Bats and Beyond: Communicating Wildlife and Climate Change Empathy to Youth through an Electronic Field Trip

Peyton N. Beattie
Graduate Student
University of Florida
pbeattie@ufl.edu

Kevin W. Kent
Graduate Student
University of Florida
kevin.kent@ufl.edu

Teresa E. Suits
Graduate Student
University of Florida
teresasuits@ufl.edu

Dr. Jamie L. Loizzo
Assistant Professor
University of Florida
jloizzo@ufl.edu

Dr. J. C. Bunch
Assistant Professor
University of Florida
bunchj@ufl.edu

Research Type: Quantitative
Research Priority Area: Ag communications, Ag literacy

Bats and Beyond: Communicating Wildlife and Climate Change Empathy to Youth through an Electronic Field Trip

Abstract

Today's youth must take decisive action to maintain and improve the world by being environmentally literate through understanding, interpreting, and applying information and media about the environment and human interactions. Ample room exists for science communicators and educators to work together to develop real-world programs for connecting youth audiences with scientists and science research to impact environmental perceptions, attitudes, and learning. Universities, Cooperative Extension, museums, and schools can use electronic field trips (EFTs) as a vehicle to connect youth audiences to scientists globally. Sixty-four classrooms in the United States and Trinidad and Tobago participated in an EFT at the University of Florida Bat Houses with three mammalogists from the Florida Museum of Natural History. The study examined students' attitudes toward wildlife and climate change through pre/post-surveys, before and after participating in the EFT.

Introduction

Environmental communication leverages media with writing and imagery as a vehicle to educate, inform, and sometimes even persuade audiences about the environment and human relationships with the natural world. Today's youth must take decisive action to maintain and improve the world by being environmentally literate through understanding, interpreting, and applying information and media about the environment and human interactions (Roth, 1992). Environmental literacy has an established history and is often defined as a combination of scientific knowledge, problem-solving, and critical thinking for fostering and growing positive environmental behaviors and attitudes (Cole, 2007; Roth, 1992). Increasing opportunities exist for environmental communicators and educators to develop innovative programs for addressing environmental engagement and literacy in youth audiences. The American Association for the Advancement of Science's (AAAS; 2009) Project 2061 includes benchmarks such as *The Living Environment* and *The Nature of Science* with specific recommendations for introducing PK-12 youth to environmental concepts, as well as how scientists work to investigate problems and find solutions. The Next Generation Science Standards (NGSS; 2013) focus on cross-cutting concepts such as ecosystems, genetics, and global climate change. The National Research Council (NRC; 2000) suggested connecting PK-12 classrooms with the broader community to expand youth engagement and learning with a variety of concepts. Therefore, ample room exists for science communicators and educators to work together to develop real-world programs for connecting youth with scientists and science research to impact environmental perceptions, attitudes, and learning.

Literature Review

The following literature review including sub-sections about EFTs, wildlife empathy, and climate change attitudes informed the study design.

Electronic Field Trips (EFTs)

Communication and education programs can introduce youth to environmental science concepts, careers, and locations during a typical school day via online interactive technologies (Cassady et al., 2008; Garner, 2004; Tuthill & Klemm, 2002). Ideally, children should spend direct, in-person time outdoors for many physical and mental benefits, and learning about the world around them (Pate et al., 2011). While it is still highly recommended children directly engage with the environment for deep learning, in-person field trips are often not possible for schools. The cost and logistics to plan and implement traditional field trips have reduced the amount of time teachers can take students off school grounds to unique locations for studying the environment (Tuthill & Klemm, 2002). Instead, educators can leverage EFTs hosted from natural outdoor locations. EFTs can be streamed into classrooms to communicate and raise awareness about environmental issues, related STEM research, and careers (Loizzo et al., 2019).

EFTs (also sometimes referred to as virtual field trips) involve computer mediated-communication between a host location and a student site (Loizzo et al., 2019; Loizzo & Beattie, In Press). The programs can be offered in real-time (i.e., synchronous) via live, interactive web-streamed video or self-paced (i.e., asynchronous) via pre-recorded videos, websites, or virtual reality. Science communicators, educators, and scientists have developed and implemented various topics, formats, and technologies for EFTs. For instance, the Purdue zipTrips program included an EFT about animals, diseases, and genes for middle school students. The 45-minute zipTrips had an in-studio and off-site audience, live interactions with scientists, pre-recorded segments, and integrated activities. The EFTs positively impacted middle schoolers' perceptions of scientists and their research (Adedokum et al., 2011a; Adedokun et al., 2011b). The EFT examined in this study, called *Bats and Beyond*, followed a live, interactive web-streamed video format from a university field site with scientists to youth in PK-12 classrooms throughout the United States and Trinidad and Tobago. The EFT included scientists presenting their wildlife and climate change research in real-time, as well as pre-recorded images and footage of bats and international research sites.

