International Journal of Learning, Teaching and Educational Research
Vol. 10, No. 3, pp. 1-16, March 2015.

The Nature of High School Students' Experiences at a Great Lakes Biological Field Station

Marc Behrendt
Ohio University
Athens, Ohio, USA

Abstract. The purpose of this case study is to explore how high school students experienced a four-day field trip at Stone Laboratory Biological Field Station, from a visiting student's perspective, in order to understand the value of that field station and its impact on science, science education, and students' lives. Chosen from a population of fifty students, six rural high school student participants attended a four-day field trip, involving of two days and three nights at Stone Laboratory and excursions to two neighboring islands. Participants were given cameras to record their experiences during the field trips to record anything they found significant or meaningful. After the trip, students were asked to select the five most significant images and write a paragraph, describing the significance of each image. Each participant was interviewed three times in semi-structured and unstructured formats. Analysis consisted of open coding using apriori and emergent codes. Significant findings included: 1) Stone Lab provided a unique and novel venue where the equipped laboratories, the managed shorelines, and the natural areas provided the ingredients for awe and wonder; 2) the field station's unique setting inspired curiosity and motivation among students; 3) in reference to science education, the payoff for these experiences was increased interest in science; 4) three of the six participants redefined their career goals after their four day immersive Stone Lab field experience; 5) students developed a sense of appreciation for the Lake Erie environment.

Keywords: Stone Laboratory; Biological Field Station; Informal Learning; Experiential Learning; Photovoice

Introduction

Biological field stations create a uniquely positive learning environment for students, where each student is able to explore, discover, and reflect over the things that they personally find interesting (Malinowski and Fortner 2011; NRC 2009; NRC 2014; Organization of Biological Field Stations 2014; Woodhouse and Knapp 2000). Students in preschool through graduate school find biological field stations interesting and motivating. The field station experience can be life changing. Many biologists and environmental scientists proclaimed a field station experience strongly influenced their decision to pursue biology as a career (Arvey and Riemer 1966; NRC 2014).

For the purposes of this article, the definition of a biological field station (henceforth to be called a field station) will be a facility located in an isolated, natural area. The field station may be focused on research, education, community outreach, or conservation, with a focus on that region's habitats, ecosystems, flora and fauna, and environmental issues (Arvey and Riemer 1966; NRC 2014; Organization of Biological Field Stations 2014). A field station is typically a college or university satellite facility. In the early 1900's, most field stations focused on nature study. Arvey and Riemer (1966) recognized that research was a primary mission for roughly half of existing field stations, the other half focused partially or entirely on student education and field experiences. Field stations were often the entry point where scientists performed and honed their research.

Arvey and Riemer (1966) recognized that little information was published about field stations, although field stations provided a significant service connecting students to authentic science experience. A literature search yielded research illustrating that field stations are recognized as a venue of research, but the pedagogy and methodology is barely explored. In 2014, National Research Council (NRC) published an extensive document that examined "the value and sustainability of field stations and marine laboratories in the 21st century" (NRC 2014). "The committee encountered a significant challenge to empirically demonstrating the value of field stations due to the lack of aggregated data on their activities and impacts on science and society" (NRC 2014 p. 8). The lack of research concerning field stations extends to outcome and impact of field station pedagogy (NRC 2014).

Science Education and Learning

Environmental education is affectively learned through personal, hands-on experience in the field (American Institutes for Research 2005; Organization of Biological Field Stations 2014). Experiential learning may encompass direct encounters with a specific topic being explored, such as through vocational training, or more commonly and in this study's prevue, learning gained through every day lived experiences (Smith 2001). Kolb (1983) described the four stages that must occur for experiential learning to occur: concrete experience, reflective observation, abstract conceptualization, and active experimentation, and the cycle continues through concrete experience and beyond.

Because a major goal of any field trip is to create student learning, a brief look at learning will connect the functions of field stations to the students' experiences. Kolb and Kolb (2005) identified six key factors concerning learning:

1. Learning is a process, not an endpoint. It requires feedback, reconstruction and reflection of the experience;
2. All learning is relearning, which is maximized when student beliefs and ideas are included to develop assimilated, new refined ideas;
3. Learning requires understanding an experience through opposing methods of experiencing, feeling versus thinking, or doing versus watching;
4. Learning consists of feeling, thinking, doing and watching;
5. Learning occurs from an experience between the person and environment;
6. Learning creates knowledge (Behrendt 2014, p. 38).

