THE EFFECTS OF AUTHENTIC LEARNING EXPERIENCES ON FEMALE STUDENTS' PERCEPTIONS OF SCIENCE AND CONFIDENCE IN ATTAINING A STEM CAREER

by

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ABSTRACT

The purpose of this research project was to determine whether authentic learning experiences improve female students' perceptions of STEM and confidence in attaining a STEM career, to what degree hands-on experiences contribute to perceptions of STEM, which tools do Zoo Academy teachers use to create authentic learning experiences for students, and what strategies teachers currently use to engage female students in STEM.

This project was carried out at Omaha's Henry Doorly Zoo and Aquarium in Omaha, Nebraska. Local high school juniors and seniors who wish to gain authentic learning experiences may attend high school on zoo grounds in a program called Zoo Academy.Zoo Academy students learn through hands-on activities, shadowing zoo employees, conducting independent studies, and speaking to the community about topics such as conservation. Much of their learning takes place outdoors rather than inside a classroom.

Data regarding female students' STEM perceptions and identity was collected through surveys, student and teacher interviews, and the Draw a Scientist test. Analysis of the student interview, student surveys, teacher survey, and Draw a Scientist Test reveals that authentic learning experiences improve female students' perception of science and identity in future STEM careers, hands-on experiences contribute positively to perceptions of STEM, Zoo Academy teachers have a variety of tools at their disposal to create authentic learning experiences for students, and teachers use various strategies to engage both male and female students in STEM.

My findings revealed two major takeaways: authentic experiences improve all students' attitude toward learning, regardless of subject; and teaching style has an overwhelmingly strong impact on students' confidence and identity.

INTRODUCTION

For three years, I taught in a traditional classroom in Tumwater, Washington. I taught middle school science and mathematics, followed by fourth grade general education and sixth grade science, social studies, and STEM. Many of my female students began the year with low confidence in science stating, "I like science, but I'm not good at it," when in reality they're some of the most innovative thinkers. As a college graduate, I was endorsed to teach elementary, middle level math or science, but I needed to choose whether I wanted to teach math or science. I am skilled in mathematics, but my heart isn't always in it. I am forgetful of science concepts, but science keeps me awake at night, wondering all the "what if's" of the universe. I went with my heart and chose to teach what I love—science. I want to inspire my students, specifically girls, to do what they love and pursue their passions in life.

In January 2013, I wanted to impact a larger volume of students than just the sixty-six I saw daily. I sought a position in the Education Department at Omaha's Henry Doorly Zoo & Aquarium in Omaha, Nebraska. I landed this position by showcasing my skills and passion for science and expressing my desire to help promote the Zoo Academy offered for high school students. In June 2013, I moved to Omaha to begin this new chapter of my life in informal education. I served as the Outreach Manager; I visited businesses, schools, libraries, homeless shelters and retirement centers to teach children and adults about conservation of animals and how they can be stewards of the environment. Although I did not teach in Zoo Academy, I worked closely with these students, bringing them along on community outreach programs and advising them as they worked on their senior projects.

Focus Statement

Women are underrepresented in STEM careers. I suspect this is a result of girls' identity in science declining from intermediate to secondary education. I want female students to feel confident in their science skills, capable and interested in attaining a career in Science, Technology, Engineering, or Mathematics (STEM). This leads me to my primary research question: Do authentic learning experiences improve female students' perceptions of STEM and confidence in attaining a STEM career? Additionally, to what degree do hands-on experiences contribute to perceptions of STEM? What tools do Zoo Academy teachers use to create authentic learning experiences for students? What strategies do teachers currently use to engage female students in STEM?

CONCEPTUAL FRAMEWORK

The year 1957 launched more than the Soviet's Sputnik; the United States launched an effort to recruit and educate students who would become the next generation of innovators in science, technology, engineering, and mathematics (STEM). This sense of urgency inspired by the Dwight D. Eisenhower Administration diminished two decades later, shaking the United States' foothold in international competition. Today, our best and brightest are failing to be represented and developed, left unable to reach their full potential to contribute to society. The National Science Foundation (NSF) recognizes a need to regain our excellence in STEM education and cultivate young innovative minds (National Science Board, 2010). To accomplish this task, it is imperative we investigate the status of STEM in the United States today.

Science and math achievement of students in the United States is not representative of our role as an international leader of scientific innovation. Although National Assessment of Educational Progress (NAEP) results show improvement in students' knowledge of math and science, most do not meet a satisfactory level of proficiency. Among forty countries participating in the 2003 Program for International Student Assessment (PISA), U.S. students ranked 28th in math literacy and 24th in science literacy (Kuenzi, 2008). The National Science Foundation is alarmed by these lackluster results, as they provide evidence the United States fails to prepare an adequate number of students, teachers, and professionals in STEM. NSF is not the only fretting organization; in July 2012, the Obama Administration announced the President's plan to create a STEM Master Teacher Corps. The STEM Master Teacher Corps will expand to include 10,000 of the best STEM teachers in the U.S. These teachers will promote STEM education in their communities and will receive resources to mentor teachers and inspire students. Obama places a high priority on improving STEM education, as evidenced by his statement , "Efforts to improve STEM education are going to make more of a difference in determining how well we do as a country than just about anything else that we do here" (Larson, 2012). Our nation may only tackle the grand challenges, such as clean energy, stewardship of natural resources, and medicine advances, if we can increase the number of students pursuing careers in STEM areas (Sadler, Sonnert, Hazari, & Tai, 2012).

There is a critical need to enroll a higher proportion of students in STEM career fields. In 2002-2003, only 16.7% of baccalaureate degrees awarded in the US were affiliated with STEM. On the other hand, 64% of baccalaureate degrees awarded in

Japan were STEM-related, followed by 52.1% in China (Kuenzi, 2008). What may also be disturbing is interpreting graduate level degrees; according to NSF Survey of Earned Doctorates, foreign students earned one-third of doctoral degrees awarded in 2003, the majority being in the field of STEM.

The time has come to look at the human capital available in our homeland. Focusing efforts on STEM education with our students is an effective way to invest in our future. One of our biggest hurdles to jump in recruiting more students to STEM is the gender gap. Studies of intended or declared college majors reveal patterns of inequality. In a 2003 national study of high school seniors, the likelihood of females indicating an interest in a STEM degree was 60% less than degree intentions of males. (Riegle-Crumb, Moore, & Ramos-Wada, 2011). The population of females could be a precious resource to engage in the field of STEM. Why are females underrepresented in STEM fields? The factors may be related to academic performance, confidence, perceptions, and interest in STEM.