Wildlife Empathy

Youth empathy toward environmental issues and ecosystems via an introduction to animal models can be achieved through EFTs. Research has shown visitors to informal learning spaces such as zoos and aquariums often hold pre-existing, high empathy for wildlife (Young et al., 2018). Thus, there is a need to reach youth who may not necessarily have access to or typically visit settings to learn about animals. Young et al. (2018) defined empathy as, "...a stimulated emotional state that relies on the ability to perceive, understand and care about the experiences or perspectives of another person or animal" (p. 329). It is imperative that environmental communication and education programs depicting human-animal interactions keep empathy in mind, when developing key messages and images.

Kellert (1984) found the most frequent attitude type children hold toward animals is 'humanistic' – meaning they have strong affection toward animals, mostly pets. Prior research showed introducing youth to animals can positively impact their awareness, attitudes, and empathy toward bigger picture environmental issues such as endangered species and climate change (Morgan & Gramann, 1989). Morgan and Gramann (1989) found that when a wildlife expert

demonstrated engagement with snakes, such as holding a snake for others to see and touch, people often became vicariously less fearful of the animals. Wagler and Wagler (2014) found educational activities which included live endangered spiders reduced children's (i.e., ages 10-11) fear and disgust of spiders. Hence, animal models have the potential to influence attitudes toward animals and increase human concern for how changes in the environment are impacting animals.

Climate Change Attitudes

According to the Intergovernmental Panel on Climate Change (IPCC, 2014), the current warming trend beginning in the mid-20th Century can be attributed to human activity with a probability greater than 95%. Via the Cloud and Land Elevation Satellite (ICESat) and the NASA/German Aerospace Center Gravity Recovery and Climate Experiment (GRACE), NASA (2018) recorded a .12-inch increase in sea levels since 2012, with recorded ice losses of 241.4 billion tons per year in Antarctica.

Children learn about climate change inside and outside of the classroom. Researchers have found that school-based interventions can increase climate change knowledge for children in Bangladesh (Kabir et al., 2015). The National Education Association (Flannery, 2017) advised teachers to use accurate data, local stories, cross-curricular connections, and inspiration for climate change education. Outside of the classroom, informal science learning centers (ISLCs) like zoos, museums, or libraries serve as a "safe" neutral space for visitors to learn about environmental issues and develop attitudes (Clayton et al., 2009). Humans have developed attitudes, perceptions, and beliefs about climate change. Affective (i.e., emotional), beliefs (i.e., values), cognitive (i.e., knowledge), and behavioral intentions are used to explain environmental attitudes (Christensen & Knezek, 2015). Research has shown young people form attitudes on climate change through their education and can be influenced by teacher figures. Middle school children in North Carolina reflected on their teacher's beliefs that climate change is happening, but they formed their own opinions about climate change, which differed from their teacher's (Stevenson et al., 2016). One study found science teachers' teaching styles differed on climate change, based on their political ideologies (Plutzer & Lee, 2018).

Conceptual Frameworks

Social Cognitive Theory (SCT; Bandura, 2009) and the Theory of Planned Behavior (Ajzen, 1991) were conceptually used to guide this study.

Social Cognitive Theory

SCT guided this study to inform how the vicarious learning environment (Bandura, 2009) of an EFT impacted students' attitudes toward wildlife and climate change. Additionally, the researchers examined how the participating teachers perceived the students' attitudes toward wildlife and climate change within the vicarious learning program. The environment in which a person lives and the behaviors they see modeled is how their learning is constructed, rather than construction through individual autonomy (Bandura, 1999, 2009). Therefore, a person can witness an event and use "cognitive, vicarious, self-regulatory, and self-reflective" processes to

determine how that event will shape their knowledge and behavior (Bandura, 2009, p. 95). Within this study's EFT program context, researchers used a pre-/post-survey to investigate how the students used cognitive, vicarious, self-regulatory, and self-reflective processes to adjust their attitudes regarding wildlife and climate change.

