CONNECTING INTERST IN AND AWARENESS OF THE ENVIRONMENT WITH AN INFORMAL EXPERIENCE

by

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DEDICATION

I would like to dedicate this thesis to my mother, Mary Wait. Even though you are no longer around to see me finish, I would like to thank you for being my biggest cheerleader and supporting me always. I could not have done this without you. I miss and love you.

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
STEM	Science, Technology, Engineering, and Mathematics
The Meadows Center	The Meadows Center for Water and the Environment
Texas State	Texas State University
US1100	University Seminar
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNEP	United Nations Environmental Programme
AKASA	Awareness, Knowledge, Attitude, Skills, and Action
IRB	Institutional Review Board
SSS	STEM Semantics Survey
EAQ	Environmental Awareness Questionnaire
ROSE-D	Relevance of Science Education-D
STEM-CIQ	STEM Career Interest Questionnaire
α	Cronbach's Alpha

ABSTRACT

Universities play an important part in creating a more environmental literate society and providing resources to help encourage more people to enter STEM careers, a rapidly growing field in a time where environmental issues are becoming more of a worldwide concern. The responsibility for solving these issues is being left to the younger generations (Wang & Zhang, 2021), and universities need to take a more active role in environmental decisions and practices by regarding their students as our future community leaders, decision makers, and opinion shapers as the future of our society (Gurbuz & Ozkan, 2019). For this study, I aimed to look at how an informal learning experience, as part of a mandatory class at a university, affected students' interest in and awareness of science, STEM careers, and environmental issues. I used the theoretical framework of "science capital," a conceptual theory on how to use the experiences that a person is provided in supporting and enhancing people's attitude, engagement, and participation in science (Archer et al., 2022). I created a pre- and post- questionnaire by combining four instruments: STEM Semantics Survey, Environmental Awareness Questionnaire, Relevance of Science Education-D, and STEM Career Interest Questionnaire. The participants in this study were university freshman students enrolled in a mandatory class designed for freshman, which also included a glass-bottom boat ride as an informal learning experience, part of a nature and research center part of the university campus. I expected that the students who participated in the study would have an increase in their interest in and awareness of STEM, science, environmental awareness, and STEM careers. My assumption was that there would be an increase, whether it was minimal or significant, in either of the areas. Results from the study were mostly insignificant for the impacts of glass-bottom boat ride on the opinions of the students. The p-values found were statistically insignificant for all scales in each instrument

except for the STEM Semantics Survey scale for math and the Environmental Awareness Questionnaire scale for "interest in nature", inferring that the treatment of the boat ride did not have a statistically significant effect on the students' STEM, environment, and science perceptions. However, the implications of the study with other research shows that with an increase of similar opportunities, there is a potential to make an impact in student's interest in and awareness of STEM, the environment, and opportunities within STEM career fields.

I. INTRODUCTION

Environmental issues such as climate change, water pollution, and introduction of invasive species are becoming more of a concern for the public (Waliczek et al., 2017; Vasiljevic-Shikaleska et al., 2018). These issues are creating environmental damage, which is occurring on an individual, institutional, and societal level, and are mostly caused by unconscious human behavior (Yucedag et al., 2017). Environmental damage has the potential of being alleviated or reduced if the public is knowledgeable about environmental issues, aware of problems, and willing to work towards a solution (Ozsoy, 2012; Veisi et al., 2018; Veysel & Can, 2020). The responsibility for solving these pressing environmental issues is being left to the younger generations (Wang & Zhang, 2021). Finding solutions require more people to enter Science, Technology, Engineering, and Mathematics (STEM) careers in order to help advance research and for the establishment of a scientifically literate society.

With the growing numbers of environmental issues that are facing the world today, it is important to have additional people entering STEM careers to advance research, creating a strategic value in the education and career fields (Claussen & Osborne, 2013; Lloyd-Strovas et al., 2018). Archer et al. (2015) discussed the need of supporting students in understanding the importance of STEM in careers, everyday life, and the potential use in their future. Schools play an important role in developing skills as a venue in creating awareness, knowledge, attitudes, and environmental ethics to help solve the growing environmental issues that we are facing (Ashmann & Franzen, 2017).

Higher education institutions, along with primary and secondary schools, can play an important role in creating a scientific literacy by helping to fill the gaps in students entering the STEM career field by giving them opportunities to increase their environmental knowledge. The

National Research Council (2003) expressed the need to inspire undergraduate interest in the sciences, and in 2012, the U.S. President's Council of Advisors on Science and Technology set an ambitious goal of increasing students with STEM bachelor's degrees by one million in 10 years (Young et at., 2018). Colleges can work towards a greener society by creating an atmosphere of environmental literacy through the creation of learning laboratories for communities and by providing a place where students can develop new habits (Durr et al., 2017). Universities can take a more active role in environmental decisions and practices by regarding their students as our future community leaders, decision makers, and opinion shapers as the future of our society (Gurbuz & Ozkan, 2019). Creating an environment where there is environmental literacy within the University context provides an opportunity to create a resilient and sustainable community that can be a model for the greater community at large.

Formal classrooms are critical in creating a scientifically literate society that has an interest in and awareness of environmental issues. However, informal science learning experiences and environments offer a unique opportunity to get students outside of the classroom to learn. Informal science education allows for students to get outside of the formal classroom setting and has the potential to increase environmental and scientific literacy with the potential to gain interest in STEM careers (Falk & Dierking, 2010; Boyce et al., 2014). Informal learning environments and experiences differ from formal learning in that they are usually freely chosen by the learner and align with the learner's interests (Henriksen, et al., 2015; Staus & Falk, 2017). Teaching outside of the classroom has the opportunity to promote an appreciation and connectedness to the environment and to the field of STEM and associated careers. Bonnette et al. (2019) found that informal science learning experiences have the potential to close the gaps in STEM and help foster a love for science.

Background Information

This study takes place at The Meadows Center for Water and the Environment (the Meadows Center), which is a research and nature center that focuses on water resources and environmental stewardship. The center is part of Texas State University (Texas State) in San Marcos, Texas and is located on the shores of Spring Lake, which is considered to be a living laboratory on the second largest spring system in Texas. The site is an ideal location for environmental education and outdoor learning activities through the Spring Lake Education Program. The Meadows Center provides informal programming for participants of all ages with educational field trips to the site using glass-bottom boat tours, adapting learning objectives to the needs of the audience. The program designed a glass-bottom boat tour specifically for Texas State freshman students that are enrolled in the course University Seminar (US1100), a class designed for new students introducing them to being in college and the university. The tour is designed to be an informal learning opportunity for students that helps introduce them to the San Marcos River, the flora and fauna of the area, and teaching the students the importance of water conservation and stewardship.

Problem Statement

The purpose of my study is to investigate the impact of participation in an informal learning experience on college students' interest in and awareness of science, STEM careers, and environmental issues.

Research Question

My specific research question is: To what extent does participation in an informal science field trip enhance interest and awareness in STEM, the environment, science, and STEM careers? My underlying assumption is that students who have opportunities to participate in informal science experiences will be more likely to develop an interest in and an awareness of the environment and STEM topics and thus be more likely to have an interest in STEM careers. To answer my question, I used the data collected from a pre- and post-questionnaire that was specifically designed to be administrated before and after a glass-bottom boat tour, which was used as the informal learning experience for university students at the Meadows Center.

Significance

With the increasing need for students to enter into a STEM career pathway, it is imperative to continually create opportunities for students to have experiences in informal programs that are science or STEM based. Goff et al. (2020) found that students' relationships with science and math and the connection with informal learning settings persist into college and may help with an ultimate entry into the STEM field. It is my thought that creating experiences like these for university freshmen is an ideal opportunity to spark an interest in science and influence their major and potential future career choice.

II. LITERATURE REVIEW

In the coming decades, there will be an increased need for more scientifically informed citizens as complex environmental issues arise and there becomes a need for a better understanding of the environment on a local and global scale. Roth (2002) defined environmental literacy as a set of understandings, skills, attitudes, and habits that empower people to relate to their environment positively, and to take their daily and long-term actions to maintain or restore their relationships with others and the environment. The emergence of destructive environmental problems can be reduced if its citizens develop environmental literacy (Veisi et al., 2018). Environmental literacy is defined from variables that are believed to influence responsible behaviors as a result of environmental education and from the need of societies to have environmentally literate members develop these same responsible behaviors (Roth, 1992).

Environmental Education

Environmental education, as defined by UNESCO (1977), is the process of creating a world that is aware of and has concern about the environment and the associated problems that affect it. Its goals are to create individuals and collectives that can work towards solutions of current problems and prevent new ones through the knowledge, attitudes, motivations, commitments, and skills that they have learned. Environmental education programs are important for encouraging positive attitudes about the environment through developing awareness and creating relationships to natural environments (MacRae, 1990). Even though the values of environmental knowledge and education have been internationally endorsed, college students are still scoring low on their environmental literacy. Kaplowitz and Levine (2005) found that two-thirds of Americans fail simple tests on environmental knowledge. Using a similar instrument, Lloyd-Strovas et al. (2018) found that undergraduate university students were averaging a 52% score, meaning that they were not environmentally literate.

To have a more holistic development of environmental education, there needs to be an understanding of how to teach for and about the environment. UNESCO and UNEP set guiding principles on environmental education through "The Tbilisi Declaration" (1977). They set five categories of environmental education goals and objectives, which later became known as the AKASA model. These categories are defined as the following:

1) Awareness: to help individuals and groups acquire an awareness and sensitivity to the environment and its related problems.
2) Knowledge: to help individuals and groups learn the basic understanding and gain experience of the environment and its related problems.
3) Attitudes: to help individuals and groups gain feelings of concern and a set of values that will create a motivation for actively working towards environmental improvements and protection.
4) Skills: to help individuals and groups gain the skills to identify and solve environmental problems.
5) Participation: to help provide individuals and groups an opportunity to be actively involved in working towards solutions of environmental problems.

