Preparing Preservice Teachers Using a Civic Engagement Model:

The Effect of Field Experience on Preservice Teacher Knowledge, Skills, and Attitude

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Abstract

Participating in a civic engagement partnership, Towson University preservice teachers deliver educational programming at the National Aquarium to students from local schools, focusing on Chesapeake Bay water quality and human impact. Teaching Environmental Awareness in Baltimore (TEAB) is designed to engage students (both preservice teachers and K–12) in environmental issue investigations relevant to the local community and promote deep, critical thinking. From a civic and socio-scientific viewpoint, our project has the following aims: (1) to focus on urban youth who may have limited personal experience with nature and/or have a limited understanding of local natural resources, (2)to assist preservice teachers in becoming confident, competent environmental educators through practical, hands-on professional development, (3) to enact a place-based environmental curriculum that meets both the instructional guidelines of local school districts and State content standards.

Introduction

A national movement, sparked by Richard Louv's (2005) treatise *Last Child in the Woods*, has catalyzed collaborations among government agencies, schools, and nonprofit and community organizations, with the goal of reconnecting children with the environment. The positive impacts of spending time in nature on a child's physical, cognitive, and social development have been well established in the literature (James, Banay, Hart, & Laden, 2015; Thompson Coon et. al., 2011; Rook, 2013). These impacts are especially crucial due the lack of public understanding in the United States of the importance and benefits of nature and the ecosystem services it provides (Duvall & Zint, 2007; Turnpenney, Russel, & Jordan, 2014).

The State of Maryland contains rich and varied natural resources that provide both tangible and aesthetic value to its residents. These natural resources provide critical ecosystem services that maintain clean air and water and provide productive land to support its residents. Despite its aesthetic and economic value, Maryland's natural resources face a multitude of long-term environmental threats. For instance, the Chesapeake Bay has been the focus of ongoing restoration efforts for more than two decades; yet, in recent years , the University of Maryland Center for Environmental Science assigned the Bay a D+ in overall health, based on six ecological indicators (University of Maryland Center for Environmental Science, 2018). Nutrient pollution from agriculture continues to be a problem in freshwater streams and rivers. Land development, especially along the shores of the Bay, continues at a rapid pace, and this land development threatens the water's-edge ecosystems along the shores. Baltimore joins other post-industrial legacy cities in an uphill battle to modernize aging infrastructure and rehabilitate local waters stressed by generations of manufacturing outflow and inadequate regulation. Even as the industry of the Inner Harbor has been replaced by a revitalized waterfront and service economy, water quality continues to suffer as storm run-off and sewage overflows raise bacteria, nutrients, and debris levels well above of healthy levels. Air quality, especially in central Maryland, ranks among the worst in the nation (Goldberg et. al., 2014). Critically evaluating local environmental problems and developing solutions is difficult and requires fundamental understanding of the interconnectedness of ecological systems and human impacts on them. The conservation, restoration, and long-term sustainability of Maryland's natural resources are dependent on future generations of citizens who can serve as environmentally literate stewards of the state's natural resources and can make informed decisions that will affect their families and their communities.

Environmental education rooted in local, place-based issues is one way to ensure that our youth have the knowledge and skills necessary to address these complex socio-scientific issues as adults (Klosterman & Sadler, 2010). Furthermore, environmental literacy is a component of overall scientific literacy (Blumenstein & Saylan, 2011) and requires the same skills as other STEM fields (Jordan, Singer, Vaughan, & Berkowitz, 2009). With the goal to create a more environmentally literate citizenry, the following initiatives have been implemented in Maryland K–12 schools over the past six years:

- Environmental literacy standards for K–12 students were adopted.
- The state began requiring that all students enrolled in public schools are to engage in a "meaningful watershed educational experience" at least once at the elementary, middle school, and high school levels (Chesapeake Bay Watershed Agreement, 2020).
- Beginning with the freshman class of 2013, all high school seniors must satisfy an environmental literacy graduation requirement (Maryland State Department of Education, 2019). To date, Maryland is the only state to mandate this requirement, although several other states have adopted and implemented environmental literacy standards.

These changes in K–12 education in Maryland Public Schools have created the need for school systems and institutions of higher education to reevaluate how they deliver instruction for both K–12 students and the preservice teachers who will eventually be teaching them. School districts need support from outside partners to provide appropriate and meaningful watershed educational experiences for all students. Additionally, there is a pressing need to provide appropriate training to preservice and inservice teachers; they must have the content knowledge and pedagogical expertise to ensure their ability to plan instruction that will align with the new environmental literacy standards and meet the requirements for the Meaningful Watershed Educational Experience (MWEE). This will enable our students to eventually meet the environmental literacy graduation requirement.

We aimed to address these needs by forming a partnership between an institution of higher education (Towson University) and an informal educational institution (National Aquarium). In this partnership, Towson University preservice teachers deliver educational programming focusing on Chesapeake Bay water quality and human impact to students from local schools. Teaching Environmental Awareness in Baltimore (TEAB) is designed to engage students (both preservice teachers and K–12) in environmental issue investigations relevant to the local community and to promote deep, critical thinking. From a civic and socio-scientific viewpoint, our project has the following aims:

1. To focus on urban youth who may have limited personal experience with nature and/or have a limited understanding of local natural resources,
2. To assist preservice teachers in becoming confident, competent environmental educators through practical, hands-on professional development,
3. To enact a place-based environmental curriculum that meets both the instructional guidelines of local school districts and State content standards.

We are also aiming to address the following more overarching civic issues through our project activities:

- The infrequency of contact between children and nature and their lack of appreciation and awareness of the local environment,
- A disproportionate lack of exposure to nature for at-risk urban youth,
- The need for well-trained teachers who can provide experiential education opportunities that foster children's affinity for nature and a stewardship ethic that is supported by knowledge.