Learning can be formal or informal. Formal learning is obligatory, planned, assessed, and teacher-centered, has a predetermined curriculum, and allows minimal social interaction (Saylan and Blumstein 2011; Wellington 1990). "Formal education is the interaction between a teacher and a student within a systematic framework of standards, tests, and a fixed curriculum" (Zandstra 2012, p. 25). In contrast, informal learning is not confined to a classroom, but is voluntary, loosely organized, not assessed, student or learner-centered, has an open-ended curriculum, and allows social interaction (Falk and Dierking 2000; Hofstein and Rosenfeld 1996; Rennie 2007; Wellington 1990). The learning is controlled by the learner. Informal learning experiences can be broken down into three significant components or contexts, the physical, social or personal, and cognitive (Falk and Dierking 2000; NRC 2009). Informal learning is individualized to each person's reality, to their motivations, past knowledge, interests, beliefs, and expectations. Friends, and any associated social group, teachers, guides, and bystanders influence the learning. The physical context is determined through the venue or setting. There may be a program or organized activity, but the informal learning determines what the student will learn, which very well may be a topic not intended by the program organizers (Falk and Dierking 2000). Education programs at field stations are by definition, informal learning. Therefore, students may participate in the activities, but each experience will be unique, defined by each individual student.

Learning has also been defined through the use of an ecological framework, the term "ecological" meaning the relationship between the physical environment with the cultural environment and its associated individuals. Each involved individual possesses unique personal development and differences in his or her background due to finances, education, family traditions and beliefs, and associations with peers (Bronfenbrenner 1977; NRC 2009). The ecological framework recognizes three different lenses in which to analyze informal science learning: the cognitive/affective or people-centered lens, the place centered lens, and the culture centered lens (NRC 2009).

The cognitive/affective or people-centered lens focuses on the development of interest, knowledge, affective responses, and personal identity, including prior knowledge and experiences Behrendt 2014; NRC 2009. NRC (2009) proposed the term people-centered lens because it focused on an individual's affective and cognitive response to an experience. The term cognitive/affective lens will be used to clarify the intent of the lens.

The place centered lens focuses upon the physical aspects of the informal science experience, including the setting, resources, tools, and equipment being utilized. The place-centered lens will vary depending on the venue. Individuals will respond differently depending on the physical setting and the equipment available (NRC 2009).

The culture centered lens focuses on the relationships the individual has with the community of friends, teachers, and other individuals directly or indirectly involved in the experience. The community may provide values, skills, knowledge and personal identity to the individual, and the individual may provide values, skills,

knowledge and personal identity to the community. An individual will act, perform, experience, and learn differently depending on the composition of the community (NRC 2009). These lenses were significant and were utilized during transcript analysis to determine apriori codes.

Stone Laboratory Biological Field Station

An informal learning venue is any non-school location where learning might take place, including museums, science centers, zoos, and field stations (Falk and Dierking 2000). A venue is defined by its purpose. Visitors at a zoo will observe animal exhibits in a manipulated setting, visitors at a science center will experience interactive stations in a manipulated setting, and visitors at a field station will encounter both formal learning through classroom lectures and informal learning through hands-on, personal experiences while immersed in a natural setting (Falk and Dierking 2000).

Biological field stations may be associated with general habitat types, including freshwater, saltwater, terrestrial, and wetland (Arvey and Reimer 1966). Field stations are also differentiated as research-based, instructional, or both. Marine biological field stations tend to be larger and more instructional because aquatic habitats are not as overwhelmed by constant student usage. Inland biological field stations are often research-based, fearing that an influx of humans would alter the terrestrial environments.

For this study, a field station with a goal of student instruction was desired. The Ohio State University's Franz Theodore Stone Laboratory (henceforth to be called Stone Lab) was the primary option for this study due to convenience as well as having met the needs of this study. Stone Lab is a freshwater marine biological field station located on Gibraltar Island, a six-acre island located in western Lake Erie, owned by The Ohio State University and managed by the Ohio Sea Grant College Program. To support and implement its mission of promoting research, education, and community outreach, Stone Lab is equipped with three large research boats and several motor boats (Ohio State's Stone Laboratory 2013). The classroom building has two large laboratory workrooms on the first floor and smaller workrooms on the second and third floors, equipped with instrumentation and tools ranging from high quality microscopes, digital equipment, binoculars, nets, and boots.

Of particular concern to this study is Stone Lab's commitment to provide quality, hands-on educational opportunities for middle and high school students. Up-to-date equipment utilized by researchers and the summer college courses becomes available to the fall and spring workshop programs. The equipment and opportunities a Stone Lab workshop program offers to students is not possible in a school classroom.