According to the Tbilisi Declaration, the principles require a farther reach than the K-12 formal education system. Its aim is to reach a broader audience of citizens, adults, and environmental professionals UNESCO (1977).

Environmental education can be linked to the promotion of nature and outdoor study and later to the conservation movement, which helps reveal the different causes of environmental issues and the appropriate ways to effect change (Stevenson, 2007). Participation in environmental activities has a high significant relationship with environmental awareness. Environmental awareness refers to the knowledge about the environment and attitude, values, and necessary skills to solve environmental problems (Vasiljevic-Shikaleska et al., 2018) and is defined by the ability of the individual or group to understand the relationship of human activities on the status of environmental quality (Mei et al., 2016; Tang et al., 2022). Environmental education is seen as the primary focus of human awareness that guides our current and future society towards sustainable development (Ramos et al., 2015).

Environmental Knowledge

Environmental knowledge, as defined by Yusuf & Fajri (2022), is a general knowledge about the facts, concepts, or relationships of the surrounding environment and its ecosystems. An introduction of environmental concepts, knowledge of human needs, and the understanding of relationships of these is essential for an educated populous to make decisions on sustainable development challenges. However, knowledge is not enough; people need to care about these connections. For people to exhibit positive environmental attitudes and behaviors, there needs to be a deep love and affection for the planet (Orr, 1996; Ozsoy, 2012). Given an opportunity to create a sense of ownership and empowerment, people are more likely to become responsible citizens who can potentially affect the attitudes and behaviors of others.

Environmental attitudes and behaviors are correlated to a person's environmental awareness and knowledge. Environmental attitudes are the sum of all positive and negative thoughts of a person who exhibits environmentally beneficial behaviors, value judgements and readiness to solve them. Environmental behaviors refer to behaviors that do as little harm to the environment as possible (Garbuz & Ozkan, 2019). Pierce et al. (2021) found that environmental knowledge positively correlates with pro-environment behaviors. Responsible environmental behaviors are a learned response or action. There is a need to further research into the process of how environmental knowledge effects attitudes and the way it interacts with behaviors that produce responsible behaviors to the environment (Paço & Lavrador, 2017; Wang & Zhang, 2021).

Role of College on Environmental Behaviors

The purpose of a college education is to equip young people with the tools to be successful when they graduate and to foster an environment that promotes ideas and new concepts. Universities bear an important role in promoting pro-environmental behaviors due to their responsibility in increasing knowledge and awareness (Gurbuz & Ozkan, 2019). Environmental issues are often left to the younger generations, and with universities being able to promote an atmosphere to learn about these issues, these institutions have an opportunity to create awareness and promote environmentalism (Jurdi-Hage et al., 2019). Their attitudes, values, and beliefs have the potential to influence the future of politics, industry, and policy. Lloyd-Strovas et al. (2017) stated that college students are more susceptible to becoming better informed citizens and potentially more concerned about societal issues, especially when it comes to environmental problems.

It is important to look to college students because they will be the decision makers of the future. College students have been found to be concerned with issues that present an environmental challenge, especially pollution (Lucena et al., 2019), hazardous waste, and air quality (Gigliotti, 1994). Creating environmental literacy and positive attitudes in college environments can help solve these issues and work towards a greener society (Durr et al., 2017). Students at the university level are at an age where they can understand the challenges and uncertainties of the environmental issues that we are currently facing (Jurdi-Hage et al., 2019). Higher education must foster the interest in research and management of environmental education with the purpose of developing responsible citizens with sustainable attitudes (Lucena et al., 2019). As environmental knowledge in students increase, so does their environmental attitudes.

For America to maintain its competitiveness within the STEM fields, there needs to be a push for students to study these disciplines. The United States federal government identifies that STEM majors are crucial to our national competitiveness, innovation, and are an area of "national need" (Goan et al., 2006). STEM instruction, in the educational system, integrates these disciplines with real world problems to help students to become thinkers and innovators. Archer et al. (2022) found that underrepresented students have a lower interest in STEM subjects and STEM fields because they have not had equity in their learning experiences. Studies have shown that using both in-school and out-of-school interventions to connect underrepresented students to STEM professionals and careers have a positive impact on increasing awareness and interest in STEM careers, especially those in secondary and post-secondary level (Avery, 2013; Kier et al., 2013; Young et al., 2018).

Role of Informal Experiences

Informal learning environments are those that are either out-of-school or out-of-class interventions, which can be place-based outdoor environments or at informal learning centers, including nature centers or museums. These types of experiences provide an opportunity to disrupt the normal class routine and place the student in a new learning environment. Informal learning environments can be part of formal learning through field trips or taking class time outside of the standard classroom to a specific place that is significant. Informal learning environments provide students with experiences that allow them to actively participate while promoting a positive attitude and increased interest in science (Boyce et al., 2014). When students are given the opportunity to learn through out-of-class interventions, they can learn strategies to protect the environment and offer a chance to develop an empathetic relationship to nature (Archer et al., 2022). The National Resources Council (2009) found that most of what people know about science is learned in informal settings, which fosters a positive attitude about science when learned in these types of environments.

Studies showing University student's interest in and awareness of STEM increase with engaging coursework and participatory experiences in environmental activities. However, there is a need to look at specifically how informal learning experiences influence these attitudes and beliefs. Archer et al. (2022) found that informal learning experiences can provide an entry point for students to gain interest in STEM learning. To date, there is limited research done on these impacts, especially as part of a college course curriculum. This information may help encourage more universities to take an active role in fostering an appreciation of environmental awareness and an interest in STEM for students and provide opportunities for them to learn about the environment and STEM in informal learning environments.

Conceptual Framework

This study emerges from the conceptual framework of "science capital" and its theorization and research on understanding science engagement and participation (Archer et al., 2012; Archer et al., 2015). The theory of "science capital" was conceptualized from Bourdieu's theory of social reproduction, where capital is a valuable and exchangeable resource in society that can create social advantage for those that possess it (Bourdieu, 1986). "Science capital" is not a different type of capital but a conceptual theory on how to use the experiences that a person is provided in supporting and enhancing people's attitude, engagement, and participation in science (Archer et al., 2022).

The concept of "science capital" can be described as a 'holdall' of resources and experiences that an individual possesses that affects their ability to have a science identity and have the potential to pursue a science career (Nomikou et al., 2017). This 'holdall' analogy consists of four different areas: what science you know, who you know, how you think, and what you do (Dewitt et al., 2016). Archer et al. (2015) broke science capital into eight dimensions: science literacy, science-related attitudes and values, knowing how to apply science, science media consumption, participation in informal science learning, family science skills and knowledge, knowing people in a science-related roles, and talking to others about science.

Knowing how to increase a person's science capital when creating learning opportunities is something that both formal and informal learning experiences need to use as guiding principles when engaging students with science. It represents a person's science qualifications and has the potential for raising the awareness and value of a science degree (Archer et al., 2015). This research proposes that if students are given opportunities to increase their "science capital," they will increase their science experience and resources which will potentially increase their interest and awareness in science and STEM.

III. METHODOLOGY

My project did a pre/post comparison designed to estimate the causal impact of an informal learning experience through a quantitative approach using questionnaires disseminated before and after a glass-bottom boat tour. I used a specifically designed field trip for US 1100 students, a class designed for freshman and incoming students at Texas State University. The Meadows Center provides an environmental education experience through a glass-bottom boat tour and serves as the informal learning experience being studied.

The boat tours are led by experienced staff, most commonly senior level or graduate students, which are employed by the Meadows Center as environmental interpreters. The specific, hand-selected staff are instructed to facilitate the class as if they are guest lecturers. Each interpreter undergoes training on the semantics needed to teach the class as well as the specific learning objectives that the course and university wants the students to gain from the experience. The curriculum includes information on the flora, fauna, and unique geography of the university as well as discussions on how students can become better stewards of their university, given the unique location of the school compared to Spring Lake and the San Marcos River. Students are encouraged to discuss effects of non-point source pollution and ways they can be more conscious water users.

This study chose to investigate the effect of these tours on students due to the learning goals of the tour as well as the potential impact these tours have on their greater audience. In the year before this study, the Spring Lake Education Program had 110,173 visitors to the center, with 33,372 school children and university students engaged in their environmental and STEM focused educational tours (The Meadows Center for Water and the Environment, 2019). Environmental education is the baseline for the educational programs at the Meadows Center.

Following the AKASA model, these programs are designed to promote awareness and positive attitude about the environment, while students gain knowledge and potential skills about science and nature through participation. The tour designed for the US1100 course uses this model's objectives to specifically teach students about the importance and sensitivity of the university's location and to help them connect their interest in the river to ways they can be more environmental conscious. The environmental interpreter leading the tour also serves as a mentor by relating to the students, discussing their own learning goals at the university, and promoting the opportunity of the job position of environmental interpreter.

Following IRB approved guidelines (Appendix A), this study recruited students through their University Seminar class when their instructor signed up for the glass-bottom boat tour, a field trip offered to the class, through the Meadows Center Education Office. All students were asked to complete a pre-questionnaire (Appendix B) prior to their scheduled boat tour. After the scheduled tour, an email was sent to the entire class, regardless of if they had taken the boat tour, and were asked to fill out a post-questionnaire (Appendix C).

Participants and Recruitment

Participants of the study were university students that were currently enrolled in the course US1100, during the fall semester of 2020 (Table 1). Demographic information was collected to compare demographics of the freshman class and the total population that participated in the survey to the study population to make sure the sample was reflective of the university. Differences in gender of those that participated in the pre-questionnaire and those that participated in both were the same (73% female, 27% male) and slightly different when compared to the total freshman class (61.5% female, 38.5% male). Participation defined by ethnicity was reflective of the university with both Hispanic and white non-Hispanic being represented equally (41%) and was considered to have general reliability.