Although our project involves several entities, and our goals stated above address more than one audience, the data presented here focus mainly on the effect of the project on preservice teachers. In particular, we wanted to answer the following questions:

Can integrating non-formal educational field experiences that focus on local environmental issues into teacher preparation programs promote enhanced preservice teacher content and pedagogical knowledge, as perceived by preservice teachers?

Can integrating non-formal educational field experiences that focus on local environmental issues into teacher preparation programs promote more positive attitudes towards teaching environmental education, and perhaps toward the environment itself?

The specific objectives of this study are as follows:

- Preservice teachers will report deepened understanding of how environmental factors affect aquatic life in the Chesapeake Bay.
- Preservice teachers will feel confident teaching environmental education topics in non-formal settings.
- Preservice teachers will demonstrate increased personal interest in environmental issues affecting their local community.
- Preservice teachers will report strengthened pedagogical content knowledge in delivering science lessons.

Program Partners

The pilot semester of our project was financially supported by a SENCER-ISE grant awarded to Towson University and the National Aquarium.

Since its opening in 1981, the National Aquarium has been a gem in the very heart of Baltimore's Inner Harbor, and generations of Maryland families have walked through its doors and shared in the wonders of the undersea world. Its mission, to inspire the conservation of the world's aquatic treasures, has motivated thousands of Marylanders to appreciate and protect the delicate habitats in their own backyards. The Aquarium educates more than 150,000 Maryland schoolchildren a year, both at the Aquarium and in the classroom. The Aquarium's conservation and education programs, coupled with the many affordable-access programs offered to Maryland residents, ensure that nearly 400,000 Marylanders are able to visit the Aquarium each year. Urban conservation is a major theme in the Aquarium's new Conservation Plan. Under this plan, the Aquarium is working to provide urban residents with the tools and skills to make changes in their communities. Because we are a coastal city, Baltimore's urban communities are becoming increasingly impacted by environmental challenges. To combat these challenges, an educated citizenry is necessary.

Towson University is recognized as Maryland's preeminent teacher education institution and as a national model for professional educator preparation. The Fisher College of Science and Mathematics (FCSM) at Towson University has a distinguished history in the preparation of STEM classroom teachers and STEM education specialists. The Fisher College prepares STEM preservice teachers to become facilitators of active and inclusive learning for diverse populations of students. FCSM faculty, who comprise a diverse community of teacher-scholars, have a wide range of strengths and specialties. Academic programs require teacher candidates to demonstrate professional knowledge, skills, and dispositions that place students at the center of active learning and emphasize higher order thinking. Through innovative educational partnerships, TU's certification programs provide teacher candidates with progressively responsible field and/or clinical experiences in a variety of settings. These rich experiences are designed to enable teacher candidates to merge theory with classroom practice and to develop and refine their knowledge of and skills in STEM teaching and learning.

At the Aquarium, preservice teachers are able to directly apply their learning from postsecondary coursework in a practical setting. As a result, they gain valuable career experience while making a significant contribution to the local community and its children. By serving as educational interns, the preservice teachers serve the needs of the local community by fostering environmental awareness among urban youth.

Methods

Research Design: Participants

Subjects in this study were elementary education preservice teachers at Towson University who were enrolled in one section of SCIE 376: Teaching Science in the Elementary School. Maximum enrollment in these sections is 18. Typically, students are 19–23 years old, and most are female. There were 16 students enrolled in the Fall 2017 pilot semester and 13 students enrolled in the Fall 2018 semester. The study utilized convenience sampling; thus, any preservice teacher enrolled in the course could participate but was not required to. Students were recruited regardless of age, sex, or ethnicity. The research design and participant recruitment methods were approved by the university institutional review board.

Research Design: Location

All activities were conducted at the National Aquarium in Baltimore, Maryland. The location of the National Aquarium was well suited for our purposes for two reasons. First, the Aquarium is located on a major tributary of the Chesapeake Bay, making it a perfect venue for investigating the socio-scientific issues surrounding water quality and watersheds. Second, the Aquarium is located in the same community where our target school-age population lives, allowing us to emphasize place-based educational strategies.

Research Design: Task/Preservice Teacher Content

The field study component that is required of a MWEE is often difficult for Baltimore City Schools to implement due to a lack of safe study sites within the local area. The National Aquarium is a logical partner for them, as it is located in the same neighborhood as the schools and students we are aiming to reach, and there are many accessible study sites on the aquarium property where students can safely access the water and examine human impact. The "What Lives in the Harbor" program is designed to meet the Chesapeake Bay Agreement requirements for an MWEE and is aligned with the Baltimore City Public Schools sixth-grade curriculum. MWEEs are learner-centered experiences that focus on investigations into local environmental issues that lead to informed action and civic engagement. Educators play an important role in presenting unbiased information and assisting students with their research and exploration. In our case, the field experiences take place at the National Aquarium, entirely outdoors. Students begin their visit to the Aquarium's waterfront campus with a brief discussion about their local Baltimore Harbor watershed and its place within the larger Chesapeake Bay. Students then rotate through three stations where they take water quality readings. At the request of City Schools the Aquarium uses Vernier equipment, which is the same equipment used in high schools. Each station is led by two preservice teachers and lasts approximately 25 minutes. At each station, students collect quantitative data that will help them determine which organisms on their organisms cards would be able to survive in the harbor, based on the data they have collected. All data are recorded on paper data sheets, and also on portable electronic devices, which save the data for reference later; the data are also sent to the classroom teacher for later use in synthesis and conclusion activities that take place in the classroom. A brief description of each station appears below.