The EFT developers intentionally designed and viewed *Bats and Beyond* as a vicarious learning experience. The EFT featured scientist role models, photos, and video content that could impact participants' understanding of the specific content within the program, including bats, mammalogy and specimen curation, and climate change through a segment dedicated to each of these content areas. In turn, through vicariously viewing the role models and visual content, the EFT aimed to influence youths' wildlife empathy and climate change attitudes.

Theory of Planned Behavior

The Theory of Planned Behavior (TPB; Ajzen, 1991) also conceptually served as a lens for researchers to understand students' behavioral beliefs regarding wildlife empathy and climate change through their attitude changes before and after the EFT. TPB aimed to predict a person's behavior based on their intentions and perceived behavioral control (Ajzen, 1991). Intent to perform an action is determined by a person's internal will to want to complete such behavior. Still, that intent can also be limited by factors outside the person's control, including money, time, or skills (Ajzen, 1991). Considering a person's intrinsic motivation to perform an action coupled with a person's actual ability to perform the behavior leads to actual control of the behavior (Ajzen, 1991). Ajzen (1991) noted, "perceived behavior control, together with behavioral intention, can be used directly to predict behavioral achievement" (p. 184).

The EFT developers and scientist role models intentionally included visual and audio content discussing human impacts on wildlife/bats and the environment. Specifically, developers and scientist role models aimed to use the example of how sea level rise and climate change has impacted bats' habitats and migration patterns to impact youths' understanding of climate change and intentions to participate in conservation behaviors for improving the environment.

Purpose and Research Questions

The purpose of the current study was to investigate how an environmentally-focused electronic field trip (EFT) program produced by agricultural communication, leadership, and education graduate students impacted participating youth's wildlife empathy and attitudes toward climate change. Further, the investigation also sought to describe students' attitudes toward climate change and wildlife empathy. More specially, the following research questions guided this research study:

- What impact did participation in the EFT have on students' attitudes toward wildlife?
- What impact did participation in the EFT have on students' attitudes toward climate change?
- What were the teachers' perceptions of the impact EFTs had on students' attitudes toward wildlife and climate change?

The study aligns with multiple topics outlined in the American Association of Agricultural Education (AAAE) Research Agenda. The EFT content and research focus on youth's climate change and wildlife attitudes addressed complex problems occurring in the world, research priority area seven of the AAAE Research Agenda (Andenoro et al., 2016). Additionally, the study implemented new technologies, practices, and products to lead change in youth's attitudes about wildlife and climate change, which is a focus of research priority area two of the agenda (Lindner et al., 2016).

Methods

EFT Context

Graduate students at the University of Florida developed, implemented, and assessed the *Bats and Beyond* EFT program, as part of the fourth author's *Information and Communication Technologies* course. The eight graduate students enrolled in the course designed and delivered the EFT with the assistance of three scientists. The EFT was live and web-streamed at the bat houses on the University of Florida campus on November 15, 2018. Two sessions were offered at 2:00 p.m. and 4:00 p.m. EST. The EFT was titled *Bats and Beyond* to reflect the focus of the program's content. Three segments were included in the live webcast: (a) an overview of bats, bat houses, and mammalogy careers; (b) an inside look at the university museum's bat collections; and (c) the mammalogists' bat genetics research conducted in The Bahamas. As such, three mammalogists from Florida Museum of Natural History volunteered to assist with the EFT. The graduate student course participants included seven master's and doctoral students specializing in agricultural education, communication, leadership, and Extension and one agricultural and biological engineering doctoral student.

The Institutional Review Board for Human Subjects Research at the University of Florida approved this study. Teachers were recruited to participate in the EFT through various outlets, including (a) direct email invitation to museum teacher contact lists and agriculture teachers in Florida, (b) word of mouth via students' personal education contacts, (c) Streaming Science social media, and (d) direct email through Extension offices in Florida. Teachers registered for the EFT via the registration form and indicated their interest in participating in this research. Approved opt-out consent forms were sent home to parents to inform them of their child's participation in the EFT and anonymous research. Parents who did not wish for the child to participate had the option to sign and return the forms to school. However, no parents opted for their child to not participate.