A long-lived stereotype suggests girls are not as good at math as boys. However, results of achievement tests given to elementary and high school students indicate this gender gap has closed. Although females perform just as well as males, perception and interest in STEM fields differs between genders. Boys typically have more positive math attitudes, less math anxiety, and more positive self-concepts than girls. These attitudes impact performance, enrollment in math courses, and pursuit of math careers. A large body of work reveals parents' and teachers' gender stereotypes, beliefs, and expectations regarding students' math abilities affects their attitude and achievement toward math (Gunderson, Ramirez, Levine & Beilock, 2011).

Throughout high school, the number of boys who intend to obtain a STEM career outnumbers girls with the same intentions. By the end of high school, boys are three times as likely to pursue a STEM career than girls. This disparity is found in engineering more than science. Medicine and health careers are more attractive to females, whereas engineering is more attractive to males. Interest in particular areas of STEM is likely to be the result of gender stereotyping. Pedagogy used in high school science classes may favor males or fail to connect to females' interests in an engaging way. Even single-sex organizations have a reputation for reinforcing gender stereotypes. For instance, Girl Scouts present fewer science activities than Boy Scouts; additionally, Girl Scout badges use language such as "Sky Search" instead of "Astronomer" and "Car Care" instead of "Mechanic" (Sadler et al., 2012). These subtle messages given by society can impact girls' interest in STEM fields and be reinforced throughout their K-12 educational experience. Since career interests already exist during high school, our attention may need to turn to engaging girls at the elementary and middle school level. One way we can capture girls' interest is to provide authentic learning experiences.

Effective science curriculum addresses specific needs of female students. The National Science Teachers Association (NSTA) declares curriculum and instructional strategies must be matched to learning styles (Tyler-Wood, Ellison, Okyoung, & Periathiruvadi, 2011). Science programs should provide hands-on, real-life field experiences combined with opportunities for cooperative learning and verbal/language arts components.

Studies have been conducted on science workshops for girls in order to understand the impact on participants' short- and long-term performance, interest, and

perceptions of STEM areas. Bringing Up Girls in Science (BUGS) was an after school environmental science program funded by the National Science Foundation, designed for girls in grades four and five. Active classroom involvement was a key method for promoting gender equity. Thus, the program incorporated hands-on laboratory experiences, real-life connections, and cooperative learning. Women scientists worked with the girls as mentors and role models. Short-term gains were made in the girls' performance and attitudes toward science. Eight years later, the college-aged girls still demonstrated improved achievement and more positive perceptions of science than girls who had not participated in the BUGS program (Tyler-Wood at al., 2011). The results of this study reveal girls' learning styles and interests must be considered to engage girls in science.

The Center for Pre-College Programs at New Jersey Institute of Technology sponsors Woman in Engineering and Technology Initiative-FEMME, a summer program designed for girls in grades four through eight. The purpose of the program is to increase the number of women interested in STEM careers. Girls in this program experience classroom learning, hands-on activities, laboratory experiences, field trips, and opportunities to speak with female engineers about career options. FEMME participants are more knowledgeable about technology and engineering careers than girls and boys of similar backgrounds who did not participate in FEMME. At the beginning of the program, only thirty-two percent of the students were able to describe the work of engineers; by the end of the program, eighty-three percent of the students could identify types of engineers and explain their job duties. Follow-up studies have revealed over sixty percent of past participants were working toward a technology-based degree or had

begun a career path in engineering, mathematics, science or computer technology (Hirsch, Berliner-Heyman, Cano, Kimmel, & Carpinelli, 2011). The success of FEMME may be attributed to positively influencing girls' knowledge and attitudes toward science before the girls reached high school.

A short-term program with long-term impact was the Summer Science Exploration Program (SSEP), an inquiry-based program science camp which aimed to stimulate middle school students' interest in science careers. A total of 158 students, including an equal number of boys and girls, participated each year in this two-week program, which was hosted in science laboratories at Hampshire College. SSEP allowed students to explore biological and health-related topics. Students learned to formulate their own questions and design experiments using field techniques to answer their questions. They also learned to analyze data, communicate their findings, and propose further questions they would like to explore next. By the time SSEP students entered high school, their level of interest in science was much higher than non-SSEP students. All students were given the Career Decision-Making System – Revised (CDM-R) career interest survey. Students rated their interest in ninety-six items that describe science career activities. Scores could range from an interest level of zero to a high interest level of thirty. SSEP students scored an average of 21.79 interest in science, whereas non-SSEP students scored an average of 13.65 interest in science (Gibson & Chase, 2002). The findings of this study suggest authentic, inquiry-based learning impacts student interest in science more than traditional textbook teaching.

The demand for Science, Technology, Engineering and Mathematics professionals is significantly higher than the supply. In order to best utilize our human

capital, our efforts must be shifted toward improving STEM programs and captivating more students. In order to improve STEM programs, we must promote gender equity; maintain high expectations for all students; provide activities which incorporate varying learning styles; empower students with hands-on, inquiry-based field experience; and provide male and female role models for students. Students who are provided these learning experiences will feel more confident, capable, interested, and more positive toward STEM, which will lay the stepping stones along the pathway to STEM careers. Only then will our nation be able to secure a foothold among global competition.

METHODOLOGY

My passion is to inspire girls to achieve STEM careers, or at least to cultivate an interest and identity in STEM areas. I want to know how to accomplish this goal most effectively, so my research project involved evaluating the impact of Zoo Academy on female high school students. The following research questions were asked: do authentic learning experiences improve female students' STEM performance, perceptions of STEM, and confidence in attaining a STEM career? Additionally, to what degree do hands-on experiences contribute to perceptions of STEM? What tools do Zoo Academy teachers use to create authentic learning experiences for students? Finally, what strategies do teachers currently use to engage female students in STEM?

Participants

This action research project was carried out at Omaha's Henry Doorly Zoo and Aquarium in Omaha, Nebraska. The Henry Doorly Zoo and Aquarium holds a full-time, year-round high school academy on zoo grounds, offered to local high school juniors and seniors who wish to gain authentic learning experiences through working with science

professionals at the zoo. Students who aim to participate in the program must submit an application and an essay describing how the program will contribute to their success now and in the future. Zoo Academy students may register to spend half or full days at the zoo, taking all regular high school classes, in the unique setting of a zoo. These students learn through hands-on activities, shadowing zoo employees, conducting independent studies focused on science, and speaking to the community about topics such as conservation. Much of their learning takes place outdoors rather than inside a classroom.