- **Plankton & Turbidity:** Turbidity is defined and the consequences of low or high turbidity are discussed. Human impact on turbidity is emphasized as well as the impacts of high turbidity, such as decrease in the amount of light available for photosynthesis and increased water temperature. Turbidity is measured with a Secchi disc. Students assess phytoplankton living in the harbor using handheld microscopes and observe water color to determine the species of phytoplankton present. The observation and discussion of plankton in the water emphasizes the key role that plankton play as a primary food source for the harbor's food web.
- **Dissolved Oxygen & Salinity:** Dissolved oxygen and salinity are measured with Vernier probes. Dissolved oxygen and salinity readings are taken both at the surface and closer to the harbor bottom. Human impact on these parameters is discussed, as well as what the measurements mean for the organisms living in the watershed. Emphasis is placed on the impact that low dissolved oxygen levels have on the ability of aquatic organisms to survive in certain water systems and the impact of salinity changes as a stressor for marine ecosystems.
- **Temperature and pH**: Temperature is measured with a digital thermometer and pH is measured using pH strips. Common household items (bleach, milk, orange juice) are used to relate the pH scale to the students more effectively. Emphasis is placed on the influence of temperature and pH on the chemical and biological reactions in marine ecosystems.

After completing all of the stations, students analyze the data they have collected to determine which organisms would be able to live in the Baltimore harbor, and are asked to support their conclusions with evidence from the data. To test their hypotheses, students survey and catalog what they find in bio-hut cages suspended off the Aquarium piers using the iNaturalist app on an iPad. The bio-hut is a double cage system where one side is filled with oyster shells that attract rapid colonization by microorganisms. The oysters are seeded with spat (juvenile oysters) that grow and serve as biological filters by filter feeding and removing algae from harbor water. Mussels and barnacles that attach themselves to and grow on the oyster shells act as living filters in these urban waters. The outer cage is empty and provides only shelter, offering a predator-free zone for juvenile native fish. The double cage system of the bio-huts restores some of the ecological function once provided by the wetlands historically found in the area. The group discusses whether their predictions were correct and why or why not. They also discuss what water quality parameters seem to be the most important to biodiversity. Finally, preservice teachers have the students take inventory and count the living spat (oyster larva) on the oyster shells inside the bio-hut cages. These data are provided to the Aquarium's Field Conservation Department and contribute to one of the Aquarium's broad conservation goals. At the end of each school year, these spat will be added to the Aquarium's recently created oyster reef, which provides a unique habitat to the urban wildlife of the Baltimore Harbor. This onsite action project will help inspire students to plan their own action projects, as they learn about how the Aquarium's oyster reef, floating wetlands, and bio-huts are creating natural ecosystems that support the diverse life in the harbor. Following their field experience, students complete an action project at their schools. During the pilot, students identified one water quality parameter that is negatively affecting organisms in the harbor and then worked in groups to brainstorm issues in their neighborhood that could impact water quality and aquatic species in the harbor. Students selected one issue and suggested an action they or others in their neighborhood could take to positively change these conditions. From this exercise, pilot schools conducted several different action projects, such as discussing and designing a small garden on the school's property in the following school year; creating posters to promote improving water quality and reducing waste; writing letters to the principal and elected officials about the importance of the bay; and pledging to reduce, reuse, and recycle 10% more over summer break.

Data Collection

Survey Instrument: STEBI (Science Teacher Efficacy Belief Instrument)

The identification of various methods that can help to develop self-efficacy is becoming an increasingly important aspect of science education research and the professional development of teachers (Ginns, 1996). The STEBI was used to measure science teaching self-efficacy and outcome expectancy in preservice teachers. Since our subjects are preservice teachers, we used the STEBI-B, which is designed for this audience (Riggs & Enochs, 1990). The STEBI-B was chosen as an instrument in this study because it has been commonly used in science education research studies and because studies have found the survey instrument to have high validity and reliability (Bleicher, 2004; Bleicher & Lindgren, 2005; Settlage, 2000; Schoon & Boone, 1998). The STEBI-B consists of 23 Likert scale response items and is broken up into two subscales, personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). The subscale personal science teaching efficacy measures the participant's belief in the ability to teach the subject of science effectively (Deeham, Danaia, & McKinnon, 2017). Deeham et al. also describe the outcome expectancy subscale as a measure of the participants' broad views of science teaching related to why students perform as they do. The items for the two subscales are randomly placed throughout the survey. A paired t-test was used to determine any significant difference in the pre and post survey answers.

Survey Instrument: Environmental Education Attitudes Assessment

To assess preservice teacher attitudes and beliefs toward teaching science, specifically environmental education, an analogy was administered pre/post. Participants were asked to complete the analogy, "Teaching environmental education is like ______." They were then asked to accompany their answer with a drawing that illustrated their thoughts. The analogies that the preservice students create and explain helps to capture their attitudes towards teaching, thereby giving us insight into their teaching self-efficacy (Hanson, 2018). Data collected were coded based on the categories described in Table 1 .

After coding the data from the science teaching analogy, the analogy results were linked to the STEBI scores, to give insight into the preservice teachers' teaching self-efficacy and their attitudes towards environmental education.

Survey Instrument: SALG (Student Assessment of Learning Goals)

The SENCER SALG was administered pre/post and was used as an evaluation tool to gather learning-focused feedback from students. The SALG has students assess and report on their own learning and on the degree to which certain aspects of the course have contributed to that learning. The SALG instrument may be one of many assessment practices that can assist in gathering feedback for both teaching and learning assessment (Scholl & Olsen, 2014).

Weekly Reflections

Weekly reflections serve as an outlet for students to self-report their current attitudes towards environmental education and their assessment of their teaching. Included with each open reflection assignment is a required question for students to answer: What is your current attitude towards teaching environmental education? Have there been any changes since last week? Any positive/negative experiences?

