to advancement than experience when working in science organizations, and I wanted to be ready for all opportunities that presented themselves to me.

My Master's in Science Education was an interesting journey for me. I found yet another new culture I had to learn, that of academia. I felt like a newborn thrown into the graduate program. Words and language did not match definitions I had for the same objects and events. New titles graced activities and methods that did not match what I had learned in informal or formal science education I experienced outside of the College of Education's ivory towers. It was a brand new learning experience in which I needed to teach myself the language and watch to see the logic behind what was being done. I found as I got into the course materials, those activities being advocated in courses, through a cognitive psychology class, or educational evaluation, or science methods course were things I did inherently without knowing they were recommended by the various standards or best practices. I did them because they worked for me through my own experimentation with my various audiences in my informal science institutions (ISI) experiences. Now I had names for what I did and could better seek out guidance to make what I did better.

I was drawn very closely to constructivism, experiential learning, and to qualitative research methodology allowing me to observe and wait for patterns to emerge during this time. I was guided in my learning by my curiosity and interest and had great facilitators to point me onwards to the resources I needed to answer my questions. This was a structured journey allowing me to explore, yet also offered the guidance and support to wander without getting lost. These areas of study and the method of support built upon my own interests and what I did in developing learning opportunities.

I continued to learn and grow and became more conversant in this field of academia. This growth helped me walk more easily in all the domains of education in which I was involved. I could understand the hardcore sciences and conservation messages as easily as I could the “teacher speak” in the classroom or community informal science institution (ISI), or the professor or colleague at the university. Most importantly, I could unpack what was going on in each setting and use it in all of the others. I became fluent in each of the cultures and could translate each to the other.

The Graduate Certificate Program: My Frame of Reference; My Involvement

I was a member of the original 2006 cohort of informal and formal educators put together for the *Informal Science Institutions: Environmental Education Graduate Certificate Program*. This came to be as a result of an earlier group of educators and scientists working with the Center for Ocean Sciences Education Excellence – Florida (COSEE-FL), seeking a way to provide professional development to employees of zoos and aquaria working in education departments educating the public with a goal of science literacy for their community (Spector, 2009a, Ball, 2012). A majority of the educators and scientists in the COSEE-FL group saw a very clear need 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).

I came to the group to learn more about education in formal classrooms and what I learned was the culture of K-12 education. Local and national standards were things I knew little about and were important to be able to work with formal teachers. This was just the tip of the iceberg. I truly needed to learn the language of education. We were both saying the same words, but

meaning totally different things. I wanted to get on the same page with my brothers and sisters in the schools. This ISI group also became a way for me to make connections in other ISIs to pool resources, advance professional relationships, and collaboratively work to improve what I was doing while working with the FWC and with my new partner organizations.

I experienced a constructivist classroom working through an emergent design in the ISI classes. We the “students,” could step forward on equal footing with one another and the professor and explore the questions we had. Our educational experience became scripted to our “need to know” and our want to learn. Each class, held in a variety of ISI locations across the Tampa Bay Area, was tailored to what the group wanted to work on in the context of the overall themes of the class. It became what you wanted to invest your time and energy in, in a safe living laboratory. The professor served as a facilitator for the learning to happen, bringing in readings and media resources, speakers, curricula, and her experiences while tasking us to do the same. This fit my learning style, and I soon was working closely with her on the classes and pursuing my Master’s in Science Education to deepen what I was experiencing while using the certificate as the central component of this degree.

A guiding question throughout this face-to-face program, was “What should we do for the next version of the program?” Personally, the program had a huge impact on me and really helped to refine my educational practices and made me a better educator all around. I could now communicate more effectively with formal classroom teachers and access a wide network of community resources to provide high quality, meaningful learning opportunities. I took this to heart and worked closely with the professor to cull out what worked well and what needed to be improved for the next wave. In surveying colleagues in the program and presenting what we did in the program at professional conferences and to other informal educators, we found that there

was interest to make the program more accessible to people with varied schedules and varied locations, including across the country. The decision was made to put the program online.

Over the course of a year, I helped serve as an architect restructuring classes held in person to a new format for asynchronous distance learning through Blackboard, a classroom content management system used by the University. This role included reviewing materials, adding in newer content, supplementing existing materials, and working to develop learning opportunities that could be carried out anywhere the program participants were located. Beautifully, informal science institutions (ISIs) exist in some form in just about every community in this country. I also set up the online shells for the first classes and structured how the materials would be viewed and used throughout the course, while offering technical support for participants and the professor as needed. While I casually reviewed class proceedings throughout the program, I served as a participant observer when I enrolled in the fourth and final course as a student to help include different perspectives and to add to the conversations that were surfacing over the course of the program.

This program structure was largely orchestrated from our own first hand experiences which correlated with the National Resource Council's (Bell, Lewenstein, Shouse, & Feder, 2009) review of informal science education released after the initial pilot program and before the first students were enrolled in the online classes. The NRC report echoed what we had found locally as needs for ISIs across the entire country. NRC findings were also incorporated into the online version as they helped provide rationale for the program itself for the participants.

I served as a spokesperson for the online certificate and recruited several participants into the program through my involvement in the community and professional organizations with whom I

developed strong personal relationships outside of the classes. In a large way, the certificate built friendships as I worked as mentor, coach, and confidant with these participants. These relationships made me a participant in the classes, even when I was not directly working with them. I helped make decisions for things that would be offered later on in the classes.

I left the Florida Fish and Wildlife Conservation Commission to go to work for a national non-profit service learning company, Earth Force. The move was made to allow me to do more education with school aged children. There was a very strong political agenda to do away with any state agency's effort to educate, other than through the Department of Education at that time. My job with the FWC was to educate the public on the research and management of the state's wildlife resources to effect behavioral change and improve attitudes towards conservation and environmental stewardship, yet I was being restricted by state legislature and political mandate to do those things without educating the audiences with which I worked.

My job in Earth Force was to work with teachers to help their classes develop long-term service learning projects improving their communities. This meant developing and fostering relationships with public and private school teachers in which I knew the teacher, the students, the school, and district administration, as well as the surrounding community groups and resources that could help to make each project as successful as possible. I worked with teachers to connect the service learning project with their curricular designs in an effort to teach required school content in a real world context for meaningful learning so that it was not something extra or a duplication of the subject matter they already taught. I had to know the distinct cultures of my community network and the formal K-12 education enterprise to do this job successfully.

The crashing financial wave of Earth Force brought me to teach at Terrace Community Middle School (TCMS). TCMS is a public charter school ranked near the top of the charts in Florida state assessments of student achievement year after year as well as being nationally recognized as one of the best in the country with two Blue Ribbon School awards. Here I put my educational skills to work. I was fully immersed in the culture of formal education and pulled on my strengths using the community to provide meaningful learning opportunities. I found my informal education experiences helped me extensively to work with my colleagues and my students, because I could better understand the K12 experience as a whole and knew what resources were available to bring to the school and classroom. Skills that benefited my students included my ability to use teachable moments and true student generated pathways, working from a wide knowledge base and lived experiences of my own, knowing how to say, 'I don't know' and being honest enough to do so, and knowing how to recover and take gaps in my knowledge base and make them a learning opportunity for both myself and my students. Having a liberal arts education with classes across the disciplines allowed me to generate a wide range of points of entry into science content that were new and novel to my students. My experience in drama classes helped me daily to inject humor and a more communal environment for learning into my classroom. My informal education experiences, and entering the classroom later in life as an alternatively certified teacher, allowed me to work more effectively with my co-workers and serve as a team member and mentor to some of my younger colleagues who had more experience in the formal classroom, but had less life experience and overall educational acumen. Graduate work in science education provided me credibility with parents, students, administration and other teachers. However, my years of informal experience were not acknowledged or respected for the contribution to my development as an educator and success in

the classroom. I perceived the more than a decade of informal experience allowed me to try different approaches and be innovative and effective. Ironically, school administration did not value this experience, because they saw me as a novice educator with no formal classroom experience. To them, my informal background was trivial and contained no real substance. This perspective restricted me from taking advantage of many opportunities to provide meaningful learning for my students, because school administrators did not directly see things tied to the state's high stakes testing agenda.

I eventually left TCMS to move to northeast Florida where I took on a seventh grade science position in a huge A rated school in an affluent beach community in Duval County. In this new position at Duncan U. Fletcher Middle School, I was hired last minute and given a very different mix of students from what I had taught at TCMS. Here, students were very low in terms of reading and writing skills and were used to doing a bare minimum to skate by in their classes. This was a huge contrast from a nearly seventy percent gifted rate at my previous school where students fought tooth and nail to excel. Where homework was expected every night at TCMS, Fletcher honored the District wide initiative that homework should be given very sparingly and could not negatively impact a student's grade. It was made very clear that students were to pass at all costs even when they could not demonstrate mastery of content or skills necessary to be promoted. The students knew this and took advantage of it to act out and do as they pleased. Despite failing courses, they knew that they would be promoted on to the next grade levels and would graduate even if they could not read, do basic arithmetic or write a coherent sentence. Administration hid all of this under a shiny veneer of 'discipline' and 'accountability' through 'positive behavior intervention strategies' that did nothing more than gloss over all of the problems this massive district buried to maintain a positive community reputation of high

graduation rates for all students. It was apparent that bribery was the only strategy they felt they had left to encourage students to perform the way they were supposed to.

My experience at Fletcher left me very burnt out and cynical. I could not have stayed in that system any longer than the year I was there, because I felt boxed into a no win environment where I had to demonstrate student gains to stay employed, with students who didn't care if they passed or failed. Administration seemed to trust my abilities to maintain order and to teach some of their most challenging students through their preset, boxed curricula, but made it very clear that if my lowest failing students did not pass, I would not be retained. This went so far as to be a threat that no matter how well I documented all of the interventions and supports I provided my students, I would be let go if certain students were not "given" satisfactory grades. I couldn't ethically succumb to this and changed school districts.

This school year, I moved to the small Nassau County School District and am teaching biology at West Nassau High School in a very rural community of Callahan, Florida. This is my first time teaching high school students and look forward to comparing and contrasting the differences between my middle school experiences with this opportunity. I chose this job as it gives me the opportunity to integrate my teaching strategies and content without the preset pacing guide that limited me to what I could teach. My students will still be judged by their performances on a state end of course exam, but I have every bit of encouragement and support from my administration to make the content as hands-on, minds-on, and personally relevant to my students as possible. This includes using the entire campus, including our school's aquaponics greenhouse, community resources, field trips, and building a month long service learning project as a capstone to the course. Of note, when I interviewed for this position both

the assistant principal and principal are also alternatively certified science teachers who saw great opportunities and valuable experiences in my background in informal science education.

Problem Statement

This study, herein, is an evaluation designed to determine the efficacy of the online version of the *Informal Science Institutions Environmental Education Graduate Certificate Program* and its efficacy in providing long term professional development to enhance the skills of formal and informal educators so they could contribute meaningfully to the improvement of science literacy in their communities.

A literature review was conducted to examine the context of the online graduate certificate program and to attempt to establish a baseline from which I could evaluate the overall experience of the learners in gaining the intended professional development designed to make them more successful. Inherent in the challenge to construct professional development for informal science educators (ISEs) is an evaluation of the product developed when it is implemented.

Program evaluation is the systematic collection of information about the activities, characteristics, and outcomes of programs to make judgements about the program, improve program effectiveness, and/or inform decisions about future programming. (Patton, 2002, p. 10)

In its strictest definition, “evaluation” refers to the process of determining the merit, worth or value of something, or the product of that process” (Scriven, 1991, p. 139). Patton states that evaluation is a critical process in gathering and analyzing the data about a program with the

purpose of making a judgement about the said program (Patton, 1987). In this case a program evaluation is done to determine the value and increased efficacy of the ISI certificate program while helping to guide how the program will be conducted in the future.

This study attempts to provide insight into the thinking involved in the learners' growth as they converted theory presented in course materials into practice, while simultaneously shedding light on the effectiveness of the ISI program.

Chapter Two: Review of the Literature

The Context of the Study: The Problem

Science Literacy and Science Education Reform

Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately.

(National Research Council, 1996, p.22)

Society requires a scientifically literate citizenry. As the National Resource Council states in its *National Science Education Standards* (NSES) (1996), this entails developing a populous that has the ability to make decisions based on the knowledge and understanding of scientific

concepts and processes, economic productivity, and active involvement in society through civic and cultural affairs. In essence, a person should be able to make sense of their world, given the proper supports and context. As a science educator, this has been my marching order, work with people to develop their ability to look critically at the information at hand and draw conclusions that can be acted upon. This goal of scientific literacy has been the aim of many generations of society builders from the earliest Greek academies to the inclusion of science as one fourth of the required educational curriculum in the late 19th Century by the Committee of Ten and the more contemporary science and education reform movements that have been evolving since World War II (DeBoer, 1997; 2000).

The Space Race with Russia, in the wake of Sputnik, provided a catalyst for the United States to reexamine its education system while placing an emphasis on science and mathematics. This paradigm stressed a high level of rote memorization and subject specific skill development, but lacked the development of real world meaning and trans-disciplinary portability of learnings and skills (DeBoer 1991, 1997). Inherently this system, could not produce the quality of worker who was skilled to function in a highly technical world that required a person to be able to think critically and apply skills in a wide range of contexts (Bybee, 1997; Hurd, 1997). Students were trained to be book smart with a large amount of content knowledge but had no ability to apply this knowledge in any practical application outside of the context of the classroom. This process, despite an increase in knowledge gains, represented no improvement into making Americans scientifically literate.

In 1983, *A Nation at Risk* (National Commission on Excellence in Education [NCEE], 1983), was published as a call to arms to revamp the American education system yet again. This report, as well as many others, stated that the U.S. school system was failing to produce scientifically

literate students who could compete in a world, not to mention a global economy, where science and technology was advancing forward in warp speed (Bybee, 1997; Hurd, 1997; NCEE, 1983).

Science for All Americans: Project 2061, Benchmarks for Science Literacy, the *National Science Education Standards* and the *Next Generation Science Standards* all aim to create a baseline for science teaching to develop a scientifically literate society. Each document or report attempts to limit the content to the most important “ideas” students should know while developing a person who can function in a society filled with science and technology. Each, however, do have their own subtleties.

Science for All Americans: Project 2061 was the first attempt at creating a set of parameters for teaching science education that could be used nationwide. *Project 2061* was developed by the American Association for the Advancement of Science (AAAS) as a way to foster a scientifically literate society (American Association for the Advancement of Science, 2006). To AAAS, scientific literacy meant an American was 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 (Rutherford & Ahlgren, 1989, p. xiii).

To attain a scientific literate society would require overhauling science education in schools that was often described as being a mile wide and an inch deep.

Scientists participating in *Project 2061* established parameters to be used by curriculum developers determining what should be taught in schools to change the entire science education enterprise. The material needed to have utility, meaning it could impact an individual in more than one setting. It should promote social responsibility and have both “intrinsic value of knowledge” as well as philosophical value. That is to say the topics should be able to cover the basic questions of life as well as the deeper questions of society. The final criterion was whether or not the material would enrich the student’s childhood (Rutherford & Ahlgren, 1989).

Project 2061 developed a narrative of the basic concepts once the important themes were selected. These were meant to be the gist of the subject a person could remember years after formal education. The narratives were simple in language and structure to be applicable to anyone reading them. They were designed this way deliberately to advance attaining the goal of “science for all Americans” (Rutherford & Ahlgren, 1989).

Science for All Americans also touched on practices of effective learning and teaching. It reminded teachers of the basics of cognition that had been developed earlier in the century through theorists like Bruner, Schwab, Piaget, Ausubel, Novak, and others. Things like a student’s prior knowledge, desire to learn, the amount of feedback given, progression from concrete to more abstract concepts, and being given sufficient opportunity to practice new skills, were some of the instructional goals mentioned that could help educators, not just science teachers, in their practice. The text went further though: it nudged teachers to try to remember to teach science as *both* process and practice with active learning that focused on inquiry skills and the nature of science (Rutherford & Ahlgren, 1989).

Benchmarks for Science Literacy (American Association for the Advancement of Science, 1993) was a continuation of AAAS's goal for a scientifically literate society. It was designed to be a "set of tools for educators to use in designing K-12 curricula that would meet the content standards" created in *Science for All Americans* (American Association for the Advancement of Science, 1990). The purpose of *Project 2061*'s work here on this effort was to creatively develop what a curriculum should look like if it was not obstructed by politics and location, something that could be used by every American student. It was not to be a national curriculum, however, but a curricular framework and sequence that could be adapted and utilized for a great variety of needs, while still conveying the key concepts and how they should look at groups of grade levels. (American Association for the Advancement of Science, 1993). In essence, it was a "suggested" way of doing business for science educators across the country that showed what progress "should look and feel like" for students on their way to becoming scientifically literate adults.

The National Science Education Standards (NSES), produced by the National Resource Council (NRC), incorporated the work of *Science for All Americans* and was developed simultaneously with the *Benchmarks for Scientific Literacy*. NSES were also designed to promote a scientifically literate society by creating "science standards for all students" (National Research Council, 1996). It was also designed to provide criteria for people at all levels to evaluate whether or not certain strategies would encourage scientific literacy. Where it diverged from its predecessors, NSES developed "standards" for science teaching, professional development of science educators, science education programs, and systems (National Research Council, 1996). These additions coupled with the science content themes that were also in *Science for All Americans*, were set up to help reform the entire system, not just what the students were taught.

The *NSES* were overhauled in 2013 into the *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013). This newest document, continues the work of its predecessors while also expanding to include the focus on engineering and emphasis on the role of argumentation in science. The *NGSS* also aim to promote college readiness and 21st Century Skills allowing students to integrate science skills into the context of students' lives across disciplines (NGSS Lead States, 2013).

Science literacy has been the goal of many reform efforts designed to improve formal K-16 classroom education in the United States. From the earliest efforts of the Committee of Ten to integrate science into the curricula of schools, to initiatives dripping in national pride to keep up with the Russians in the Space Race and the Cold War, to meeting the demands of today's highly technical and scientifically driven global economy and everyday life, science literacy is a critical component for defining the skills and abilities of a constituency. Over these many years and initiatives, very little has been done to bridge the gap between the formal educational enterprise (K-16 schooling) and science learning outside of the classroom where people spend most of their time.

The Role of Informal Science Education

Beyond the schoolhouse door, opportunities for science learning abound. Each year, tens of millions of Americans, young and old, explore and learn about science by visiting informal learning institutions, participating in programs, and using media to pursue their interests. Thousands of organizations dedicate themselves to developing, documenting, and improving science learning in informal environments for learners of all ages and backgrounds. They include

informal learning and community-based organizations, libraries, schools, think tanks, institutions of higher education, government agencies, private companies, and philanthropic foundations. Informal environments include a broad array of settings, such as family discussions at home, visits to museums, nature centers, or other designed settings, and everyday activities like gardening, as well as recreational activities like hiking and fishing, and participation in clubs. Virtually all people of all ages and backgrounds engage in activities that can support science learning in the course of daily life. (Bell, Lewenstein, Shouse, & Feder, 2009, p.1)

The average American spends about five percent of their lives in formal K-16 educational classrooms, with only a fraction of that time dedicated to science instruction (Falk & Dierking, 2010). Informal science education encompasses all the ways people learn science outside of K-16 formal schools and is driven by what the learner chooses to learn. Falk and Dierking contend that these “free-choice learning experiences represent the single greatest contributors to adult science knowledge; childhood free-choice learning experiences also significantly contributed to adult science knowledge” (Falk & Dierking, 2010, p. 489). Those people who facilitate such education are referred to as Informal Science Educators (ISEs) and the facilities for which they work are called Informal Science Institutions (ISIs).