The spring and fall workshop curriculum has been crafted and shaped over decades of workshop programs. Instructors, typically recent environmental science or biology graduates or upper level environmental and biology major college students gaining work experience, give a short classroom presentation, and then take the

students outside to explore and discover what was just taught. Workshops are usually one or two days in length, although some schools opt to extend the stay. The visiting school's teacher preselects the workshops that the students will experience, and occasionally, the teachers will do much of the initial classroom teaching, leaving the Stone Lab instructors to lead the field and laboratory experiences. There may be up to five different workshop classes going on at one time. Attending students separate into cohort groups, and then rotate between different workshops. Each workshop class lasts a maximum of two hours in length, but usually ends 15 minutes early to allow students some personal time between workshop classes. In this study, the student group thatconsisted of 50 high school students, divided into four cohort groups that participated in the immersive courses: ornithology, aquatic invertebrate biology, island botany, plankton biology, fish biology, and activities on "BioLab", one of the large research vessels.

The study originally intended to examine biological field stations in general. However, it was realized that each field station was unique and presented unique experiences for visiting students. It was decided to focus this study specifically on Stone Lab, rather than the more generic biological field station.

Materials and Methods

This reported case study is a small segment of a larger case study that investigated how high school students experienced an extended and immersive field experience. This study specifically explored how high school students experienced a field station during a field trip. A case study design was utilized, a format suitable to explore real-world situations, cultures, and programs, to investigate and understand what goes on there and how participants perceive things (Creswell 2013; Stake 1995; Yin 2009). The case study was bounded by participants (the student participants attending a single rural high school), setting (Stone Lab's specific program; Stone Lab's geographical location on an island), and time (a four-day immersive field experience). The case study utilized interviews, photovoice, and observations, leading to analysis searching for patterns of common meaning derived from the student participants' experiences during the field program, culminating with a final case description (Creswell 2013) .

Participants

Participants in this study consisted of students ranging from ninth through twelfth grade at Rural Ohio High School (ROHS) (pseudonym), which was selected because biennially, a group of students traveled to Stone Lab for a four-day immersive science experience. All students in the school science club were invited. Although expected to pay for their experience, students could participate in fund raising events to pay for the field trip. For this study, the two cooperating teachers made their classrooms and students available for interviews. The participant pool consisted only of students who planned to attend the field trip and provided parental permission forms to participate in the study. Six students were purposefully selected to participate in a case study, stratified by gender and interest in science, resulting in four female and two male students, three self-identified as high interest

and three as low interest in science. All other participants in the pool participated in focus group discussions. Internal Review Board permission was sought and granted by Ohio University.

Credibility and validation were important priorities. The rationale for the decision of type and quantity of participants was defined by the question and by the available sample pool (Patton 2002). Sample size is an issue in which little consensus is found throughout the literature (Onwuegbuzie and Leech 2007; Patton 2002). "If interpretations and theories remain strictly localized, then the size of the sample is not as crucial" (Onwuegbuzie and Leech 2007, p. 115). The context within the current study was very narrow, bounded by location, time, event, and participants. The sample sizes needed be large enough to achieve data saturation in which no new emergent themes are uncovered with further data collection, yet small enough to develop depth. Guest, Bunce, and Johnson (2006) suggested that data saturation occurred with twelve interviews, illustrating that 92% of codes developed from a series of transcripts were created after twelve interviews in one study, and 88% of the codes developed in another study. However, the overarching themes in those same studies were thoroughly established after six interviews, suggesting six interviews may be "sufficient to develop meaningful themes and interpretations" (Guest et al 2006, p. 78). In this study, there were six participants, and each was interviewed three times, for a total of 18 interviews.

Site selection

As described earlier, the study explored the students' four-day immersive experience. The first two days students participated in experiential classes at Stone Lab on Gibraltar Island. On the third and fourth days, students travelled to Kelley's Island and South Bass Island, but ate breakfast and dinner and slept at Stone Lab.

Procedure

The goal of this study was to gain insight to how high school students experience a field station during a field trip. Qualitative research methods were utilized, specifically semi-structured interviews, observations, and photovoice with essays and unstructured interviews. Semi-structured interviews were conducted at the school prior to and following the Stone Lab field trip. Unstructured interviews were conducted after the field trip, to allow each participant an opportunity to comment on the photographs that they had taken during the field trip as part of the photovoice activity.