Professors of the course were given the opportunity to register their course sections for a glass-bottom boat tour, which is designated specifically to enhance the learning objectives of the course. These objectives include learning about what makes the university unique and opportunities that are available for students. The tour requests were submitted through the Meadows Center's website. Once the tour time and date were confirmed, the Meadows Center staff sent a confirmation and then requested a course roster, which was due a week from the scheduled tour. This was used for contact tracing for COVID-19 protocols and to contact the students for recruitment of this study.

Table 1.

Participant Demographic Information on Ethnicity and Gender

Variable		Pre-Tour (n)	Paired Tour (n)	Post Tour (n)
Ethnicity				
	Hispanic or Latino	211	10	
	White (non-Hispanic)	212	16	
	Black or African American	72	2	
	Native American or American Indian	7	1	
	Asian or Pacific Islander	16	1	
	Other	8		
Gender				
	Female	385	22	60
	Male	139	8	19
	Other	1		1

The pre-tour questionnaire was sent to students by section number, within the week prior to their scheduled glass-bottom boat tour (Appendix B). The entire class roster was then sent another email with the post-tour questionnaire within the week after the class participated in the tour, regardless of their attendance (Appendix C). Submitted questionnaires that were either submitted by someone under the age of 18 or those that were deemed incomplete were discarded.

Questionnaire

The questionnaire was developed using existing instruments and was designed to measure a student's levels of interest, awareness of, knowledge, and their career interest in environmental issues and STEM. The questionnaire took an average of 15 minutes to complete and requested participant information on gender, age, ethnicity, if they had been on a glass-bottom boat before (generally asking). It included four different pre-existing independent instruments: (1) 25-item STEM-Semantics Survey (SSS) (Tyler-Wood et al., 2010), (2) the 28-item Environmental Awareness Questionnaire (EAQ), (Moore et al., 2016) (3) 18-item Section D from the Relevance of Science Education, (ROSE-D) (Schreiner & Sjoberg, 2004), and (4) the 12-item STEM-Career Interest Survey (STEM-CIQ) (Tyler-Wood et al., 2010).

The instruments were chosen based on their design to answer the specific research question proposed in this study and the desired education gains of the tour: interest in STEM, the environment, and STEM careers. The methods support the theoretical framework of the study and can measure the gains in each of the eight dimensions as described by Archer et al. (2015). Figure 1 maps out the connections between the different instruments to the eight dimensions of science capital. Both questionnaires consisted of the same instruments in order to measure change in student's answers after the glass-bottom boat tour, the specific informal learning experience being evaluated.

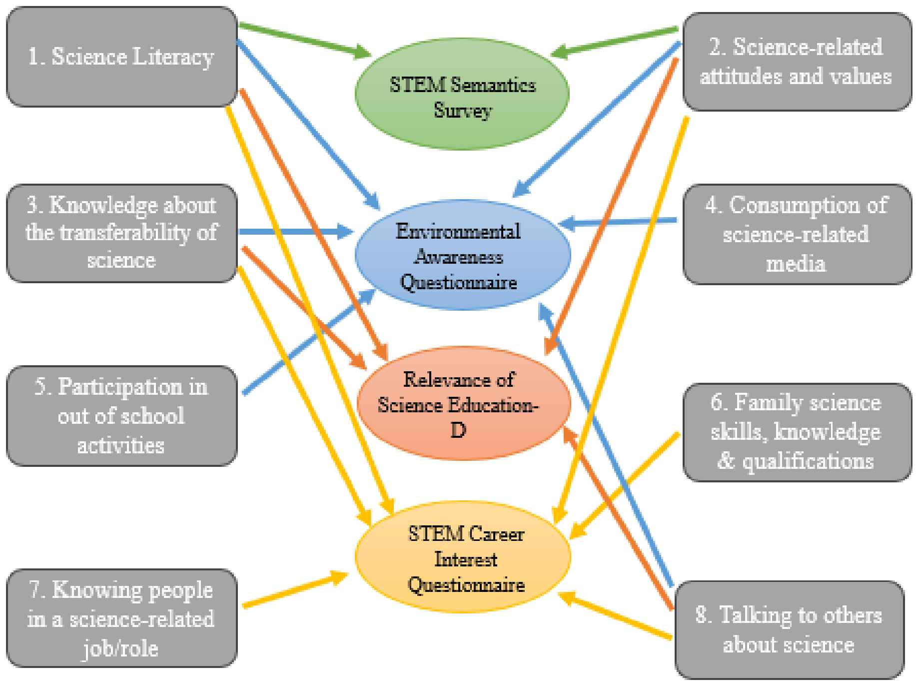

Figure 1. Map of connections between the eight dimensions of science capital and the instruments that were selected for this study.

Data Sources

The questionnaires were created through and administered to the participants through the Qualtrics online software. Data for this qualitative study came from the pre- and post-questionnaire. Both sources consisted of the same questions to measure instrument score change after the treatment of riding the glass-bottom boat tour. The four different instruments were used to determine the student's interest in STEM, their environmental awareness, and interest in pursuing a career in STEM.

STEM Semantics Survey. The SSS is a 25-item instrument meant to assess general perceptions of participant interest in science, technology, engineering, and mathematics (Kier et al., 2013). The survey uses semantics with differential adjective pairs that are separated into five sub-scales with each described by the same five adjective descriptors, unlike likert-type scales that use expressions (Knezek et al., 2011). Each sub-scale has the order reversed for each descriptor adjective and is counterbalanced to help with the accuracy of the survey (Tyler-Wood et al., 2010). This is done with three adjective pairs that are in the form of positive-negative and two category pairs being reversed (negative-positive). This reversal is different in each scale, ensuring that the data were counterbalanced. When examining the internal consistency of the survey, Tyler-Wood et al. (2010) found that their calculated Cronbach's alpha (α) ranged from 0.84 to 0.93, showing high consistency and reliability, and in the range of "very good" to "excellent" according to the DeVellis (1991) guidelines.

Environmental Awareness Questionnaire. The EAQ is a 28-item Likert-type instrument that was developed by Moore et al. (2016) with their program OUTSIDE, which looked at changes in environmental awareness and increases in knowledge after "learning about science in nature." It is divided into five subscales of awareness (learning about environmental science, interest in nature, use of technology, communication skills, and learning science) and was designed to be taken before and after their outside learning experience (Moore et al., 2016). The researchers found the instrument to be reliable (α=0.79), which is in the range of "acceptable" to "good" according to the DeVellis (1991) guidelines.

Relevance of Science Education-D. The master ROSE instrument was developed as an international survey project by Schreiner and Sjoberg (2004). It consists of 250-items, divided into seven groups, and gathers information on student's opinions of school science and science related issues (Jenkins & Pell, 2006). For my study, I used a subset of items from the ROSE, section D "Me and the environmental challenges," which includes 18-items inspired by research on alienation, powerlessness, and meaninglessness (Hebel et al., 2014). In a separate study done by Jenkins & Pell's (2006) outside of the main ROSE project, they looked at science education's effect on student's voice regarding environmental issues and used only section D of the ROSE instrument. Exposure to science and environmental education can initiate student empowerment in regard to environmental issues as well as interest and engagement, the main goal of this study. The internal reliability of the entire ROSE instrument is “excellent” (α=0.90), with section D having “good” reliability (α=0.76) (DeVellis, 1991; Schreiner, 2006).

STEM-Career Interest Questionnaire. Tyler-Wood et al. (2010) suggest that the STEM-SSS be used in conjunction with the Career Interest Questionnaire (STEM-CIQ). The STEM-CIQ is a 12-item survey, which consists of three sub-scales which use a likert-type scale. It was designed to measure interest in pursuing a career in the STEM field, interest in pursuing an education that would lead to a career in the STEM fields, and perceived importance of a career in STEM (Christensen et al., 2015). STEM-CIQ has been found to cross-validate and enhance portions of the SSS (Tyler-Wood et al., 2010). The entire instrument was found to be reliable as a tool for assessment (α=0.94), with each scale ranging from “acceptable” to “excellent (α=0.86, α=0.94, α=0.78) (DeVellis, 1991; Tyler-Wood et al., 2010).

Data Analysis

The pre- and post-questionnaires were closed after the semester had concluded, and both questionnaires were exported from Qualtrics into Excel. Responses that were marked as “false” if the participant’s submission was marked as incomplete. After removing incomplete surveys and those submitted by participants under the age of 18, the pre-questionnaire had 541 usable submissions and the post-questionnaire had 87 usable submissions. Unique identifiers for each submission were then compared between the pre- and the post-questionnaires to match any participants who had completed both surveys, resulting in 30 paired submissions. The data were then coded to enable analysis. Each instrument was coded separately, as they were independent assessments (Table 2).

Table 2.

Instrument Scale Scoring Method and Type

Instrument	Scoring Scale	Type of Scale
SSS	Very Unlikely (1) to Most Likely (7)	Semantic differential
EAQ	Strongly Disagree (1) to Strongly Agree (5)	Likert-type
ROSE-D	Disagree (1) to Agree (4)	Likert-type
STEM-CIQ	Strongly Disagree (1) to Strongly Agree (5)	Likert-type

The SSS was separated into its five corresponding sub-scales: science, math, engineering, technology, and career. Each scale had the same 5 adjective descriptors but 2 of the questions in each had the adjective pairs reversed to be negatively worded. The participants chose a number from 1 to 7 for each question, with the higher number meaning that the participant felt stronger towards that adjective. Due to the adjective descriptor reversal, each scale had to be scored differently, meaning a score of 7 on a reversed question was actually a 1 (Table 3). The instrument was inherently designed with counterbalancing, resulting in a need for different scoring procedures with each scale. When scoring the answers, I went through each subscale separately and coded each question that needed reverse coding separately. The SSS was scored by averaging the scores for each scale and then a total score was determined by adding the average scores for each scale.