Study Design

Researchers conducted this study using a survey design approach. Researchers analyzed a sample (i.e., two schools - School A and School B) of the population (i.e., 64 schools participating in the EFT) to understand both tangibles (i.e., demographic data) and intangibles (i.e., student and teacher attitudes; Ary, Jacobs, Sorrensen, & Walker, 2014; Creswell & Creswell, 2018). The student and teacher surveys for this study were developed using Qualtrics, an online survey platform, and disseminated to the teachers who signed up to participate in the EFT via the Qualtrics link provided through email. Teachers distributed the pre- and post-surveys to the students. The population identified for this study was all schools (n = 64) who

participated in the *Bats and Beyond* EFT. The sample for this specific study were the two schools who were classified as the intended audience for the EFT (i.e., middle and high schools) and were the two schools who completed all three surveys disseminated (i.e, the pre-survey, post-survey, and teacher survey). Thus, purposive sampling techniques were used to determine the sample for this study (Ary et al., 2014).

Participant Demographics

There were approximately 330 students from 64 elementary, middle, and high schools who participated in the live EFT webcasts. The two schools examined for this specific study were School A, and School B. School A is located on the eastern coast of central Florida. There were 738 students enrolled in School A in the 2018-2019 school year in grades 9-12 (Public School Review, n.d.). Seventy-five percent of students enrolled in School A were white, 10% of students were Hispanic, 7% of students classified themselves as two are more races, 6% of students were Asian, and 1% of students were black (GreatSchools.org, n.d.). The school-wide gender breakdown for School A was 50% female and 50% male (GreatSchools.org, n.d.). School B is located in north-central Florida. There were 948 students enrolled in School B for the 2018-2019 school year in grades 7-12 (Public School Review, n.d.). Seventy-four percent of students enrolled in School B were white, 13% of students were Hispanic, 10% were black, and 3% classified themselves as two or more races (GreatSchools.org, n.d.). Students' gender breakdown at School B was 48% female and 52% male (GreatSchools.org, n.d.). For this study, researchers analyzed School A & B, grades 8-12. Specific demographic information regarding the student participant sample are outlined in Table 1. There was one teacher from School A and two teachers from School B for three teachers included in this study.

Table 1

Demographics of Student Participants

		Pre-test (%)	Post-test (%)
Gender	Male	48.1	57.0
	Female	49.4	40.5
	Other	1.3	0
	Prefer not to say	1.3	2.5
Race	White	63.6	69.6
	Black or African American	16.9	11.4
	American Indian or Alaska Native	3.9	3.8
	Asian	3.9	2.5
	Other race	1.3	2.5
	Two or more races	9.1	7.6
	Prefer not to say	1.3	1.3
Grade	8th	1.3	1.3
	9th	62.3	55.7
	10th	29.9	38.0
	11th	5.2	3.8
	12th	1.3	1.3
Students	School A	77.9	75.9
	School B	22.1	24.1

Instrumentation

Student Survey

Students participating in the EFT were asked to participate in pre- and post-surveys. The student survey measured students' level of agreement or disagreement with 19 statements on a 7-point, Likert-type scale. Of the 19 total statements, 16 were analyzed to address the objectives of this study. Ten of the statements regarded wildlife empathy, and six statements regarded climate change. The remaining three statements were outside the scope of this study and were not analyzed. Some of the climate change statements used for this study were adapted from a climate change attitude instrument developed by Christensen and Knezek (2015). Individual item means and standard deviations are reported, thus reliability estimates were not computed because constructs were not developed. Validity is important to quantitative research to ensure the study is accurately measuring what was intended (Ary et al., 2014). Face and content validity of the instruments was determined by graduate students who were heavily involved in the production of the EFT. Face validity was determined by ensuring the questions on the instrument were relevant to the purpose and objectives of the EFT.

Teacher Survey

Teachers of the participating EFT classrooms were invited to participate in a post-survey. Forty-four statements were included in the teacher survey for the teachers to rate their level of agreement or disagreement. Seven of the 44 statements were used in the analysis of this study because of their direct relation to the students' attitudes toward wildlife and climate change. This study measured teachers' level of agreement or disagreement using seven items on a 7-point, Likert-type scale.

Data Analysis

All objectives of the study were analyzed using descriptive statistics. Individual mean scores and standard deviations were reported for each of the statements included in this study. The original values for the Likert scales were recoded to reflect a 1 to equal strongly disagree and a 7 to equal strongly agree, as the inverse scale was used in the survey. The values were re-coded to increase understanding of the results presented below. The following real limits of the scale were used to interpret the recoded mean scores and standard deviations: 1.00 – 1.49 = *strongly disagree*, 1.50 – 2.49 = *disagree*, 2.50 – 3.49 = *somewhat disagree*, 3.50 – 4.49 = *neither agree nor disagree*, 4.50 – 5.49 = *somewhat agree*, 5.50 – 6.49 = *agree*, 6.50 – 7.00 = *strongly agree*.