Learning Science in Informal Environments: People, Places, and Pursuits (Bell, Lewenstein, Shouse, & Feder, 2009) explicated a knowledge base needed by informal science educators to enhance their contributions to public science literacy and to build a bridge between formal schooling K-16, informal science learning, and lifelong learning. Prior to that NRC report, a limited number of long-term professional development opportunities, such as graduate courses or

programs, for ISEI personnel were available (Ball, 2012; Bevan and Semper, 2006; Tran, 2008)

In essence, this NRC document challenged the science teacher education enterprise to develop and to supply the necessary education for informal science education providers to enhance their effectiveness educating the public and to work more effectively with formal teachers K-16 to attain the goals of the *National Science Education Standards* (NRC, 1996) and currently the *Next Generation Science Standards* (NGSS Lead States, 2013).

Falk et. al. (2007), reporting on how the population at large learns science suggests that “potentially a more holistic approach to science education, one that better integrates school, work and leisure time learning experiences...could be a more robust approach to long-term gains in public understanding of science” (pg.10). These out-of-school learning opportunities, making up a majority of an individuals’ time, are the greatest influences for creating substantive science learning and development of the science literacy so necessary in society. Thus science teacher educators responding to the challenge of the desired professional development for ISEs can expedite gains in science literacy for all. Providing such long-term professional development for ISEs forges alliances between science teacher educators and ISEs helping teachers in schools provide their students habits for life-long science learning and encouraging use of community resources in teaching K-12 science. Yet, little effort has been put forward to accomplish this.

The Informal Science Institutions Environmental Education Graduate Certificate Program, Course Design

The program titled, *Informal Science Institutions Environmental Education Graduate Certificate Program* (ISI) was originally implemented between 2006 and 2008 by the University of South Florida (USF) (Spector, 2009b). The knowledge base in the four courses of this certificate

program, taught sequentially by a science teacher educator, encompassed the desired outcomes explicated in the NRC (2009) report through long-term professional development for educators working in informal science learning environments. This ISI graduate program met the challenge posed by that NRC report (Ball, 2012).

The ISI program was initially pilot tested with a face-to-face cohort and culminated in its own evaluation study (Ball, 2012). I was a member of this original cohort, recruited by participants of a preceding series of community building classes held in partnership with USF and the Center for Ocean Sciences Education Excellence – Florida (COSEE-FL). As a precursor to her dissertation, Ball (2010) examined my experiences in the ISI program. Her external view of my work and of me showed and validated the depth of the growth I felt I had made as an educator completing this certificate program. Formal K-12 classroom educators also participated in the ISI program (Ball, 2010). They provided a K-12 perspective for the ISE participants, while learning to enhance their teaching by integrating ISE community resources into their formal teaching practices.

Upon completion of its first iteration, the ISI Graduate Certificate program was then transformed into an asynchronous distance-learning platform, Blackboard, incorporating lessons learned from the face-to-face pilot. The program was then set into motion with a new group of formal and informal educators completing the four semester long classes through guided inquiry, open class discussion boards, and assignments designed to provide the learners connection to their professional lives and the communities surrounding them.

Course Structure

The four courses in the ISI program were structured as loosely guided inquiries that enabled participants to construct knowledge by selecting from a variety of resources provided to them, as well as materials students actively sought to incorporate into the weekly tasks. Weekly assignments were structured to build commonality in general backgrounds as well as materials personally relevant to the participants' interests and lives. Student participants often added relevant material to the course that they recommended to other classmates, or were things that they had a personal desire to learn more from or about. Weekly prewrites encouraged students to deliberately focus on creating and restructuring their knowledge as they encountered class materials and incorporated information into their own cognitive frameworks. Upon completion of the readings, students were then required to metacognitively explore their sense making so they could explain how all materials were being connected/ built/ modified in their mental frameworks.

Communities of Practice, a Deliberate Course Design

Communities of Practice were first described by Lave and Wenger (1991) in their discussion of learning as a social activity. They felt that communities of practice were everywhere and everyone participated in many different types at work, in school, at home, and in leisure and recreation. Specifically, communities of practice can be described as "Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger, McDermott, & Snyder, 2002, p. 4). Wenger (1998), goes on to state that everyone plays a variety of roles in each of their

communities of practice ranging from leadership roles to outsider, dependent on their comfort, security, interests, and level of involvement in the activity at hand.

The graduate certificate cohort was in large part brought together through a random draw of participants interested in environmental education and who were seeking professional development in education practices as a whole. Because of these common goals, the students could be united around the central themes of the certificate, while freedom to express a variety of viewpoints in a safe, nonjudgmental environment was maintained. Diversity and individuality were encouraged while a concerted effort was made to minimize perceived superiority based on titles, rank or levels of experience. The graduate certificate offered an opportunity to unite professionals from across the southeast United States, specifically west central Florida, to share their expertise, build upon their passions through course themes, and otherwise build a community of practice over the certificate's four semester period.

Chapter Three: Methodology

Research Process and Method

This research was conducted as a qualitative, emergent design study grounded in constructivism. The online pilot ISI graduate certificate program cohort members' experiences were gathered through collection and analysis of class materials, interviews with participants, and other artifacts generated during the program. I used case studies to help tell the stories of the participants while processing the question of what was going on in the interactions among the students and within their learning individual learning experiences.

Constructivism, as defined by Denzin and Lincoln (2005), is the interaction of an individual's perspectives within specific contexts as they make meaning of events and experiences within these contexts. Phillips (1995) explains that constructivism is a very complex philosophy with a huge range of interpretations and applications. While there are many different forms and approaches to a constructivist pedagogy; difference is placed on the emphasis on how the learner constructs knowledge within various settings. This can be under the constraints of power, money, culture, and society in social constructivism or through psychological constructivism in which the focus is applied to how the learner creates meaning in their individual minds and in shared understanding within groups (Phillips, 2000; Richardson 2003).

While my analysis through these case studies discuss the critical power structures of society, politics, and job stress that impacted the study participants, I have deliberately focused on the

psychological constructivist approaches to meaning making to explore how the students formulated their own meaning as individuals and how they built a shared understanding within *this* community of learners. The nature of the course structure, through discussion boards and open ended assignments designed to capture prior knowledge and metacognition, lends itself to the “social nature of formal knowledge development within an expert community, and of knowledge creation that can take place within a social grouping” (Richardson, 2003, pg. 1625). Psychological constructivism also provides a window into this program to examine the contributions of each participant individually within the group, and how the collective group negotiated through dialogue and discussion, the shared meaning making (Phillips, 2000).

Emergent design allows the researcher the ability to use the skills of a naturalist to look at his or her research study. This allows him/her to see what is going on in a situation and draw out the patterns inherent there. Like the research scientist studying an ecosystem they know intimately, the researcher can immerse himself or herself in the study and look for the things that don't match up to the background, or tease out the hidden meanings camouflaged in plain sight.

Additionally, emergent design carries a flexibility about it that is especially appropriate for conducting naturalistic or “real world” research which seeks “to say something sensible about a complex, relatively poorly controlled and generally ‘messy situation’”(Robson, 2002, p 4). In a cursory review of the online data, it was apparent that attempting to identify the factors impacting the interactions and growth of the graduate certificate participants over a two year period was going to be very complex and “messy”.

Wright defines emergent design further by stating that it “carries with it a requirement for active involvement with processes, a continual reflection upon ontological and epistemological validity,

the flexibility to cross between paradigms...and a confidence to think, “outside of the box” and to make decisions appropriately but not necessarily conventionally” (2009, p.64). From my involvement as a certificate participant, ISI professional, and as a certificate instructor, it was going to take some out of the box thinking to capture and present the journeys of these students with honesty and fidelity.

Research Questions and Emergent Themes

The initial questions that guided the study of the online program were “What is going on here?,” “What happened when informal science educators had opportunity to study in a formal graduate program consistent with the NRC (2009) report?” and, “How were the participants’ outcomes consistent with those described as necessary in the NRC (2009) report?”

An iterative process of data analysis led to emergent questions, a sampling of which follow:

- How did participants make sense of program content?
- In what ways did learners translate theory in coursework into practice in their lives?
- What factors impacted participants’ performance in the program?
- How did participants manage time?

These emergent themes were examined through each individual and triangulated across the group to ensure saturation. To capture these findings and to maintain fidelity to the individuals who participated in the program, I choose to report their experiences as case studies that can tell their stories with accurate, thick, rich description.

Merriam (1998) defines qualitative case study “as an intensive, holistic description and analysis of a bounded phenomenon such as a program, an institution, a person or a social unit” (p. xiii). She goes further to describe a “case as a thing, a single entity, a unit around which there are boundaries” (p. 27). This can include a single person, a program or a group. The key to her, is that a researcher can specify a critical or interesting phenomenon and draw boundaries around it. In my study, the defining boundary is participation of all four courses in this graduate certificate program. Case study also lends itself here as it can incorporate the context of the individuals in their entirety as they interact with my bounding construct of the structures of these graduate courses (Yin, 2002).

The emergent design of my study aligns particularly well with Robert Stake’s fluidity of research in his vision of a case study. Stake describes the case study process as “naturalistic, holistic, ethnographic, phenomenological, and biographic research methods” that allow a researcher to understand what is going on or how things happened (1995, p. xi). This design method allows for the researcher to “get messy” in examining how the emergent themes or issues rise to the surface and ultimately explain the phenomenon or system studied. As the researcher in this study, I use the emerging “issues as conceptual structure in order to force attention to complexity and contextuality... because issues draw us toward observing, even teasing out, the problems of the case, the conflictual outpourings, the complex backgrounds of human concern (Stake, 1995, pp. 16-17). This allows me to interpret what is going on in my primary review of the materials to develop the themes and categories that will in turn answer the research questions I developed.

Stake has also heavily influenced my choice in reporting the findings as case studies that can tell the story of the participants as they journeyed through the two yearlong graduate certificate. He states that “case studies are useful in the study of human affairs because they are down-to-earth

and attention holding” (Stake, 2000, p.20). Stake goes further, explaining that “case studies will often be the preferred method of research because they may be epistemologically in harmony with the reader’s experience and thus to that person a natural basis for generalization (p. 20). In short, by capturing what Merriam (1998) describes as “thick description,” and what Stake sees as writing that is personally relevant, I can craft my interpretation of what happened in the certificate program while also providing the readers their own vehicle to draw conclusions based on their own previous experiences.

Data Sources and Collection

The data sources include participant artifacts, weekly journals, and ongoing online class discussions among the community of learners. Additional information was gained from personal conversation and interaction with the investigator face-to-face and online interactions including text, and email.

Participants

The online version of the *Informal Science Institutions Environmental Education Graduate Certificate Program*, had eleven total participants. Of the group, there were five males, and six females. Ages averaged in the late 20s to mid-30s with two participants in their forties (one male and one female). Only three participants were informal science educators with seven formal classroom teachers and one self-described scientist.

The initial class had six students in the cohort and suffered dramatic turnover as four would not return to complete the certificate (three males- two teachers and the scientist, and one female teacher). In total, four new participants joined in the second semester, bringing the class

numbers back to six. In the second semester, two informal educators joined and took the first class on their own as independent study, interacting with and building on the class journals of the students preceding them. The remaining two new students, both female, similarly completed the first course after completing the second class, out of order. I joined the fourth semester, the Environmental Update course to add an additional male and informal perspective as a participant observer.

Each participant is briefly described while detailed case studies are constructed of the key participants. Emerging themes are triangulated among participants to help evaluate the growth of the individuals and the successes of the program. All students' names have been changed to protect their privacy and to ensure anonymity.

First Cohort

Abbie was an alternatively certified middle school science teacher who worked in a small religious, private school where she had a wide range of freedom to construct her curricula and learning environments. She regularly used community resources and saw her teaching in her classroom to be more exemplary of what an informal educator would conduct. Abbie's undergraduate studies were in biology and she worked as a forensic pathologist before teaching. She was in her late twenties, married, and with no children when she started the program. She is a participant in all four courses and completed all the coursework, but did not officially receive the graduate certificate due to not meeting university health requirements for vaccinations.

Bobbi was a middle school science teacher with a degree in secondary science education. She eventually left teaching entirely to become an insurance representative. She only completes the first course before leaving the certificate program and education as a profession.

Bruce came to the program with a Bachelor's Degree in marine science and Masters of Arts in Teaching in Science Education. He was employed as a public high school teacher teaching marine science, biology, anatomy and physiology and chemistry. Previously Bruce had worked in freshwater fisheries for a government agency conducting informal aquatic education and public outreach as well as habitat and species management. He was in his mid-twenties, married with a newborn daughter. Time constraints of teaching a wide variety of courses with multiple layers of course preparation and a newborn child hindered Bruce from completing the certificate. He left the program after the first semester.

Matthew was also in his mid-twenties, was unmarried, and had no children. He described himself as a scientist but had interests and degrees across the board including a bachelors in marine science focusing on biology, and Asian Studies focusing on culture and religion. He was a Ph.D. candidate in chemical oceanography and a research assistant in the field, although he didn't complete this terminal degree. Matthew taught English in Asia and traveled extensively across the globe. He left his doctoral program to pursue his artistic and cultural interests while working with a dance and entertainment group. He also did not continue the ISI program after the first course.

Maddie was a formal classroom educator teaching marine science with over five years teaching experience at an affluent school in an affluent school district. She has a Bachelor's Degree in marine science from a private liberal arts college and a Masters in Science Education. Since completing the certificate program, Maddie has completed her Ph.D. and has taken over a leadership role in her school and district. Much of her educational practices mirror informal strategies, e.g. taking her students out regularly to collect marine specimens aboard a boat. She

has replicated many of the learned practices from the graduate certificate program into her day to day teaching. She was in her mid-twenties, not married, and had no children.

Nicholas came to the first ISI class with a Master's degrees in Educational Leadership and Secondary Science Education focusing on Biology. His Bachelor's degree was also in Secondary Science Education focusing on teaching biology. Nicholas wanted to enter the doctorate program in Educational Philosophy and had a long term goal of being a college professor. He was a full-time student during the certificate program but had previously taught high school biology and physics for four years. He was in his mid-twenties, unmarried, and had no children. Nicholas did not continue certificate after the first course.

Joined in Second Course

Brenda joined the cohort in the second course. She was married with no children and Bachelor's and Master's Degrees in Secondary Science Education focusing on biology instruction. She is a middle school science teacher who prefers to work in Title I schools for the "dynamic" nature of the students. While opportunities arose for participants to meet in person throughout the certificate program, Brenda participated in all of the courses from out-of-state and by long distance methods such as email, online chats, and discussion boards.

Carol was an alternatively certified middle school science teacher working in a large, but more rural school district. Her undergraduate degree was in environmental science with an emphasis on chemistry and biology. She also held a Masters in Secondary Science Education. With more than ten years of classroom experience, she eventually moved to teaching in the state virtual school program before leaving education entirely to go to work for her husband's graphic design company. During the certificate she was in her forties, married, and had two sons.

Mandy was in her mid-thirties and married with “no human children” when she started the program. She is an informal educator with an undergraduate degree in fine arts focusing on biology and scientific illustration from a liberal arts college. Her Masters’ Degree is in Environmental Education. She has worked in a variety of informal science institutions including a zoo, museum, and a parks and recreation department where she was employed during the courses.

Ronnie started the program in his forties while married to a radiation oncologist. They have one daughter. He has a Bachelor’s Degree in marine science and graduate coursework in secondary science education and a Masters in aquaculture. He is an alternatively certified teacher who taught in elementary, middle school, English for Second Language Learners, and adult education programs. Throughout his professional career, Ronnie has bounced from the corporate world and sales, to education, to nonprofit informal education enabled by the financial freedom afforded to him through his marriage.

Chapter Four: Analyses and Findings

Participant Case Studies

Abbie

Abbie was an alternatively certified middle school science teacher who worked in a small religious, private school where she had a wide range of freedom to construct her curricula and learning environments. She regularly used community resources and saw her teaching in her classroom to be more exemplary of what an informal educator would conduct. She was in her late twenties and was married with no children when she started the program. She is a participant in all four courses and completed all the coursework, but did not officially receive the graduate certificate due to not meeting university health requirements for vaccinations.

Abbie had a bachelor's degree from the honors college of her university in Interdisciplinary Natural Sciences/Biology. This program allowed her to take many science courses in various disciplines during her undergraduate education and completed a thesis in genetics and phylogeny. Upon graduating, she went to work as a forensic autopsy technician.

Despite being a self-claimed "science geek", she felt unfulfilled as a scientist and returned to school to complete an alternative certification program to obtain her educator's certification, which involved taking nine specific education courses. Abbie stated that "although my family always supported education, they were quite disappointed when I chose to be a teacher and thought I could do much "better" with my life. They have since come to appreciate my chosen

career. This definitely influences my perceptual screen.” She later continued on and completed a masters of education in science education and began work for a doctorate that she did not complete.

Abbie is an overachiever, a workaholic, and a people pleaser. The Ph.D. is something she desired, but her desire was lessened by the influence of her loved ones, her mother’s battle with cancer, an extremely demanding work schedule from a job she loved, and the multiple changes in careers of her husband.

She grew up as a “star athlete” softball player and was an excellent student in a small-town and was the first one in her family to graduate college. This well rounded nature, allowed her to gain full scholarship for her undergraduate work and extends throughout her interests and personality. Abbie describes herself as having “multiple personalities;” loving beer and contact sports like football and ultimate fighting; a very active lifestyle bowling, playing volleyball, and softball competitively; volunteering as a Big Sister; baking and cooking; and being addicted to crime shows and thought inducing movies. She goes further to describe herself as a “tomboy” who has “girly girl tendencies” and gets along best with men.

Abbie’s dynamic nature allowed her to approach the ISI certificate program with a liberal perspective; she’s not just a private school teacher, nor just a scientist. She was a chameleon capable of blending in with all of the certificate participants in their own interests and backgrounds. She could match experiences in the classroom with the teachers, talk science with scientists, be “one of the guys” with the males in the program, and be refined and lady like or “country” and “outdoorsy” when the settings required it. This talent, and a gifted intellect, allowed her to read patterns in her classmates’ work, pull on her own training and experience,

and synthesize these components into a quality product. This allowed her to generate thoughtful work without needing the prerequisite reading, effort, and time that her classmates required. Abbie did not have to fully invest herself into the learning tasks and assignments she was working on to be able to appear fully engaged while she dealt with major issues outside of her graduate work.

Teaching in a private school offered Abbie curricular freedom in a setting that wasn't standardized test driven. It gave her the chance to bring strategies to her students that could never be implemented in the accountability focused, scripted out instruction with which the surrounding public schools were dealing. Hands-on/minds-on learning, active science investigations, and student driven learning were hallmarks of her classroom. She had the support of her community in terms of supplies and freedom to push students, because the school saw real learning as more important than repeated high stakes testing. She was able to engage her students regularly in projects while also taking them outside on school grounds and fieldtrips to places as far away as the Florida Keys. The small size of the school and the heavy familial and community connections built a very tightknit environment in which Abbie flourished.