Table 3.

STEM Semantics Survey Scoring Guide

Scale	Adjective Descriptor Reversal Scoring
Science	Sci 1 Reversed, Sci 2 Reversed, Sci 3 Reversed, Sci 4, Sci 5
Math	Math 1, Math 2 Reversed, Math 3 Reversed, Math 4 Reversed, Math 5
Engineering	Eng 1 Reversed, Eng 2 Reversed, Eng 3, Eng 4 Reversed, Eng 5
Technology	Tech 1 Reversed, Tech 2, Tech 3, Tech 4 Reversed, Tech 5 Reversed
Career	Career 1, Career 2, Career 3 Reversed, Career 4 Reversed, Career 5 Reversed

The EAQ was separated into scales based on its themes (factors): learning about environmental science, interest in nature, use of technology, communication skills, and learning about science (Appendix D). Questions that had a negative context (Q5, Q6, Q8, Q14, Q16, Q20, Q27) were reverse coded, meaning a participant score of 1 was actually a 5 in these specific questions. The five factors were then scored by calculating the average. A total score was then achieved by adding the average scores of each factor.

ROSE-D questions were also reviewed and coded, with the negative context questions (Q1, Q3, Q8, Q9, Q13, Q16) reverse coded (Appendix B). The ROSE-D, already being a scale of the main ROSE questionnaire, was scored by averaging the scores for each question to determine the general opinion of the students.

The STEM-CIQ was separated into its three scales interest, intent, and perception and then coded. It was scored by averaging each scale and then a total score was achieved by adding the average scores.

Analysis

The purpose of this study was to examine the students' initial perceptions of STEM, the environment, and science and then determine if there were changes in perceptions after the glass-bottom boat tour. To address my research question, I first assessed the pre- and post-questionnaires with a descriptive approach, due to the low number that were paired (n=30). Box and whisker plots were developed for each instrument, using the paired data to visualize variation in responses after the treatment, examining changes of the median and the interquartile range (middle 50% of the participants). Box plots use the mean and interquartile range to show spread and difference, and when data is robust it can determine if there are any outliers in the data or if the data is symmetrical. It also can be used with small sample sizes and allows for researchers to do a quick comparison between data.

The scores for each scale and instrument were then exported into the statistical software SPSS. Analysis of reliability test was run on each instrument to see the internal validity, or Cronbach's alpha. I then conducted an ANOVA test of the total pre- and post- test to determine if there was a statistical variance between the two data sets. I then conducted an ANOVA on the paired pre-tour data to the total pre-tour data as well as the paired post-tour data and total post-tour data. These statistical tests will show if there are any consistencies with the data. My final test that was performed was an ANOVA of the paired data, which supports the research question of this study. The f-value, p-value, mean, and standard deviation were reported for each test.

Limitations

This study was conducted during the fall semester of 2020, during the peak of COVID-19 pandemic, which influenced the number of participants. The course was taught online instead of in-person. Some professors that typically included the boat tour in their curriculum decided to not include the boat ride in their fall 2020 course due to the pandemic. Additionally, some students that were assigned the boat ride as part of the course opted out of riding the boat likely to maintain social distancing.

All classes scheduled to ride the glass-bottom boats were sent the initial questionnaire. However, the return rate was lower than the initial questionnaire. COVID-19 and the remote learning environment potentially limited the number of students willing to participate in completing the questionnaire because of online fatigue. In the previous fall semester, of 5,721 students scheduled for a boat tour with their classes only 4,985 students actually participated on the scheduled tour. The fall 2020 semester in which the study took place only 2,585 students took the tour out of the 3,260 that were scheduled.

The questionnaire instrument provided participants the opportunity to skip questions, which in some cases resulted in incomplete submissions. Some questionnaires were also deemed unusable due to single response answers across the questionnaire. For example, students scoring each question with a one or five across the entire questionnaire, ignoring the questions that were reverse coded, were extracted from the final data set as they were considered unusable. The time that was taken to complete the questionnaire was also taken into consideration. Of the 3,260 students that were sent the pre- and post-questionnaires, I was only able to use 541 pre-questionnaires (out of 639 total submissions) and 82 post-tour questionnaires (out of 143 total submissions). Of the usable responses, 30 questionnaires were able to be matched with the pre and post submissions from students with identifying data provided.

Another limitation to the study was the tour itself. Even though each environmental interpreter is instructed specific items to discuss on their boat tour, the actual tour is based off of interpretation and not a script. With that in mind, every tour is different based on what is either seen or brought up on the tour itself. This has a potential to impact the fidelity of these tours and create inconsistencies with the information between classes.

IV. RESULTS

To assess the influence of the glass-bottom boat tours, I analyzed the responses using two different methods. Table 4 reports the percentage of submissions that were either complete, partially completed (one to three instruments were incomplete), or incomplete (all four instruments were not completed). All submitted questionnaires that were not complete were removed from the data set and then the complete data was analyzed in two different approaches. The first examined the data with a descriptive lens. Using a box and whisker plot to compare the pre- and the post-tour data that were paired, changes in the distribution of data, notable outliers, and where majority of students scored were noted. The second approach calculated the statistical variance within the data collected, examining the influence of the informal learning experience on the students' perceptions of STEM, the environment, and science.

Table 4.

Completion Percentages for the Questionnaires

	Submissions (n)	Complete (%)	Partially Complete (%)	Incomplete (%)
Pre-Tour Questionnaire	639	84.66%	8.76%	6.57%
Post-Tour Questionnaire	143	60.84%	19.58%	19.58%

Descriptive Approach

SSS. Figure 1 shows the results of the SSS portion of the questionnaire. The box and whisker plot indicates the median (line in middle of box or 50% of the participants) and distribution of data looking at changes of the first quartile (Q1, bottom of box). In the pre-questionnaire, students had the highest perception of "science", with over 75% of students scoring the scale the highest (Q1=4.375). Perceptions of "math" were the lowest in the pre-questionnaire, having the lowest Q1 score (Q1=2.375). An improvement was seen in most students in “science” and “career”, with the distribution of data skewed (median more towards Q3) to higher scores. The ceiling effect that can be noted with “science”, “technology”, and “career”, which can be an issue with box plot analysis, are accounted for with the desired results of these questionnaires with wanting students to have high scores in these topics.

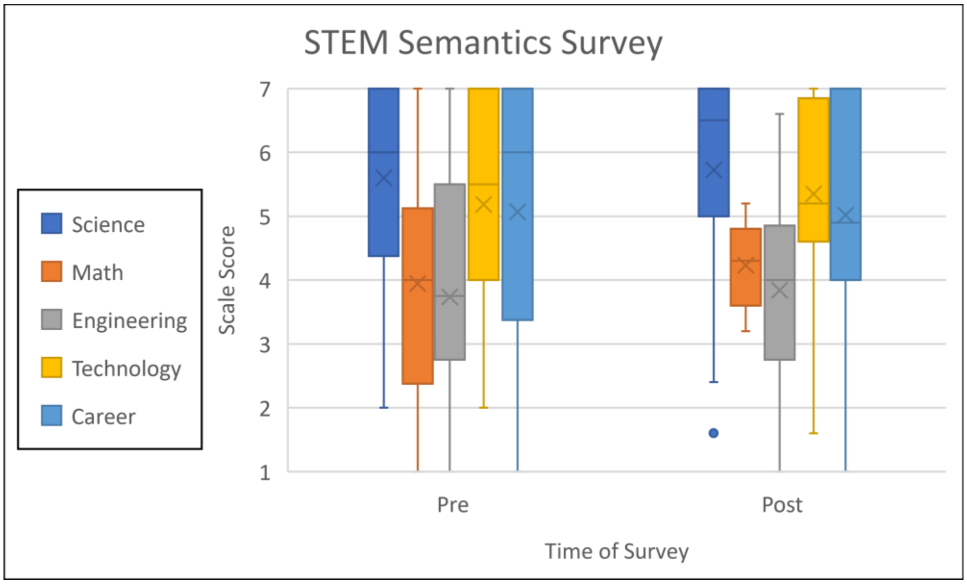

Figure 2. Box and whisker plot of the STEM Semantics Survey pre- and post-tour data.

EAQ. Figure 3 depicts the box and whisker plots created for the five different factors in the EAQ. In both the pre- and post-questionnaires all participants scored a three or greater (neutral score=3) in the scales for “learning about the environment”, “interest in nature”, and “use of technology”. Over 50% of the participants in both questionnaires had a positive response in all the scales (median ≥ 4). “Interest in nature” and “learning science’ scales display an increase in median after the treatment, which portrays gains in both areas in 50% of the students participating.