Limitations

A limitation of the pre-survey and post-survey design used in this study is the duration between the pre and post-survey not being adequate time to demonstrate larger mean differences regarding students' attitude change. The nature of this exploratory study and the small sample size does not allow for the results and conclusions of this study to be generalized to everyone who participated in the EFT but rather only explains what occurred in students' attitudes and perceptions of the teachers from School A and School B.

Results

RQ1. What impact did participation in the EFT have on student's attitudes towards wildlife?

Students' highest mean score regarding their attitude toward wildlife for both the pre-survey (M = 5.05, SD = 1.39) and post-survey (M = 5.32, SD = 1.17) was it is important that scientists study bats (see Table 2). The more negative attitude, indicated by the lowest mean score, students reported for both the pre-survey (M = 3.27, SD = 1.54) and post-survey (M = 3.27, SD = 1.63) was related to bats are pests.

Table 2

Student Attitudes toward Wildlife Before and After the EFT

	Pre (n = 77)		Post (n = 79)	
	M	*SD*	*M*	*SD*
It is important that scientists study bats.	5.05	1.39	5.32	1.17
Scientists are working on ways to protect bats.	4.97	1.17	5.23	1.21
Bats are important to agriculture.	4.95	1.49	5.22	1.26
I like learning about agriculture.	4.82	1.62	4.75	1.35
I like learning about bats.	4.73	1.50	4.60	1.52
Bats are cute.	4.56	1.92	4.48	1.84
I can help protect bats.	4.35	1.52	4.36	1.54
I am concerned about bats.	4.32	1.58	4.46	1.34
Scientists should leave bats alone.	3.82	1.47	3.95	1.35
Bats are pests.	3.27	1.54	3.27	1.63

Note. Real limits of the scale: 1.00 – 1.49 = *strongly disagree,* 1.50 – 2.49 = *disagree,* 2.50 – 3.49 = *somewhat disagree,* 3.50 – 4.49 = neither *agree nor disagree*, 4.50 – 5.49 = *somewhat agree,* 5.50 – 6.49 = *agree,* 6.50 – 7.00 = *strongly agree*

RQ2. What impact did participation in the EFT have on student's attitudes toward climate change?

The students reported a more positive attitude regarding the item bats are important to our environment for both the pre-survey (M = 5.39, SD = 1.59) and the post-survey (M = 5.58, SD = 1.17; see Table 3). A lower mean score regarding I believe human activity does not cause climate change was reported by the students for both the pre-survey (M = 3.30, SD = 1.81) and post-survey (M = 3.29, SD = 1.77).

Table 3

Student Attitudes toward Climate Change Before and After the EFT

	Pre (n =77)		Post (n = 79)	
	M	*SD*	*M*	*SD*
Bats are important to our environment.	5.39	1.59	5.58	1.17
I believe human activity causes climate change.	5.05	1.65	4.96	1.75
I like learning about the environment.	4.97	1.57	4.75	1.37
Climate change is causing problems for bats on our planet.	4.72	1.30	4.79	1.29
I can help prevent climate change.	4.31	1.57	4.26	1.49
I believe human activity does not cause climate change.	3.30	1.81	3.29	1.77

Real limits of the scale: 1.00 – 1.49 = *strongly disagree*, 1.50 – 2.49 = *disagree,* 2.50 – 3.49 = *somewhat disagree,* 3.50 – 4.49 = neither *agree nor disagree*, 4.50 – 5.49 = *somewhat agree,* 5.50 – 6.49 = *agree,* 6.50 – 7.00 = *strongly agree*

RQ3. What did the teachers perceive the impact of participating in the EFT had on students' attitudes?

The teachers' perceptions regarding the students' attitudes was the most positive related to I encourage wildlife empathy in my class/program (M = 6.67, SD = .58; see Table 4). The lowest mean score reported by the teachers was regarding my students are concerned about bats (M = 4.33, SD = .58).