There is also a catch to working in a small private school, Abbie was heavily tasked with many of the things the science department was doing. She was a middle school science teacher, science fair director, and science curriculum leader. She states "Basically, if it has to do with science at my school, I have my hands in it!" The stress of being responsible for teaching six or seven different science classes at a time, each with their own required preparations was a lot. Important to consider, she was working alone to create these courses, many of which she had never taught before, while trying to make each class as hands-on and as engaging as possible. It takes time to put together quality learning activities. Next, she managed everything to do with her school's

science fair and the science fair projects. Working with the students on their projects; organizing the after school event; securing judges, prizes, and awards; and working with her surrounding school district to have her students compete in the regional and state science fairs were all things for which she alone was responsible. At science fair time, she logged many more hours than should be expected from one person. Abbie also served as a representative for the accreditation and evaluation team for her school's national accreditation. In this role she visited other private schools and reviewed their programs to ensure they were meeting their educational goals. Finally, she worked with the other science teachers throughout the K-12 school to ensure that subjects and classes were curriculum mapped and ensured the proper scaffolding for a quality science education that encouraged lifelong learning. She states as a private school teacher that she comes "from a different place than a public school teacher, because I have the ability to choose how to enrich my curriculum and what topic to focus on." Her work life consumed huge amounts of her time and did add a lot of stress to her life, but Abbie loved her job, the team she worked with, and the students she taught.

Abbie's husband was pursuing a major career overhaul during the time of the certificate. During the certificate program, he had gone back to school to become a hairdresser with the intentions of opening his own salon. This was a major overhaul. He had previously left a family business as a brick mason to become a chef, before leaving that to sell cars. In each of these jobs, he had been very successful and was the main breadwinner. His return to school left the household strapped, because he was not providing his share of financial support to cover the expenses. Their home soon fell into foreclosure. Abbie's salary alone was not sufficient. This was exacerbated by Abbie's mother moving in with them as she battled health issues that required assistance from her daughter.

These personal stressors drove an already time strapped Abbie to tutor students after school and on the weekends and to teach math, science, and STEM camps for her school and the local science museum during holidays and summer break to supplement her income to pay mounting bills. This young lady, who was in excellent physical condition, began to succumb to the overwhelming pressure around her. She started to lose weight she could not afford to lose and her hair began to fall out. Through this all, Abbie still completed her classwork to finish the certificate program and her Masters of Education in Science Education. She was not officially awarded the graduate certificate because the university would not grant her clearance for missing vaccinations for this program, but exempted her for them for her Master's program. She had too much to deal with in her personal life to battle university bureaucracy to receive her rightfully earned certificate.

As an alternatively certified teacher, Abbie was required to take nine specific courses to provide her with the underpinnings of teacher preparation in order to gain her teaching certificate. In essence, she was given the cut and dry versions of classroom management, educational philosophy, a brief history of American education and a methods course for ways to teach secondary science topics. She felt the teacher prep program was very disjointed and lacked the rigor her science classes provided in her undergraduate studies.

The ISI certificate courses were different for Abbie. They were open ended and let her choose things she was interested in and could be incorporated into what she could directly use in her classroom. Abbie states in one class, that she

selected this particular activity to review, because I love finding new ways to teach students about the solar system. Plus, I wanted to see if the lesson was similar to what I

do. Space is such an abstract and fascinating concept for students, especially at 11 and 12 years old, which is when I teach this concept. I designed a really fun activity to teach this concept, and I think it might work even better than the one summarized by the presenter. My activity takes two 45-minute class periods and incorporates math, science, and art.”

She saw her success in designing activities was as good, if not better than exemplar models top science curriculum writers and ISIs were using around the country. In other examples, she saw things like an “assessment carousel” and could envision it slightly “tweaked” so that it met her needs. “I am going to adapt this activity to a review I will be conducting with my 6th grade students this week. My creative “juices” are flowing and I think they are really going to enjoy it!” In another assignment, Abbie states the document to “be a very useful resource when attempting to navigate the multitude of resources in the community. The detailed list of possible resources, items/services that each could provide, and suggested activities when involving each type of organization is fantastic. While reading this section, I scribbled a tremendous amount of notes in the margins and plan to attempt to contact a resource within each category this school year. What a great way to expand my horizons! Many of the resources, such as banks, cosmetologists, exterminators, and radio stations, are options that I have never considered.” These were all people she would later begin building relationships with and have serve as guest speakers or judges for the school science fair. It became apparent, Abbie was finding things that matched a classroom that was not the old school paradigm of the talking head teacher and fit into her active learning philosophy. Abbie was growing her classroom out of the four school walls with new ways to incorporate community resources of wide types and varieties.

As part of expanding her world view and incorporating more ISIs and ISI created materials, Abbie began to question how other teachers perceived these community resources. This became

very clear in the third ISI course as class participants began to generate ideas on how to better bridge the gap between formal and informal educators. Brenda, Carol, and Maddie all felt, as public school teachers, it would be great to have a school district sponsored community liaison who knew what was available from ISIs and could facilitate seamlessly with school teachers to setup meaningful relationships between the two groups. This position would be fluent in life as a teacher, the state standards and district initiatives, and be fluent with what was available from the many resources in the community, knowledgeable, and connected enough to be able to get them for the teachers. Ronnie felt that some ISIs, like Earth Force for which he was working, already filled that niche but were underutilized because teachers felt overwhelmed with what they were already required to do. Mandy's perspective, as the other ISI representative, was that she wanted to create something, as she referred to it, "like a Chinese restaurant menu," that could be used by teachers to pick and choose from the resources or activities she had available to them. As different ideas emerged, Abbie felt there was a critical component missing: Did teachers already use ISIs, and if they didn't, did they want to?

Abbie, looking at her own experience in the classroom and time constraints, felt that a lot of teachers may not have wanted to be bothered by an ISI staff member or an ISI liaison.

Advertisements, both physical and emailed, only had about "15 seconds" to gain her interest before they were discarded. Even as a seasoned teacher with over seven years of experience, Abbie felt she didn't have any time to waste on things that weren't readily of value to her. She had built all the community relationships, searched out all the resources, and planned out all of her field trips to the ISIs she used herself. She felt that a lot of the ISIs couldn't meet her specific needs for the curriculum she designed for her private school. That is not to say she didn't use ISIs. She regularly did. Abbie just didn't have the time to waste working with random ISI staff to

build programs she already had built or trips she had already designed to meet her learning goals for her students. She felt that a lot of the pre-made programs and educational kits had been made to meet perceived needs of public school teachers and were lacking the rigor she expected.

To address these concerns, she built a web-based survey she sent to a wide range of teachers in charter, public, and private schools to “determine their existing knowledge and beliefs about ISIs, their beliefs about the validity/importance of ISIs in the current education system, and several other topics that will inform our future research in this area.” In about three weeks’ time, she had gotten responses from nearly sixty teachers in a range of grades from elementary to high school. She found that those surveyed did indeed use ISIs and really would like a web-based database that could provide them with information about programs and materials available from their community resources. Abbie did find two other key details in her survey: More experienced teachers were most likely to use community resources, and only teachers who saw value in ISIs were likely to visit or use their materials. These results complemented a similar but different survey that Mandy sent out and received about 120 responses specific to the region surrounding her nature centers. The results of both surveys were incorporated directly into the guide Mandy built for a product for use at her nature centers.

The ISI program also made Abbie examine her work, her experiences, and be self-reflective in ways she never had been before. In one reflection, Abbie talks about realizing she has a perceptual screen that shapes how she makes sense of what she experiences, and that in turn, shapes how she functions as a learner and ultimately as a teacher.

Perhaps I have gone on much too long about my recent experience, but I thought it might explain what [Course Professor] calls my perceptual screen. The screen

through which I view assessment might be different than yours and I think that you must understand where I am coming from in order to fully comprehend my reasoning. So, to fully respond to the initial question... How have I been assessed in my college courses or in school in general? Ineffectively. I will end by saying that most of my graduate courses have represented a departure from this trend. For the first time in my life (other than in the Honors College), I feel as if there is an attempt to create methods of assessment that go beyond the simple rote memorization and basic concepts. I am also encouraged to assess my own learning, a task that has been valuable to me.

This realization was something very stark for Abbie as she could see correlation to how *she was herself* responding to things. While responding to a prompt about how exhibits are designed for ISIs, she illustrates this further by examining the “different roles,” she plays at an ISI with the different audiences of people with whom she visited. She states these roles have included “as part of a family group, as a learner, as a science professional, as an educator with a group of teenagers, as an educator with a group of young children, as a wife trying to facilitate and maintain interest for my husband, and as a person simply seeking enjoyment. In each of these roles, my purpose for being at the museum was entirely different.”

Abbie describes the facilitator role she plays with her family and friends. In this capacity, she serves as an engaging tour guide meant to illicit a strong sociocultural connection to the exhibits, void of her own personal growth.

When I visited a museum as part of a family group, I acted as a tour guide and science “expert” while enjoying the conversation and company of my family

members. I had very little desire to learn new things and instead focused on providing enjoyment for my family as they moved through the museum. When I have visited museums as a wife with my husband, my role usually involves keeping his interest in the museum, answering science questions, and helping to keep my husband entertained. Despite an interest in science, my husband is not an avid visitor of museums and gets bored very easily, so he would be considered a challenging museum visitor.

As an educator, Abbie engages her students, age appropriately, with the presented materials. Here, she works to gain knowledge and excitement for younger children and to build critical thinking for her older students as she encourages them to dig deeper into the content for meaning.

When I visited a museum as an educator with a group of teenagers, I took on a very similar role to the one I had taken with my family group, except with a greater emphasis on digging into the meaning of each exhibit instead of providing a purely entertaining experience. When I visited a museum as an educator with a group of young children, my role was entirely different than the others I have described. Since the groups consisted of children ages 4 – 6, a large part of my focus was on the safety of the children and making sure the group stayed together. Of course, I made considerable effort to help the children understand each exhibit, but there was a bigger focus on getting the children excited about science in general and getting them to want to know more.

Abbie even played a variety of roles when she visited ISIs for her own benefit. As a learner and as a science professional, she seems to compartmentalize away the social environment and enjoyment components of the museum, instead focusing on the direct learning experience she could take away from the visit. Due to her rich science background, she is often left lacking after these experiences due to the targeted exhibitry being focused on youth or audiences less scientifically knowledgeable.

As a learner, I visited the museum because I was curious in the exhibit and wanted to educate myself on its contents. I had no desire to be engaged in the entertainment aspect of the museum and simply wished to explore the exhibits on my own. As a science professional, I visited the exhibit with a very similar attitude as when I was visiting purely as a learner. I do remember, however, being disappointed in the level of science being presented and the juvenile feeling of many exhibits.

When she discusses her own enjoyment in museums, Abbie comes across less stringent and more apt to indulge in the social aspects of the experience, taking in the people around her and just generally having more fun.

Finally, I have often visited museums purely for enjoyment and with no other purpose in mind. I enjoy being surrounded by science and learning, and enjoy doing something different. I enjoy seeing other people have fun and am an avid people watcher. It might seem strange, but some of my enjoyment in visiting museums comes from watching other people, young and old, engage in the museum experience. In considering the many roles that I myself have taken when

visiting museums, it is easy to understand the difficulty one might encounter when trying to create museum exhibits or experiences to effectively address every type of museum visitor.

This long self-dialogue Abbie has, helps her to make sense of the materials she is reading in class and connects to other course work she has taken in educational philosophy and in the ISI certificate. She clearly connects to the roles Falk and Dierking describe in her class readings and can see her own actions integrating sociocultural learning theory of how people gain deeper understanding when they make meaning within a group of peers or loved ones.

Abbie was becoming self-aware and is metacognitively building a much larger mental framework. She could see how she was processing things and how they fit into the “big picture.” This awareness allows Abbie to be more precise in building her own learning experiences to incorporate social learning for her students. The freedom in her classroom afforded to her from being in a private school allows her to serve as a truly self-reflective, facilitative teacher building these social learning opportunities through multidisciplinary scaffolded projects that allowed students to marry book learning with real world connections. The annual food drive she organized expanded into the life science classes to discuss proper nutrition, before morphing again into building a community garden that her students maintained. This learning unit addressed the life cycles of plants, the carbon and nitrogen cycles, photosynthesis and cellular respiration, and human nutrition. It was rounded out by having the students harvest what they had grown, then donating it to the foodbank they had researched. The students owned the learning and were emotionally stirred by serving those less fortunate than themselves. Strategies of service and project based learning, emphasized in the ISI certificate program,

complemented her interests in nutrition and healthy eating leading to greater satisfaction for her in the job she loved.

As Abbie completed the certificate, she is under great stress from her professional, personal, and academic lives. Through greater self-awareness of her expanding perceptual screen, which in turn helps and is helped by her feelings of validation of her professional work as a teacher, Abbie finds great enjoyment in seeing her students' successes in her classroom. The certificate program provided a supporting literature base, for her, of why what she does as a teacher works. It explains why she as an individual perceives and responds in so many different roles to her screen of sociocultural learning opportunities and how she can successfully function as the chameleon academically switching hats to facilitate her interactions with her classmates and ultimately her students in her classroom at her private school. As she became more comfortable with how she innately operated, she could harness what was most effective for her teaching style and find stability and great enjoyment in her job that others would find overwhelmingly stressful.

Maddie

Maddie was a high school science teacher working in an affluent school district. She had taught biology, environmental and marine science, and had over five years teaching experience when she began the ISI Certificate Program. With a Bachelor's Degree in marine science from a private liberal arts college and a Masters in Science Education, Maddie was driven to complete a Ph.D in science education. Since completing the certificate program, Maddie has completed her doctorate and has taken over a leadership role in her school and district. During the certificate program she was in her mid-twenties, not married, and had no children.

Moving from a Midwest state to the Gulf Coast of Florida inspired Maddie towards a career as a marine biologist at a very early age. Through the support of her family, she soon fell in love with exploring the coastal environments that surrounded her. These things helped stir her love for the marine world and built her scientific interest in biology. She says that she has “to thank my parents for allowing me to cut open my pregnant guppies, taking me fishing, and filling my weekends with snorkeling trips. This frequent interaction between these organisms functioned to lessen the amount of anthropocentrism in my understanding of biology.” Her family’s support of her inquisitive nature at a very early age built and nurtured her scientific interest that would drive her towards a career in science. This desire to be a marine biologist encouraged her to be a diligent student who excelled at her school work, so she could complete the degrees her childhood dream required.

In her undergraduate work, Maddie really enjoyed her schooling and excelled. She found her classes to be challenging with a good mix of lectures, labs, and some fieldwork that helped to expand her skills in doing formal science work. This schooling also helped her sense of self as she was able to develop and conduct her own scientific research.

Upon graduating with a bachelor’s degree in marine biology, Maddie explored the career possibilities in marine science before she pursued advance degrees like a masters’ or doctorate. She soon found fresh-out of college marine science jobs were mostly low paying, hourly positions that worked full time with no insurance or benefits. Both of Maddie’s parents were teachers, so she decided she would give teaching a try.

Maddie’s first teaching endeavor was a rude awakening for her. Her initial assignment was to teach eighth graders a comprehensive science course that she approached as she herself had been

taught; with lecturing, note taking, outlining book chapters, and heavy vocabulary lessons. She found her students struggled greatly with these techniques as they were ill prepared. Many had a disdain for science or worse, didn't care about school, or were dealing with huge issues of their own off campus.

She moved to high school, because she thought her students there would be better prepared for her teaching methods. She had these same struggles before she realized she had to make her teaching engaging to the students and be differentiated enough to meet their needs as learners. Maddie found great enjoyment in her newfound freedom to create her own materials. Her students fed on her enthusiasm and succeeded.

That sense of happiness faded with the rise of the standardized testing movement and greater emphasis on teacher accountability. She worried going away from the prescribed district materials would lead to her students' failure. Job satisfaction left her and she decided she needed to do something different. She pursued her goal of completing a Ph.D. while continuing to teach. Maddie entered the ISI program at this time as a participant in the first online course and is the only original member of that class to complete all four courses and receive the certificate.

While she worked in a relatively progressive county that allowed greater freedom for its teachers, Maddie felt the pressures of having to abide by district initiatives that didn't always seem to match one another. For example, there is a paradox she sees in putting an emphasis on making learning relevant to the student's real world while instilling the utmost importance of succeeding on tests driven by "rote memorization." She saw great benefit from teaching in a way that built student engagement and "buy-in that what the students are learning can someday be applied to a future profession." However, she felt that the system was only "turning out

students who can't or won't think for themselves, and who constantly rely on being told what to do." This is an ongoing theme for Maddie and she clearly describes what she sees in the education system surrounding her.

In most K-12 classrooms there is push given by the administration that educators need to tie in the lesson to real life experiences, engage the students, and at the same time follow the standards. I believe for most science teachers that due to time, resources, and possibly even lack of subject matter knowledge, this is rarely taken as it should be. Many focus on preparation for college, which in many cases translates into the amount of content learned by the end of the semester.

Advanced Placement classes are the perfect example. Some of these teachers instruct with only the goal of a grade on the test.

Maddie goes further stating even though these methods might produce sufficient or even excellent results on the standardized tests, the students are lacking the enthusiasm for learning and any real knowledge gains. She states; "unfortunately, this inquisitiveness we see in children seems to go away as students get older, and I admit it may be in large part due to formal education and its lack of flexibility." The students are mere automatons that respond with what the teacher or testing assessor wants, with no real understanding of the material they have mindlessly regurgitated to complete the task.

In my experience, the students that are a product of this type of teaching are limited when it comes to scientific thinking, and as they go farther along in the education system it seems increasingly difficult to get them to consider different opinions or make conclusions on their own. These students are limited to one side

of a situation and waiting to be fed information without the ability to be critical which will not only impact success in science, but how a student questions and challenges other knowledge as a whole. Without the eagerness to discover and enjoyment in creative activities it makes the classroom setting less gratifying and effective for both the teacher and the students. As standardized testing and control from government programs like No Child Left Behind increases pressures on the classroom teachers many are finding it more difficult to find time for the lessons beyond the normal rote and memorization activities.

Maddie also felt she was different from her peers because of her science first background. While she had no education classes prior to entering the classroom, she felt she could see the bigger picture of the science content because of her biology background and could apply the appropriate scaffolding to better facilitate her students learning of the materials than her education prepared colleagues.

I acquired a bachelor's degree in science before any education classes, and I've found that this sometimes sets me apart from my colleagues in how we view our positions as science teachers. Many focus entirely on the vocabulary and tests, completely leaving out the best part of the discipline, which is the questioning, investigations, and experimentation. This isn't to say I didn't think about my standards the entire time. The possible labs we talked about always had their place in what I was required to teach. For instance, normally the biology teachers do a unit on organic molecules (lipids, nucleic acids, carbohydrates, and protein) where the students learn about the structure what types of food are in each category, etc. It's an important unit, and we review and use most of that

information later on in the year, but I've always felt we didn't relate it to enough in the beginning for the students to actually care and remember about its elements.

Maddie came to the ISI program while in the second semester of doctoral work in science education. She was teaching high school and was very frustrated with the battle between teaching her students the way she felt was right, with enthusiasm and active engagement that could be time consuming but built depth of knowledge, or in a way her school district was mandating that superficially covered a great breadth of material so her students could simply perform well on tests. She saw the benefits of teaching standards driven content in a way that was relevant and engaging to her students. They deeply understood the material and could connect it to real life relevant to themselves while both she and her students had fun learning. However, Maddie felt like she needed to be more in line with the testing emphasis the education enterprise was forcing on her that required too much material to be covered in a school year in any other way than old paradigm strategies of the teacher controlling the learning environment in the way she herself had learned; a way in which she knew her students weren't succeeding. Returning to school, she hoped, would provide her with the support and tools she could use to unite these two disjointed strategies in her classroom.

When tasked to describe the differences between formal and informal learning, Maddie described the major differences between the two similarly to old and new paradigm teaching structures of teacher controlled learning versus student centered and teacher guided learning. She saw the science education reform movements as being much more "informal learning" compared to the current machinations of the accountability movement that stressed a much more dominant teacher controlled classroom.

When I think of formal learning I picture a classroom setting with routines, lectures, and worksheets. A more accurate definition is probably just the average classroom, where the teacher leads the class according to the standards. I see informal learning as education that takes place outside of the classroom, or learning driven by student interest instead of that of the teacher. I would expect that in the sciences especially, informal learning is the direction most of us would like to see the education system leaning towards.