Zoo Academy students come from two feeder suburban school districts. There are seventy-nine total students, including fifty first-year students and twenty-nine second-year students. I randomly selected ten female students to participate in an audio-recorded interview. Thirty-six female students from one of the feeder schools completed the student survey and Draw a Scientist test. The Draw a Scientist Test was designed by David Wade Chambers in 1983 with the purpose of investigating children's perceptions of scientists. School children were prompted to draw a scientist, and the drawings were analyzed for the following stereotypical indicators: lab coat, eyeglasses, facial hair, symbols of research, symbols of knowledge, and products of science. In my research, I analyzed the gender depicted in the drawing and in which setting the scientist was drawn: a typical lab setting or a field setting. Additionally, data were collected from one of the partnering schools. Thirty junior and senior females in Honors Anatomy/Physiology completed the traditional student survey and the Draw a Scientist test. Two Zoo Academy teachers completed a teacher survey to provide insight from their unique perspective.

Intervention

The goal of this study was to discover the characteristics of Zoo Academy that makes it unique from a traditional classroom setting. Zoo Academy teachers provided me insight regarding teaching methods they use on a daily basis that may be different than teaching methods typically used in high school classrooms. These strategies include assigned independent studies, open-forum style classroom, opportunities to shadow zoo employees, and collecting useful data alongside scientific researchers at the zoo. Ultimately, my goal was to determine how experiences in Zoo Academy impact female students' perception of science and identity in attaining a STEM career.

Data Collection

Data regarding female students' STEM perceptions and identity was collected through surveys, student and teacher interviews, and the Draw a Scientist test. The degree to which hands-on experiences contribute to perceptions of STEM was measured using a student interview, a student survey and the Draw a Scientist Test. Information regarding the tools used by Zoo Academy teachers to create authentic learning experiences was collected through the Zoo Academy student interview and survey and a Zoo Academy teacher survey. Strategies used by Zoo Academy and traditional teachers for engaging female students in STEM was determined through the Zoo Academy student interview and survey, traditional student survey, and the Zoo Academy teacher survey. Data collection tools are summarized in Table 1.

Table 1
Data Triangulation Matrix

Focus Question	Data Source 1	Data Source 2	Data Source 3
Primary Question: 1. Do authentic learning experiences improve female students' perception of science and identity in future STEM careers?	Zoo Academy Student Interview	Draw a Scientist test- Zoo Academy v. Traditional Students	Student Survey—Zoo Academy and Traditional
Sub-Questions: 2. To what degree do hands-on experiences contribute to perceptions of STEM?	Zoo Academy Student Interview	Draw a Scientist test- Zoo Academy v. Traditional Students	Student Survey—Zoo Academy and Traditional
3. What tools do Zoo Academy teachers use to create authentic learning experiences for students?	Zoo Academy Student Interview	Zoo Academy Teacher Survey	Student Survey—Zoo Academy
4. What strategies do teachers currently use to engage female students in STEM?	Zoo Academy Student Interview	Zoo Academy Teacher Survey	Student Survey—Zoo Academy and Traditional

DATA AND ANALYSIS

Analysis of the student interview, student surveys, teacher survey, and Draw a Scientist Test reveals that authentic learning experiences improve female students' perception of science and identity in future STEM careers, hands-on experiences contribute positively to perceptions of STEM, Zoo Academy teachers have a variety of tools at their disposal to create authentic learning experiences for students, and teachers use various strategies to engage both male and female students in STEM.

Hands-on experiences and perceptions of STEM

The degree to which hands-on experiences contribute to perceptions of STEM was measured using an anonymous survey, a ten-item student interview, and the Draw a

Scientist Test. Ten female Zoo Academy students were randomly chosen to interview, thirty-six female Zoo Academy students completed the anonymous survey and the Draw a Scientist Test. Thirty female students enrolled in an Honors Anatomy/Physiology course at the home high school also completed a similar survey and Draw a Scientist Test.

Hands-on learning experiences foster positive perceptions of STEM. Seventy-seven percent of Zoo Academy students agreed strongly that hands-on learning makes science, technology, engineering, and/or math more enjoyable than in a traditional classroom setting; on the other hand, fifty-six percent of traditional high school students strongly agreed hands-on learning makes science, technology, engineering and/or math enjoyable. Students cited the following hands-on activities as most used in Zoo Academy: shadowing zoo keepers and assisting with daily tasks, daily care for class pets, dissections, animal diet preparation, feeding and training zoo animals, research, and practicing skills related to veterinary science. The traditional students in Honors Anatomy/Physiology participate in Health Systems Academy, which involves internships and shadowing in the hospital setting outside of class. These students also perceive that lab activities are more commonly used in their class, while Zoo Academy students perceive lab activities are not common. All students were asked to rank the following activities in order from most used in the classroom to least used in the classroom: lectures, lab activities, research projects, reading and worksheets, and presentations. The majority of Zoo Academy students ranked lectures as used most often, research projects second, presentations third, lab activities fourth, and reading and worksheets last (Figure 1). The majority of traditional students also ranked lectures as used most often, but

claimed reading and worksheets was used almost as often, followed by lab activities, presentations, and research projects (Figure 2).

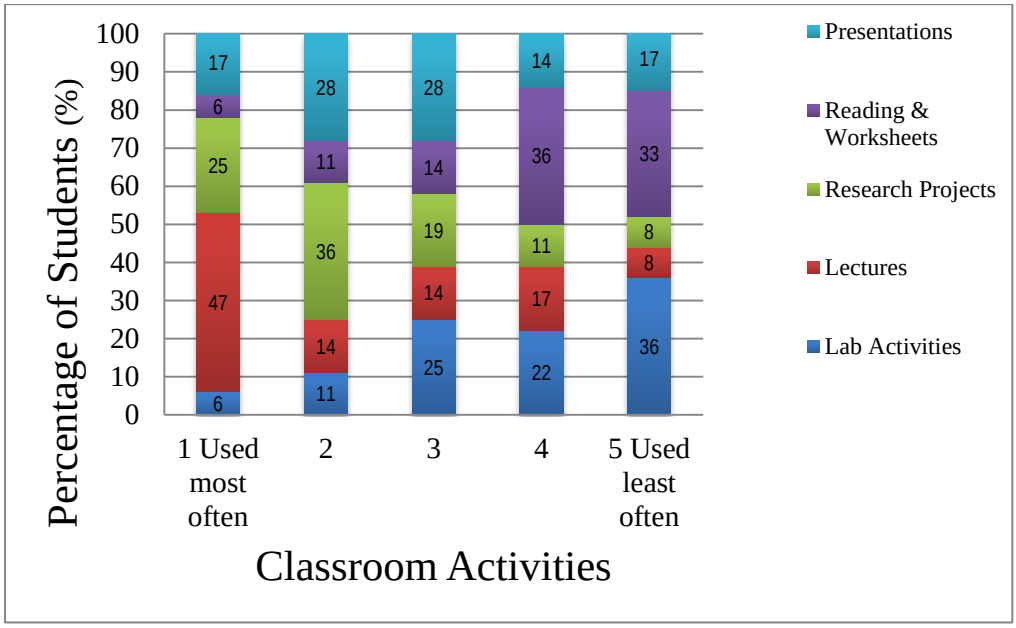


Figure 1. Zoo Academy Student Survey, Activities in the Zoo Academy Classroom, (*N*=36).