Students completed six weekly reflections throughout the semester, and these weekly reflections were analyzed through open coding techniques using NVivo software. Interrater reliability was established through the use of two different coders to develop codes and observe trends

TABLE 1. Coding Categories for Environmental Education Attitudes Assessment

Category	Definition
Negative	Very clear negative perceptions
Struggle	Process implied with negative connotations
Uncertainty	Feeling uncertain
Indifferent	Neither positive nor negative is implied
Good with one negative caveat	Statement mainly positive with one exception (word or phrase)
Journey	Implies a struggle yet a positive or surprising outcome
Positive	Very clear positive perceptions

in the data. Three weeks out of the seven were selected using a random numbers calculator, then those weeks were coded separately by both individuals. From these three weeks, larger codes were developed: Negative Attitude, Positive Attitude, Self-Efficacy, and Classroom Management. The weekly reflections gave insight into the attitudes and self-efficacy of the students through self-reporting information.

Results

Survey Instrument: STEBI (Science Teacher Efficacy Belief Instrument)

Attitude outcomes were measured through pre/post data taken from the STEBI, which was administered to all Towson University students enrolled in the course. Paired t-test results show that the experiences at the Aquarium led to an increase in both science teaching self-efficacy ($p=.003$) and teaching outcome expectancy ($p=.031$). See Figure 1 for individual pre and post STEBI scores.

Individual questions were analyzed to determine areas of largest growth in self-efficacy. The question showing the largest gains was "I know the steps necessary to teach science effectively"; the average pre assessment score was 36 while the post assessment average score grew 14 points to an average of 50 points. Another survey question that showed large gains was "I wonder if I will have the necessary skills to teach science"; the average pre-assessment score was 34 and the post assessment average was 47. This increase of 13 points suggests that the preservice teachers were not wondering whether they would have the necessary skills to teach science as much as they did before the field experience. These individual STEBI question results are meaningful because they suggest that the preservice teachers were feeling more capable of teaching science effectively after this non-formal educational field experience.

FIGURE 1. STEBI Pre and Post Assessment Scores

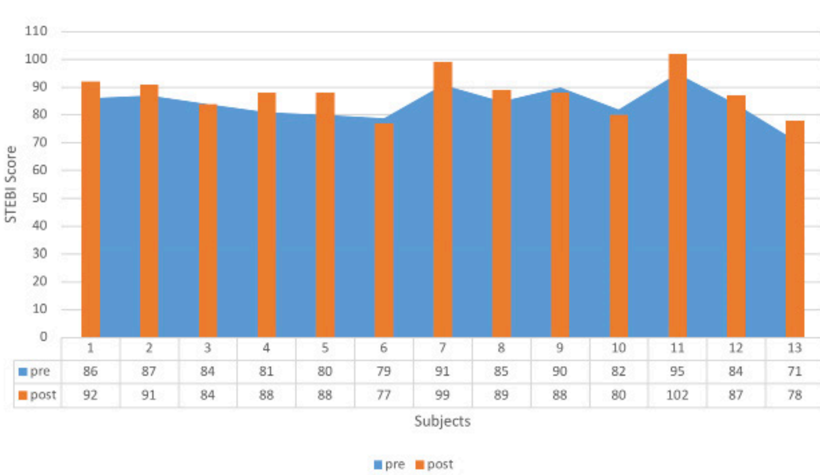


TABLE 2. Results of Preservice Teacher Coding per Coding Classification

Preservice Teacher	Pre EEAA	Post EEAA
1	Negative	Positive
2	Struggle	Good with one negative caveat
3	Positive	Positive
4	Struggle	Negative
5	Indifferent	Journey
6	Journey	Indifferent
7	Negative	Positive
8	Struggle	Journey
9	Struggle	Journey
10	Struggle	Positive
11	Negative	Journey
12	Uncertain	Uncertain
13	Uncertain	Positive

Survey Instrument: EEAA (Environmental Education Attitudes Assessment).

The results of the pre EEAA show that most of the preservice teachers' attitudes towards teaching environmental education were coded as negative or a struggle (61.5%). After the field experience, we saw a shift in the responses, as only 8% were coded as negative or struggle. Instead of a predominately struggle or negative attitude in the preservice teachers in the pre-EEAA (61.5%), we saw predominately journey and positive attitudes in the post EEAA (69%). The largest area of growth was in the positive category; only one preservice teacher was coded as positive in the pre EEAA, but in the post-EEAA there were five preservice teachers whose responses were coded "positive." Samples of each coding description appear in Table 2 above. See Figures 2 and 3 for results by coding category.

Survey Instrument: STEBI + EEAA

Linking the results

Table 3 illustrates the linkages between each participant's pre/post STEBI score and pre/