Unfortunately, with standardized testing and the ever increasing control over how and what is taught I see a greater pressure towards the formal learning structure.

For Maddie, she felt good teaching in the classroom mirrored what ISI educators did in the freedom of their institutions, be learner focused and relevant to their backgrounds and lives. Maddie recognized her job satisfaction and the techniques that she used successfully within her classroom leaned heavily on this. She joked that teachers “lusted” after being able to do their jobs correctly without government interventions like the ISIs, but recognized the safety of school funding compared to the financially hard hit community organizations. The ambiguous battle of wide breadth of knowledge and greater depth of understanding didn’t have to be a struggle as she could develop her own curricula. With the help of ISI materials and community resources, she could accomplish both tasks while maintaining a high level of rigor. This reassuring reality came to Maddie as she delved deeper into the content of the ISI certificate and actively interacted with this cohort of professionals going through similar struggles.

Maddie goes further to describe what she is striving to be as an “effective educator.”

In order for a teacher to be an effective educator I believe the student has to be set up in a position in which they think actively about the information that is

presented whether that means comparing it to prior knowledge or synthesizing the information to apply to other situations. The moments when I've failed at this in my classroom are very obvious, with the blank stares and boredom. Creating engaging types of lessons is difficult, but rewarding for both the teacher and learner.

This student empowerment is based on looking at the whole student for Maddie. It is not a numerical test score based on reading, math, or writing proficiencies. She knew she had to understand her students' backgrounds, prior knowledge, and interests to be able to connect to them at their individual levels. Maddie also very clearly states that many teachers forget to take into account the "intellectual developmental" levels of their students and how there are many foundational gaps in science knowledge, at times, that must be addressed before new knowledge on higher level content can be gained.

She also needed to be able to pull from a wide variety of entry points for her audiences to be able to get them engaged in the material. Maddie felt she did this best as an avid lifelong learner who was constantly enriching herself with new knowledge. She pursued her learning endeavors both formally through ongoing graduate coursework, professional development workshops, and through informal learning with friends and colleagues.

Professional development workshops for Maddie were a mixed bag. School and district sponsored trainings were lacking for her. Most spouted on about techniques and tools for perpetuating the methods of teaching that Maddie's students struggled with, and she ultimately quit going. She instead started seeking out her own professional development and began to attend the workshops sponsored by ISIs where she was able to gather materials she could use that

matched her pedagogy. She specifically cited efforts by her water management district and local aquaria that provided the things most relevant to her. She stated she got the most from these workshops when the ISI was clearly in touch with what the teachers wanted from the workshop. These events were also of personal interest to her thus lending to her natural desire to learn about water resources and the ocean.

I've taken advantage of many lessons and resources made available by ISI's, and I appreciate how much time went into designing those lessons. As a first year teacher long ago, I quickly realized that the textbook and the labs accompanying it weren't as engaging as I knew they could be. I've experienced the Project Wet and Wild trainings mentioned in the articles and I'd recommend those workshops to many of my colleagues.

Continuing her intrinsic motivations, she admits freely she is a "social facilitator" of learning amongst her friends. She described a monthly get together she and her friends developed called "Wings and Fins." At these events, they get together to have chicken wings and drinks before going on a field trip to the aquarium where they talk about fish and Florida ecology. The informal, social atmosphere of the food and beverages before the journey to the ISI allowed an environment in which all participants were relaxed and engaged, taking in the experience. It is important to state that quite a few of her friends were professionals in various sciences including marine biology, oceanography, and environmental science. The conversations of this group were definitely of a scientifically literate level that included ongoing research and current trends in the various fields. This was an engaged sociocultural learning environment where all participants shared in the knowledge making at hand. Maddie also attended and encouraged her students to

participate in other science and community based events like local beach cleanups and science festivals.

Her social connections with current scientists and researchers also provided her a wealth of resources she could capitalize on in her classroom. In one example, she talks about meeting up with a pair of friends who were science professors at a local university. She begins talking about having a month of time in her curriculum to work on the nature of science and wanted to be able to do a variety of inquiry based, hands-on activities. They immediately put her in contact with a colleague of theirs who was conducting ant research. They scheduled a meeting the following week. Immediately, she was able to plug her friends' network into her classroom to have an engaging experience for her students. In another example, she met another friend and a colleague of his for lunch. In this case he was an emeritus professor in marine science who couldn't understand why students' ability to generate interest in real world phenomena had disappeared. Instead of finding a content expert to serve as a guest speaker, this scientist encouraged Maddie to build more questioning strategies into her toolbox, that would in turn help her to develop more open ended activities in which her students could practice their own questioning to generate hypotheses from real world examples. Maddie was also able to help Mandy with her "Know Before You Go" fieldtrip guide by distributing Mandy's survey to the teachers in her district to provide her feedback from the teachers who would be closest to using this tool in their classrooms.

This networking was something Maddie was capable of tapping into from the beginning of her teaching career. As her classroom experience increased and she found comfort in her subject matter, she was able to take risks and integrate more complex strategies into her teaching. She says;

I haven't done much in regard to creating these partnerships, though I've wanted to start up some sort of program with my school. Most of this is due to the fact every year I've been asked to teach a new prep, which takes up quite a bit of my time. This year I've been blessed with teaching biology honors and regular, both of which I've taught previously, which allows me to pursue a relationship cultivated through the local university.

In each example of partnering with an ISI resource, Maddie was able to enhance her curriculum by incorporating new perspectives and current research from the greater community surrounding her. These successes, coupled with her growing awareness of community resources from the certificate program, encouraged her to keep growing her "informal teaching" strategies and to build larger partnerships with ISIs.

In the third course of the certificate, Maddie set out to get her students actively involved in marine field-work with her local aquarium. This came about as a result of a class assignment to explore local ISIs. She extended the assignment by tying it into something she could use in her classroom for her teaching. She set out to work with an aquarium she had volunteered at previously, that had an education program and worked with school groups. Maddie contacted the school program's coordinator and met with him to discuss what she envisioned for the partnership, a series of fieldtrips in which students did "real science", like collecting samples of water and organisms, recording the findings, and analyzing the data set they generated over the course of the school year. It was very important to Maddie that this was not just to be a couple of disconnected trips that could not be built upon in the classroom.

The school program's coordinator, a member of the first ISI certificate program, understood fully what she wanted and they were able to set up a sampling protocol for pulling seine nets to collect animals at a series of set locations at each trip. Other school groups this aquarium worked with would also generate the same types of collecting records, and Maddie could incorporate a lot of information into her students' data sets over the course of the entire year. Pre- and post- trip activities were designed for Maddie's class that tied directly to her standards. She soon had a hands-on plan to have her students actively engaged in doing real science work in partnership with an ISI, where the ISI helped provide content expertise and resources to conduct the students' work. This program encouraged Maddie to believe it was possible for her to do good science education with community partners.

In the final course of the certificate program, Maddie found out the following school year she would be teaching another new program taught for college credit, a course in marine science. She describes it;

On a side note, I just found out I get to teach the Advanced International Certificate of Education (AICE) Marine Science for college credit next year at my school, so I'm very excited to be teaching ocean related education once again. The curriculum is done at the University of Cambridge, and there are two levels. The AS level is the scientific study of the ocean and its ecosystems, while the A level concentrates on human activities and their impact. It's much different than the state standards, which lack specificity and don't integrate information that would directly impact the students' lives.

While being another new course she had to prepare to teach, it was something that built directly into her interests; teaching marine science content directly tied to her students' lives. She was very excited. This was a perfect combination for her, because she was able to teach the content she loved like an informal educator, the way she wanted to teach it.

Maddie's development through the ISI certificate program could be seen as a progression from a frustrated teacher, who wasn't sure how to handle the political interventions bogging down her classroom teaching, to a confident educator who could trust the strategies she was using would properly prepare her students with meaningful knowledge that would translate beyond standardized tests.

Maddie had only a few education courses before coming into the cohort, but here she was able to connect the pieces of inquiry based teaching methods and her own sociocultural educational philosophy with community resources and current science that made learning relevant to her students. Maddie knew lifelong learning played a large role in her own life, because she could directly see how the science impacted her. She began to restore some of her students' interests in her class by returning to hands-on, relevant materials that connected the lesson to the students' lives outside of the school grounds. They could see why they were learning the content and why it mattered in the big picture to be critical, scientifically literate citizens. Maddie gained confidence from the certificate program by seeing the integration of new paradigm teaching, where the professor handed the students control of the program and served as a facilitator to the learning at hand. This allowed her the comfort that she could use a progressive release of control to empower her students in their own learning. She was reassured you could add mutually beneficial community partnership between an ISI and a school to meet the needs of the teacher in meeting science standards and learning goals. She began expanding her "classroom walls" by

bringing in more resources and partners to her school, as well as doing more outside in the real world through fieldtrips and fieldwork. Maddie's takeaway from the ISI certificate was subtle; it was a growth in knowledge and even more growth in confidence and enthusiasm to teach in the ways she knew worked best for her students.

Brenda

Brenda was a middle school science teacher working at a Title I charter school in the urban inner city in the Midwest. She had recently completed her bachelor's degree from USF and was working to complete a master's degree, through distance learning, in secondary science education with concentrations in teaching biology. She was married and was the youngest participant in the program in her early twenties. Brenda also was the only African American in the cohort. Collectively, she represented a unique perspective as a fresh, novice teacher working in a poor charter school outside of Florida. She is also the only participant who has an undergraduate degree in education.

Despite providing a fresh and novel perspective, Brenda's brevity provided little elucidation to her studies and how they connected to her real world. She completed her assignments to the required specifications; almost to the letter. This allowed her to complete the certificate program, but unfortunately did not really give much of a window into her growth and development as an educator. Brenda did express similar struggles to Carol, with whom she started the certificate program.

Brenda was new to teaching, having completed one year working with sixth graders before teaching seventh and eighth graders while completing the certificate program and her master's degree. This experience was fresh from a bachelor's degree in science education. Her motivation

for taking the certificate was the online nature of the courses and their offerings that gave her a way to stock her educational toolbox with community resources that could help her teach at her STEM focused charter school. Similarly to the other teachers, Brenda was trying to figure out how to deal with high stakes standardized testing, the role of standards and their impact on her classroom, and how best to make science relevant to her learners.

Brenda makes it clear she is a teacher who feels strongly about how the standards should direct her on what to teach. “Standards are vital and critical to education. Standards ensure that students are meeting benchmarks across the nations and are on one accord. They help schools and teachers attain mastery in their subjects and grade levels.” She goes further stating that “They are a basis for curriculum and instruction. Standards are consistent across the board. Teachers can choose how they teach the curriculum to help students but the standards remain the same.”

While she says teachers have the freedom to steer the curricula, they shouldn’t stray far. “Just like in law and war when you don’t have standards individuals deviate. A lot of times when people deviate they go to the extreme. If you don’t have standards, who is to say what is acceptable or not? Standards hold schools, counties, and teachers on a level playing field.”

Despite this heavy reliance on standards driven instruction, Brenda felt the accountability measures of teacher evaluation and high stakes testing had left teachers shackled to a curricula to which their students largely couldn’t relate.

Students do not like science because it is not applicable; so teachers need to make it applicable. Science isn’t fun anymore. All these tests and concepts students have to learn makes it difficult. Science isn’t about what intrigues the student.

They learn what the state determines should be learned. Curriculum guides leave no room for fun and intrigue.

This left Brenda with feelings of increasing pressure that her students' performance on one test could completely misrepresent her whole year long efforts to successfully teach them science.

No testing would certainly allow the fun back into schools. It is so frustrating to come and think about the test because that test will measure my efforts as a teacher. This is the first year I have had eighth graders and one of the most stressful things has been the [state mandated end of course exam]. It has caused me to stress and some levels of anxiety because at times I feel that this test will define my abilities as a teacher.

This pattern of following the curriculum guide to prepare students for “the test,” also created students that were “very needy” for the teacher to “spoon feed” them content in chunks that they could easily be memorized and regurgitate. Brenda states that “one of my biggest struggles is getting kids to think outside of the box and find answers on their own.” All that mattered to her eighth grade students, however, was the correct “answer” and they wanted it whittled down to only that. This was a systemic issue that Carol, Maddie and Brenda could console each other on as they completed their courses. According to the reports of these three classroom teachers, their middle and high school students had become complacent with the current learning model represented as a standardized multiple choice test score; it was no longer about building knowledge.

Brenda was working to complete a master's program fresh out of her own undergraduate degree in education. She had little teaching experience and was relying on the mechanics of classroom

management and teaching strategies she had been taught in her classes as she taught her first middle school classes. In her own admission, she was struggling with working with her own “inner city” students. She “felt that teaching was an art that takes experience and knowledge” and that “not everyone can teach.” Brenda’s mandated middle school curriculum covered a wide range of materials and much of it her students couldn’t relate to and found to be boring. She found the key to her success was to make science content relevant to her students and she could engage them in the material that was in the curriculum. However, she was afraid to try strategies that didn’t meet the curriculum guide or that potentially could be too time-consuming or that would challenge the students to think critically.

For Brenda, the ISI certificate program did three things; introduced her to new content material that could help make her curriculum relevant to a variety of learners, provided her with a greater familiarity and understanding of informal science institutions, and encouraged her to use more inquiry based strategies in her classroom.

The Environmental Update course provided a great exploration into global climate change and current marine science research for Brenda. With a background in teaching biology, she states that she had to step out of her “comfort zone” and “move into new areas of science education.” This course did that for her as she explored broad thematic concepts like climate change and how it ultimately impacted public health. After listening to several webinars created by the United States Center for Disease Control (CDC) on the potential health risks that could be increasing as a result from climate change, she states that “these webinars have really reshaped my thinking.” She supports this by stating that her baseline knowledge of “global warming” was only about Al Gore and *An Inconvenient Truth* and shrinking ice caps due to an “influx of carbon dioxide.” Brenda never envisioned a connection to how increasing heat and tropical diseases could

negatively impact human health. In a journal assignment Brenda says this new deeper understanding showed her that climate change permeated everything.

Adding this journal has opened my eyes on the impacts of climate changes from a public health perspective. When I think of climate change I think of ice caps melting, heat waves and rise in sea level. HIV/AIDS, malaria, and malnutrition are the terms I think of when I think of public health. For the first time in my collegiate career I am introduced to this perspective that they are connected. I am adding new awareness of how climate change impacts nations globally.

Global climate change is not just a surface level circumstance. Climate change goes beyond **An Inconvenient Truth**. Climate change isn't just about polar bears and hybrid cars. This change goes beyond what you see in the news. What is happening as a result of climate change is about human beings' lives and existence.

This big picture awareness immediately triggered ways in which she could “bring the new knowledge into the classroom” as she could see how this could be a hook to engage her students into how climate change impacted them directly. She was starting to see a vehicle to teach huge abstract concepts that affected each of her students in her city daily.

Before this program I didn't know what an ISI was or meant. I came in with so many preconceived notions and misconceptions about informal science education. This program has opened my eyes to the dynamics of classroom teaching, learning styles, and methodology. I have truly been renewed in the area of informal science education.

Brenda is clear she knew little about informal science institutions, and what she initially thought was flawed. To her, ISIs were dry museums or dirty science centers that were to be used as days out of the classroom as a fieldtrip for fun. At the beginning of the certificate program, the learning opportunities provided by these informal settings were not evident to Brenda. She had little instructional time she could sacrifice to field trips that did not directly support standards based instruction. In reading the case studies and viewing examples of the varieties of ISIs, her interests were piqued, and she began to explore these community resources in her own area. She visited a nature center on her own to create her own case study for a class assignment before returning later with her husband for enjoyment. Brenda soon found opportunities to volunteer and locations she would later take her students. “The program has changed my perspectives on field trips, off-site explorations, and classroom activities. I am now comfortable in the area of planning and developing fieldtrips to ISIs and creating hands-on classroom activities that connect our trips to the curriculum.” With an introduction to ISIs and their benefits, Brenda soon found ways to confidently integrate these community resources into her classroom that could build on her emphasis on standards, while providing engaging ways to connect her students to real world learning.

Brenda also took the opportunity presented to explore different inquiry strategies. Brenda states that “science teaching that is riveting, life changing, and impacting takes a paradigm shift into student-centered, inquiry-based and expeditionary learning.” While she believes inquiry is a great method of instruction, she worries that “inquiry as a technique” can draw a lot of fire in the “high stakes testing, standards and attempts to ‘teacher proof’ curricula’ world. She explains her concerns with trying to teach through inquiry;

High stakes testing, whether we like it or not, is what school districts are pushing for. This type of testing plays a major role in our curriculum. I feel that sometimes I don't have time to let my students run things. I am more concerned about the knowledge attained and how they test. I am struggling every day to teach my students how to attack a question and how to use the process of elimination. I don't mind being a facilitator but how much time is it going to take? How long do I have to be a facilitator? I have so many standards to cover and concepts to teach that time is always limited. My teaching time is so precious that I will admit that sometimes it is much easier to be the director than the facilitator.

She is right to be nervous about teaching differently than her peers in this time of teacher and student accountability. Her perception of limited time is also a very real concern with a curricula that she agreed was "a mile wide and an inch deep." However, she was missing the concept that inquiry could be a progressive release model she could gradually empower her students and didn't have to always "let them drive." This was a huge realization for her as it freed her to be more exploratory in her teaching methods and confident in doing so. Brenda states;

"I will admit that one of the misconceptions I had was that inquiry was a free for all teaching strategy. Over time I learned that inquiry can be guided and structured, making the learning comprehensive and impactful. The teacher sketches and designs the blueprint in which the students build upon. In the beginning, I will admit how I struggle to let my students take control and responsibility for their learning."

A critical and potentially compounding component that ties directly to Brenda and her self-described paradigm shift to inquiry based strategies and the use of ISIs, is the role of professional experience and wide ranging content knowledge. Brenda viewed teaching as an art that is mastered like a trade over a time. She felt that as a person progressed through his/her career, he/she must continually improve personally with expanded, current content knowledge, ways to connect with youthful students, and building a comprehensive toolbox of pedagogy. When she started the certificate program, Brenda had “survived” her first year teaching and was progressing in her career through year two into year three teaching. Although, she was teaching new grades and subject matter, she was gaining comfort through experience and was being able to supplement what she was doing in class with a support group in the cohort. She especially bonded with Carol who regularly offered her support in the online forums and in journal responses. In these ways, the ISI certificate helped her by providing her the growth in content knowledge she could immediately use to make learning relevant to her students, improved her “toolbox” by refining and making comfortable the use of inquiry based strategies in her classroom, and opened the door to ISIs that could provide lifelong learning and enjoyment for her and her students.

Carol

Carol came to the cohort in the fall semester of 2010 where she and Brenda both took the first and second courses simultaneously. Chronologically, the first course was offered in the spring semester of 2010 before being offered again over the summer, especially for Ronnie and Mandy. This iteration of the methods course that Brenda and Carol took built on the materials generated and refined by all participants to that date, as well as their own additions.

Carol was an alternatively certified middle school science teacher with over a decade of experience working in a large, rural school district that had fully and openly embraced the accountability movement being pushed in Florida. This schoolroom context included a shift to state standardized testing, multiple changes in state and national science standards, and the beginning of high stakes accountability for students, teachers, and schools that directly impacted student retention, teacher pay, and school funding. This created, for her, an environment where she felt the art of teaching had been removed, while she had been pigeonholed into teaching to standardized tests through a very narrow interpretation of the state science standards.