Table 4

Teacher Perceptions of Students' Attitudes toward Wildlife and Climate Change (n = 3)

	M	*SD*
I encourage wildlife empathy in my class/program.	6.67	.58
I discuss climate change concepts in my class/program.	6.67	.58
The EFT increased my students' understanding of the role bats play in the ecosystem.	6.00	1.00
My students are concerned about the environment.	5.67	1.15
My students are concerned about climate change.	5.33	.58
My students knew about bats before the EFT.	4.67	.58
My students are concerned about bats.	4.33	.58

Real limits of the scale: 1.00 – 1.49 = *strongly disagree*, 1.50 – 2.49 = *disagree,* 2.50 – 3.49 = *somewhat disagree,* 3.50 – 4.49 = *neither agree nor disagree,* 4.50 – 5.49 = *somewhat agree,* 5.50 – 6.49 = *agree,* 6.50 – 7.00 = *strongly agree*

Conclusions and Discussion

Wildlife Attitudes

The students maintained a consistent attitude about wildlife before and after the EFT and indicated they somewhat agreed, neither agreed nor disagreed, or somewhat disagreed with nine of the ten statements regarding wildlife empathy. The students' attitudes towards bats are pests were consistently the most negative and indicated they somewhat disagreed with the statement before and after the EFT.

The participating students' attitudes regarding the statement bats are cute moved in a negative direction according to the real limits of the scale between pre-survey and post-survey. The research team discussed this finding and attributed this negative direction in attitude to the pictures of bats and pinned bats exhibited throughout the EFT program. The EFT program exposed the students to what "real" bats look like, whereas students may have only had idealized images of bats in their minds before the EFT program. Some of the bat images the students viewed throughout the EFT are presented in Figure 1.

Figure 1. A picture of a live, real bat taken by one of the participating mammalogists and a picture of a pinned bat collection taken by a graduate student shown to students throughout the EFT program.

Teachers somewhat agreed their students knew about bats before the EFT. However, the teachers neither agreed nor disagreed that their students were concerned about bats. The teachers strongly agreed wildlife empathy is encouraged in their class/program, and they discuss climate change concepts in their class/program. The students and teachers who participated in the *Bats and Beyond* EFT neither agreed nor disagreed the students were concerned about bats. Kellert (1984) discussed programs could not solely entertain with animals to have an impact. The findings from this study and Kellert's (1984) statement indicates a need for children to have prolonged interactions with animals and the environment for deeper learning. Young et al. (2018) confirmed that empathy is a complicated construct, which takes time and multiple interactions to grow.

Climate Change Attitudes

The students' attitudes toward climate change remained consistent before and after the EFT. The students' attitudes toward the presented climate change statements ranged from somewhat disagree, neither agree nor disagree, or somewhat agree. The students had the most negative attitude regarding I believe human activity does not cause climate change and indicated they somewhat disagree before and after the EFT. Teachers somewhat agreed their students are

concerned about climate change, and the teachers indicated they discuss climate change in their class/program.

The results of the study indicated students who participated in the *Bats and Beyond* EFT from School A and School B agreed that bats are essential to the environment after the EFT. Similarly, the teachers who participated in the EFT from School A and School B perceived the EFT increased their students' understanding of the role bats play in the ecosystem. Understanding the importance of an animal (i.e., bats) to the environment supports Thompson and Gullone's (2003) research, which reported a positive and statistically significant relationship between humans and how they treat animals and, ultimately, the environment. Additionally, this finding aligns with Wagler and Wagler's (2014) research that specified animal models positively influence attitudes towards animals and increase concern for how changes in the environment impact animals. The implementation of EFTs has repeatably shown positive impacts for youth audiences. EFTs are important to the agricultural communication field because of its unique position to engage with youth audiences in a dialogue around complex agricultural and natural resources issues rather than just developing content to be passively received by youth audiences. However, Streaming Science's EFTs are in their infancy, and the team has established a number of recommendations for practice and research to ensure EFTs are continuously increasing impacts with youth audiences around agricultural and natural resources topics.

Recommendations

Research

Future iterations of the EFT experience could better utilize the question and answer portions of the program to not only respond to questions from youth, but to also ask youth to respond to evaluation-type questions in real-time, such as (a) What do you think is the most important finding of this research?, (b) How do you feel about bats?, and (c) What are some ideas you have for protecting the environment? In-depth analysis of supplemental materials teachers use in the classroom before and/or after the EFT could be conducted to understand the impact of supplemental materials on student learning outcomes. Researchers could also observe a classroom participating in the EFT and observe the same classroom not participating in the EFT to understand how teachers interact, discuss, and teach climate change and wildlife empathy, as compared to the scientists. There are opportunities to determine if EFTs impact other audiences besides youth (i.e., adults) and impactful with different types of content (i.e., developing complex solutions to complex problems rather than just engaging in dialogue around complex problems). Lastly, can an EFT be developed and hosted that has larger impacts on its audience than previously determined. More substantial impacts include concepts other than attitude, knowledge, and opinions and are geared more toward behavior change and developing complex solutions.