Photovoice is a method that allows the researcher to see an experience from the viewpoint of the participant (Wang and Burris 1997). An image is powerful when associated with the participant's explanation or purpose for the photograph. Photovoice also helps students to relive their experiences, to help them remember their experiences. In this study, each participant received an Olympus VR 310 digital camera with an 8 GB graphics card. They used photovoice to show what they thought was significant as they participated in the four-day field experience.

Participants were asked to take photographs from the moment they left the school until they arrived home again four days later.

To gain context and understand the students' perspectives of the field station experience, it would assist the reader to understand the general field trip experience at Stone Lab. To set foot onto Stone Lab, a student first must ride a school bus, then a ferry, to South Bass Island, a bus to the opposite side of the island, and then boats to Gibraltar Island. Once students arrive, they cannot leave the island; they are immersed in a science culture for the duration of their stay on the island.

On this field trip, students arrived at the island on a sunny, 70°F day. The first evening included an organizational meeting, followed by evening activities, including volleyball and a bonfire. Student free time occurred whenever they were not obligated to classes, meetings, or curfew. During free time, students were able to explore or socialize as they chose, within the rules.

The next day began with heavy rain and strong north winds with the temperature around 40°F. Students participated in four 2-hour classes, with an evening program about Stone Lab's history and past research. The third day started with periodic downpours and strong winds and temperatures around 45°F. Students completed their fifth workshop class, and then rode a large jet boat to Kelley's Island, where they hiked approximately two miles to a wildlife area to explore the glacial grooves, island geology, the Lake Erie shoreline, amphibians and reptiles within the wildlife area, plants, fossils, and unique habitats in the region such as a local alvar. The students had the option to explore on their own, in self-determined groups, or with one of the teachers. The evening meeting at Stone Lab consisted of two scientist guest speakers, and then a cat dissection for interested students. The final day began with warmer temperatures and sunshine. Students traveled to South Bass Island, where they visited Perry's Monument commemorating the Battle of Lake Erie. When the program concluded, the students hiked and explored a wildlife museum, a crystal cave, and the South Bass Island State Park shoreline to look for Lake Erie watersnakes.

Back at school the Monday after the field trip, each participant was asked to select five images from his or her own camera that best captured what he or she considered were significant or meaningful experiences. Then the participants were asked to write a paragraph or short essay for each image, describing why the photograph was meaningful for them. Once completed, the researcher conducted unstructured interviews, asking each participant to slowly scan through the full collection of their field trip images and explain or discuss the images, why they took the image and what it meant to them.

Observation methods were utilized before, during, and after the field trip. The researcher was the sole observer and spectator in the science classroom before and after the trip, where participants were observed during lab activities with the goal to understand the behavior, activity engagement, and interactions with other students, all providing evidence of participant interest. The observations provided an additional benefit by allowing the participants to become familiar with and comfortable around the researcher, which created open communication during the

interviews. At Stone Lab, the researcher was a participant observer, observing the participants during the activities.

Each participant was asked to fill out a short survey, which solicited their demographic information, and concluded by asking the participants to list their favorite and least favorite subjects, activities, describe their future plans, and finally to identify his or her level of interest in science on a Likert-like bar. The survey was created to understand each student, and was not used in any data analysis.

Credibility and validation was an important priority throughout the development and implementation of the larger study, from which this smaller, more focused study was drawn. Method triangulation was employed using interviews, observations, and photovoice. Other methods included independent peer review, member checking, and rich description of the Stone Laboratory program generated from a pilot study and multiple observations. A daily journal was maintained, with a full audit trail to back up the research.

Analysis

Data focused on the participant's experiences during the field trip, and was cross analyzed with the other participants' experiences to illustrate themes, and common and unique experiences. The data were broken down with the research questions in mind to direct the analysis. Questions explored in this study included, how did high school students experience the Stone Lab Biological Field Station during a four-day field trip? What aspects of the experiences led to development of interest? The observations and interviews were transcribed, coded using apriori codes derived directly from the ecological framework, and emergent codes derived from the participants' words or actions. Codes specific to the physical lens of experience dealt primarily with setting. Codes specific to tools were usually implied.

Photovoice images were linked to the accompanying essays, and were coded together. Each essay was treated as an interview transcript since it was the participant's personal voice, or photovoice. Since the participants selected these images and essays due to the photographs' meaningfulness, all coding of photovoice transcripts was considered significant.