The state of her school district pushed her to go back to school to complete a Masters in Secondary Science Education. To complete this degree, she took an educational leave from her school to take graduate classes full time in the final course of the certificate program in the Fall Semester of 2011. She also completed a certificate to teach high school biology and anticipated either going back to her school to work on special projects, or to shift to teaching high school as well teaching as an adjunct professor at the nearby community college. Her undergraduate degree was in environmental science with an emphasis on chemistry and biology. During the ISI certificate program, she was one of the oldest course members, in her forties, and was married with two sons.

At the beginning, Carol was very timid in submitting her opinion and questioned how she did everything, because she wanted to do what was right for the professor. She was gauging her responses to what she thought would make her look the best, rather than trusting in herself and putting out her best product. She states; “I can remember beginning the course work very unsure of myself and not accustomed to the open ended assignments we were given. I was emailing the professor for reassurance the first few weeks to be sure I was on the right track, very worried that

I wasn't giving her the type of responses and work she was looking for. Of course, she kindly encouraged me to keep doing a great job.” Carol felt that her initial “responses were slow” and that she was “a little hesitant to put my thoughts and comments out there.”

Carol found her groove in the program through this metacognitive reflective assignment at the midterm of the first course: In the assignment, she and her fellow students had to take a look at their own work, the work of their classmates, and judge their meaning making in the class as well as their own effort to be an active learner engaged with the materials and their classmates. “I upped my game and I really understood the expectation for this program after that” assessment, she reflected. She goes further, “I went from being unsure- to being quite self-assured in the work I present currently in this program and feel confident that my comments and questions posed to my peers in the course is meaningful and something they need to hear.” This reflective activity, repeated throughout the entire program, expanded her world view and supported her growth as a learner, participant, and as an active resource as a formal teacher working in the trenches of a public school system in this cohort. By the end of the certificate program, Carol saw herself having completed her own “paradigm shift.” “I think being immersed in the program for over a year really let me embed the concepts we learned and understand what it means to be not a ‘teacher’ but a facilitator of learning to all people in different forums of science.”

As she finds the freedom to express her opinions in the class, Carol’s role of the school teacher comes across as very contrarian and caustic at times to other participants. Her responses to new or different approaches to teaching, like project based learning and service learning, or opening up her class to more student-centered and open-ended inquiry methods, are all rebuked and left at the side as “too time consuming”, or as methods that would never work in her school system under the current restrictions. As dismissive as these broad-stroke statements sound, Carol was

not saying that these methods were not good. She was stating that under the current system, they would not be allowed to work successfully. The perceived negativity and her overall demeanor is a byproduct of massive changes in Carol's perceived role of a teacher and good education; she sees a shift from what she saw as good teaching for her to learn science as a youth to the current system within which she was teaching.

I think back to my school days... really not too far ago, at some of the struggling schools I attended, and I thought I was learning pretty good science. In fact the science was better to me then compared to some of the science I see delivered now. I wonder what happened in that gap? I think before we had curriculum maps, my experience was that teachers were doing more inquiry and service learning. Then came the standards to be sure everyone was learning what they were supposed to, and the perceived freedom that sparked hands-on activities dwindled and the lessons became canned. Now, we are trying to fix the mandatory teaching curriculum with inquiry and service learning and teaching the teachers how to do it.

In peeling back the layers, Carol is struggling to find her identity in the educational accountability enterprise. She sees the shackles of curricula and pacing guides coupled with district mandated teaching strategies greatly impacting her ability to teach to her strengths as a professional educator who is capable of making sound decisions for the betterment of her classroom. She complains the needs of her learners and what good teaching is all about, has been forgotten because of the forced mechanics of scripting out her teaching to meet the content standards being implemented by the state and all of the requirements of her teacher evaluation system forced upon her by her district.

When responding to reading the National Resource Council's **A Framework for K-12 Science Education: Practice, Crosscutting Concepts, and Core Ideas**, Carol boils down the problem of implementing the recommendations from the NSES and NGSS to them being "undermined by having standardized testing and pay for performance related to student test scores (my district). The gov't must realize that the true STEM instruction is just not compatible with standardized tests and high stakes for teachers with the pay scale." In her opinion, a teacher has a key decision in designing his/her teaching game plan; "Make sure a student can answer a set of test questions designed on a 'big idea' or cultivate innovative thinkers who ask questions to which there is not an answer yet." She goes further in accurately stating, and echoing Maslow's Hierarchy, "Teachers are less likely to take the risk of empowering students to learn in such a holistic way when their pay and job depends on it, can you blame them for sticking with the safe thing that ensures good test scores?" Ensure job security and high pay by "teaching to the test" or stand to lose your job in a rough economic period by creating critical thinkers who may not score as well on the state tests. That is the quagmire in which Carol found herself.

The decision of the teaching approach is complicated for Carol. As she digested the materials of the certificate, she reflected back saying, "I can say I fully embrace teaching science by hands-on, minds-on, and application with problem solving. Although I have always thought of myself as an excellent listening learner that could study notes and listen to a lecture and pass any exam in my younger years that I attended school, I question now if I could have used the critical thinking skills and applied that knowledge in a real life circumstance years ago as an "A" student." Her students lack the components of life experience and the wider framework for building deep connections she felt was critical in building a curriculum driven by inquiry and problem solving. "I feel that I can now, but this is due to the ability to assimilate information

differently as I have much academic and life experience under my belt. I will say that I believe the best practices of formal teaching of science are undermined by the FCAT standardized test.”

Within her quote, Carol also reveals an underlying ambiguity that further complicates her choice in teaching styles. She specifically states that she is an auditory learner who had an innate ability to recall from memory lecture and notes taken from things she heard. This skill set greatly helps Carol the student in her studies to be successful throughout most of her own formal schooling. Carol’s own accomplishments in this passive transmission style of learning led by the teacher clashes with the new approaches that empowers the students in their own meaning making. During the certificate program, Carol states that as a teacher she doesn’t get bogged down in what style she uses, because she used a blend of the teaching that she experienced as a student while incorporating it around the textbook and curriculum maps that the district was requiring, and supplementing as needed.

The reason I probably do not experience much of a difference is because of my methodology of teaching. The textbook and curriculum map have always been more or less a guide for me, not a bible. I have taught big ideas and a whole lot of extra ideas too, if I felt the students needed to know it. After teaching for a while, it seems that sensing what you need to teach your group of students becomes almost intuitive; the standards are the skeleton to put all the rest of the body of knowledge on.

Other issues Carol saw in teaching with the recommendations of the NGSS and NSES could be seen in the amount of content required to be taught in a school year and the political pressure for students and schools to succeed on the standardized tests. “There is no way to teach through the 5 E’s that is promoted by the district and get the high test scores that are required. The biggest

reason why is time, there is too much curriculum for middle school science to cover and do it in a hands on problem solving manner, which could take a week per concept. Eighth graders are tested on three years of science learning; however, it is the eighth grade teachers that have the testing year to be accountable. I believe the district knows this, but its hands are tied as well. The students must perform...so it is a 'don't ask, don't tell' if the students are making good grades, everyone is happy and you must be teaching the right way.”

Time, throughout the course, is an eminent component for Carol. It becomes an obstacle for her in the interconnections of her school, personal, and professional life that requires her to change her strategies to handle this delicate balance. She states repeatedly in her work that the time commitment of being a student is far greater than being a teacher. Thus, she makes a conscious and deliberate decision to put her professional career on hold and take leave from teaching to complete her master's degree by taking her graduate work full time. She comments “teaching all day” would be easier than taking a full course load of graduate classes. While she doesn't go into in any real depth, this also helps her to accommodate her family and personal life more adequately by taking out the time requirements of teaching full time. Carol also felt good teaching is time consuming. Under the constraints of standardized testing and completing a curriculum guide or pacing map, it can't be accomplished in public education.

Carol was greatly impacted by the ISI certificate program. She was disequibrated through the pedagogical materials she was being presented as it reinforced sound approaches that would promote scientific literacy and critical thinking skills for her students, but clashed with what worked best for her as a student and the requirements, and reality, of teaching within her public school district. This internal battle pushed her out of the brick and mortar classroom into a virtual school that gave her the freedom to create a learning environment “that lends itself to putting

learners in the driver's seat of their educational experiences." Unfortunately, this teaching endeavor didn't provide great enough opportunities for her to conduct the quality of teaching she expected. She ultimately left education entirely to work as a graphic artist with her husband.

Superficially, the ISI program provided Carol other minor benefits. She enjoyed the science content presented in the Environmental Update course, because it built on her engrained interests while providing material she could take back to her classroom to provide "real world examples" her "kids could get." She also saw value in the varying personalities and the networking of working with the cohort. This encouraged her to get more active in professional organizations like the National Science Teachers Association and community groups where she collaborated on various projects and presentations with several of her program mates.

Mandy

Mandy came to the certificate program late, joining during the summer before the second semester. She took the first course alone interacting with the professor and postings previously uploaded by the cohort in Blackboard, while simultaneously taking the second course with the cohort. She came to the group, under recommendation and encouragement from a participant of the original face-to-face program as an experienced informal science educator (ISE) who had worked in various informal science institutions (ISIs) including a zoo, a science center, and her current position with a county parks, recreation, and natural resources department. In this role, she was an education and volunteer division manager coordinating various nature centers, volunteers, and educational staff conducting programs for schools, stakeholder groups, and the public. She developed and conducted educational programming, served as liaison for the county

with other groups and organizations, and helped to design and implement exhibits in the nature centers and parks throughout the county.

Professionally, Mandy worked for a County Natural Resource Department as the manager of the Education and Volunteer Division. The Division was responsible for connecting the public with the County parks and preserves through their nature centers, general public, targeted interest groups, and school and homeschool programming. Her duties included creating educational programming like nature walks, Pre-K Mom and Me classes, fieldtrip activities for school groups, developing events catered to groups that wouldn't normally use the parks (like art classes and therapy groups), managing paid staff, volunteers, and interns. She also was responsible for exhibit and signage design for the nature centers. Additionally, she represented the Division on various partnership initiatives and committees for other conservation groups like the National Estuary Programs which functioned in conjunction with her preserves.

Educationally, she grew up in a public school system of a coastal southeast state before going to a Liberal Arts college for a Bachelor's degree in biology and to work in the fine arts. She fell short of a minor in fine arts specializing in scientific illustration. Mandy then went to another university to complete a Master's in environmental education. Her interest in this Master's program was born from her desire to share her love of all things natural and educate without having to go into a formal classroom environment. Both of her parents were teachers and her mother helped craft the state mathematics standards and helped write the mathematics section of the statewide assessment test. She never wanted to go into the formal classroom to teach as it felt restricting and would curb her creativity and not allow her to teach to her abilities. Mandy's parents also made her promise she would never get sucked into the classroom itself. When she entered this ISI graduate certificate program, she had a desire to pursue a doctorate. The

investment of time in the degree as well as balancing her personal life and a career in very turbulent economic times with looming threats of layoffs, ultimately led her to not go on for the Ph.D. after the certificate program was completed.

She had very diverse interests: Some of these included the environment, science fiction and fantasy, video and role playing games, belly dancing (she performs and teaches), gymnastics, physical fitness, martial arts, annual global world travel, as well as a keen interest in the Orient and Asian cultures.

Mandy showed great creativity and motivation to fully engage in the open-ended assignments, regularly going above and beyond requirements and infusing extra resources and materials. She was consistently excited about the work at hand and tied the materials from the classes to the work she was doing in her job and in her personal life. This created a cycle: She conducted the pre-write assignment to gauge her previous knowledge, did additional research to explore what the readings or videos could be about, completed the readings or videos and supplemented them with further materials, and then reflected back on how this new knowledge fit into her cognitive framework. She created continuous dialogue with other classmates in the weekly online discussions incorporating what she was taking from the community of learners as well as leaving an indelible image that others took back into their own lives. This weekly cycle expanded further as she very quickly began to take the materials and personalize them to her life professionally and personally.

Mandy functioned as an artist would with a pallet full of raw materials in front of her. She pieced through the materials she had in her existing knowledge and experiences, sorted through the available resources in the ISI program's Virtual Resource Center, cobbled in the additional

supplies found available from quick research, and crafted her meaning making into this work of art. As an expert artisan, she reflected back on the work, polished the rough edges, enhanced the finest details, made it her own, and shared her masterpiece with others.

Mandy repeatedly explained how she made sense of the assignments. For example, during a weekly assignment discussing the International Program for Climate Change (IPCC), she states “Absolutely the only familiarity I have with this topic is via Maddie’s [pseudonym] report from last week. From reading her report, I gathered that this program created several resources about climate change....This topic will definitely require further study on my part.” This does not dissuade her. She sought out the IPCC website and began to explore the available resources in the sections relevant to her, including the Press Room and Outreach Sections. This was above and beyond the readings available in the program.

Next, she connected the material from the IPCC report to material previously presented relating to climate change and human health. She stated,

I was aware that there was a health element, but like many people in this class probably did not have the best idea of just how great of an impact climate change could pose to our health. I certainly could not guess just how many different ways the issue could affect us - heat waves, air quality/asthma, pollen allergies, even ticks! So, clearly there’s a huge impact on human health and a connection to the health sciences.

She then took this realization further and tied the material back to previous courses when she said,

It's become clear to me, at least, that climate change simply must be taught and researched in an interdisciplinary modality. There are far too many connections to this issue to make it a function of any one branch of science or study for that matter. I keep picturing it like the concept maps we learned to make in the very first course in this certificate class.

These realities, as Mandy put them together, were brought back to her job as she “could definitely see generating further interpretive work, either in the form of signage, online exhibit/pages, or paper media that would expound on this connection further.”

Her interests in informal science institutions connected her free time to class assignments while she over hauled her work. Her interests also built a model in which these three large realms of her life came together in synergy, and created time for her to balance things. She visited museums, nature centers, zoos, and aquaria with a new eye to details she previously had not considered. Even as a person who spent large amounts of time in ISIs throughout her life and across the world, Mandy now delved deeper into their structures and found additional aspects she took from the ISI organizational cultures, programming, and exhibitry. In the context of the classes and class assignments, Mandy also learned about the formal education enterprise. She gained insight into educational structures of standards, standardized testing, and the culture and expectations of classroom teachers. She learned the “educational languages” and became adept talking with teachers, understood what they were looking for, and determined how best she could structure what she was doing for her job to meet their needs. This came from both reading and learning from coursework and also from getting to know and networking with formal teachers in the cohort. These things became the context for her changing how she did her job and led to

great success with her coworkers and superiors. It brought her recognition that encouraged her to continue blending what she was doing.

Examples of her fusion of personal life and course assignments were visible in a variety of places throughout the program. For example, she read *An Ocean Blueprint for the 21st Century* (U.S. Commission on Ocean Policy, 2004) in the Environmental Update class and connected it to an ecotour company she used while on vacation in the Galapagos Islands and their conservation messaging. Then she wrote about the connection in the class discussion board. She combined the conservation messaging and a partnership with one of the local ISI tour groups that regularly visited her sites to sell her nature preserves for an assignment in social marketing for the class. She worked out the logistics of this project in class discussion forums. She thus provided a large infusion of materials and inspired other classmates to look at the impacts of ecotourism in their locales.

As part of her work focus, Mandy enhanced her partnerships with the school district to have her nature preserves, including their nature centers, serve as destinations for fieldtrips and educational staff as tour guides for the county's students. Mandy stated she had innumerable resources that could greatly help teachers and schools, but building the proper teacher and district buy-in was a difficult task. The District expected huge support from Mandy's Division and really overworked them. She specifically referred to the relationship as being "parasitic" and unsustainable for herself and her staff. She described the situation as follows:

This definitely got to be pretty taxing upon us because the demand was so high. When it finally got to be too overwhelming, we tried to move toward a more mutualistic model, though, as there were grumblings from my boss

and several of our Board members that this was not the role a County Department should fill. As the arguments that programs for public schools should be offered by, well, public schools grew louder and more frequent, we tried to think up ways to still provide great programs while also helping out the Department. And of course service-learning projects... [an instructional strategy learned in the ISI program]... was the answer to this conundrum. By requesting visiting school groups participate in a 1:1 ratio of educational program time to volunteer time, both organizations benefited from the trip as opposed to one reaping the entirety of the profits.

Mandy also found a huge gamut of teachers' expectations for those who visited her sites. These ranged from teachers who simply came to the sites and her programming to "have a day off from teaching" or to just "play in the kayaks and in the water," to gung-ho and engaged educators who wanted to establish long term partnerships to conduct full year or multi-year service learning projects. Others still wanted a "Chinese restaurant menu- type setup" for which they could pick and choose the activities and focuses they wanted. This great mix of desired relationships and directives from the school district left Mandy struggling with a way to accurately market what she could provide the teachers and appropriate expectations for these trips. These work issues emerged for her in the Community Resources class when collaboration was the curriculum topic. She ultimately developed the *Know Before You Go* brochure for her cumulative course project and used it to build better programming with her staff and the school district.

The program readings discussed a variety of forms of collaboration and sparked her curiosity to find if there were any resources beyond the professor's materials that specifically connected ISIs

and formal education. She found a Master's Project from the University of Oregon titled, *Collaborations between Art Museums and Schools: A Focus on High School Art Teachers' Utilization of Museum Resources* by Eunju Nam (Nam, 2009). This resource, while related to an art museum, echoed a lot of the issues she was having with her school district and her nature centers and supplemented the course materials very well for her. Nam's findings were right in line with what she had been reading throughout this course and included; Lack of awareness of museum resources, no strong dialogue between high schools and the museum, limited time for museum trips, transportation/parking problems, not enough money for field trips, difficulty in coordinating school and museum schedules, and that workshops not very well publicized (Nam, 2009). This echoed her current situation and helped reassure Mandy she was not unique in this dilemma.

She integrated the concerns from Oregon with her own experience to create an electronic survey assessing what her county teachers wanted from her preserves. The survey was uploaded to the class discussion board where it was enhanced with feedback from other cohort members. It was then sent to her contacts, and contact lists from the cohort, requesting responses. This collaboration brought together the perspectives of the classroom teachers and the resources of the other informal educators in the cohort to shape the survey, and in turn increased participation providing a diverse collection of respondents. From the results of this in and out of class effort, Mandy then began to shape a brochure that would help explain the intricacies of the programs she offered in a way that made sense to formal teachers while streamlining her work efforts.

Mandy connected her personal growth and job development in a way that enabled her to recognize herself as being an effective senior level ISI professional during a course discussion about progressions available in varied types of ISI positions. In essence, she explicitly saw the

ISI program as a direct benefit to her personal interests in the field. She could see direct correlation between the ways this learning experience tied directly to her job making her a more effective educator, while immediately improving her work products. Mandy then saw her work in a more holistic context than she had ever perceived it. She stated,

Instead, I was immersed in a world that went so far beyond what I already knew and really challenged me to expand my own personal perspective on not just environmental education but upon the field in which I'd worked my entire life. It may seem odd to say that I suddenly saw my own career field in an entirely new light, but that's exactly what happened. I truly experienced the paradigm shift where I no longer saw myself as an educator working to communicate a message but now understand how I'm part of a thread of interconnectivity that includes not only other IE's [informal educators] but also the formal educators and scientists who work alongside us.

She felt empowered by this new perspective in that she was not alone and was a part of a bigger global initiative. This program enabled her to see herself as a part of a larger enterprise. In turn, this gave her a larger stockpile of resources to be used in her setting. Mandy said,

By just having the opportunity to turn my brain on and specifically focus on informal learning, and how it was transpiring in my own little world at the county, gave me an exhaustive new expanse of material from which to work. That in itself made this class "worth it" for me.

Mandy gained a greater level of self-efficacy from the graduate certificate experience, which translated to a desire to share her skills and perspectives. This included a newfound desire to present professionally and to publish her writings that she never would have considered doing before.