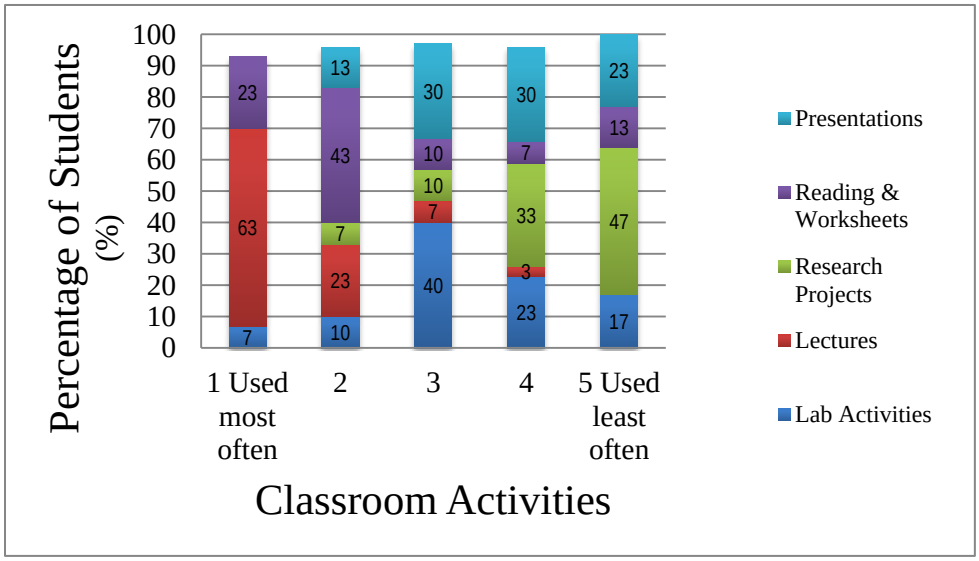


Figure 2. Traditional Student Survey, Activities in the Traditional Classroom, (*N*=30).

Zoo Academy students place a higher value on hands-on learning than their counterparts, although the Honors Anatomy/Physiology students still gain authentic intern and shadowing experiences in Health Systems Academy. There may be a correlation between the value placed on hands-on learning and student perceptions of scientists. Students were asked to draw a scientist and include a caption describing the actions of the scientist. The purpose of this task is to determine perceptions and stereotypes held about scientists. Sixteen percent of traditional students illustrated a scientist in a setting other than a laboratory, while forty-three percent of Zoo Academy students illustrated a scientist in a setting other than a laboratory (see Figure 3).

Although both groups of students illustrated an evenly distributed number of male and female scientists, Zoo Academy students depicted male and female scientists working together more often than depicted by traditional students. Many Zoo Academy students are firm in their belief that anyone can do science, as seen in Figure 4. Note that none of the figures have indications of gender, setting, lab coats, goggles, etc. This student understands that science is a diverse field and not intended to take place in a specific setting. It seems that some of the traditional students do believe female scientists are capable of making important contributions to science, as seen in Figure 5.

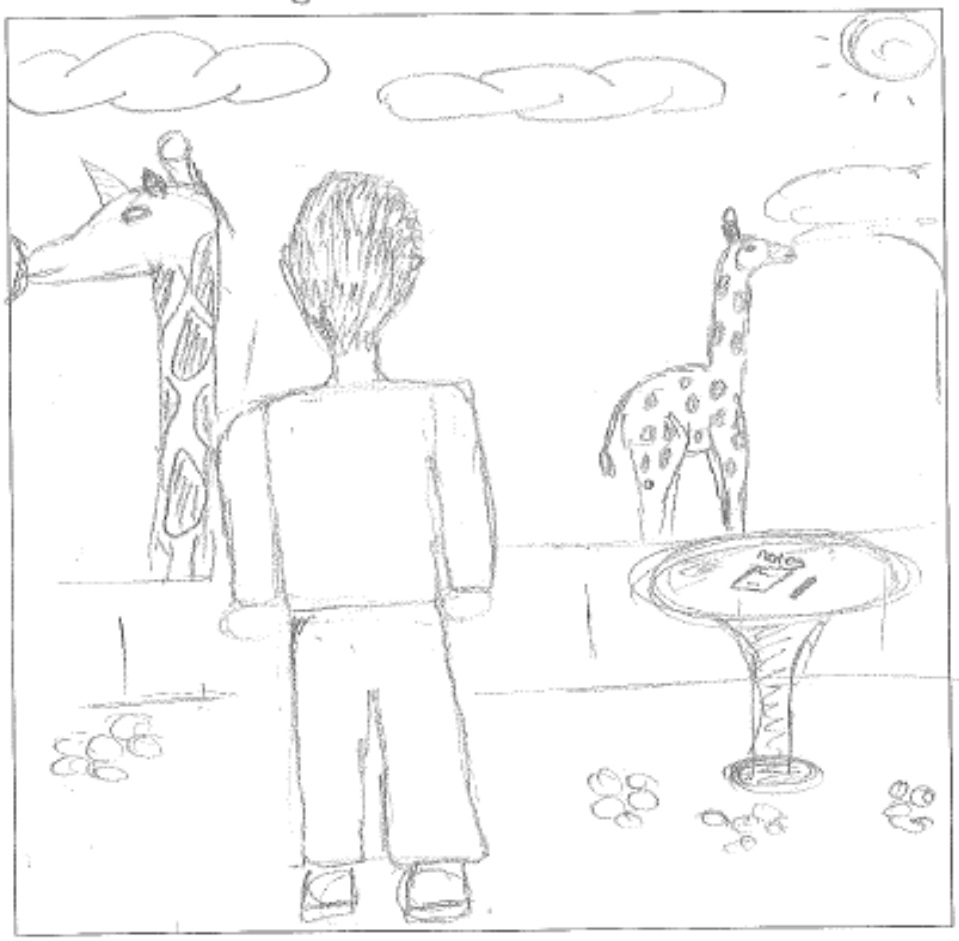
One hundred percent of Zoo Academy students interviewed say that hands-on learning in Zoo Academy makes learning easier, more memorable and more fun. Many of the students also mentioned that hands-on learning is not better just for girls, but it is a better way for all students to learn. One student stated, “Zoo Academy is not like a typical high school classroom with the teacher up at the front of the classroom lecturing. Here, you actually do hands-on things with live animals and the whole zoo is your

classroom!" Most students mentioned that in a traditional classroom they may be told to read about a principle and complete a worksheet without understanding why they have to do it. In Zoo Academy, they may read about a science principle in the textbook, and then they get to go observe the principle in the field. One student noted, "Instead of just looking at books, you get to go out into the field and observe animals. Shadowing the keepers is hands-on! Instead of taking a normal biology class and learning about how people train and feed animals, we actually get to do it so it's visual and easier to remember. I've never been great in science, but I do like learning about science. Being in Zoo Academy makes science ten times easier because my teacher is great at showing me things rather than telling me 'look in your book.'" It is clear to see Zoo Academy students place great value on hands-on learning and positively impacts their perceptions of STEM!