Observation requires researcher interpretation and inference of feelings, engagement, and behavior. However, the observational inferences were strengthened when combined with the interview and photovoice data. Field notes were transcribed, and emergent data were recorded for patterns or themes.

Results

All themes and patterns from the larger, original study connected to Stone Lab in some way. The purpose of this study was to explore how high school students experienced a field station during a field trip, from a visiting student's perspective in order to understand the value of that field station and its impact on science, science education, and students. Because the data are entirely from the students' perspectives, supportive evidence to the major themes will consist of the students'

words. Only representative quotes have been presented to limit the length of this section. The names are pseudonyms, followed by the student's level of science interest, H(igh) or L(ow). To further protect the students' identities, the dates of the interview comments are not included. It should be noted that all three aspects of the ecological framework are represented through the students' statements. The physical aspect is the primary focus of this study, however, also of interest are the portions of the cognitive/affective and cultural frameworks that integrated with the physical.

Focus on Learning

The three students with high interest in science enjoyed the learning opportunities at Stone Lab. "I like [that] the focus is all on learning, it is fun learning, and I like the location because I love Lake Erie" (Janessa-H, interview). Janessa-H saw the experience as purposeful learning. "It is all applicable, it really helps, it is real science, not just here, take notes on this, you will never actually use it in life - this is an actual career, this is actually happening every day" (Janessa-H, interview). The three students with low interest in science participated in and enjoyed the experiences, but did not reveal the passion for the program topics. David admitted, "Unless you are an important scientist, you are not going to need to know the birds…" (interview).

Affective Responses

The significance of affective responses was evident throughout the interview and photovoice data. Although this study was not designed to examine emotion, the prominence of the affective comments provides insight to how students experienced the field station field trip. Among the six participants, 39 different affective responses were identified. Fun, like, and happy constituted a majority of the responses, but awe and wonder, and boredom required a deeper examination. Awe and wonder included feelings of amazement, admiration, or surprise. All six participants revealed a moment when they saw something and were amazed. Rainbows and sunsets promoted many comments.

"I went out on Alligator Bar and saw this beautiful rainbow behind Perry's Monument. I was amazed because I hardly ever see them and when I do, they're really faint or small. This one is clear and pretty big, which really excited me" (Willa-H, photovoice).

"And it was at sunset, that is where I got that really cool sunset picture, too. That was amazing" (Willa-H, interview).

Willa-H had strong negative feelings about snakes during the pretrip interview, but her feelings changed after finding and holding a snake. "I love snakes. I think they are so cool. And they are cute and cuddly" (Willa-H, photovoice). This statement is significant, illustrating a new understanding while her affective response changed from fear to wonder.

David-L had never seen the Great Lakes before this trip. He expressed his wonder as he watched the storms move across the lake, "We sat there and watched it, and then there was a big storm off in the distance, so we came in and it went from dry and slightly warm to just pouring down rain, that was kind of a, that was a neat thing."

During the post-trip interview, David-L discussed the memory of the moment he looked out over the lake, "And just the vastness. It looks like the sea…the way the water moved, the way you could see the water had been going in the same pattern for like, a hundred years, it dug a circular shape into the rocks…Sometimes it made you feel warm inside, like even though it was cold, it just felt like, something was really neat about it, like it was different, you can't really explain it, but it was different."

Lucas-L had little interest in science. His focus was on relationships with peers. He photographed an image at night and wrote, "I love the night because everything is calm and relaxing. I saw how the moonlight just reflected so perfectly and needed a picture" (Lucas-L, photovoice).

Not all comments were positive. It is noteworthy that the three participants who made comments about being bored were the three students who were least interested in science. David-L spoke about his feelings after the plankton lab failed to collect specimens to examine, "I did not get anything. After that, I was really bored" (interview).

Lucas-L regularly spoke of boredom throughout the interviews. Concerning the wildlife area hike, he stated, "We were just screwing around and it was a lot of fun. I don't know, I was kind of bored with it" Concerning the hands-on botany class Lucas-L admitted, "To be honest, I think I was really bored and I completely checked out of the class, I just started taking pictures of pretty much anything. Pause yeah, he loves Batman..." Lucas-L admitted that he was usually bored in science class, "After 20 minutes, I am out of it, I just don't pay attention…I like to kind of move around, so you are not sitting in one place, drool is coming out of your mouth" (interview).