Most of all, I am astounded by my sudden desire to reach out and bring information to others on a professional level. This is something that I absolutely have never at all been interested in doing before, although I regularly help my boss prepare presentations for use in workshops and conferences across the nation. It's just not something that's ever really interested me. But, after completing this course, I feel far more confident in my own knowledge and skillset and I feel that I have an important perspective to share. I have a new understanding of the roles of IE's, and a sort of insight into the communicative network we all must work better to form. I'd like to share this with our growing world, along with the good works and projects that my own agency has created, in order to build an active dialogue that supports communication and ISE practice improvement.

Study in the ISI program resulted in a new conceptual framework for Mandy. This new framework changed the perceptual screen she used to interpret her personal and professional life experiences. Her new cognitive mindset caused everything to start to connect to everything else. This gave Mandy the opportunity to experience the synergy of interconnectedness of a global paradigm. The interconnectedness enriched learning from life experiences and increased her enjoyment and satisfaction. The expanded knowledge was then applied to Mandy's job, which

stimulated creation of new job products and enhanced job performance. These products then were shared with the (ISI) cohort. The cohort's discussion of products contributed to more knowledge building that enlarged everyone's conceptual framework. Products were refined as a result of the cohort's discussion. These refined products fed back into Mandy's job leading to an increase in job satisfaction and job security.

Mandy integrated what she learned from the ISI program into everyday life (her life-long learning). The perceptual screen she developed in the ISI program emerged as a cognitive framework in which to integrate all she experienced. She expressed great satisfaction in doing so; and thus seamlessly tied three major components of her life together. The program peaked her interest. She enjoyed what she was reading/doing in class, which in turn provided opportunities in the workplace to apply what she was learning to the real world, and made her more effective and efficient. This in turn led to being able to have more time in her personal life to explore her interests, which infused back into her schooling and into her job.

Ronnie

Ronnie came to the certificate program looking to get involved in the Tampa Bay educational community. His wife is a very well renowned radiation oncologist from a very elite Ivy League medical program. This afforded him the opportunities to work part time and to go back to graduate school.

His background provides him a diverse history of experience. Born and raised in Puerto Rico, Ronnie grew up on the water. At seventeen years of age, he was kicked out of his house by an alcoholic father. He went to Boston on a sailing scholarship and completed a degree in marine biology. From there he went back to the Caribbean Islands where he served as crew and then

captain on a series of private yachts traveling through the South Atlantic and the Gulf of Mexico. He left the islands to complete a prestigious master's degree in aquaculture in California, with stops in the Florida Keys and Texas.

He met his wife in Texas. She had come to the United States from Mexico, and was working as a waitress while preparing to go to school. He worked to support her through medical school and her residency. While in Texas, Ronnie became an alternatively certified elementary teacher for classes of students who were predominantly English Language Learners. Many of these kids only knew Spanish, and he could connect easily with them through his own Hispanic background. He felt very empowered and built relationships with families he taught that he maintained over the years and cross-country moves. Ronnie left teaching in Texas when he and his wife had to relocate to the northeast U.S. for her medical schooling. This led him to a change in career fields to selling computer software packages to large corporations in the height of the IT boom. Ronnie also, worked with existing customers, offering prepared training sessions to employees of the companies who bought the software. A very social person, Ronnie could talk to anyone about anything and was excellent at building relationships and salesmanship.

Eventually, Ronnie and his family moved to west central Florida for his wife's job. She was widely sought after and actively pursued for her skills by medical corporate recruiters. Ronnie sums up his initial entry into the job market in Florida as humbling and downright discouraging to him.

My first year was very difficult in terms finding employment. I was a substitute since it was nearly impossible to find a full time job as a teacher. Then I was lucky enough to find a position as an Adult Education Bilingual Teacher. During

these past years, my intention was to find a job in the scientific field. I have a degree in marine biology, but I hadn't been a biologist for 15 years. I applied countless places and spoke with scientist all over the area. I received many rejection letters and most of the time I didn't even get that. I realized that the region got hit very hard by the financial crisis of 2008 and true unemployment was probably upwards of 20 percent. I was lucky enough to find a field of study that combined my two interests in life teaching and science. ... I think that after two years of looking for employment in the field of science and constantly being rejected I had resigned myself to not ever returning to science. My knowledge of professional career positions in science is tainted by the lack of opportunities I encountered over the past two years.

Ronnie found employment in Florida working part time as a substitute teacher and volunteering for a couple of non-profit organizations that helped newly emigrated Spanish speakers adjust to life in the United States. Through these efforts, Ronnie taught night school for adults of all ages, specializing in English and courses designed to get General Education Diplomas (GED) for his students. Ronnie described his work as “a Bilingual Teacher” teaching both English and Spanish because there were many “Latin Americans in need of an instructor who can help them move forward with their acquisition of the English language. I volunteer my services partly because I do not want my teaching skills to become rusty and partly because I have a desire to help the community. I have made many good friends and I can say that I have changed students’ lives for the better.” He connected beautifully with many of his adult students and felt very close connections to them, often assisting where he could outside of the classroom. During the day, he took care of his daughter, including getting her involved in community service so she could see

how fortunate her family was. This lifestyle, having his family supported by his wife's excellent career and working minimally, left Ronnie looking to improve himself and to help establish his own professional identity again after sacrificing his careers on several occasions.

Ronnie came back to school to work towards a master's degree in education, and as an intended byproduct, built relationships that lead to a job in which he felt personal satisfaction. Ronnie was vaguely familiar with Informal Science Institutions from his own visits to various types like parks, museums, and aquaria, where he greatly enjoyed the recreational aspects of these environments himself. Here in these ISIs, he states that he learns through the experience of "doing stuff" but that he really had no idea of the full range of opportunities for science learning they could provide. This lack of knowledge, and his own classroom experience, had built for Ronnie an "ambivalence" for ISIs as some could be "extremely lame and foster the individual's indifference to their science education." Despite this duality, he saw there was huge potential for the right ISIs to help formal education in providing expertise and/or materials to schools during and after school. More importantly, he repeatedly points out that ISIs like parks, nature preserves, zoos, or museums provide a gigantic hook that can grab a person's enthusiasm, and with it, their interests into learning more. That interest built in doing and seeing in ISIs should be supplemented with formal learning in a hand and glove relationship between the ISI and schools.

Hands-on, minds-on activities were a huge key for successful teaching for Ronnie. In his elementary classrooms, he found that building a "lab," somewhere he could engage students with concepts concretely, led to the best and most long lasting knowledge making. When he had the opportunity and support from his administration, Ronnie poured substantial amounts of his own money into the classroom to equip it with live animals and resources to create these labs and

hands-on activities. This carried over to his adult language acquisition classes as he could ground the classwork in real world learning that greatly facilitated their transition into effectively using the new language, culture, and skills they were experiencing. He also had the opportunity to work in a school environment driven by standardized testing in which his “first principal constantly threatened to fire teachers if her ‘skill, drill, kill’ methodology was not implemented.” This was an environment that he knew he couldn’t survive as it clearly contradicted what he knew to be right and how he worked best with his students.

It became clear as Ronnie completed the first course of the ISI program, Methods for Interpretative and Transformative Standards Based Education, he was truly a marine biologist who had been alternatively certified to teach elementary school. He innately knew how to work with students and was trained under the fire of his alternative certification program in the classroom, but he was missing the theoretical framework for why these educational methods worked for him. At the time of this course, he was also taking an educational psychology course that added depth of knowledge of theorists like Piaget, Vygotsky, Dewey, Skinner and others that he regularly connected back to the coursework of the program and to his own experience. The blending of these classes with his frames of reference revealed to Ronnie that he felt he was a social constructivist who saw education as a learning enterprise that built on the individual’s prior knowledge, their cultures and interests, and the material to be learned. The combination of these courses connected the dots for Ronnie and allowed him to begin to see value in creating environments that could build on the interests and the unique individuality of the learner in classrooms or in ISIs.

During this time, Ronnie was encouraged by the certificate professor to attend a workshop that was presented to a group of local schoolteachers by a national service learning company that

connected community resources with the formal classroom. She felt this workshop catered to Ronnie's interests in real world learning grounded in concrete experiences while presenting a project based strategy that could be integrated into the classroom around the required curricula and science standards. This workshop also illustrated a nonstandard ISI that did not have a concrete location, but travelled to schools and served very specifically to support teachers who built environmental projects driven by their students' interest and desire to improve their community. The course professor utilized this organization's service learning process and a case study of this nonprofit itself, in the certificate program to illustrate the work that was being done in the communities around the university and across the country. This workshop also introduced Ronnie to the organization which would soon hire him.

Ronnie attended the workshop and was blown away by what he saw. "This gave me a firsthand look at everything I have been reading about over the past few weeks. I did not have a clue what Service Learning was. I thought that we were going learn how to train teachers." Instead, Ronnie saw a method of professional development where the instructors mimicked the process the teachers themselves would conduct with their students once they returned to the classroom. Over the course of the three-day workshop, each teacher developed and completed a service learning project. This allowed them to experience what their students would do, while the presenters modeled the role of a teacher as a facilitator for them. Ronnie came away very enthusiastic and had to try this teaching strategy himself with his night school students. He ultimately set up a small service learning project working with a local food bank to gather food and clothing.

Just about everything taught in the Earth Force in-service was brand new to me.

During the in-service, my boss's boss asked the presenters about the program. I

took it as an opportunity to tell her that I would be very interested in involving my

ESOL class in some service learning. I know this is a reach from teaching science, but I am sure that we can use the methodology and apply it to our situation. The class is given at the Family Resource Center every Monday and Wednesday night. I have initiated the program and we are currently looking for a specific project to undertake. I knew that the first time I did this would be the most challenging. The students are all very excited about service learning so we are off to a great start. However, my goal is to have the students interact with others purely in the English language. EVERYONE in the area speaks Spanish! I can go the entire day over there without speaking a word of English, no problem. Servicing a community that speaks Spanish as a first language and expecting my students to practice their English at the same time is a challenge.

Through his participation in the certificate program and his attendance at the Earth Force workshop I had conducted, I got to know Ronnie, his very diverse background and his enthusiasm for working to build real world learning. When the opportunity arose around the end of the second ISI course, I was able to hire him to work part time with me in Earth Force. In this ISI role, Ronnie got to work with about twenty teachers providing them the resources they needed to successfully carry out their service learning projects with their classes. I also took advantage of his experiences as a salesman in corporate America and his willingness to delve into possible partnerships to gain funding and support for the community building work we were conducting in Florida. Both of these roles required him to become familiar with all of the community resources of the region and be able to pair them with the teachers he was supporting in the classroom. Before the fourth course began, Ronnie's wife accepted another job opportunity in central Florida, about an hour away from where we were working, causing him to

uproot again and commute back and forth to work. We worked together for about a year before Earth Force downsized Florida operations during the final class of the certificate, and did away with my position. This left Ronnie to support all operations in the state alone. He only stayed the remainder of the school year before he left the organization to seek a job closer to his new home. He worked briefly as an ISI educator for a large marine theme park near his new home before returning to the classroom as a middle school science teacher.

Ronnie stumbled into the ISI certificate program. He had gone to back to school in hopes of completing a master's in education when he came into contact with the professor of the ISI program and was intrigued with the role ISIs could play in educating kids. Ronnie says;

I had never heard of the phrase Informal Science Institutions, much less how they could play an essential part in modern (high stakes test driven) public education. The possibility that they can fill a void that has been created artificially by political means is both exciting and gives me great hope. The last class I took allowed me to take a totally new prospective on Informal Science Institutions. I am a Science Lab addict. Informal Science Institutions could possibly substitute key elements that have been cut out of modern public school science classes. I first heard this when I started class, maybe I'm wrong, but it may be possible to have inquiry driven science classes at these institutions.

This enthusiasm matched innately with his desire to build learning labs in his former elementary classrooms and his efforts to build real world opportunities for his adult night classes.

As Ronnie progressed further into the certificate program, his awareness of what an ISI was and how they could be of use to classroom teachers grew tremendously. Ronnie quotes Charlie Brown in admitting “the more I learn, the more I learn I have more to learn.” Through his reading of course materials and his own exploration out into his community resources, Ronnie’s new perspective “has expanded what I now consider an Informal Science Institutes. This allows me to consider many more institutions as Informal Science Institutes, which in turn gives me the awareness that I did not have before to look for a partnership.” In redefining a resource that Ronnie previously dismissed as “lame” was huge for him as an educator. He states; “I believe this to probably be of the most use to me as a teacher. It allows me to look at these entities whereas before I would have never even considered them. This consideration can translate to a richer learning experience for my students and myself. Making me aware of these possibilities not only helps me as a teacher but can potentially have an impact on students’ lives.”

Beyond the ISI facilities, Ronnie also gained a new perspective on ISI staff as he saw some of the high quality products they could produce across the country and got to see firsthand what they could do. In reviewing a curriculum on climate change, Ronnie compares what he could put together in his classroom to what he found prepared from a renowned ISI, “They turn the curriculum into a real scientific experience, as opposed to a recipe. I think of some of the labs that I had with my students and in college and realize how “cookie cutter” some of them were. By collecting, looking, analyzing and discussing it with others, students can become comfortable with the process, increasing chances that the students will enjoy future scientific endeavors.” His perceptions of ISI staff as just “old Hippies” or people “who couldn’t do science” was completely overhauled as he began to uncover these professionals were highly skilled and very competent in their fields.

Ronnie's perception of ISI staff members as subpar seemed to emerge from his grad school experiences working on research side by side with people who had no formal schooling in what he was studying. He points specifically to spending a summer observing and recording whales and having the "old guys without a degree" serve as guides and boat captains that helped him and the other researchers. In looking back at this time in his life, he realized the guides working with him had gained great practical and applied knowledge of the whales he was researching by being in the environment and studying them daily out of their own interests. They were committed beyond the summer study program Ronnie and his classmates were enrolled in and were experts despite the lack of a science degree. He realized he had been working with ISI staff members serving as guides for his research activities. They were uniquely qualified for this role because they knew the whales innately and could locate them each day from repetition and having known the whales' individual patterns of behavior and personalities. These "uneducated wharf rats" working for Ronnie and his classmates, were really an untapped expert resource that were dismissed because they lacked the official degrees to support their experience on the water with these animals. The elitist superiority of his youth, feeling better than his guides because of "his education," left him in hindsight feeling like he missed the opportunity to deliberately learn from the experiences these gentlemen had to offer.

This retrospective on his whale research experiences also made him look at his own education in a new light. Ronnie began to see that education, good education, was more than just completing worksheets and being able to regurgitate facts. To him, his biggest realization was that his educational experience had failed to prepare him to be a scientist. His true learning was by "doing science" that he experienced working as a marine biologist.

I had a very negative view of the possibility of learning at an Informal Science Institute when compared with the formal education that I had received. This despite the fact that I had personally benefited from instruction at an Informal Science Institute. I was able to remove the stigma I had associated with Informal Science Institutes and replace them with the respect they deserve and the possibility that ISI's will give students a chance to learn science using much more successful and research proven methods. I have realized that in some cases I have an education that involves little more than memorization.

He had completed his readings, done the homework and class assignments for his science degrees. However, none of that was as useful as the knowledge he built by completing the research himself. He knew intimately the life cycles of conch from raising them himself. He could identify types of whale songs by listening to them from experiencing those sounds on a boat in the middle of the Pacific Ocean. Despite years away from being a marine biologist, his knowledge was fueled by what he had done, not what he memorized. This realization was reinforced again by watching his daughter learn and succeed in school in many of the ways that he had. Ronnie says; "this was made more obvious when I helped my daughter with her science homework. We did her homework and I am sure she will have no problem recalling the definitions on test day, but was there any meaningful learning involved?" Ronnie felt that the most important learning he had was by doing and that ISIs could help reinvigorate education with more of this action in the classroom.

As Ronnie progresses through the certificate program, and becomes an ISI educator himself, he begins to see a great need to provide more opportunities for meaningful learning in the classroom. He and the cohort members begin developing ideas for creating an "ISI liaison" that

can help bridge ISIs with the formal classroom teachers. Working for Earth Force had helped him find very applicable resources and ways to get the experiential learning into the high stakes testing driven classroom. Ronnie knew it was possible, but this liaison had to be teacher friendly and easily capable of meeting the needs of the formal classroom.

As part of a class assignment, Ronnie relies on his experience in the internet technology field and begins to build an application for smart phones that teachers could quickly use to cull through to find resources for their classroom. The design of the app would be set by him but would be maintained by the ISIs in real time, providing current information and advertisements of upcoming and available programming, guest speakers, materials and fieldtrips that the teacher could use. The idea of this app would be to serve as a meeting post or one-stop shop to bring the ISIs together with teachers and start to build ongoing, beneficial relationships between the two groups. Ronnie would hash out the initial structures of the app and the idea of it would garner great reviews, but the initial time and cost to have it built required a grant to fund the app's creation. He would take a grant-writing course through a local nonprofit, but would not secure funding for his creation.

Ronnie also worried that many other formal educators felt the same negativity he had towards their informal brethren working in ISIs and posited a way to improve that.

I have had changes in my outlook on ISI professionals. I feel that it would be productive to help ISI educators obtain teaching certificates from the state. I did not think it was very necessary until now. I do understand that you receive training in pedagogy when and if you obtain a masters' degree in Science Education. The certificate would give the ISI professionals a firm grasp on what is

required from a formal educator. This may even help bridge the gap between the two, as a sort of camaraderie can form in the classroom environment, during the certification process. A separate path formed for ISI educators exclusively would run the danger of further isolating the two careers.

While Ronnie now saw great value in ISIs and ways they could directly help improve the educational enterprise, he wanted to provide them the credentials that could improve their credibility with the teachers with whom they wanted to work. He felt building in an official teaching certification for ISI professionals would be one way to validate their expertise and provide a shared experience with their formal classroom-teaching colleagues. This would also provide an avenue of communication for both types of educators to have a common language and understanding of educational philosophy and pedagogy that would ideally create more seamless relationships and in turn lead to more meaningful learning opportunities nurtured by both classroom and community resources. Ronnie believed that this could be accomplished as an alternative certification program for ISIEs like what is conducted for science majors when they become classroom teachers or expanding the existing ISI certificate program with the appropriate classes into a Masters of Arts in Teaching program that would include a state approved teaching license.

Ronnie grew exponentially throughout the ISI program. He came into the program as a scientist turned teacher curious about what an ISI was and left as an ISI professional himself who was convinced education could be vastly improved by bridging the classroom with informal science institutions. He felt that ISIs lacked perceived credibility that alienated formal teachers overtaxed with standardized tests from willingly seeking out beneficial partnerships and meaningful learning opportunities. Ronnie knew that if the formal teachers could see the real benefit of

having ISIs help build active learning for with their students, education would be far more improved and all involved would find the experience much more meaningful.

Findings

This study was designed to evaluate the efficacy of the online version of the *Informal Science Institutions Environmental Education Graduate Certificate Program* and its efficacy in providing long term professional development for the formal and informal educators who participated in this program. The central idea in developing the Certificate Program was that by enhancing the skills of these educators they would be more capable of improving the science literacy of their respective audiences.

I used an emergent design to iteratively examine the student generated journals and assignments for the themes that surfaced throughout the four semester long courses to examine how participants were making sense of their experience and internalizing the learning opportunities. Initially, the questions that guided the study of the online program were “What is going on here?,” “What happened when informal science educators had opportunity to study in a formal graduate program consistent with the NRC (2009) report?,” and “How were the participants’ outcomes consistent with those described as necessary in the NRC (2009) report?”