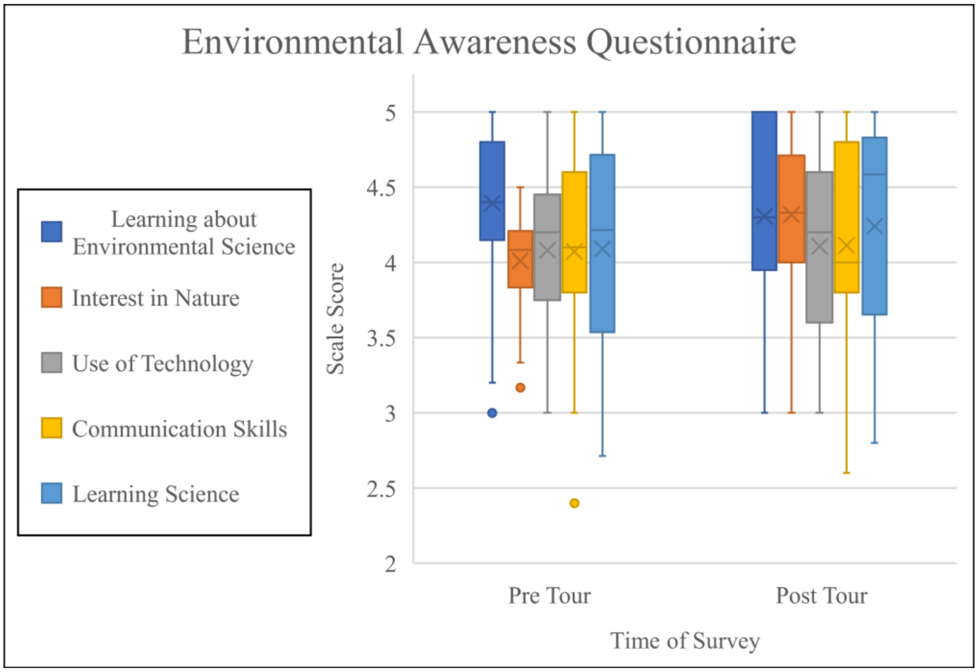

Figure 3. Box and whisker plot of the Environmental Awareness Questionnaire pre- and post-tour data.

ROSE-D. This project only looked at the section D "Me and the environmental challenges" of the ROSE instrument. Since there were no sub-scales for this section, I looked at the scores for both the pre- and post-questionnaires to see where students' opinions fell, with the highest possible score being 72 and the lowest 18. Box and whisker plots were developed to visualize the distribution of the data, which showed both questionnaires having similar and normal distributions (Figure 4). However, the box plots show a slight decrease after the treatment, with the scores ranging from 47 to 69 in the pre-questionnaire and 46 to 66 in the post-questionnaire.

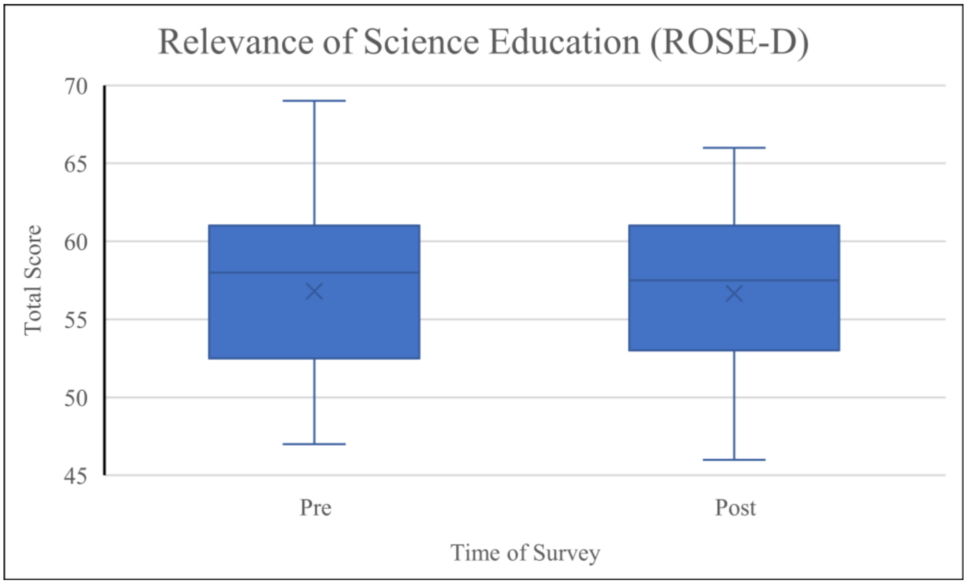

Figure 4. Box and whisker plot of the Relevance of Science Education-D pre- and post-tour data.

STEM-CIQ. Figure 5 shows the box and whisker plots for the three scales in the STEM-CIQ. Pre-questionnaire participants' answers ranged from strongly agreeing to strongly disagreeing on all three scales, with 50% scoring neutral or higher (median ≥ 3). The post-questionnaire had similar results, except the range for the scale "importance of STEM career" ranged from slightly disagree to strongly agree.

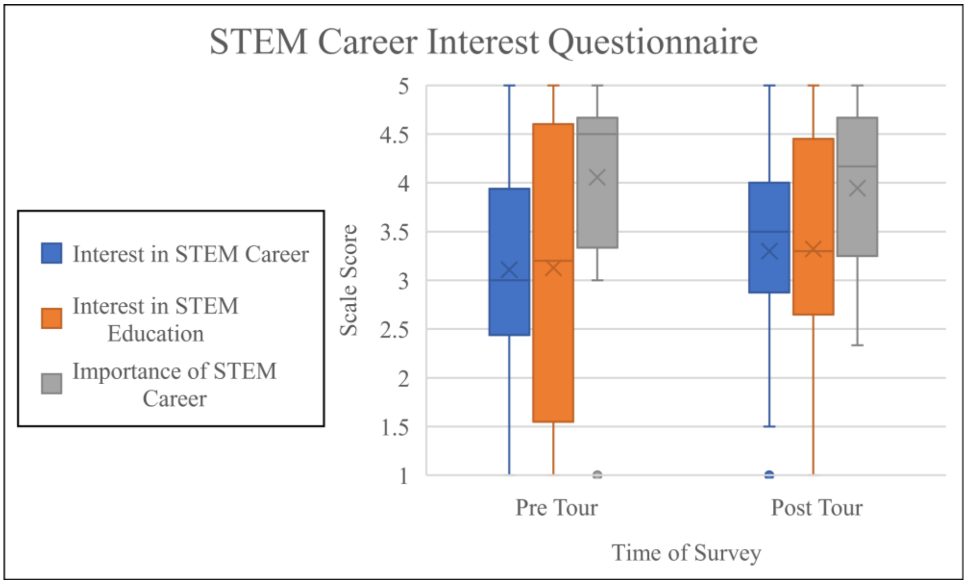

Figure 5. Box and whisker plot of the STEM Career Interest Questionnaire pre- and post-tour data.

Statistical Results

I conducted statistical analysis of the data to determine if there were any reliability issues and if there were any significant variances between the answers from the two questionnaires. The paired instrument data were compared to the total data from each instrument to determine if there were any significant variance between the data sets to ensure that the sample was an accurate representative from the population. Variance and reliability of the data were only analyzed for the paired data sets.

Analysis of Reliability

An analysis of reliability was calculated to determine the internal consistency and strength of the data. I used Cronbach's Alpha (α) for the data from the students that had completed both a pre- and post-questionnaire (Table 5). Cronbach's Alpha was chosen to determine reliability due to most of the scales in this study being Likert-type. When using DeVellis's (1991) analysis of utilizing α, any value that is under 0.6 has low reliability. Both the pre- and the post-responses for the ROSE-D had an α that fell into this category (pre α=0.312, post α=0.544). The SSS and STEM CIQ both had an alpha level that fell above 0.9, which is interpreted as having excellent internal consistency and reliability. The EAQ's α fell in the range of questionable to acceptable (pre α=0.668, post α=0.762). Low α values are common with data that have questions that seem to be not relevant or not enough questions.

Table 5.

Cronbach's Alpha for the Pre- and Post-Tour Instruments

Instrument	Cronbach's Alpha	N of Items
Pre-Tour STEM Semantics Survey	0.906	25
Pre-Tour Environmental Awareness Questionnaire	0.668	28
Pre-Tour Relevance of Science Education-D	0.312	18
Pre-Tour Career Interest Questionnaire	0.959	12
Post-Tour STEM Semantics Survey	0.954	25
Post-Tour Environmental Awareness Questionnaire	0.762	28
Post-Tour Relevance of Science Education-D	0.544	18
Post-Tour Career Interest Questionnaire	0.956	12

Analysis of Variance

With the large number of pre-questionnaire responses (n=526) and relatively small number of post-questionnaire responses (n=80), the number of students that completed both was small (n=30). My research question asked if the informal learning experience, a glass-bottom boat tour, influenced students' interest in and awareness of STEM, the environment, and science. The focus of my analysis was on the students who completed both questionnaires.

To determine if the pre- and post-tour data was an accurate representation of the paired data, I conducted a one-way ANOVA test on three different groups: total pre-tour questionnaire data to the total pre- and post-questionnaire data, paired pre-tour questionnaire data to total pre-questionnaire data, and paired post-tour questionnaire to post-tour questionnaire. A post hoc test was not run on any of the analysis due to there being only two groups being compared.

Table 6 depicts the analysis of the total pre- and post-tour questionnaire data, looking for any variance between the pre- and post-tour questionnaire data. The output expressed several significant differences in the student responses from pre-tour and post-tour, including a scale from each instrument, indicating that the two data sources could support the research question. From the initial box plot analysis with the “science” scale revealing an increase in median between the treatment, there was a significant in the two instrument variances ($F=6.815$; $p=0.009$). Within the EAQ, the scale “learning about environmental science” revealed significant variation ($F=12.475$; $p=0.000$). Even though the ROSE-D revealed minimal change between the two paired treatments with the box plot, the data showed that there was a significance between the total data ($F=4.863$; $p=0.028$).

This finding could be a result of this instrument being looked at as a whole instead of an average as was done with the other scales or that the paired data were not an accurate representation of the students that took the US1100 course. Within the STEM-CIQ, the scale that represents “interest in STEM education” revealed a significant variation between the two data sets ($F=4.795$; $p=0.029$). These findings do suggest that there is a variation in student answers from their initial participation in the questionnaire to later in the semester. However, there is no suggestions as to what cause of this finding could be, due to a majority of responses to questionnaires not being paired.

Table 6.