Interest

Students identified moments when they were engaged and interested. Willa-H talked about the surprises and unexpected activities during her trip to Stone Lab, "Going to Stone Lab, I didn't know what to expect in the first place. So everything was, you turn around and there was something new. And you are, oh, I didn't know that was going to happen." "When I first stepped onto [the beach], I didn't expect it to be gravel, it was weird, I am used to sandy beaches, like even on Kelley's [Island], it is sand. It was weird" (Willa-H, interview). The novelty of the setting grabbed her interest and her curiosity motivated her to explore.

Paige-H described triggered interest concerning this trip, "Just being able to explore that and see all the different formations nature has made around it, was pretty cool. And then you get to see all the plants and animals, mostly plants, all the way back

there and have different teachers point out to you, that is this, and it does this. That's kind of cool" (interview).

Lauren-L experienced the same activities as the other participants, yet she exhibited little interest, in spite of the new environment and island activities. On the first day, she took only four digital images. During the post-trip interviews, Lauren-L did not discuss anything concerning her experiences of that first day's activities. During the botany class, Lauren-L did discover an interest in plants, and said that while she was not inspired to take more science classes, she did crave to go out into nature and look for new plants.

Willa-H-'s final comments in her final interview defined her experience at Stone Lab:

> It was really intense, I just felt, very curious, but also, [pause], I don't know how to explain it. Amazed. Because I had never been put into a situation where you were like in depth, going into all this stuff, it was like, it wasn't in a classroom, like you were there learning, and it wasn't like learning, you were exploring, you were doing all this stuff, I was like this is awesome. It was also very exhausting, you are doing so much and even though it was like, I was cold and wet and muddy, through all of that, it was just wonderful, it was great, and I just remember, not when I was at Stone Lab, but after, when I came home, I just missed it so much, it kind of hurt a little bit. I just want to be back at Stone Lab. For one more day.

Willa-H was intrinsically motivated. She was curious. She was excited. She wanted to continue exploring and discovering.

Interest Influenced Future Lifeplans

Three students acknowledged that this field trip had affected their career and life paths. Most profoundly affected was Willa-H, "It made me sure of what I want to do, to go into a science career. I realized there is so much that I wanted to learn and do and I wanted to be the one who was figuring things out and telling people about it, so when we were exploring and learning, I really want to be the one exploring and learning all the time. That is just what I want to do with my life" (interview). Paige-H said that because of her time at Stone Lab, she was changing her major from American Sign Language to environmental science.

Culture

Codes connecting culture and Stone Lab as related to this study were minimal. Stone Lab was the setting for social interactions. Many images and comments involved peers, including during exploration and activities. New bonds formed among the 50 students. Willa-H voiced sadness when she was discussing her gallery of photographs, and came to the final image of the group photo taken moments before all the students loaded onto the buses to head home, "here we are, now I will never forget any of you" (interview).

Island Setting Facilitated Class or Activity

Most participants did not make direct, relevant comments concerning the setting, but regularly inferentially acknowledged the Stone Laboratory and island settings. Kaylie-H recognized that the Stone Lab setting created a mystique or ambiance that could not be recreated in the classroom. "It has been there so long and so many students have come there, and have had life changing experiences and learned so much. I like that it has that feeling of age and that feeling of knowledge in it" (interview).

Most comments focused upon experiences and not the setting, although it was the unique setting that accommodated the experiences, as illustrated by the following comment, "I liked the macroinvertebrate walk on Alligator Bar. We saw several [species of animals] that I had not seen before, we found a water beetle that is actually kind of rare and we don't usually find it, and we found it, and we were kind of excited about that, laughing really geeky things, that was pretty cool" (Paige-H, interview).

Participants did not initiate any comments concerning tools used on the field trip, but mentioned tools as a means to explore or discover. Tools were essential to the experiences and seemed to be considered part of the experience. "We were trying, all of us, tried into the microscope to get pictures" (Kaylie interview). Paige used the identification keys to identify macroinvertebrates, plankton, and plants, "I knew it was Dutchman's breeches, because I had seen it before, but trying to get it to key" (interview). Paige-H and Kaylie-H were able to explore the wetland because they had the foresight to bring along boots, "We had to go into this back area that was almost too deep, it hit the top of our boots" (Paige, interview). During his interviews, David-L acknowledged using tools on the research vessel to determine water clarity and depth. The most common tools that participants recognized were microscopes, identification keys, nets, binoculars, and hammers.