Major Themes and Summation

As I examined each participant’s work, I began to develop a case study of each individual who participated in all four classes to tell their story. This allowed me to look in-depth at the growth of the individual while still capturing their unique personalities and circumstances that impacted them over the course of the program. Each person has his/her own history that impacted how

he/she made sense of what was happening to him/her that was critical to tell. In some cases, “real life” greatly hampered the individual with added stress, time consuming nuisances, or ground shaking catastrophes. In others, the circumstances led to greater ease in completing coursework, allowing them better opportunity to flourish than their classmates were afforded.

As the layers were peeled back through this emergent design, the data analysis generated four dominant research questions that impacted all participants;

- How did participants make sense of program content?
- In what ways did learners translate theory in coursework into practice in their lives?
- What factors impacted participants’ performance in the program?
- How did participants manage time?

While each individual participant is described in the case studies, commonalities can be seen across participants that address each question.

How Did Participants Make Sense of Program Content?

The program was designed to be a guided inquiry that allowed participants the opportunity to explore a wide range of materials centered on a weekly theme or topic. In some instances, students were given a specific question to think about as they read through and responded to the readings. In other cases, there was a range of materials that students could choose from and address. At all times in all assignments, participants were expected to conduct a quick write to describe their baseline knowledge of the topic before they read the materials and then explain what the reading meant to them and how they made sense. This was a structural design to help

participants explore what they knew and to metacognitively explore their own meaning making to encourage deeper connections to their lives. Students were always encouraged to bring in other materials relevant to the course topics or that connected, directly or indirectly, to what was being studied. This student generated material helped to connect the dots between the class assignments at hand to other components of the learners' worlds like other classes, what was going on in their workplaces, or in their own personal lives. In being personally relevant, and through reflection to prior knowledge, these assignments connected into each student's greater mental framework. This allowed each participant to be able to see how they were constructing their own meaning as they progressed through the certificate. With ongoing feedback from classmates and the course professor, students continually expanded and refined their journal responses through more informal asynchronous dialogue in the online discussion boards. Meaning making and knowledge acquisition did not stop when a page limit had been met or a series of questions had been answered with what the participant thought the professor wanted to hear. Additionally, the courses were specifically structured in this manner to model a differentiated, constructivist learning environment where a community of learners felt supported and secure to explore a wide range of perspectives where no one was above another, products could mirror the personality and needs of the learner's style, and the topics of the courses themselves could be flexed to pursue the needs and interests of all participating members.

Unfortunately, this course structure created confusion early on with some participants as many had little experience with a true constructivist classroom. This in particular seemed to hit those who had not had liberal arts focused education in the past. Specifically, the more science disciplined students were disoriented in there not being a cut and dry, black and white, singularly

right answer. One could not simply just “guess what was in the teacher’s head” and complete the assignment.

Carol and Brenda struggled particularly hard in the first course as they had never experienced anything like the courses found in the certificate program. Repeatedly, Carol sought verification and validation from the course professor that her work was on task and had worth. She felt particularly vulnerable as she and Brenda were taking the first and second courses at the same time with other cohort members who had already completed the first class and knew what to expect.

Mandy excels in the freedom of the course design as it allowed her to open up the class materials and directly connect them to her life out of school. This blended the work commitments she had to do with her academic learning with her vacations and methods of relaxation, making the learning meaningful and fully relevant to her. Because of this interplay, she regularly expanded her journals well beyond a specific recommendation of pages to include other materials that piqued her interest. She portrays a learner who saw an opportunity to build her mental framework to her specifications, moving pieces with well-balanced engineering coupled with the artist’s finesse of beautifully refining her knowledge base as she added to her mental mosaic. Her success could be attributed to being a person who thrives in between the precision of science and the whimsy of art, balancing a background in fine arts with the focus of someone who loves the natural world. She takes the best characteristics of being multifaceted and connects who she is with the course, personalizing the classwork to her needs and her interests.

Abbie approached the coursework from the perspective of someone who had been brought up in a challenging honors college that was multidisciplinary in its studies. She knew how to put her

voice in her writing and worked to produce a product that reflected her style. While thoughtful in her writing, she could be very set in her ways, approaching class materials with an attitude of “are these as good as mine” or “is this relevant to me.” This caused her to be dismissive on the surface to things that she couldn’t readily see fitting into her classroom immediately, while subconsciously incorporating the underlying components into her teaching toolbox over time.

Ronnie made sense of course materials in an eye opening overhaul of his view on ISIs. His initial feel was that informal science institutions were places you went to have a good time at, to relax. Over the course of the certificate program, he found a new definition of what these places were, while also shifting his perspective from ISEs as “old hippies” who didn’t know anything into a belief that these educators were a professional work force who had the tools to help really educate the populous to be more scientifically literate. These new views were huge for him as he turned himself into a community resource within an ISI to help provide support and materials to formal classroom teachers trying to complete service learning projects with their students.

Ronnie began to see how his own desire to build labs and hands-on activities in his former elementary classrooms was limited in scope by the resources of public schools and the accountability movement. Teachers like him were being boxed in by standardized testing and teaching to the test. Through his own pocket, he supplemented his classroom with materials and lab supplies to build opportunities for his elementary students to do science. He found that the ISIs could be the bridge to provide the required resources in and out of school to allow for learners to meaningfully interact with science content. To him, an ISI could be the key to building a scientifically literate society. Furthermore, as an alternatively certified teacher with a background in marine biology and science research in aquaculture, the ISI program brought him up to speed on educational philosophies and the pedagogical approaches, and terminology of

formal education. This helped him better communicate with formal educators as he could understand them from his own experience in the classroom as well as being able to speak their language.

Maddie made sense of course materials by finding reinforcement for doing education the way she felt was right rather than cater to the political structure of the standardized testing and evaluation movement. As she grew frustrated with pressures to “teach to the test,” the ISI certificate provided her a template for teaching success: Make sure the students are engaged in the materials and they will learn what they need for the test. Seeing new ways to integrate material that her students could relate to, or could experience hands-on, brought greater understanding for her students, which in turn instilled greater confidence in Maddie that her students would succeed.

In What Ways Did Learners Translate Theory in Coursework into Practice in Their Lives?

It is the ultimate goal of any educator to see how their students’ actually apply course content into their everyday lives. The length of the certificate program, over two years, allowed the participants to take course material and gradually experiment with it in their lives. Through the development of relationships among the participants in this cohort, walls came down, allowing individuals to freely share what they were doing and to collaborate among the group. This relationship building extended from the Certificate program’s intended goal of developing communities of practice that built a learning environment in which all participants could comfortably share without fear. As I delved deeper into each individual case, it was very apparent that each member was using course promoted strategies and materials, or were directly inspired by these, in their professional lives.

Abbie had built her science curriculum out of a lot of hard work at her private school. She had put a lot of time researching and securing materials she felt were good for providing a hands-on environment for her students and she was very proud of what her blood, sweat, and tears had built. As an alternatively certified teacher, she had taken only the bare bones minimum requirements for her teacher preparation program to secure her professional teaching certificate. This left her to learn to teach by feel and instinct. By entering the certificate program, she had hoped to find more community resources and assets that she could bring into her classroom. She did this by trying out various lessons that had been used to model inquiry or project based learning in the ISI courses in her classroom. The courses also provided Abbie confidence as she saw the curricula she was building was quality learning and she gained the research base and terminology to support why she was using the materials and activities she did in her classroom. Abbie re-envisioned what community resources could look like as she was exposed to new and different ISIs and reached out to new-to-her ISEs who could come visit her classroom or could provide technology, plants, or other resources she could use with her students. For Abbie, the program provided new avenues for her to explore and new contacts she could make to help improve her school's science courses.

Maddie really mirrored Abbie in how she applied course content to her classroom. She also was an alternatively certified teacher who had gained her teaching certificate through a teacher preparation program for science majors. She learned quickly that her students needed engagement and learning opportunities relevant to them to be successful. She had tried her hand at teaching as she had been taught, through rote memorization and lecturing, and soon found her students were unenthused about science class. Maddie soon brought the real world into her classroom to connect the student's everyday lives with course content. She found success in

these methods until the standardized test initiatives added fear of her students' failure to her classroom. By entering into the ISI program, Maddie built her confidence back up that by doing what she knew worked, making learning meaningful for her audience, she could teach her way and not "just teach to the test." This confidence encouraged her to reach out to a nearby aquarium and build an ongoing relationship in which she could bring her students to the ISI to conduct real science through collecting organisms and recording and reporting data. Through this community partnership, she was able to build on repeated field trips throughout the year by incorporating them directly into her required curricula with pre and post activities. She found she could substitute monotonous lessons with these trips and make science "fun again." Her teaching assignment changed for the next school year after the certificate program ended. The new courses included an opportunity for her high school students to gain college credit and consisted of a curriculum that directly encouraged her to incorporate real world learning and focused on marine science. Maddie was very excited to be able to blend her science background and enthusiasm with meaningful subject matter with which she could directly connect her ISI partnership. Through completion of the certificate, Maddie had regained her confidence she was a good teacher and the enjoyment in her career. She continued to complete her doctorate.

In Brenda's abbreviated writing, compared to the others in the cohort, she barely touches on how she's taking the certificate materials and applying them in her life. She states in several journals she is hesitant to try inquiry as a teaching strategy, because she only knows this method as open ended and "out of control". Brenda goes further to stress that she had too much material to cover in a very limited time to let students wander at their own pace through a lesson. Like the other public school teachers, Brenda is afraid that if she doesn't lead the classroom directly, her students won't know the materials they are responsible for learning before the standardized tests

at the end of the course and they will fail. This concern also ties to security in the profession as she knows she is going to be evaluated on the success of her students on this standardized test. Over time, especially in the Methods course of the program, she started to see that inquiry is a spectrum and can be teacher or student controlled. Brenda began to understand she can give her students some control of their learning as she leads a more guided inquiry, ensuring the coverage of the materials and a deeper understanding at the same time. She reported she is more comfortable with trying this guided inquiry, but never stated if she implemented this strategy. Brenda also gained a new perspective on ISIs and had gained comfort to attempt to take her students out for fieldtrips.

Carol came to the certificate program as a frustrated teacher looking to complete a master's degree in science education with hopes it would re-energize her work in the classroom. She too, had enough of standardized testing and demoralizing teacher evaluation systems that encouraged only minimal meaningful learning and a lot of methodology to do well on the snapshot state mandated assessments. She had seen a shift in the public schools in which she felt like she had learned better science as a student than what she was capable of teaching today. This push to narrow down content to "just hit the Standards" left her feeling empty and out of place. As Carol completed the certificate program, the course content came alive for her. She grew out of being unsure of her work and began to pursue promoting the work of the certificate program with several presentations at the state and regional science teachers' conferences. Carol knew in her heart she was no longer happy in the classroom under the current state of education and found the approaches she longed to teach were being advocated by a science education reform movement over thirty years in the making. The old paradigm of a teacher dominated classroom of student automatons regurgitating meaningless facts on a multiple choice test was not for her

any longer. She resigned her position in the classroom. At the end of the third course, Carol says;

I started this degree at a time when I am at a crossroads in my feelings about career goals and paths. This module has so far broadened my awareness of opportunities and also motivated my resolve to not go along with educational approaches and philosophies that I do not believe in. I have realized there are teachers that think alike (like me) and that I am not stagnant as a pawn to another's plan, but can be an instrument of change with the confidence of my education to support me. I think this has made the difference in my position, feeling and knowing my profession, but now I know the worthiness of backing it up and supporting/defending best practices.

She goes further to say the Environmental Site Explorations course really struck her with the content to the point she was changing the direction of her master's degree so she could better serve as a change agent who could make a difference.

I have been so excited by this class that I decided to take a step back and branch out to get my biology specialization as part of my degree starting in the fall. My goal is to now get myself in a collegiate position that can facilitate my ideas for change.

For Carol, completing the ISI certificate program had not just added tools for her teaching toolbox, it completely redefined her professional goals. She was empowered with the knowledge that she was not alone in trying to teach meaningfully for her students and soon wanted to

position herself to advocate for system wide change for the betterment of the students and teachers caught in an archaic standardized testing system and promote scientific literacy for all.

Ronnie quickly found himself with the opportunity to become an informal science educator tasked with supporting classroom teachers as they implemented the service learning projects about which he had only recently read. For him, integrating strategies promoted in the class jumped from the pages of the readings directly to becoming his job. With working for Earth Force with me, he found that it was critical to build relationships quickly with a diverse audience of stakeholders in a huge range of professions; from scientists to government bureaucrats, to educators working within ISIs. These relationships soon became the underlying skeleton from which he could provide the community resources; financial support, content experts, tools, plants, or other materials that the teachers needed for their students to successfully complete their environmental work. He was “the guy” that could get the things the teachers didn’t think were possible for their classroom or didn’t know were available. When not supporting classroom projects, Ronnie pulled on his corporate America hat and used his past in sales techniques to reach out to businesses and other organizations that could provide the funding to help support the Earth Force organization pay the bills so that they could have the ability to work with the teachers’ whose students were carrying out the community projects.

Ronnie found he had to wear many hats as an ISE and needed to be able to develop strategic partnerships to best help the teachers accomplish their goals. He needed to be well versed in the politics of the school systems he worked in and how to best package himself to gain entre’ into the schools that were less inclined to have their teachers and students conduct these projects that deviated so far from the testing initiatives in place. This could be in recruiting new teachers or principals who were receptive to setting up environmental science projects, or working with a

district service learning coordinator who was attempting to force every teacher in her district to do a service learning project. It could also be in trouble shooting on how to get native plants donated from a nursery miles away from the preserve to the elementary school that wanted them planted in as part of their ecosystem restoration project. Ronnie felt that the certificate program was highly beneficial to him as it helped provide him with the tools to thrive in this new position. By knowing what types of ISIs existed, he could better search for the right fitting partnership for the teacher he was supporting. Through greater comfort with educational languages, he could speak to groups of teachers, or school site or district wide administrators, to gain support to develop projects. These newly acquired skills enhanced his likeable nature and rich science background to help him serve as an excellent informal science educator.

As an ISE, Mandy, like Ronnie, was immediately able to take the course materials and integrate them directly into her professional life. In this capacity she acted like a sponge taking course information and automatically turning it into a product at work. As the courses talked about engaging visitors through interactive exhibitry, Mandy was opening a new education center at a preserve for which she was responsible. She took advantage of the tips and examples to help construct her own exhibits that allowed the visitors the typical opportunity to touch and feel and hear, while also having the chance to integrate technology to provide more customized interaction. When course topics shifted to global climate change and the subsequent impacts to human health, Mandy looked for ways to add the content into her staff members' interpretative talks on their hikes with guests through the preserves. She also worked hard to develop signage and "mobile" exhibits that could move throughout the preserves to educate on climate change and how it would directly impact the county in which these centers were located. When Mandy built her Know Before You Go brochure, she coupled the intellectual and material resources of

the course, to create a work product that was the culmination of her learning in class. This included incorporating feedback from the teachers within the cohort and their larger networks of colleagues throughout the region. By gaining an accurate pulse of what the teachers wanted, she could build her “Chinese restaurant menu” of quality offerings that also encouraged deeper, meaningful learning promoting more than a day out of the classroom for teachers and students. It was critical to Mandy to create great products that were valuable to her workplace and the community stakeholders who would use them. By refining the products with the knowledge she gained in the certificate program, she gained recognition from her superiors and greater buy-in from the public and school districts with which she partnered.

What Factors Impacted Participants’ Performance in the Program?

When evaluating the makeup and results of the cohort that participated in all four courses of the ISI program, each participant was faced with various factors in completing the certificate they had to overcome. All graduate students have to balance all of the factors in their lives with their graduate schoolwork. Time, or the lack there of, was the biggest threat to success for participants and will be addressed as its own emergent theme. Other identified factors impacting performance in the program related to uses of time that created a cycle in which each factor exacerbated or enhanced the others. Sample factors included (a) family and relationships, (b) changing political environments in education and overall job stress, (c) financial and economic downturn in society, (d) nonstandard working hours including, nights, weekends and holidays, and (e) little extra compensation for professional growth and advanced degrees.

Family and Relationships

The role of an individual's family can have many effects on them. In the cohort, this was witnessed as both a positive and negative force.

The shadow of the family could weigh down expectations of success with short sighted views from loved ones who saw no positives in supporting the participants' studies. This was the case with Abbie as she was the first to complete any college degree in her family. While she wanted to complete a doctorate for her personal success, her family saw her "wasting time" on formal schooling to be a teacher. In general, they couldn't understand why she wanted to be an educator anyways. The impact of multiple, continual changes in career and career training her husband sought, also consumed financial resources and added stress to her when she became the sole breadwinner and her salary could not keep up with rising bills. Without the support of her loved ones, Abbie accepted that there "wasn't a reason" to pursue the doctorate, because there wasn't a reward for her to complete the degree working at her private school. Her personal goal was supplanted by her husband's desire for his success in completing his trade study and opening his business.

When families supported schooling, the participants thrived. This could be witnessed in the cases of Carol, Ronnie, Mandy and Maddie. Because of their spouses' financial support, Carol and Ronnie had the freedom to pursue school full time as they chose. Carol was able to secure a sabbatical for professional leave from her school district that gave her the time to still "be a mom" and work on her classes and classwork. This enabled her to complete a master's degree in science education. The success of Ronnie's wife and the financial security it provided allowed him to dabble in a lot of classes and workshops throughout the ISI and collegial worlds. He could

balance his schedule to attend ISI facilities and the professional development they offered while working part time around his daughter's schedule. This let him explore his interests and really mix what he was learning about in the "online classroom" of the certificate program with what was going on in his community in real world time. Ronnie's wife's successful career also proved to be a negative as it caused them to frequently relocate and for him to stop pursuing further graduate work after a move out of the region. Mandy's husband also saw benefit in ongoing development through education. Both Mandy and he were taking various classes in martial arts, personal fitness, and for professional development as they both saw the need to enrich the mind and body. For Maddie, the support of her parents encouraged her to pursue her advanced degrees. With their backgrounds as teachers, they instilled great value in lifelong learning that was evidenced in her continual hunger to learn socially with her friends and through the pursuit of her masters' and doctorate.

Job Stress

With working professionals, careers can be demanding. In education, formal and informal, job stress can take a toll on an individual. Teachers are required to work many hours beyond the "standard work day" to grade student work, communicate with parents, and create lesson plans and engaging activities for their students. Throw in afterschool functions like tutoring or coaching and the hours worked in a day can quickly rise and become all consuming. Additional responsibilities like coordinating a science fair or planning an overnight field trip can become very daunting.

For informal educators, this stress can be equally intense. Rather than having the constraints of working in the school system, ISEs instead work under deadlines for submitting or reporting grants, working with multiple partnering organizations, opening a brand new facility, or simply functioning as a skeleton staff to complete the work of many more staff members than can be employed, or simply ensuring their organization has proper funding to pay staff and “keep the doors open.”

All certificate participants showed varying levels of increasing stress as a result of their jobs. Abbie dealt with building a quality science department at her private school that could meet the needs of her students and her perfectionist standards. The stress of developing many new courses each semester was exacerbated by also scheduling and coordinating her school’s overnight, multiday fieldtrip and schoolwide science fair through which she helped to coach each student’s project.

Brenda struggled as a new teacher in an inner city charter school. She felt the pressure of following a stringent pacing guide her students couldn’t relate to and didn’t provide the depth of knowledge she felt necessary. These issues coupled with a lack of teaching experience left her struggling to find a balance of what she was taught in her education classes as good teaching and being able to cover the material the way her administrators required so the students could be “prepared” for the standardized testing they would take.