FIGURE 2. Individual Preservice Teacher EEAA Codings in Pre/Post Test

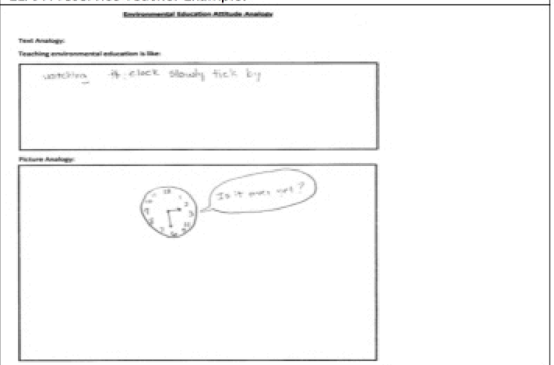
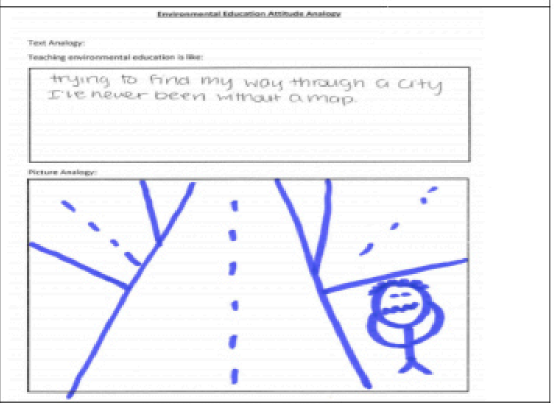
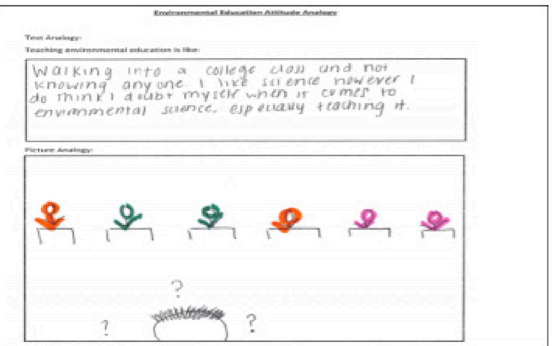
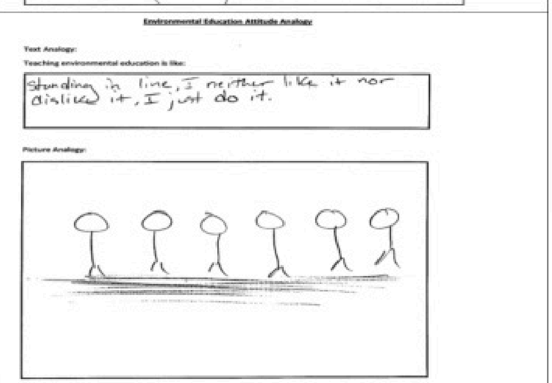
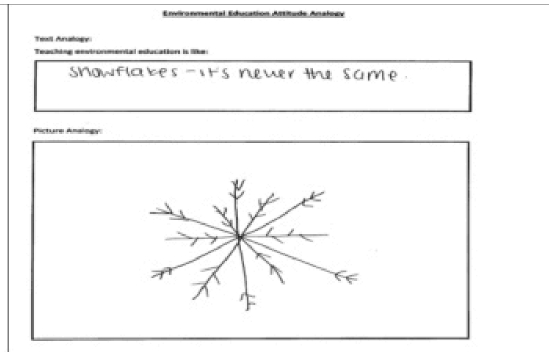
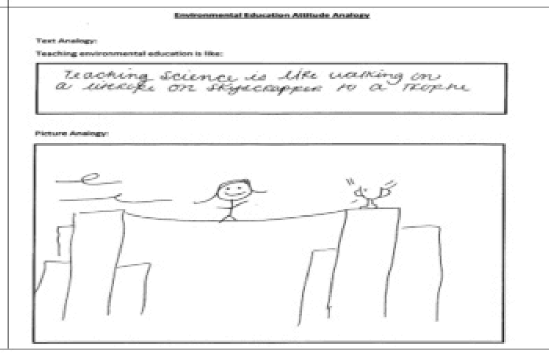
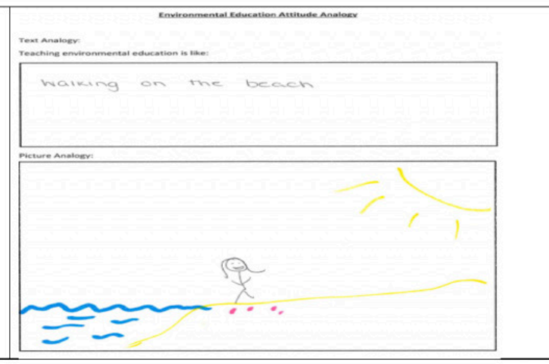
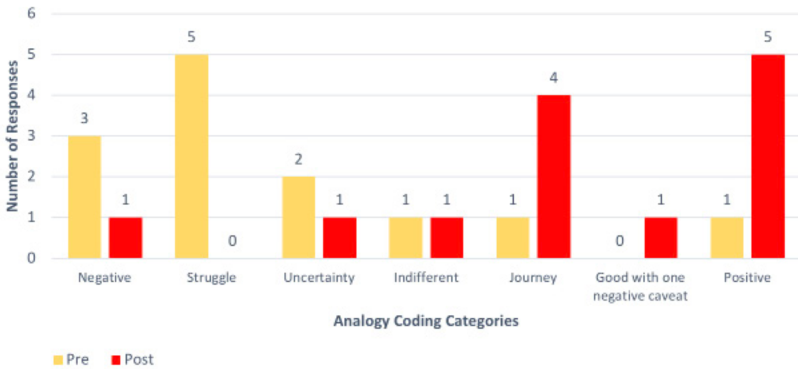
Coding	EEAA Preservice Teacher Example:
Negative	
Struggle	
Uncertainty	
Indifferent	
Good with one negative caveat	
Journey	
Positive	

FIGURE 3. EEAA Pre to Post Coding



post EEAA. Of the 13 preservice teachers who were administered the STEBI and EEAA, seven subjects (54%) demonstrated growth in both self-efficacy and in attitudes towards environmental education from pre to post. Five students (38%) demonstrated growth in one area but not the other and only one student (8%) demonstrated a decrease in both areas. Overall, there were nine out of 13 students who demonstrated growth in self-efficacy and nine out of 13 students whose attitudes towards environmental education became more positive over the course of the study.

Weekly reflections

Qualitative data collected through analysis of weekly reflections support the findings presented from the SALG that personal interest in the civic issues being studied did increase among participants. These data show that overall students became more interested in socio-scientific issues and watershed issues in particular as a result of participating in this course. A few students' comments that were written in reflections at the conclusion of the course appear below.

> *The journey has opened my eyes on topics that are related to and inside of the subject environmental science, and that I am certainly more comfortable handling and teaching the subject than I was prior to this experience.*

> *I learned how to be respectful towards the environment. It is important to teach this quality to kids at a young age.*

Students also felt that they gained skills that would help them be more effective teachers in the classroom. It was evident to us through their written lesson planning and through teaching observations that their delivery methods improved over the course of the semester, but students also reported feeling more confident in teaching science content to children.