Discussion and Recommendations

Literature describes biological field stations in general as venues where education and research occurs. Field stations themselves are rarely the focus of research (NRC 2014). This study examined the role a biological field station played in relation to students' lived experiences. As demonstrated through students' statements, the field station's setting played an important role in the students' experiences by providing a new, stimulating setting where they could safely direct their personal interests into explorations and discoveries. Student participants identified two important aspects of field station settings. First, Stone Lab provided a unique and novel venue where the students attended environmental science workshop classes. The field station provided equipped laboratories, managed shorelines, landscaped and natural areas, and an environment where students were able to explore safely. Stone Lab could not construct the awe and wonder, but it provided the ingredients for students to experience awe and wonder. Second, Stone Lab's unique setting inspired curiosity

and motivation among students, who became extrinsically and intrinsically motivated, depending on the depth of their interest, compelled them to explore the new environments.

Stone Lab is a modern, high tech research facility for researchers. The high school students enjoyed using the tools and equipment that is not typically available for use in traditional secondary school science rooms. Although tools enabled exploration, discovery, understanding, and knowledge, the participants did not recognize tools as a source of interest or excitement. Students expected and accepted the presence of the tools. Tools held no special place in the participants' memories.

There was a great divergence in what the students found interesting and significant. Students already interested in science were excited to participate in the activities, to explore, discover, and try out new skills. Students with less interest in science became excited about the novel setting of the big water Great Lakes ecosystem, where each activity was an entirely new experience. Biological field stations might consider creating two tier programs that may provide high-science-interest students activities focused on new skills and knowledge, and providing low-science-interest students activities focused on experiencing, exploring, and discovering the novel setting, and how that novel setting is relevant in their lives.

Impact on Science Education

In reference to science education, the student participants unanimously related increased interest in science because of the field station experiences. The immersive science environment and Stone Lab's setting provided authentic, hands-on activities and opportunities for exploration and discovery that engaged the students and triggered interest at some level. Learning requires interest. Interest, especially intrinsic interest, will lead to increased learning, scientific literacy, and promote interactions and persistence within the STEM fields (Hidi and Renninger 2006; NRC 2014).

Impact on Students' lives

Three of the six high school student participants redefined their career goals after their four-day immersive Stone Lab field experience. Students may read, study, and learn about wildlife, botanical, and environmental career paths, but an authentic experience provides the knowledge and motivation to realize the reality of such a career (NRC 2014). Not all student participants were so deeply affected by the Stone Lab experience. Lucas-L attended the field trip to be with his friends and disclosed he had little interest in the planned activities. After the trip he admitted, "Everything out here was really cool to do, but I just do not like science." On the other hand, Lucas-L's photovoice images, which illustrated what experiences he thought were meaningful or significant, included animals, activities, and poignant landscapes. To determine a truer level of impact a four-day field trip at a field station may have on students' lives, a study is needed to examine the long-term effects on low and high science interest high school students.

Effect on Society

The student participants experienced Stone Lab as a new and exciting environment. What may have seemed ordinary for teachers and Stone Lab staff was a first time experience for many students. Lucas-L discovered the tranquility of the moonlit night while listening to the waves lapping the shoreline, Willa-H saw a rainbow, David-L saw big water for the first time in his life. Seeds for new consciousness and appreciation for the environment were planted.

For students not interested in science, Stone Lab provided knowledge and personal connections to the Lake Erie ecosystem and to environmental science. As future adults, these students may possess a stronger scientific literacy that will guide their decision making at home, at work, and in the voting booth. Field experiences associated with inquiry based learning have been shown to "improve a student's science scores, self-esteem, conflict resolution, problem solving, motivation to learn, and classroom behavior" (NRC 2014 p. 13.) A positive field station experience may later lead to participation in citizen science, or as a volunteer in the community (NRC 2014). The student participants admitted that this Stone Laboratory field trip indeed altered their perception of Lake Erie, of environmental science, and for some, the reality that a STEM-related career pathway might be right for them.

Conclusion

American science education is in crisis and people are needed to solve the crisis. Students need to be prepared for things that have not been invented yet. Students need knowledge and impactful experiences that will equip them as adults of tomorrow with the tools necessary to solve these problems. Classroom lecture alone will not get the job done. Students go into drone-mode and become uninterested and unmotivated (Behrendt 2014).

The classroom must be taken somewhere new, to where the students are able to become interested, a place where doors open to intrinsically motivated learning and deeper knowledge. Students need to understand the interconnectedness between the fundamentals of science, the environment, and everyday life. Quality experiences impact student learning through increased interest, increased motivation to learn, increased knowledge and a broader perspective that will help them to apply their knowledge to the world around them (Behrendt 2014).