DO NOT WRITE YOUR NAME ON THIS FORM.

1) Draw a Scientist in the box below.
2) Include a caption to describe the actions of the scientist.

Caption: taking observations for social Behavior



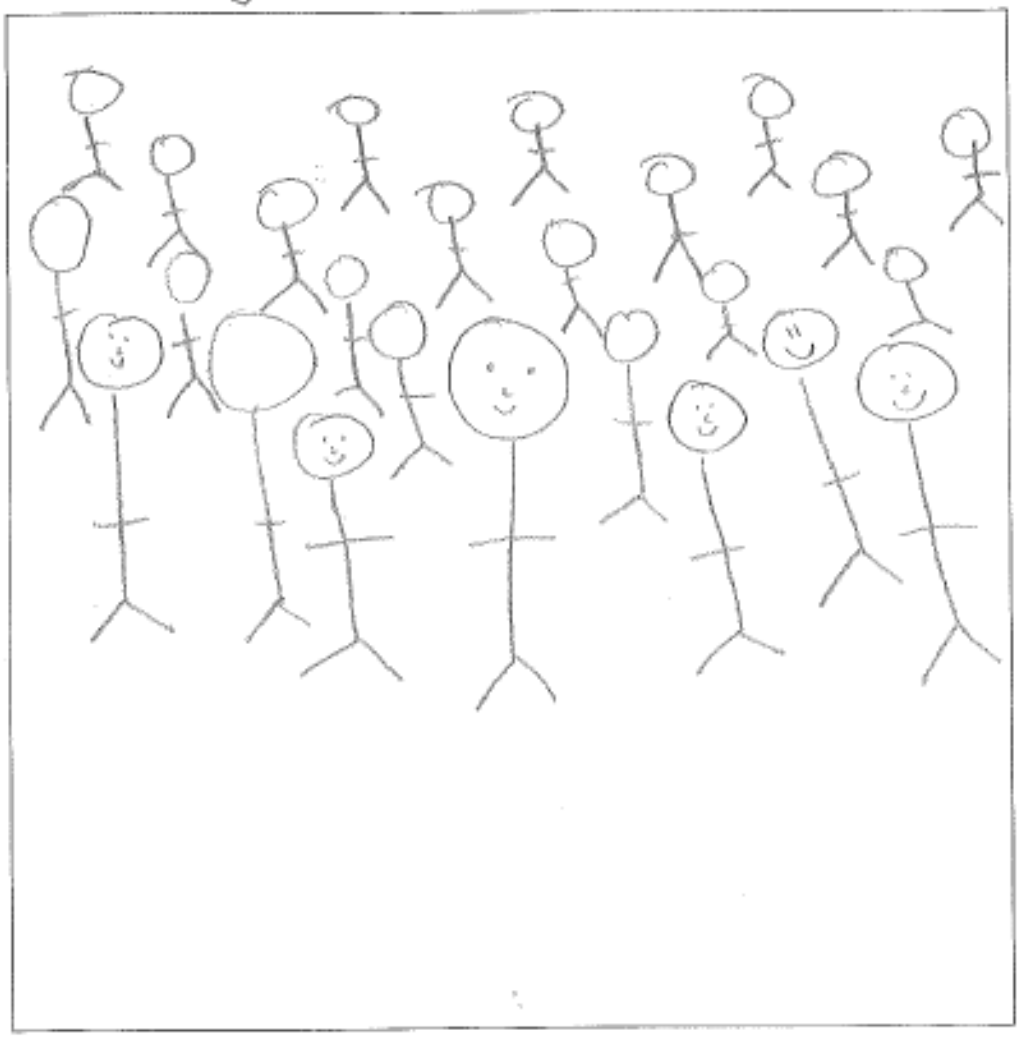
Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.

Figure 3. Zoo Academy Draw a Scientist Test, Taking Observations for Social Behavior.

DO NOT WRITE YOUR NAME ON THIS FORM.

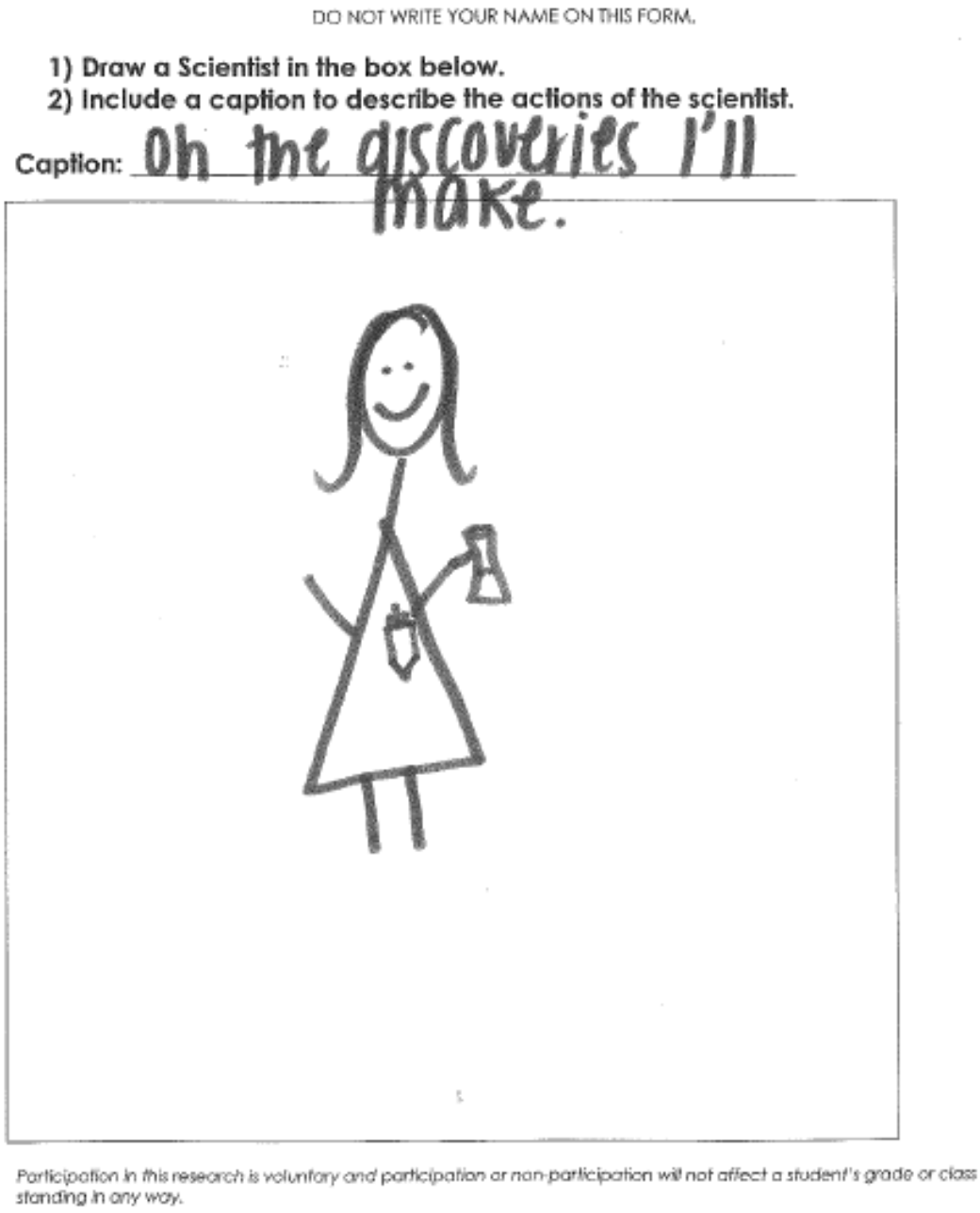
1) Draw a Scientist in the box below.
2) Include a caption to describe the actions of the scientist.