> *Seeing how much students were enjoying and engaged in the program, I can only be reassured that environmental education is a powerful and important element to elementary education.*

> *The biggest change I have found is in my confidence level. My self-efficacy for teaching science has increased 100 percent. I feel like I know the content a lot better so I can teach my students without feeling unsure of the topics.*

> *As a teacher of science, I am growing more confident in this content and I hope to apply this knowledge to my future work.*

The NVivo coded data reveal many fluctuations in preservice teacher attitudes throughout the study. In the

TABLE 3. Individual EEAA and STEBI Pre/Post Linked Results

Subject	Pre STEBI	Post STEBI	Change (+,0,-)	Pre EEAA	Post EEAA	Change (+,0,-)
1	86	92	+	Negative	Positive	+
2	87	91	+	Indifferent	Journey	+
3	84	84	0	Uncertainty	Positive	+
4	81	88	+	Struggle	Journey	+
5	80	88	+	Struggle	Journey	+
6	79	77	-	Negative	Positive	+
7	91	99	+	Uncertain	Uncertain	0
8	85	89	+	Struggle	Negative	-
9	90	88	-	Journey	Indifferent	-
10	82	80	-	Struggle	Journey	+
11	95	102	+	Positive	Positive	0
12	84	87	+	Negative	Journey	+
13	71	78	+	Struggle	Positive	+

FIGURE 4. Attitude Coding for Weekly Reflections

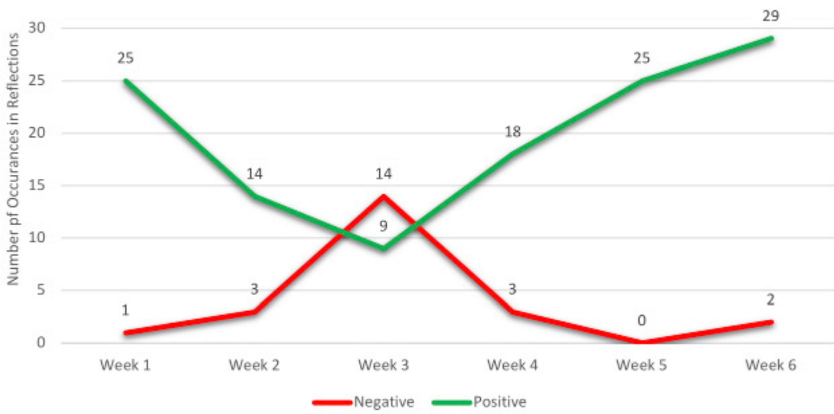
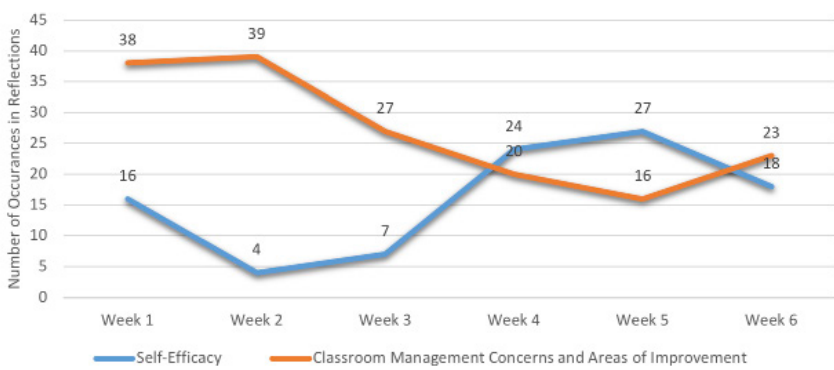


FIGURE 5. Self-Efficacy vs. Classroom Management Codes by Week



final week, there were fewer than three negative attitude codes and more than 28 occurrences of positive attitude codes. In general, positive codes tended to increase as the study progressed, and negative codes decreased after a spike in Week 3. Even though changing weekly factors at the field site, which will be noted in the Discussion section, seemed to affect preservice teacher attitude, overall there were more occurrences of positive attitudes in the last half of the field experience than in the first half (see Figure 4).

Some student responses from midway through the course that displayed these positive attitudes appear below.

I believe that my attitude is more positive now because I feel like I am learning a lot about the science content, as well as flexibility, time management, and patience, which are essential teaching skills.

My attitude towards environmental education is at a semester-high as of right now. I have always seen the value in developing a sense of environmental awareness and responsibility in the students. It is definitely fun to work with students who come into our stations with open minds and positive attitudes. It is interesting to hear about what they know, and how they connect/relate that to the information at each station.

Along with attitudes, we analyzed weekly reflections for changes in self-efficacy and classroom management concerns/areas of improvement. Classroom management concerns and areas of improvement codes decreased from 38 in Week 1 to 23 occurrences in Week 6 (see Figure 5). Self-efficacy codes were more variable. The reflections for Weeks 4, 5, and 6 contained more self-efficacy codes than Weeks 1, 2, and 3. Possible reasons for these variations are discussed below.

Survey Instrument: SALG

Personal interest data through SALG

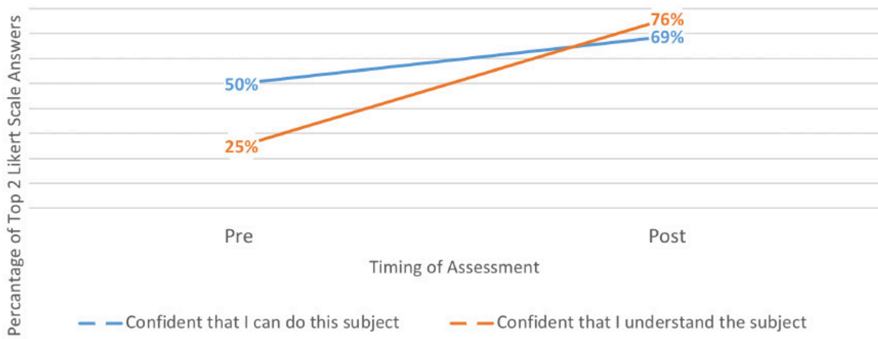
The SALG data show that students' personal interest in civic issues increased over the course of the study. Additionally, students became more interested in watershed issues and tended to regard environmental education as more important in the post test.