One-way ANOVA Comparing Total Pre- and Post-Tour Instrument Means

Instrument	Pre-Tour Mean	Pre-Tour Std. Dev.	Post-Tour Mean	Post-Tour Std. Dev.	F	Sig. (p)
SSS						
Science	5.180	1.346	5.663	1.474	6.815	0.009
Math	3.746	1.518	4.090	1.394	2.641	0.105
Engineering	3.956	1.480	3.788	1.574	0.683	0.409
Technology	5.149	1.384	5.265	1.463	0.373	0.542
Career	4.576	1.766	5.043	1.869	3.732	0.054
EAQ						
Learning about environmental science	4.048	0.634	4.350	0.560	12.475	0.000
Interest in nature	4.062	0.602	4.164	0.481	1.584	0.209
Use of technology	4.039	0.512	4.093	0.558	0.586	0.440
Communication skills	4.066	0.643	4.093	0.650	0.099	0.753
Learning science	3.831	0.666	4.166	0.707	13.439	0.000
ROSE-D	54.880	6.202	56.730	5.716	4.863	0.028
CIQ						
Interest in a STEM Career	2.914	1.104	3.204	1.160	3.672	0.056
Interest in STEM Education	2.868	1.167	3.223	1.322	4.795	0.029
Importance of STEM Career	3.836	0.846	4.000	0.944	1.953	0.163

Table 7 reflects the analysis of the data then went in to looking into variations between both the paired data and the total data or both the pre-tour and post-tour data. Looking at the pre-tour data, there were several significant variations. As with the total data results, the SSS scale for "science" (F=6.838; p=0.009) and "career" (F=4.003; p=0.046) were revealed that there was a possible significance between the total pre-tour data set and the population chosen, representing that the population that is the focus of the study may not be an accurate depiction this study. This is also represented within the EAQ instrument with the "learning about science"

(F=9.587, p=0.002) as well as the STEM CIQ with the scales "interest in STEM careers" (F=3.926, p=0.048) and "interest in STEM education" (F=4.816, p=0.029).

Table 7.

One-way ANOVA Comparing Paired Pre- and Total Pre-Tour Instrument Means

Instrument	Total Pre-Tour Mean	Total Pre-Tour Std. Dev.	Pre Pre-Tour Mean	Pre Pre-Tour Std. Dev.	F	Sig. (p)
SSS						
Science	5.140	1.336	5.800	1.375	6.838	0.009
Math	3.730	1.547	4.070	1.893	1.333	0.249
Engineering	3.960	1.453	3.830	1.895	0.218	0.641
Technology	5.140	1.373	5.300	1.579	0.378	0.539
Career	4.540	1.755	5.200	1.864	4.003	0.046
EAQ						
Learning about environmental science	4.027	0.635	4.393	0.524	9.587	0.002
Interest in nature	4.065	0.615	4.011	0.321	0.228	0.633
Use of technology	4.037	0.513	4.080	0.503	0.200	0.655
Communication skills	4.065	0.643	4.073	0.642	0.004	0.947
Learning science	3.815	0.661	4.090	0.708	4.880	0.028
ROSE-D	54.770	6.211	56.800	5.821	3.051	0.081
CIQ						
Interest in a STEM Career	2.890	1.097	3.300	1.154	3.926	0.048
Interest in STEM Education	2.840	1.154	3.320	1.307	4.816	0.029
Importance of STEM Career	3.829	0.839	3.944	0.959	0.527	0.468

Table 8 represents a similar comparison, looking at if the total data collected were an accurate representation of the post-tour sample data being analyzed. An ANOVA was run on the data, looking to see if there was a variation between the students that participated in both questionnaires to the remainder of the submissions after their scheduled boat ride. Significance was found within the SSS instrument and within the scaled "science" (F= 27.410, p=0.000) and “engineering” (F=5.756, p=0.019).

Table 8.

One-way ANOVA Comparing Paired Post- and Total Post-Tour Instrument Means

Instrument	Total Post-Tour Mean	Total Post-Tour Std. Dev.	Paired Post-Tour Mean	Paired Post-Tour Std. Dev.	F	Sig. (p)
SSS						
Science	5.183	1.490	5.727	1.527	27.410	0.000
Math	3.683	1.493	3.660	0.490	0.007	0.934
Engineering	3.425	1.560	4.160	0.773	5.756	0.019
Technology	4.908	1.630	5.347	1.302	1.549	0.217
Career	4.308	1.947	5.020	1.857	2.554	0.114
EAQ						
Learning about environmental science	4.146	0.638	4.307	0.601	1.228	0.271
Interest in nature	4.083	0.698	4.316	0.565	2.363	0.128
Use of technology	4.088	0.481	4.107	0.616	0.024	0.878
Communication skills	4.038	0.698	4.113	0.668	0.225	0.636
Learning science	3.783	0.682	4.241	0.710	8.072	0.060
ROSE-D	56.730	5.716	56.670	5.707	1.890	0.173
CIQ						
Interest in a STEM Career	3.130	1.170	3.300	1.155	0.393	0.533
Interest in STEM Education	3.175	1.342	3.320	1.307	0.220	0.640
Importance of STEM Career	4.042	0.942	3.944	0.959	0.194	0.661

The final statistical assessment conducted was one-way ANOVA on the paired data with the treatment variable being defined as whether the data came from before their scheduled boat tour or after the tour. Table 9 shows the means and standard deviations for both treatments and scales, plus the F statistic and p-value associated with each. The “interest in nature” scale within the EAQ instrument was the only scale that reported significance (F=6.604, p=0.013). This finding can be supported with Figure 3 with the box plot report for the EAQ which depicts the "interest in nature" scale having the most significant change in the range of the data.

Table 9.

One-way ANOVA Comparing Paired Pre- and Post-Tour Instrument Means

	Pre-Tour		Post-Tour			
Instrument	Mean	Std. Dev.	Mean	Std. Dev.	F	Sig. (p)
SSS						
Science	5.600	1.441	5.727	1.527	0.109	0.742
Math	3.946	1.872	4.233	0.639	0.635	0.429
Engineering	3.736	1.716	3.840	1.446	0.064	0.801
Technology	5.183	1.627	5.347	1.302	0.184	0.669
Career	5.067	1.911	5.020	1.857	0.009	0.924
EAQ						
Learning about environmental science	4.393	0.524	4.307	0.601	0.355	0.554
Interest in nature	4.011	0.321	4.316	0.565	6.604	0.013
Use of technology	4.080	0.503	4.107	0.616	0.034	0.855
Communication skills	4.073	0.642	4.113	0.668	0.056	0.814
Learning science	4.090	0.708	4.241	0.710	0.673	0.415
ROSE-D	56.800	5.821	56.670	5.707	0.008	0.929
CIQ						
Interest in a STEM Career	3.108	1.242	3.300	1.155	0.383	0.538
Interest in STEM Education	3.127	1.482	3.320	1.307	0.287	0.594
Importance of STEM Career	4.056	1.062	3.944	0.959	0.181	0.672

When comparing results between the descriptive and statistical analysis for the paired data, some interesting results appear. Within the SSS instrument, all scales had an increase in mean after the treatment except for "career" (pre=5.067, post=5.020). Figure 2 displays that the median score for the same scale decreased after the treatment as well (pre-6, post=5.02). The scale for "math" was statistically significant in the analysis comparing the total data and the treatment data to total data (total pre, total post: F=6.815, p=0.009; paired pre, total pre: F=6.838, p=0.009; paired post, total post: F=24.410, p=0.000). These findings create speculation whether the data for the research question is an accurate depiction of the students that participated in the boat tours.

The EAQ had similar results with the means between the treatment. The mean did decrease after the boat tour for “learning about environmental science” (pre=4.393, post=4.307), which was the same as the median reported in Figure 3. The mean and median were also calculated to be the same for the scales “interest in nature” and “use of technology.” This could be reflective of these scales having data that is normally distributed. The scale for “learning about environmental science” (total pre, total post: F=12.475, p=0.000; paired pre, total pre: F=13.439, p=0.000) and “learning science” (total pre, total post: F=9.587, p=0.002; paired pre, total pre: F=4.003, p=0.046) were both statistically significant in the analysis. These findings also create speculation whether the data used was an accurate depiction of the population and if these issues are being caused by a low sample size.

Rose-D and STEM-CIQ results from the statistical analysis from the paired data and the box plots do not reveal anything of significance. The data appears to be similar between the pre- and post-tour. However, during the analysis of the total data and the pre-tour data, the ROSE-D (total pre, total post: F=4.863, p=0.028) and the STEM CIQ “interest in a STEM education” (paired pre, total pre: F=4.795, p=0.029; paired pre, total pre: F=4.816, p=0.029) and “interest in a STEM career” (paired pre, total pre: F=4.816, p=0.029). These results along with the significance reported above, infer that this significance is most likely due to the large number of pre-tour submissions compared to the post-tour data and that the paired data are most likely not an accurate representative of the students enrolled in the course.

V. DISCUSSION

This study aimed to examine the impacts of an informal science experience on students' interest and awareness of STEM, the environment, and careers in STEM. Informal learning environments in the university setting can make learning less stressful without the normal constraints of a formal classroom with normal learning standards (Baucum & Capraro, 2021). Although the glass-bottom boat tour provided in this study was a short 30-minute experience, this informal education experience had potential to impact many students in gaining interest in STEM and the environment. I initially expected a high participation rate in the study given that the informal learning experience is a component of the US 1100 class curriculum, in which university freshmen enroll (n=7,171 in fall 2020). However, with the questionnaire not a mandatory requirement of the class, a shift to extensive online learning due to the onset of the COVID-19 pandemic, and professors not making the boat tour a requirement for the course, the participation of students was lower than anticipated. The number of responses that were able to be paired (n=30) resulted in a small sample size. A larger sample size might possibly have led to higher reliability and may have provided a more accurate assessment of the influence of the glass-bottom boat tour informal learning experience on student perceptions.