Caption: Anyone can be a scientist.



Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.

Figure 4. Zoo Academy Draw a Scientist Test, Anyone can be a Scientist.



DO NOT WRITE YOUR NAME ON THIS FORM.

1) Draw a Scientist in the box below.
2) Include a caption to describe the actions of the scientist.

Caption: Oh the discoveries I'll make.

Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.

Figure 5. Traditional Student Draw a Scientist Test, Oh the Discoveries I'll Make.

Tools to create an authentic learning experience

Information regarding the tools used by Zoo Academy teachers to create authentic learning experiences was collected through the Zoo Academy student interview and survey and a Zoo Academy teacher survey. Again, the survey was completed by thirty-six female Zoo Academy students. Out of those thirty-six students, ten were randomly chosen to participate in an interview. Zoo Academy teachers completed the teacher survey.

A large part of the Zoo Academy experience is providing students authentic learning opportunities. In addition to reinforcing the topic at hand, authentic learning also prepares students for the future. Students were asked, "How is Zoo Academy different from the traditional classroom setting?" Seven out of ten students mentioned in the traditional classroom, they learn something and it may or may not make sense. However, in Zoo Academy, students learn a concept and go out into the field to observe it in action or practice the learned skill. One student mentioned, "instead of learning about how people train and feed animals in a biology class, we actually get to go do it! It makes it visual and easier for me to remember." Another student noted, "Zoo Academy makes me think more… I get to focus on one subject more in-depth and go into the field and extend that learning, rather than moving onto the next topic right away."

Zoo Academy students feel better prepared for their future career. When asked if their classes are preparing them for their future career, sixty-nine percent of Zoo Academy students strongly agreed, while only ten percent of traditional students strongly agreed. Zoo Academy students were asked to list specific reasons they felt better prepared for their future career. Most responses were very similar to one student's

articulate response: “Zoo Academy helps you figure out what you do or don’t want to do because you actually get to try your hand at the skills. I’d really like to go into marine sciences, and being in Zoo Academy has allowed me to work in the aquarium for two years. The keepers help me with my experiments, and they’ve taught me how to complete daily tasks, such as testing the water quality. I’ve been able to help them with work that keeps the animals alive.” Zoo Academy empowers students because they are doing work that is contributing to science and they work alongside real scientists on a daily basis. This has helped open up many doors for the students when considering future careers in science.

Zoo Academy teachers strive to implement activities that make learning authentic for students. One teacher takes students outside whenever possible to set up plots to alter and see how they recover. The class does plant surveys, insect surveys, soil sampling, water sampling, and other authentic tests. In addition, “students perform labs and simulations for which they collect data and see results firsthand, conduct dissections and discuss how organisms function and how they differ from each other.” Students also learn about the “small city” it takes to run a zoo. They “create their own animal exhibits and zoo after learning about the various departments.” Students must present their creations to multiple zoo employees who constructively critique and judge students’ work. Another teacher incorporates as many current event discussions and article reviews as possible in the classroom. This teacher believes “when students can apply a concept to their local environment or make it personal in some way, they grasp the concepts in a completely different way.”

A prime example is when Zoo Academy students led the charge to develop and present the Shark Finning bill to Nebraska senators on December 20, 2014. The shark population is dwindling because of the shark fin trade, which involves mass slaughter of sharks for the sole purpose of obtaining their fin for products and food. Many sharks are tossed back into the ocean after their fin has been removed. Even though Nebraska is landlocked, shark products are sold in stores and served in the state's restaurants. This learning experience was meaningful, relevant, and authentic for the Zoo Academy students. One teacher responded, "Students used their knowledge of the government system, especially the Legislative Branch, to create a bill that we hope will become a state law in Nebraska."

Strategies to engage female students in STEM

Strategies used by Zoo Academy and traditional teachers for engaging female students in STEM was determined through the Zoo Academy student interview and survey, traditional student survey, and the Zoo Academy teacher survey. The majority of Zoo Academy students felt males and females do better in a setting such as Zoo Academy, and their level of engagement seems dependent on three primary factors: teacher attitude, class size, and focus on student interest.

Multiple Zoo Academy students stated that Zoo Academy was one big family. Students point to the fact that the cause is teacher attitude: "It's easy to talk to everyone and the teachers are caring. They care about what you want to do and are easier to approach when I need help." Another student stated, "Teachers here get to know students more individually and I am comfortable going to any teacher to ask for help." Students report that Zoo Academy teachers are "more uplifting, happy and enthusiastic to teach."

Zoo Academy teachers foster a learning environment that is free of judgement. "No one here judges you, so it doesn't matter what you wear. One day, everything was going wrong, I was having a bad hair and outfit day, and I felt so uncomfortable at my home high school. I came to Zoo Academy for the afternoon and all my friends were excited to see me and didn't treat me any differently." One student says it best, "The best thing about Zoo Academy is the people. The teachers and students are all great. This is a wonderful, inviting place to be every day." According to the teachers, all it takes is "being positive and motivating students to pursue their passions." The challenge is motivating students to complete their work. Teachers were asked, "How do you ensure both your male and female students are motivated and confident in their ability to reach their full potential in STEM areas?" One teacher responded, "I don't really notice a huge difference between the genders in my classroom… I have the same expectations of all my students." This teacher observes, "Female students are typically more motivated to do well than my male students. My female students tend to excel because they complete the work assigned… Confidence levels don't seem to be altered by whether or not students complete the work."