A few student comments taken from the post SALG survey appear below.

At the beginning of the semester, I had no idea what factors could affect water quality. Now, because of this internship, I know much more about turbidity, salinity, watersheds, conservation, etc. that I can take with me in my future.

I have gained many skills to help me teach science. I am much more interactive and believe science should be taught through experience after taking this class.

FIGURE 6. Self-Efficacy in Environmental Education: SALG Data



My confidence gained by this class will be taken with me throughout the rest of my teaching career.

The biggest change I have found is in my confidence level. My self-efficacy for teaching science has increased 100 percent. I feel like I know the content a lot better so I can teach my students without feeling unsure of the topics.

The content within environmental education is definitely something I will carry with me into my other classes, especially other science courses because it is super relevant. It is something I also hope to promote within my personal life among family and friends.

The quantitative data support these qualitative comments. For example, pre assessment data show that only 25% of students scored themselves a four or five on the Likert scale for understanding the concept of a watershed, but in the post test, this increased to 81% of students. When asked whether they understood the impact of human activities on water quality, 56% of students rated themselves as 4 or 5 on the pre test, while this increased to 81% on the post test.

The post SALG data reveal that student self-efficacy in teaching the subject of science and environmental education also increased. Students mentioned different aspects of growth; for example, they reported that their feelings of confidence and self-efficacy had increased and that they had overcome their fear of teaching science (see Figure 6). A few student comments taken from reflections at the conclusion of the course appear below.

I was afraid of teaching science prior to this experience, but I have since gained confidence.

The SALG data indicate that the largest growth areas in socio-scientific issues were in development of knowledge of the watershed and how human activities can affect water quality. These areas grew by over 20%, showing that these students have developed a deeper understanding and connection with the environment and how they as individual community members impact that environment. Confidence about understanding of environmental education, self-efficacy in being able to teach environmental education, and the ability to develop lesson plans in this area were individual questions that reflected growth from pre to post. See Table 4 for a summary of responses pre/post.

Discussion

Impacts on Preservice Teachers

The STEBI data demonstrate an increase in self-efficacy in the preservice teachers at the end of the non-formal education experience. The item of largest growth on the survey was "knowing the steps necessary to teach science

TABLE 4. Sample SALG Questions Demonstrating the Largest Gains

Number	Question	PRE: Percentage of a lot/great deal answers	POST: Percentage of good/great gain	Difference
1.	How human activities can affect water quality	56%	81%	+25
2.	How studying this subject helps people address real world issues such as water quality and habitat conservation	69%	81%	+12
3.	Confident that I can teach this subject	50%	69%	+19
4.	Confident that I understand the subject	25%	76%	+51
5.	The concept of a watershed	25%	81%	+56
6.	Writing lesson plans in discipline-appropriate style and format	31%	69%	+38

effectively," showing us that the preservice teachers have greater confidence in their ability to teach science effectively after the non-formal education experience. Raising self-efficacy levels in preservice teachers is essential; research has found that individuals who have a low sense of efficacy for accomplishing a certain task may avoid it (Schunk, 1991). Having high self-efficacy will help to ensure that the preservice teachers do not avoid teaching of environmental education, but instead feel confident enough in their abilities to be effective, capable, and enthusiastic environmental educators in their future classrooms.

The EEAA data enable us to observe a shift in attitudes in our subjects as the study progressed. These enhanced attitudes towards environmental education have an impact on their effectiveness as teachers (Ozdemir, Aydin, & Akar-Vural, 2009). If teachers do not have positive attitudes toward the topic of environmental education, then little instruction in this area will be given in the classroom (Ham, 2010). Thus, the impact of this educational experience on the promotion of positive attitudes towards environmental education in preservice teachers is meaningful for the implementation of effective EE.

Our data suggest that the more confident and competent these students felt in teaching environmental education, the more positive their attitudes became. Again, promoting both these factors is important, because when teachers perceive their ability to perform the process of teaching science to be low, their resulting dislike of teaching the subject of science translates into the avoidance of teaching science (Koballa & Crawley, 1985).

The weekly preservice teacher reflections revealed many fluctuations from positive to negative and vice versa in preservice teacher attitudes throughout the six weeks of the study. One factor that influenced these fluctuations was the school group who visited the Aquarium each week. The university students taught a different set of students from a different school each week; therefore each group of City school students was unique in level of preparedness for the trip and in background content knowledge pertaining to the trip. If the school group attending the program was well prepared and ready to participate, the preservice teachers tended to have more positive attitudes. If the school group was less prepared—for example, if the students did not seem to have much prior knowledge on the purpose of the program and the science behind it—then the preservice teachers tended to have more negative attitudes. Weather was another factor that affected the preservice teachers' assessment of how well a given day went. (The educational experience is based outdoors, and the weather naturally varied from week to week.) We are able to relate these factors to certain spikes and dips in attitudes and self-efficacy throughout the six weeks. In Week 3 we saw the most notable affect from these factors: there was a dip in positive attitude and a spike in negative attitudes, which we attribute to the weather. That week it was cold and rainy, and preservice teachers and Baltimore City students therefore complained about the weather throughout the outdoor experience. This factor affected the timing of the activities, since the schedule was adjusted because of the weather; it also affected the data collection, because student data collection papers were getting wet, and had a negative effect on student behavior, as complaints ran high. The day was definitely a challenge for the preservice teachers. We consider these conditions responsible for a dip in positive attitude by five code occurrences and a spike in negative attitude by 11 codes compared to the week before.