Through the words and lived experiences of the student participants, there is agreement that the four-day experience at Stone Lab was beneficial in multiple ways. The students explored, discovered, and reflected over the things that they personally found interesting. The students developed and discovered interest in many aspects of biology, environmental science, geology, and the geography of the region. Some students admitted that the field station experience might have redirected their lives to a career in the environmental sciences. The students recognized the value of Stone Lab, and ostensibly any biological field station that provides a focus on student exploration, discovery, education, and applied knowledge to the STEM fields.

References

American Institutes for Research. (2005). Effects of outdoor education programs for children in California. [accessed 2014 Dec 29]. http://www.air.org/sites/default/files/downloads/report/Outdoorschoolreport_0.pdf

Arvey, M.D., Riemer, W.J. (1966). Island biological field stations of the United States. *BioScience, 16*(4), 249-254.

Behrendt, M. 2014. Nature of High School Students' Experiences at a Biological Field Station. [Dissertation]. [Athens, OH]: Ohio University.

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist 35*, 513-531.

Creswell, J.W. (2013). *Qualitative inquiry and research design*. LA: Sage.

Falk, J.H., & Dierking, L.D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: AltaMira Press.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough?: An experiment with data saturation and variability. *Field methods, 18*(1), 59-82.

Hidi, S., & Renninger, K.A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111-127.

Hofstein, A., & Rosenfeld, S. (1996). Bridging the gap between formal and informal science learning. *Studies in Science Education, 28,* 87–112.

Kolb, D. 1983. *Experiential learning, experiences as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.

Kolb, A.Y., & Kolb, D.A. (2005). The Kolb learning style inventory – version 3.1 2005 technical specifications. [accessed 2014 Dec 29]. http://www.whitewater-rescue.com/support/pagepics/lsitechmanual.pdf.

Malinowski, J., & Fortner, R.W. (2011). The effect of participation in a Stone Laboratory workshop a place-based environmental education program on student affect toward science. *Ohio Journal of Science, 110*(2), 13-17.

National Research Council (2009). *Learning science in informal environments: People, places, and pursuits.* Washington, DC: The National Academies Press.

National Research Council (2014). *Enhancing the value and sustainability of field stations and marine laboratories in the 21st century*. Washington, DC: The National Academies Press.

Ohio State's Stone Laboratory. (2013). Mission Statement. [accessed 2014 Dec 29]. http://stonelab.osu.edu/about/mission/.

Onwuegbuzie, A.J., & Leech, N.L. (2007). A call for qualitative power analyses. *Quality and Quantity*, 41: 105-121.

Organization of Biological Field Stations. 2014. Research at field stations. [accessed 2014 Dec 29]. http://www.obfs.org/research-at-field-stations.

Patton, M.Q. (2002). *Qualitative research and evaluation methods*. Thousand Oaks, CA: Sage.

Rennie, L.J. (2007). *Learning science outside school. In Handbook of research on science education*, ed. SK. Abell, and NG Lederman. Mahwah, NJ: Lawrence Erlbaum Associates.

Saylan, C, Blumstein, DT. (2011). *The failure of environmental education: And how we can fix it.* Berkeley: University of California Press.

Smith, M.K. (2001). David A. Kolb on experiential learning. [accessed 2014 Dec 29]. http://infed.org/mobi/david-a-kolb-on-experiential-learning/.

Stake, RE. 1995. *The art of case study research.* Thousand Oaks, CA; Sage.

Wang, C., & Burris, M. (1997). Photovoice: concept, methodology, and use for participatory needs assessment. *Health Education & Behavior 24*(3), 369-387.

Wellington, J. (1990). Formal and informal learning in science: The role of the interactive science centres. *Physics Education 25*(5), 247-252.

Woodhouse, J.L., & Knapp, C.E. (2000). Pl*ace-based curriculum and instruction: Outdoor and environmental education approaches*. ERIC Clearinghouse on Rural Education and Small Schools Charleston WV. [accessed 2014 Dec 29]. http://www.kacee.org/files/Place%20based%20education.pdf

Yin, R.K. (2009). *Case study research: Design and methods*. LA: Sage.

Zandstra, A. M. (2012). *The impact of an informal science program on students' knowledge and interest.* [Dissertation]. [Waco, TX)]: Baylor University. [accessed 2014 Dec 29]. http://beardocs.baylor.edu/xmlui/bitstream/handle/2104/8481/anne_zandstra_phd.pdf?sequence=1