Results of the study report a significant variation found between the paired pre- and post-tour questionnaire with the EAQ's scale "interest in nature" ($F=6.604$, $p=0.013$). This instrument was designed to measure student's gains in awareness of the environment after an outdoor learning experience. It is difficult to prove that the results of this study are a response of participating in the boat tour. With the fidelity of the tour not being personally checked by the researcher and other confounding variables not being investigated, more research is needed to determine the effects of this experience.

Figure 6 shows the connections of each instrument to the five parts of environmental education, as was described by the AKASA model. The EAQ and the STEM-CIQ map back to each of these key factors that environmental educators want to ensure that their programs target. These key factors of environmental education also relate back to the theoretical framework of science capital and includes several factors that it includes. Moote et al. (2020) found that while students may find science interesting, it does not always translate into wanting to explore a career in the subject.

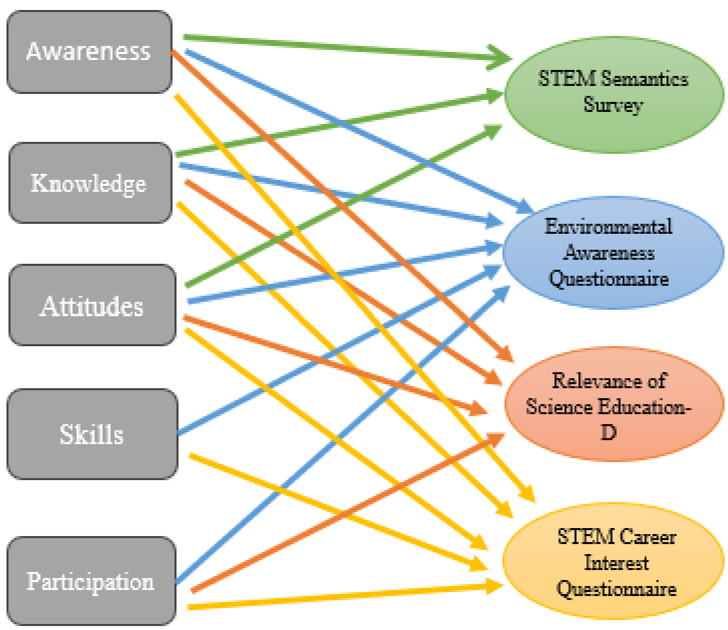

Figure 6. Map of connections between the five parts of environmental education that are listed in the AKASA model and the instruments that were selected for this study.

This study aimed to look at if an informal learning experience, the glass-bottom boat tour, could have an impact on university freshmen's interest in STEM and the environment, in hopes that similar activities within a student's college career can build on their science capital and encourage more to pursue STEM degrees and jobs. Moote, et al. (2020) found that physical science, math, and engineering attitudes have a strong relationship to science capital, with technology having very little correlation. The more access that students have to science capital, the higher the chance for students to have more motivation to value science and their future in STEM (Jones, et al., 2021).

The four instruments selected to create the questionnaire used in my study were originally developed for a younger audience than the study group. The SSS and the STEM-CIQ were designed by the same researchers and were meant to be used together, but the STEM-CIQ was designed to fill in the gap of research where there were no appropriate career interest instruments geared towards students younger than the high school level (Tyler-Wood et al., 2010). The ROSE-D was discovered to not be a good assessment for the study group due to the fact that it was designed for middle school students in Europe (Schreiner & Sjoberg, 2004). Statements in the instrument were not relatable to the students from Texas in this study nor were they in a relatable language. For example, "I am willing to have environmental problems solved even if this means sacrificing many goods." Perhaps a new instrument should be designed to target college-age participants that would capture changes in perceptions resulting from the informal learning experience.

The onset of COVID-19 may have impacted this research project. Other researchers found that students had significant learning fatigue as well as an insecurity for their personal future with the pandemic (Lynn, et al., 2022). This feeling of insecurity could have impacted the students' opinions of their potential to pursue a STEM career and attitudes toward protecting the environment in my study. It would be interesting to conduct the same study in a semester not impacted by the pandemic to compare with results found in this study. Future research could also use only the EAQ or potentially another instrument that was created specifically to look at the questions.

Evidence advances the idea that positive science attitudes decrease as youth make the transition from elementary to middle school and again when they transition from middle to high school (Habig et al., 2020). Goff et al. (2020) found that there are implications that student's interest in science and math and their relationships with informal learning experiences do persist into their college careers. Research has shown that the decision for students to enter into a STEM major has direct correlation to their initial college experiences, including interactions in academics and financially (Wang, 2013). In a study by Turner et al. (2021), researchers found that students were influenced the most through informal curriculum over formal. While this study did not find a statistical significance with one, short informal learning experience, the implications of the study with other research shows that a longer experience or multiple encounters, there is a potential to make an impact in student's interest in and awareness of STEM, the environment, and opportunities within STEM career fields.

APPENDIX SECTION

Appendix A
IRB Approval

TEXAS STATE UNIVERSITY
SAN MARCOS
The rising STAR of Texas

In future correspondence please refer to 2018338

February 10, 2018

Miranda Wait
c/o Dr. Kristy Daniel
Department of Biology
Texas State University San
Marcos, TX 78666

Dear Miranda,

Your IRB application titled, *Connecting Interest In and Awareness of the Environment with an Informal Experience*, was reviewed by the Texas State University IRB. It has been determined that risks to subjects are: (1) minimized and reasonable; and that (2) research procedures are consistent with a sound research design and do not expose the subjects to unnecessary risk. The IRB determined that: (1) benefits to subjects are considered along with the importance of the topic and that outcomes are reasonable; (2) selection of subjects is equitable; and (3) the purposes of the research and the research setting is amenable to subjects' welfare and producing desired outcomes; that indications of coercion or prejudice are absent, and that participation is clearly voluntary.

1. In addition, the IRB found that you need to orient participants as follows: (1) Signed informed consent is not required as completion and return of the survey will imply consent; (2) Provision is made for collecting, using and storing data in a manner that protects the safety and privacy of the subjects and the confidentiality of the data; (3) Appropriate safeguards are included to protect the rights and welfare of the subjects.

This project is therefore approved at the Exempt Review Level

2. Please note that the institution is not responsible for any actions regarding this protocol before approval. If you expand the project at a later date or use other instruments, please re-apply. Copies of your request for human subjects review, your application, and this approval, are maintained in the Office of Research Integrity and Compliance. Please report any changes to this approved protocol to this office.

Sincerely,

Monica Gonzales

Monica Gonzales
IRB Regulatory Manager
Research Integrity and Compliance
Office of the Associate Vice President for Research and Federal Relations Texas State University

OFFICE OF THE ASSOCIATE VICE PRESIDENT FOR RESEARCH
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Appendix B

University Seminar Pre Glass-bottom Boat Survey

Q1. What is your gender:
- Male
- Female
- Other

Q2. State your Date of Birth: ___________

Q3 State your Texas State Net ID (i.e. mw1220): ________________

Q4 What section of US1100 are you enrolled in? _______________

Q5 Have you ever been on a glass-bottom boat ride before?
- Yes
- No
- Unsure

Q6 Specify your ethnicity:
- Hispanic or Latino
- White (non-Hispanic)
- Black or African American
- Native American or American Indian
- Asian or Pacific Islander
- Other

Q7 For each of the following terms, choose one circle between each adjective pair to indicate how you feel about the object.

To me, SCIENCE is:

1.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
2.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
3.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
4.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
5.	boring	①	②	③	④	⑤	⑥	⑦	interesting

To me, MATH is:

1.	boring	①	②	③	④	⑤	⑥	⑦	interesting
2.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
3.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot

To me, ENGINEERING is:

1.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
2.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
3.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	boring	①	②	③	④	⑤	⑥	⑦	interesting

To me, TECHNOLOGY is:

1.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
2.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
3.	boring	①	②	③	④	⑤	⑥	⑦	interesting
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary

To me, a CAREER in science, technology, engineering, or mathematics (is):

1.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
2.	boring	①	②	③	④	⑤	⑥	⑦	interesting
3.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
4.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
5.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing

Q8 Please answer the questions below as honestly as you can. Use the following scale to indicate your degree of agreement with each item. Do this by selecting one of the circles.

	Strongly Disagree	Somewhat Disagree	Neither Disagree nor Agree	Somewhat agree	Strongly Agree
I think that learning about nature is important.	○	○	○	○	○
I like spending time outside in nature.	○	○	○	○	○
I am comfortable with using technology (e.g., iPads and computers) on a regular basis.	○	○	○	○	○
I can communicate well with other people.	○	○	○	○	○
I think that scientific work is only useful to scientists.	○	○	○	○	○
I think that it is not important to learn about different plants and animals.	○	○	○	○	○
I think science is interesting.	○	○	○	○	○
I think that using technology is distracting.	○	○	○	○	○
I like communicating with other people.	○	○	○	○	○
I think that I will be able to use what I learn about nature in my life.	○	○	○	○	○
I think it is important to learn about water conservation.	○	○	○	○	○
I would like to learn more about science.	○	○	○	○	○
I think using technology can help me learn science.	○	○	○	○	○
I think communicating with other people is difficult.	○	○	○	○	○
I think that science is useful to my life.	○	○	○	○	○

(Q8 continued)	Strongly Disagree	Somewhat Disagree	Neither Disagree nor Agree	Somewhat agree	Strongly Agree
I think that it is not important for me to learn about nature.	○	○	○	○	○
I would like to learn more about nature.	○	○	○	○	○
I think it is important for me to learn how to use technology.	○	○	○	○	○
I think it is important to communicate with other people.	○	○	○	○	○
I think that learning about nature will not impact my life.	○	○	○	○	○
I think that learning about science is important.	○	○	○	○	○
I think that working outside doing science activities is fun.	○	○	○	○	○
I think that using technology is important.	○	○	○	○	○
I like when other people communicate with me.	○	○	○	○	○
I think that learning about nature can help the environment.	○	○	○	○	○
I think that science is easy for me to learn.	○	○	○	○	○
I think that doing science activities is boring.	○	○	○	○	○
I think that learning about science can help the environment.	○	○	○	○	○

Q9 To what extent do you agree with the following statements about problems with the environment (pollution of air and water, overuse of resources, global changes of the climate etc.)?