Smaller class size and flexibility may also contribute to student engagement. Often, when walking through the Zoo Academy department, one will see a teacher sitting and working with two to four students. Discussion is casual, positive, and extends deeper than a teacher might be able to go with a traditional class size. "Smaller classes really help because teachers get to know YOU better as a person and how you learn," one student noted. It is easier to get to know one another because there are more opportunities to have discussions in which all students and teachers can share their

opinions. One student mentioned, “At home high school, I was terrified to answer anything in the large group because I didn’t want to sound stupid. In Zoo Academy, people have similar interests and mindsets, so I’m not afraid to comment during class discussions. Teachers make a point of leaving no student behind: “I try to assess as I go through a unit, and then work one-on-one with students who are struggling, or sometimes I do work in front of the class if there are several students having trouble with calculations or concepts.”

Zoo Academy is geared toward student interests. Students participating in Zoo Academy clearly have a passion for animals. Many of the students reported they enjoy Zoo Academy because they get to incorporate science and their love for animals every day: “Since the science is about animals, it is more interesting to me. I get to talk to keepers who have experience in the science field and can help answer questions about future careers and the road I need to take to get there,” one student claims. “I think ANYONE would do better in the Zoo Academy setting because it’s more fun and hands-on, it gives us better opportunities and a better idea about what a career in science would actually be like.” No textbook could paint the picture so clearly for students.

INTERPRETATION AND CONCLUSION

I originally set out to answer the primary focus question: do authentic learning experiences improve female students’ perception of science and identity in future STEM careers? My findings revealed two major takeaways: authentic experiences improve all students’ attitude toward learning, regardless of subject; and teaching style has an overwhelmingly strong impact on students’ confidence and identity. These findings are similar to those discovered in previous studies.

As previously mentioned, in the Bringing Up Girls in Science (BUGS) environmental science program (Tyler-Wood at al., 2011), female students made short-term gains in performance and attitudes toward science, and demonstrated improved achievement and more positive perceptions of science up to eight years later. This program incorporated real-life connections, similar to Zoo Academy. Although authentic learning in Zoo Academy improves students' perceptions of science and identity in future STEM careers, authentic learning captures the interest of students when applied to any subject. Zoo Academy is not solely focused on science; students enjoy all subjects more in the zoo setting than the traditional setting because they get to learn a concept, and then be immersed in it and observe it happening around them. With the given resources in a traditional school setting, it may be difficult to regularly provide an engaging environment related to every subject, or to immerse the students in a real-life situation in which their studies directly contribute to current research. Teachers may feel tethered to their textbook, but perhaps they can look for other ways to tie learning in to their school environment or community to make learning more authentic and meaningful for students. Traditional teachers are faced with the challenge of having to think outside the box to help their students make important contributions. Zoo Academy students have the opportunity to directly contribute to research performed alongside zoo keepers on a daily basis.

The findings of the Summer Science Exploration Program study (Gibson & Chase, 2002) had suggested authentic, inquiry-based learning impacts student interest in science more than traditional textbook teaching. In this program, students were able to explore topics, formulate their own questions and design experiments using field

techniques to answer their questions. They learned to analyze data, communicate their findings, and propose further questions they would like to explore next—Zoo Academy students experience the same process and enjoy the program because of this authentic and meaningful style of learning. This improves the attitude for learning of all students, male and female. Zoo Academy is fortunate to have a rich environment at its fingertips.

Teaching style includes level of encouragement, methods of interacting with students, tailoring lessons to student interest, and creating a safe classroom community in which students feel comfortable and welcome. The majority of Zoo Academy students note how encouraging their teachers are, how they always feel comfortable approaching their teacher when they have an issue or they do not understand a concept, how much easier it is to learn when teachers take the time to have group discussions with students, and how comfortable they feel being surrounded by likeminded students and teachers. Granted, all of these issues may be easier for the traditional teacher to juggle with a smaller class size—this could lead to another entire study regarding the effects of class size on student learning, interest, confidence and identity. Keep in mind that the National Science Teachers Association declares programs should provide hands-on, real-life field experiences combined with opportunities for cooperative learning and verbal/language arts components (Tyler-Wood, Ellison, Okyoung, & Periathiruvadi, 2011). Many of the Zoo Academy students mention the ease of learning during cooperative learning experiences and opportunities for discussion. Perhaps these techniques are better for female students, but most of the Zoo Academy students believe, regardless of gender, all students would do better in a setting like Zoo Academy.

VALUE

Although this research project was more evaluative than action-based, my findings impact how I approach teaching. My major takeaways weren't completely new to me; had I been asked if authentic learning and teaching style had an impact, of course I would have responded, "Yes!" However, these concepts resonate so much stronger with me now. I hope to always ask myself, "How can I make this learning experience authentic and meaningful for my students?" and "How is my teaching style affecting each individual student? Am I meeting their needs as learners?"

I cannot help but imagine how great of an education system it would be if students could join a variety of programs that brought out their strengths and focused on their interests, but the truth is, most teachers do not have a unique environment at their fingertips—or a class size small enough to reach every individual student every day. When I started this project, I was adamant that young female students need positive female role models in science. Although this is still very important to me, I now see the importance of ensuring authentic and engaging learning experiences for all students, regardless of gender or subject. My goal as a teacher is now to provide meaningful learning opportunities with the resources I have available, and to think outside the box about ways to help students contribute to the field. After all, teachers in Nebraska, a landlocked state, encouraged students to develop and sign an anti-shark finning bill into law. That's something you don't see in every traditional classroom.

REFERENCES CITED

Gibson, H.L., & Chase, C. (2002). Longitudinal Impact of an Inquiry-Based Science Program on Middle School Students' Attitudes Toward Science. *Science Education, 86*(5), 693-705.

Gunderson,E., Ramirez, G., Levine, S., & Beilock, S. (2012). The Role of Parents and Teachers in the Development of Gender-Related Math Attitudes. *Sex Roles, 66*(3), 153-166.

Hirsch, L., Berliner-Heyman, S., Cano, R., Kimmel, H., & Carpinelli, J. (2011). "Middle school Girls' Perceptions of Engineers Before and After a Female Only Summer Enrichment Program."Frontiers in Education [Conference].12-15th October 2011.S2D-1-S2D-6.

Kuenzi, J.J. (2008). *Science, Technology, Engineering and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Action*. Lincoln, Nebraska: Digital Commons.