Carol and Maddie both pursued the ISI certificate and further graduate studies to find a way to get around the stressors from their work lives. Each felt so pressured under the political regimes they needed to return to academia to make sure what they knew to be good teaching was even possible anymore.

Job stress for Ronnie and Mandy was also very evident. Each had to deal with downsizing in their work places as the economic downturn reduced the availability of funding and ultimately of the staffs with which they worked. Ronnie was left as the only member of his staff in the state of Florida and was required to support teachers who had previously been working with three ISI staff members, while attempting to secure future funding and still only working part time. Mandy saw a reduction in staff and had to resort to employing more volunteers to complete programming. These volunteers could be unreliable and lacked the professional commitment paid staff bring. For both of these participants, work hours escalated to keep up with the demands of their respective jobs. They were also forced to do more with less.

Changing Political Environments

To say formal, public education is political would be a major understatement. Through many reform movements, politicians, businessmen, and many others have attempted to step into the classroom to make education “better.” During the time of this study, the latest iteration of “reform” was in the guise of accountability for teachers and students. These measures were designed to grade the performances of the schools so that “bad” teachers could be replaced with better teachers to provide students with better opportunities to learn and grow. This national No Child Left Behind initiative spun off in each state to include a teacher evaluation system based on the scores of students on standardized tests calculated through a “value added model” that was to show growth while including all the real life factors influencing students, like broken homes, poverty, teen pregnancy, working students, etc. This counted for a large portion, up to 50 percent, of the evaluation of the teacher. It also included observations completed by a school administrator. The Florida Legislature took this further by establishing a “performance pay system” that determined a teacher’s pay based on their evaluation scores from year to year and

removed all vestiges of tenure for teachers coming into the classroom. This was coupled further with the economic downturn that saw teachers fired as districts could not afford the salaries they already had on the books, let alone the new bonuses that would be required to be paid out to “highly effective” teachers under this performance plan. Many teachers had been long overdue for pay raises before the job cuts went into effect. In essence, this system created a work environment in which many teachers felt they had no job security and were constantly under threat of their annual contracts not being renewed.

Additionally, teachers found their advanced Masters and Doctorate degrees under scrutiny as new certification requirements were put in place. Under the old rules, these advanced degrees entitled teachers to a bonus in their salaries regardless of the field the degree was in, because it represented a value in knowledge and experience. With the new rules, only degrees that correlated directly to the fields of certification on a teacher’s professional teaching certificate were honored and rewarded with a higher salary. This hurt a lot of teachers, because many college of education degree programs award degrees in curriculum and instruction at the graduate level and not in a highly specified area like biology, chemistry, or earth and space science to directly match the course codes the state issued as qualified degrees. Additionally, if a teacher taught a subject other than what was on their certification, there would also be no bonus for having any higher education.

The public school teachers in the certificate program, Maddie, Carol, and Brenda, felt heavily under fire in this system. They constantly stated their districts, all three different, were all about

teaching to the test so that their students could show the growth the school needed to demonstrate to grade highly and receive the funding it needed. Again, under the guise of “accountability,” many of these districts began to script out the curricula that left Brenda, Maddie, and Carol struggling to find enjoyment in teaching content that was little more than a “mile wide and an inch deep.” Each stated they felt demoralized and replaceable; if their students failed, their annual contracts might not be renewed. Likewise, they did not feel it was possible to achieve the high scores required to gain the pay for performance bonuses. These teacher’s morale had reached a low that would only be salvaged for Carol through a career change, and for a change in district initiatives that allowed Maddie to capitalize on her strengths and personal interests.

Mandy and Ronnie had to deal with the stresses of the politicized classroom differently. Instead of being able to work with students to do service learning projects or host fieldtrips, many teachers could not use quality materials or take the time from the “teacher proofed” curriculum to teach meaningfully. Partnerships dried up between classroom teachers and ISIs. Both Mandy and Ronnie had to reinvent what they were doing to demonstrate what they could offer to classroom teachers matched the state standards and could teach them more effectively than the district sponsored cookbook activities. Ronnie found allies within the school district with which he was working to help champion service learning in the secondary science supervisor and a district wide service learning coordinator appointed without any knowledge of how her teachers could complete the projects Ronnie was trying to build. Mandy had to create her “Know Before You Go” brochure tailored specifically to the needs of her teachers with whom she was working to shoehorn her county nature center into the curricula of her partners. Education had become less about teaching for meaningful learning in which the student could apply their knowledge to the real world and all about passing a high stakes test.

How Did Participants Manage Time?

It is common for science educators in all settings to perceive a shortage of time when attempting to balance professional work, personal life (especially family, health, and recreation), and time to design products to fulfill tasks (assignments) for formal coursework in higher education. The perception of not having enough time in a day to add work in formal university courses emerged as a key factor impacting the participants' performance in this program. While each participant handled a variety of time commitments in various ways, Mandy constructed a synergistic feedback loop that helped her to “make time” for the major realms of her personal, professional and academic lives.

Mandy's success in “making time” led to the following model illustrating an effective way an ISI working professional can maximize the opportunity to engage in formal university coursework while attending to his/ her career and personal life. A graphic representation of the cyclical model of the way Mandy seamlessly integrated her graduate coursework, career, and personal life is visible in Figure 1.

Mandy integrated what she learned from the ISI program into everyday life (her life-long learning). The perceptual screen she developed in the ISI program emerged as a cognitive framework in which to integrate all she experienced. She expressed great satisfaction in doing so; and thus seamlessly tied three major components of her life together. The program piqued her interest. She enjoyed what she was reading/doing in class, which in turn provided opportunities in the workplace to apply what she was learning to the real world, and made her more effective and efficient. This in turn led to being able to have more time in her personal life to explore her interests, which infused back into her schooling and into her job.

Another example of this model in action in the certificate program is Ronnie. He came to the program out of interest to learn about informal science education before having the opportunity to work as an ISE himself. His interests, and his own pursuit of lifelong learning, fueled him to pursue many professional development opportunities ranging from workshops on science content like climate change and marine science, to visiting many different ISIs, or attending grant writing and social marketing events. Each of these opportunities brought him personal enjoyment while also feeding back to what he was doing professionally as an ISE supporting classroom teachers in his community and to the certificate cohort with which he was sharing his experiences as a vital part of this community of learners. The biggest difference between how Ronnie and Mandy made time for these three realms of their lives is how time was allotted. Ronnie had to split his time up to care for his elementary aged daughter rather than working full time like all of the other participants, except Carol. This emphasis on family time, just shifted how Ronnie spent the hours in his day working professionally and being a parent while taking these graduate courses.

Carol balanced her schedule differently than any of the other participants. She was able to take professional leave from her job as a teacher to be a full time graduate student. This shifted her time away from working and instead to completing a full complement of coursework and focusing on her family. She stated in chagrin that she and Brenda are the “late night crew” as both find the time to complete the ISI coursework after everyone else has gone to bed in their respective households. Her primary focus was her family and finishing her masters quickly by going to school full time. This split allowed her to keep her energies on these two realms of her life, without having to juggle working a full time job as well. Towards the end of the certificate program, Carol did start to reach back into the professional world by developing presentations on

the ISI Certificate program and what she had taken from her experiences. She shared the presentations at state and regional professional science educators' association meetings.

Maddie balanced her time teaching and going to school part time with her personal life in a synergistic way similar to Mandy. She did not have as large of the family commitment as the others. She was not married and did not have to care for children. She took great joy in lifelong learning and made social events with her friends that tied ISI visits for class to going out for a good time. This sociocultural learning let her embed coursework into an experience she enjoyed that she could bring back to the cohort with enthusiasm. Likewise, she was connecting the class materials, especially techniques of instruction, from the ISI program back into her classroom as she built partnerships with various community resources like an aquarium and other ISEs. For Maddie, receiving the encouragement to teach the way she felt was right helped her to approach the classroom in an enjoyable way for her professionally, which allowed her to use the content material she loved and felt most passionately about with her students.

While Abbie completed all four courses, she was most impacted by a lack of time as a result of her family life. She was married but had no children, yet family took more than its toll on her. Her husband's constant changing of careers, her mother suffering from a massive illness that required Abbie to take her in and care for her, and ultimately losing her home to the financial downturn in the economy, consumed her. She wanted to be perfect in every way at her school as an excellent teacher and department chair which also devoured much of her time. During the science fair, she easily worked 80 hour weeks for almost two months of the year. These two freight trains of time commitments collided with an explosive force that physically made her sick as she attempted to balance them while taking graduate courses. She ultimately walked away from her goal of a doctorate as there just was not enough time to do everything in her life.

Where Mandy serves as the exemplar of how an individual can sew together interests in all three realms of her life, Abbie displays the individual who was broken and defeated in her pursuit of her personal goal by an imbalance in her time commitments.

Brenda doesn't really provide much evidence of how she manages her time. As a teacher and as a student, assumptions can be made about the amount of time used in these components of her life. However, she never addressed the issue of time specifically and she didn't address her personal life in the class beyond her being married. With the lack of data, it is difficult to draw conclusions on how Brenda spends her time.

Time is an amorphous resource that proves critical in graduate courses. If students can balance their lives among work, academic, and personal commitments, they can achieve a synergistic relationship that allows them to blend the requirements together successfully. When a balance cannot be achieved, the student struggles in all components of his or her life. The key in this is the flexibility of learning that allows the students to personalize their learning experiences in the graduate classes in a way personally relevant and meaningful to each student. This facet allows students from diverse backgrounds a way in which they can customize what they are doing in class directly into their lives professionally and personally.

Chapter Five: Discussion

Assertions

I began this study to examine the outcomes of a series of courses that I helped build to create a graduate certificate. Specifically, I wanted to evaluate whether or not the online iteration of the *Informal Science Institutions Environmental Education Graduate Certificate Program* truly provided the long term professional development needed to enhance the skills of the formal and informal educators participating so that they could contribute meaningfully to the improvement of science literacy in their respective communities.

My role as an internal evaluator provided an extraordinary opportunity to know the intent of the learning opportunities and why they were constructed in a particular fashion. I knew, from my own personal experience in the first face-to-face version, what it was like to complete this graduate certificate program driven by a guided constructivist classroom in which the participants' need to know and their current needs as learners could dramatically steer how course content was approached and integrated into each learners' unique mental schema and ultimately into their personal and professional practices. My role as course architect allowed me to enter and exit from the certificate landscape over the four semesters as I provided content for the classes, served as a guest speaker and a course participant in the final class to stimulate conversation, and at times to play devil's advocate. I also directly and indirectly influenced course participants through my interactions with them in various professional organizations, working with Ronnie directly in an ISI, and as classmates in other graduate courses outside of this graduate certificate.

Additionally, my perceptual screen from my professional experiences working in ISIs and formal classrooms helped me see patterns emerging from participants' data. Looking at each participant, I have shared common work experience with all of them. I have taught at the middle and high school levels, in large and small, public and charter schools. I have served as a community resource for teachers, both as an informal science educator for a nonprofit and for a government organization, understanding some of the intricacies inherent in both worlds. While having not worked in exactly the same environments, I can relate to the demands on each participant at that moment in time in their careers while they were completing this program.

After conducting a literature review that emphasized a need for greater scientific literacy in communities across America, it was evident that the formal education enterprise needs the support of informal educators working on the ground in myriad different settings in ways that provide science as both content and process, *learning science facts and doing real science*. Through bringing together these ISEs with formal teachers, it was thought each could learn the culture of the other, making each more fluent in accessing community resources to help make these educators more collaborative and able to bridge the classroom with the outside world. This bridge promotes ongoing, lifelong learning, which in turn can help the national goal of greater scientific literacy.

Scriven stated that "evaluation" refers to the process of determining the merit, worth or value of something, or the product of that process" (1991, p. 139). Patton explains that evaluation is a critical process in gathering and analyzing the data about a program with the purpose of making a judgement about the said program (Patton, 1987). In this case a program evaluation was conducted to determine the value of the ISI certificate program and if it, indeed, enhanced the skills of the educators who participated within it.

This study provided insight into the thinking involved in the learners' growth as they converted theory presented in course materials into practice. Through an iterative process of reviewing the course generated content, I was able to piece through the many layers of this two year long program to examine the growth of these individuals over time.

While all participants showed growth completing the certificate program, those who could fully invest themselves in the experiences seemed to have gained the most. Mandy and Ronnie's fusion of work, personal, and academic lives showed a synergy that created a need to know in their professional activities that could be supplemented and addressed through course content. This process also fueled them on academically as they brought back their interests for the entire cohort to share, enhancing the whole group while deepening the application of the studied materials. Ronnie's perception of ISEs also dramatically changed from those hobbyists who didn't know what they were doing to a professional workforce that were highly skilled in a variety of fields. Abbie is a unique case as she provides a counter example to the fusion of the realms of her life, professional, personal and academic. She became so overwhelmed by the personal and professional pieces of her life, they consumed her dreams of completing her doctorate for which she longed. Even though she could attribute where she was growing through continued coursework and where she was applying ISI certificate practice, Abbie simply had too much going on in her life to justify continuing beyond the certificate. Carol's sabbatical allowed her to delve deeply into the roles of inquiry in science education through the graduate certificate to form a resolution that she could no longer do "good education" as a classroom teacher, because she could not practice what she knew was best for her students. This massive change in perceptual screen and self-awareness led her to an ultimate change in careers. Maddie took the opposite road from Carol. She found the course to strengthen her resolve to teach the way she

knew was right and to push harder for her students. This led to the incorporation of more community resources like fieldtrips and ISI collaborations to infuse real world learning and approaches that made science more about doing than just memorizing rote facts. Maddie's high schoolers benefitted from her confidence and enthusiasm to see how their course contents were relevant to the communities around them. Brenda, while providing little metacognitive evidence compared to her classmates, seemed to gain confidence in her teaching through the incorporation of little tricks she could add to her tool bag from the courses.

Implications

These cases indicate the *Informal Science Institutions Environmental Education Graduate Certificate Program* was effective at enhancing the careers of formal and informal science educators. Additionally, it suggests informal science educators, although busy with their professional obligations and personal lives, can be successful in a formal graduate program designed to meet ISE needs as explicated in *Learning Science in Informal Environments: People, Places, and Pursuits* (Bell, Lewenstein, Shouse, & Feder, 2009). The emergent model indicating connections among a person's personal life, professional life, and graduate study may also have implications for other professionals desiring to enroll in graduate school. For example, science teachers in university graduate programs may also benefit from applying this model to their lives.

Dissemination

Findings will be shared through presentations at national conferences catering to science teacher, informal, and formal science educators and published in several education journals and potentially as the basis of a book.

Limitations and Future Directions

This study may generate the need for further research into professional development for ISE's and how to best meet their specific demands. This will, in turn, require further inquiry into the roles these new, skills-enhanced professionals will play in promoting the greater cause of scientific literacy for their audiences. My findings will be shared through conferences and publications.

A limitation of this study is its applicability in providing generalized statements about quality professional development for informal science educators. The results are specific to the individuals and the heterogeneous mixture of professionals brought together in the crucible of this graduate certificate program. While the results cannot paint broad stroke universal truths about the needs of all informal science educators, it can elucidate a method that may be effective in providing holistic education for this audience. Additional limitations could be seen in the time commitments and monetary costs of completing a four course graduate certificate for a field that doesn't formally recognize advanced degrees and certifications or provide compensation or recognition for obtaining them. While informal educators can be found in many different venues, the audience for this professional development could be very limited without the proper partnerships or funding to ignite the spark needed to make the impact in providing wholesale scientific literacy across America.

While serving as an internal evaluator provided me an invaluable window into all aspects of this program, some may construe this as a limitation to the study. I had to work very diligently to maintain an unbiased perspective of the outcomes and to not be swayed by my own experiences as a former participant in this program, an architect of the courses themselves, and my roles as an

informal science educator and as a classroom teacher. Through the constant support of my committee, I was able to ground my findings that maximized my objectivity to what was going on in the writings and artifacts produced by the participants of this course.

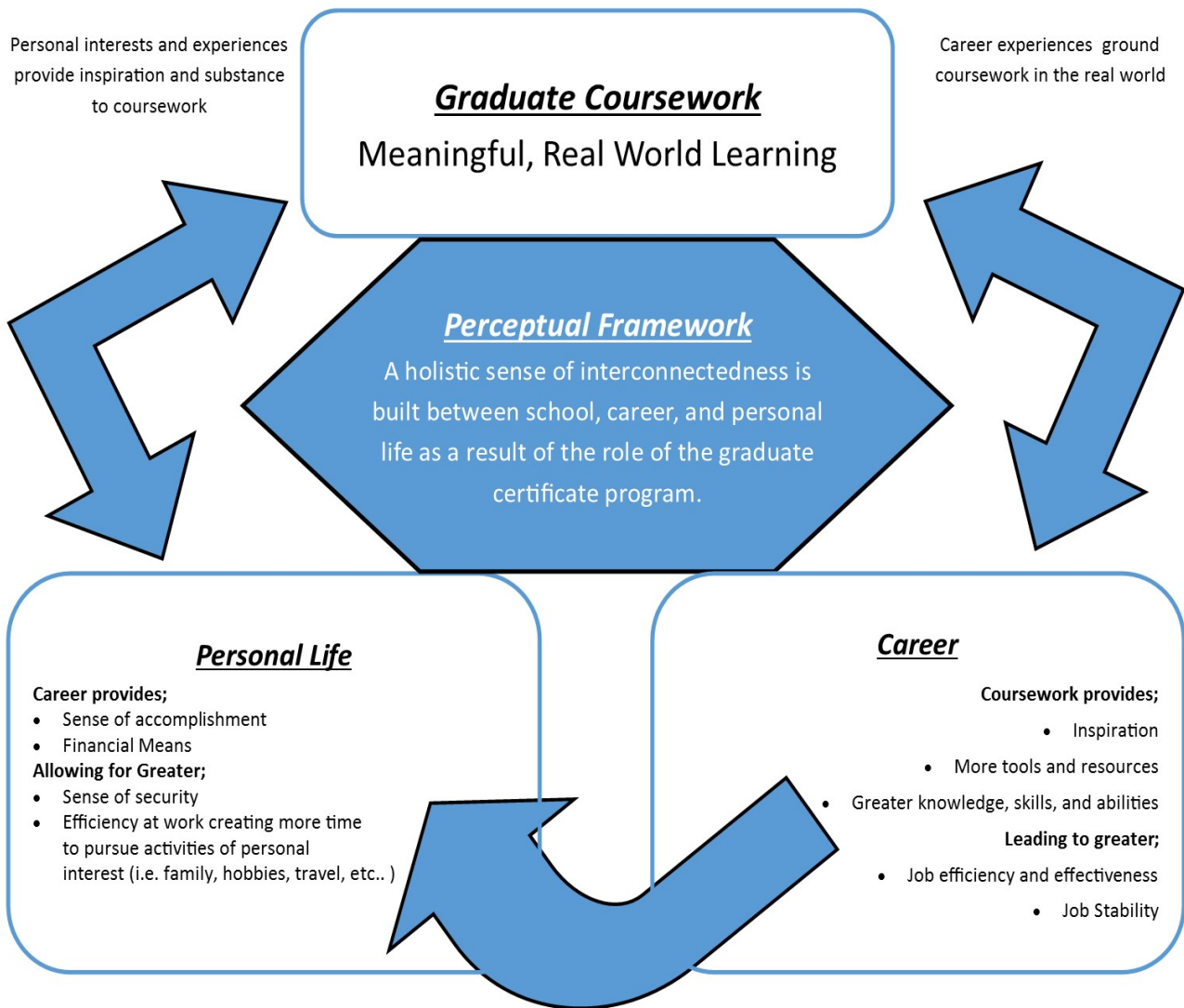


Figure 1. Graduate Coursework; Meaningful, Real World Learning

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