An opposite trend was observed in Week 5. During the programming for this week, we had several politicians and local dignitaries from Baltimore and the surrounding area observing the "What Lives in the Harbor" program. There was a news media presence there as well, and some of our students were interviewed. Many of the politicians spoke of the "good things" the Aquarium and the preservice teachers were doing. They also mentioned the positive impact the program was having on the community. Coding for Week 5 revealed the lowest level of codes for negative attitudes towards environmental education, with zero instances of negative attitudes. It appears that the university students were feeling as if they were making an impact and doing something important for their local community. It also created an increase in positive attitude codes. The students seemed to be affected by this experience and the positive feedback they received from persons not directly associated with the project. Examples from Week 5 student reflections follow.

> *My attitude towards environmental education has remained positive throughout this week. It was nice to have our efforts at the aquarium validated through the speakers during the press day. I was also*

interested to learn that this project is important not only on a state level but on a national level.

This also benefits me as a teacher of environmental education as I was congratulated on teaching the science well from an outside party's perspective. To me, this has the same effect as a parent saying I did well because while they may not understand and therefore won't focus on the teaching aspect of it, they feel that I conveyed the information well and that means a lot to me.

Impacts on Baltimore City Students

The "What Lives in the Harbor?" program not only has an impact on the preservice teachers, but it is hoped that the program will also positively impact the Baltimore City school students. While the Baltimore City Schools students were not the focus of this study, the school system has stated that the goal of the program is to reach 3,600 students annually by the year 2021 and increase their (1) knowledge of watershed concepts, (2) positive attitudes towards watersheds, (3) inquiry and stewardship skills, and (4) aspirations to protect watersheds. Measurement of progress towards these goals will be conducted by independent program evaluators. The "What Lives in the Harbor?" program plans to scale up to 67 schools by 2021, systematically adding 16–25 schools per year. As shown in Table 5, the Aquarium will use a tiered approach to serve more schools, teachers, and university interns each year over three years.

Conclusion

We believe it is essential to provide appropriate training to preservice teachers so that they have the content knowledge, self-efficacy, and attitudes to plan and facilitate instruction that will align with the new environmental literacy standards and create more environmentally literate students. We consider our project successful in view of the following accomplishments:

- Preservice teachers met the goals we had for the project and had mostly positive things to say about their experience.
- University students and faculty worked effectively with Aquarium staff to deliver quality watershed education programs to Baltimore City Public Schools students.
- A positive shift in attitude regarding environmental education was observed in the preservice teachers.
- Preservice teachers reported a deeper understanding of the environmental issues affecting aquatic life and water quality in the Chesapeake Bay.
- Preservice teachers felt more confident teaching environmental education topics in non-formal settings.
- Preservice teachers reported strengthened pedagogical content knowledge in delivering science lessons.

From a socio-scientific viewpoint, we believe that Teaching Environmental Awareness in Baltimore (TEAB) did engage students (both preservice teachers and K–12) in environmental issue investigations relevant to the local community and promoted deep, critical thinking. Our initial aims, listed below, were well addressed throughout the project.

1. To focus on urban youth who may have limited personal experiences with nature and/or have a limited understanding of local natural resources,
2. To assist preservice teachers in becoming confident, competent environmental educators through practical, hands-on professional development,

TABLE 5. The Aquarium's Tiered Approach for Systemic Implementation by 2021

Year	# of New Schools	Total # of Schools	Total # of Students	# of New Teachers Trained	# of Internships
2017-18 (pilot)		10	575	10	16
2018-19	25	35	1,880	25	64
2019-20	16	51	2,817	18	96
2020-21	16	67	3,600	18	128

Note: The 2017-2018 pilot is included to show how the Aquarium will ramp up the project from its current stage to full implementation in the subsequent three years

3. To enact a place-based environmental curriculum that meets both the instructional guidelines of local school districts and State content standards.

We were also able to address the following more overarching civic issues through our project activities:

- Increasing the frequency of contact between children and nature and fostering appreciation and awareness of the local environment,
- A disproportionate lack of exposure to nature for at-risk urban youth,
- The need for well-trained teachers who can provide experiential education opportunities that foster children's affinity for nature and a stewardship ethic that is supported by knowledge.

Through the STEBI, EEAA, weekly reflections and the SALG we were able to answer our main research questions:

1. Integrating non-formal educational field experiences that focus on local environmental issues into teacher preparation can promote better preservice teacher content and pedagogical knowledge in the majority of preservice teachers.

This conclusion was supported by self-reported data from preservice teachers through the SALG assessment data as well as through the weekly reflections coding data and STEBI. The preservice teachers reported having a stronger content background and more pedagogical knowledge than they did at the beginning of the field experience.

2. Integrating non-formal educational field experiences that focus on local environmental issues into teacher preparation programs can promote more positive attitudes towards teaching environmental education.

This conclusion is supported by the EEAA results and the weekly reflections coding data.

Due to the increased attention and focus on EE in K–12 schools and the need for effective EE teachers, implementing methods that enhance teaching self-efficacy and attitudes in the field of environmental education at the preservice stage of teaching could be of value to educators, preservice teachers, and the communities that they will eventually serve. We envision future iterations of this partnership that will include evaluating the preservice teachers who deliver EE programming using the same types of evaluation tools we might use in a formal education setting. For example, lesson planning and delivery could be evaluated using instruments such as the Reformed Teaching Observation Protocol (RTOP) (Sawada et al., 2000) or the Danielson framework (Danielson, 1996). We are also considering integrating Teacher Performance Assessment (edTPA) rubrics (Ledwell & Oyler, 2016) into the course in order to provide a more robust data set of preservice teacher progress. Much as an estuary is a transition zone between freshwater habitats and the ocean, teacher preparation is a transition zone for development between preservice and inservice teaching. Having varied experiences flow into this preservice "estuary" can help to increase self-efficacy, create positive attitudes toward teaching, and enhance content knowledge. All of these factors can aid educators in preparing students to become effective future environmental educators.

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