	Disagree	Slightly Disagree	Slightly Agree	Agree
Threats to the environment are not my business.	○	○	○	○
Environmental problems make the future of the world look bleak and hopeless.	○	○	○	○
Environmental problems are exaggerated.	○	○	○	○
Science and technology can solve all environmental problems.	○	○	○	○
I am willing to have environmental problems solved if this means sacrificing many goods.	○	○	○	○
I can personally influence what happens with the environment.	○	○	○	○
We can still find solutions to our environment problems.	○	○	○	○
People worry too much about environmental problems.	○	○	○	○
Environmental problems can be solved without big changes in our way of living.	○	○	○	○
People should care more about the protection of the environment.	○	○	○	○
It is the responsibility of the rich countries to solve the environmental problems of the world.	○	○	○	○
I think each of us can make a significant contribution to environmental protection.	○	○	○	○
Environmental problems should be left to the experts.	○	○	○	○
I am optimistic about the future.	○	○	○	○
Animals should have the same right to life as people.	○	○	○	○
It is right to use animals in medical experiments if this can save human lives.	○	○	○	○
Nearly all human activity is damaging for the environment.	○	○	○	○
The natural world is sacred and should be left in peace.	○	○	○	○

Q10 Select one level of agreement for each statement to indicate how you feel.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I would like to have a career in science.	◯	◯	◯	◯	◯
My family is interested in the science courses I take.	◯	◯	◯	◯	◯
I would enjoy a career in science.	◯	◯	◯	◯	◯
My family has encouraged me to study science.	◯	◯	◯	◯	◯
I will make it into a good college and major in an area needed for a career in science.	◯	◯	◯	◯	◯
I will graduate with a college degree in a major are needed for a career in science.	◯	◯	◯	◯	◯
I will have a successful professional career and make substantial scientific contributions.	◯	◯	◯	◯	◯
I will get a job in a science- related area.	◯	◯	◯	◯	◯
Some day when I tell others about my career, they will respect me for doing scientific work.	◯	◯	◯	◯	◯
A career in science would enable me to work with others in meaningful ways.	◯	◯	◯	◯	◯
Scientists make a meaningful difference in the world.	◯	◯	◯	◯	◯
Having a career in science would be challenging.	◯	◯	◯	◯	◯

Appendix C
University Seminar Post Glass-bottom Boat Survey

Q1. What is your gender:
- Male
- Female
- Other

Q2. State your Date of Birth: ___________

Q3 State your Texas State Net ID (i.e. mw1220): ________________

Q4 What section of US1100 are you enrolled in? _______________

Q5 Did you ride on a glass-bottom boat as part of your US1100 course?
- Yes
- No
- Unsure

Q6 Specify your ethnicity:
- Hispanic or Latino
- White (non-Hispanic)
- Black or African American
- Native American or American Indian
- Asian or Pacific Islander
- Other

Q7 For each of the following terms, choose one circle between each adjective pair to indicate how you feel about the object.

To me, SCIENCE is:

1.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
2.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
3.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
4.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
5.	boring	①	②	③	④	⑤	⑥	⑦	interesting

To me, MATH is:

1.	boring	①	②	③	④	⑤	⑥	⑦	interesting
2.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
3.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot

To me, ENGINEERING is:

1.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
2.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
3.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	boring	①	②	③	④	⑤	⑥	⑦	interesting

To me, TECHNOLOGY is:

1.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
2.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
3.	boring	①	②	③	④	⑤	⑥	⑦	interesting
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary

To me, a CAREER in science, technology, engineering, or mathematics (is):

1.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
2.	boring	①	②	③	④	⑤	⑥	⑦	interesting
3.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
4.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
5.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing

Q8 Please answer the questions below as honestly as you can. Use the following scale to indicate your degree of agreement with each item. Do this by selecting one of the circles.

	Strongly Disagree	Somewhat Disagree	Neither Disagree nor Agree	Somewhat agree	Strongly Agree
I think that learning about nature is important.	○	○	○	○	○
I like spending time outside in nature.	○	○	○	○	○
I am comfortable with using technology (e.g., iPads and computers) on a regular basis.	○	○	○	○	○
I can communicate well with other people.	○	○	○	○	○
I think that scientific work is only useful to scientists.	○	○	○	○	○
I think that it is not important to learn about different plants and animals.	○	○	○	○	○
I think science is interesting.	○	○	○	○	○
I think that using technology is distracting.	○	○	○	○	○
I like communicating with other people.	○	○	○	○	○
I think that I will be able to use what I learn about nature in my life.	○	○	○	○	○
I think it is important to learn about water conservation.	○	○	○	○	○
I would like to learn more about science.	○	○	○	○	○
I think using technology can help me learn science.	○	○	○	○	○
I think communicating with other people is difficult.	○	○	○	○	○
I think that science is useful to my life.	○	○	○	○	○

(Q8 continued)	Strongly Disagree	Somewhat Disagree	Neither Disagree nor Agree	Somewhat agree	Strongly Agree
I think that it is not important for me to learn about nature.	○	○	○	○	○
I would like to learn more about nature.	○	○	○	○	○
I think it is important for me to learn how to use technology.	○	○	○	○	○
I think it is important to communicate with other people.	○	○	○	○	○
I think that learning about nature will not impact my life.	○	○	○	○	○
I think that learning about science is important.	○	○	○	○	○
I think that working outside doing science activities is fun.	○	○	○	○	○
I think that using technology is important.	○	○	○	○	○
I like when other people communicate with me.	○	○	○	○	○
I think that learning about nature can help the environment.	○	○	○	○	○
I think that science is easy for me to learn.	○	○	○	○	○
I think that doing science activities is boring.	○	○	○	○	○
I think that learning about science can help the environment.	○	○	○	○	○

Q9 To what extent do you agree with the following statements about problems with the environment (pollution of air and water, overuse of resources, global changes of the climate etc.)?

	Disagree	Slightly Disagree	Slightly Agree	Agree
Threats to the environment are not my business.	○	○	○	○
Environmental problems make the future of the world look bleak and hopeless.	○	○	○	○
Environmental problems are exaggerated.	○	○	○	○
Science and technology can solve all environmental problems.	○	○	○	○
I am willing to have environmental problems solved if this means sacrificing many goods.	○	○	○	○
I can personally influence what happens with the environment.	○	○	○	○
We can still find solutions to our environment problems.	○	○	○	○
People worry too much about environmental problems.	○	○	○	○
Environmental problems can be solved without big changes in our way of living.	○	○	○	○
People should care more about the protection of the environment.	○	○	○	○
It is the responsibility of the rich countries to solve the environmental problems of the world.	○	○	○	○
I think each of us can make a significant contribution to environmental protection.	○	○	○	○
Environmental problems should be left to the experts.	○	○	○	○
I am optimistic about the future.	○	○	○	○
Animals should have the same right to life as people.	○	○	○	○
It is right to use animals in medical experiments if this can save human lives.	○	○	○	○
Nearly all human activity is damaging for the environment.	○	○	○	○
The natural world is sacred and should be left in peace.	○	○	○	○

Q10 Select one level of agreement for each statement to indicate how you feel.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I would like to have a career in science.	○	○	○	○	○
My family is interested in the science courses I take.	○	○	○	○	○
I would enjoy a career in science.	○	○	○	○	○
My family has encouraged me to study science.	○	○	○	○	○
I will make it into a good college and major in an area needed for a career in science.	○	○	○	○	○
I will graduate with a college degree in a major are needed for a career in science.	○	○	○	○	○
I will have a successful professional career and make substantial scientific contributions.	○	○	○	○	○
I will get a job in a science- related area.	○	○	○	○	○
Some day when I tell others about my career, they will respect me for doing scientific work.	○	○	○	○	○
A career in science would enable me to work with others in meaningful ways.	○	○	○	○	○
Scientists make a meaningful difference in the world.	○	○	○	○	○
Having a career in science would be challenging.	○	○	○	○	○

Appendix D

Environmental Awareness Questionnaire Factors

Learning about Environmental Science
1_____ I think that learning about nature is important.
1_____ I think that it is not important to learn about different plants and animals.
1_____ I think it is important to learn about water conservation.
1_____ I think that it is not important for me to learn about nature.
1_____ I think that learning about science can help the environment.

Interest in Nature
2_____ I do not like spending time outside in nature.
2_____ I would like to learn more about nature.
2_____ I think that working outside doing science activities is fun.
2_____ I think that learning about nature will not impact my life.
2_____ I think that learning about nature can help the environment.
2_____ I think that I will be able to use what I learn about nature in my life.

Use of Technology
3_____ I am comfortable with using technology (e.g., iPads and computers) on a regular basis.
3_____ I think that using technology is distracting.
3_____ I think it is important for me to learn how to use technology.
3_____ I think that using technology is important.
3_____ I think using technology can help me learn science.

Communication Skills
4_____ I can communicate well with other people.
4_____ I like communicating with other people.
4_____ I think communicating with other people is difficult.
4_____ I think it is important to communicate with other people.
4_____ I like when other people communicate with me.

Learning Science
5_____ I think scientific work is only useful to scientists.
5_____ I think that science is useful to my life.
5_____ I think science is interesting.
5_____ I would like to learn more about science.
5_____ I think that learning about science is important.
5_____ I think that science is too hard for me to learn.
5_____ I think that doing science activities is boring.

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