Larson, P. (2012). *President Obama Announces New Plan to Create STEM Master Teaching Corps*. (Office of Science and Technology Policy). Retrieved from http://www.whitehouse.gov/blog/2012/07/18/president-obama-announces-new-plan-create-stem-master-teaching-corps

National Science Board. (2010). *Preparing the Next Generation of STEM Innovators: Identifying and Developing Our Nation's Human Capital* (National Science Foundation Publication NSB 10-33). Arlington, VA: National Science Foundation.

Riegle-Crumb, C., Moore, C., & Ramos-Wada, A. (2011). Who Wants to Have a Career in Science or Math? Exploring Adolescents' Future Aspirations by Gender and Race/Ethnicity. *Science Education, 95*(3), 458-476.

Sadler, P.M., Sonnert, G., Hazari, Z., &Tai, R. (2012). Stability and Volatility of STEM Career Interest in High School: A Gender Study. *Science Education, 96*(3), 411-427.

Tyler-Wood, T., Ellison, A., Okyoung, L., & Periathiruvadi, S. (2011). Bringing Up Girls in Science (BUGS): The Effectiveness of an Afterschool Environmental Science Program for Increasing Female Students' Interest in Science Careers. *Journal of Science Education and Technology, 21*(1), 46-55.

APPENDICES

APPENDIX A

ZOO ACADEMY STUDENT SURVEY

1. Please indicate your status as a Zoo Academy student.

- Year 1 Student, half-time
- Year 1 Student, full-time
- Year 2 Student, half-time
- Year 2 Student, full-time

Other (please specify)

2. What is your GPA?

- 4.1 or above
- 3.6 - 4.0
- 3.1 - 3.5
- 2.6 - 3.0
- 2.1 - 2.5
- 2.0 or below

3. STEM is an acronym for Science, Technology, Engineering, and Mathematics. Often, the skills needed in one area, such as math, can be applied to another area, such as science.
Rate your belief in the following statement:
Males and females are equally knowledgeable in areas of Science, Technology, Engineering, and Mathematics.

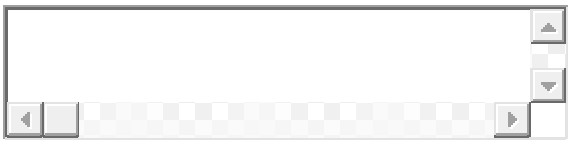
- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- I don't understand the question

4. Zoo Academy helps males AND females become interested in Science, Engineering, Technology, and/or Math.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- I don't understand the question

5. Rank the following activities in order from MOST USED (1) in the classroom to LEAST USED (5) in the classroom.
Lectures
Lab Activities
Research Projects
Reading & Worksheets
Presentations

6. In Zoo Academy, we do the following hands-on activities (You do not need to use full sentences. List different activities that are hands-on.):



7. Hands-on learning at the zoo makes science, technology, engineering and/or math more enjoyable than in a traditional classroom setting.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- I don't understand the question

8. Hands-on learning in Zoo Academy makes me more confident in my science, technology, engineering, and/or math abilities than learning in a traditional classroom setting.

- Strongly Agree
- Agree

- Neutral
- Disagree
- Strongly Disagree
- I don't understand the question

9. Zoo Academy is preparing me for my future career.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

10. List some of the things you've done in Zoo Academy that have made you better prepared for your future career.

APPENDIX B

TRADITIONAL HIGH SCHOOL STUDENT SURVEY

1. What is your GPA?

- 4.1 or above
- 3.6 - 4.0
- 3.1 - 3.5
- 2.6 - 3.0
- 2.1 - 2.5
- 2.0 or below

2. STEM is an acronym for Science, Technology, Engineering, and Mathematics. Often, the skills needed in one area, such as math, can be applied to another area, such as science.
Rate your belief in the following statement:
Males and females are equally knowledgeable in areas of Science, Technology, Engineering, and Mathematics.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- I don't understand the question

4. Classes at my high school help males AND females become interested in Science, Engineering, Technology, and/or Math.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- I don't understand the question

5. Rank the following activities in order from MOST USED (1) in the classroom to LEAST USED (5) in the classroom.
Lectures
Lab Activities

Research Projects
Reading & Worksheets
Presentations

6. Hands-on learning makes science, technology, engineering and/or math enjoyable.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- I don't understand the question

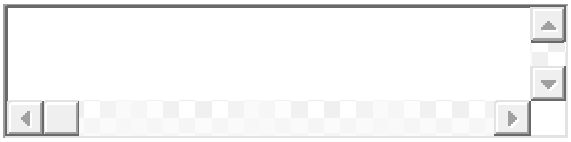
7. Hands-on learning makes me more confident in my science, technology, engineering, and/or math abilities.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- I don't understand the question

8. My high school classes are preparing me for my future career**.**

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

9. List some of the things you've done in your classes that have made you better prepared for your future career.



APPENDIX C

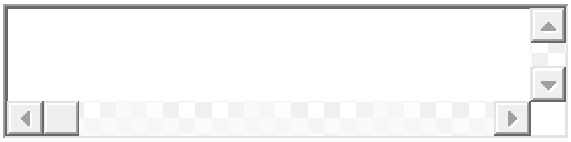
TEACHER SURVEY

1. Please indicate your school, the subject(s) you teach, and grade level(s).

2. Hands-on learning improves student PERFORMANCE in science, technology, engineering, and/or mathematics.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Additional Comments



3. Hands-on learning improves student PERCEPTIONS of science, technology, engineering, and/or mathematics.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Additional Comments

4. Please describe ways you incorporate hands-on learning in your classroom.

5. What activities do you implement to make learning authentic for students? Please list and describe.

6. A large body of work reveals parents' and teachers' gender stereotypes, beliefs, and expectations regarding students' math abilities affects their attitude and achievement toward math (Gunderson, Ramirez, Levine & Beilock, 2011).

How do you ensure both your male AND female students are motivated and confident in their ability to reach their full potential in STEM areas?

APPENDIX D

ZOO ACADEMY STUDENT INTERVIEW

Zoo Academy Student Interview

How is Zoo Academy different from the traditional classroom setting?
What types of hands-on activities do you do in Zoo Academy, and how does it affect your learning?
How have your experiences in Zoo Academy made you more confident in your science abilities?
Is science more enjoyable because of Zoo Academy? List specific examples to explain.
How does Zoo Academy help prepare you for your future career? List specific experiences you have had in Zoo Academy.
How does participation in Zoo Academy affect your future career choice?
Please tell me about a specific event in Zoo Academy that influenced your view of science.
Why is Zoo Academy a good place for female students to learn?
What specific experiences in Zoo Academy are designed to help female students succeed?
What is the best thing about Zoo Academy?
What could be improved in Zoo Academy?

Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.

APPENDIIX E

DRAW A SCIENTIST TEST

1) Draw a Scientist in the box below.

2) Include a caption to describe the action(s) of the scientist.

Caption:

_____

Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.