Practice

There is a potential for EFTs to raise awareness and support factual learning (Adedokun et al., 2011a; Adedokun et al., 2011b; Cassady et al., 2008; Stoddard, 2009). However, to impact student attitudes toward wildlife, science communicators and educators should provide supplemental materials or wrap-around experiences to prolong engagement with wildlife and

reinforce learning and attitudes. This supplemental material and wrap-around experiences provide an opportunity for Streaming Science to expand their EFT programs by developing such materials or experiences for teachers to use with students. The additional materials should accompany the lessons to ensure that students are interacting with the material for wildlife empathy to be achieved (Young et al., 2018). Additionally, Streaming Science could develop an online community of practice for participating teachers to share content or lessons they have created and taught to add to teachers' collections of resources. A community of practice for teachers participating in EFTs could open up a dialogue about STEM issues, communication and education strategies, build relationships, and answer questions regarding EFTs for implementation support and best practices.

References

Andenoro, A. C., Baker, M., Stedman, N. L. P., & Weeks, P. P. (2016). Research priority 7: Addressing complex problems. In T. G. Roberts, A. Harder, & M. T. Brashears (Eds.), *American Association for Agricultural Education national research agenda: 2016-2020.* Department of Agricultural Education and Communication. http://aaaeonline.org/resources/Documents/AAAE_National_Research_Agenda_2016-2020.pdf

Adedokun, O. A., Parker, L. C., Loizzo, J., Burgess, W. D., & Robinson, J. P. (2011a). Factors influencing participant perceptions of program impact: Lessons from a virtual fieldtrip for middle-school students. *Journal of Extension, 49*(6). https://www.joe.org/joe/2011december/a8.php

Adedokun, O., Parker, L. C., Loizzo, J., Burgess, W., & Robinson, J. P. (2011b). A field trip without buses: Connecting your students to scientists through a virtual visit. *Science Scope, 34*(9), 52-57. http://www.jstor.org/stable/43184161

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179–211. https://doi.org/10.1922/CDH_2120VandenBroucke08

American Association for the Advancement of Science [AAAS]. (2009). *Project 2061: Benchmarks for science literacy*. http://www.project2061.org/publications/bsl/online/index.php

Ary, D., Jacobs, L. C., Sorensen, C., & Walker, D. A. (2014). *Introduction to research in education* (9th ed.). Wadsworth Cengage Learning.

Bandura, A. (1999). Social cognitive theory: An agentic perspective. *Asian Journal of Social Psychology, 2*, 21–41. https://doi.org/10.1111/1467-839X.00024

Bandura, A. (2009). Social cognitive theory of mass communication. In J. Bryant & M. B. Oliver (Eds.), *Media effects: Advances in theory and research* (3rd ed.). https://doi.org/10.4324/9780203877111

Cassady, J.C., Kozlowski, A. & Kornmann, M. (2008). Electronic field trips as interactive learning events: Promoting student learning at a distance. *Journal of Interactive Learning Research*, *19*(3), 439-454. https://www.learntechlib.org/primary/p/24187/

Clayton, S., Fraser, J., & Saunders, C. D. (2009). Zoo experiences: Conversations, connections, and concern for animals. Zoo Biology, 28, 377-397. https://doi.org/10.1002/zoo.20186

Christensen, R. & Knezek, G. (2015). The climate change attitude survey: Measuring middle school student beliefs and intentions to enact positive environmental change. International Journal of Environmental & Science Education, *10*(5), 773-788. https://doi.org/ 0.12973/ijese.2015.276a

Cole, A.G. (2007). Expanding the field: Revisiting environmental education principles through multidisciplinary frameworks. *Journal of Environmental Education*, *38*(2), 35-44. https://doi.org/ 0.3200/JOEE.38.1.35-46

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage.

Flannery, M. E. (2017). *5 ways to teach about climate change in your classroom*. News and Features from the National Education Association. http://neatoday.org/2017/03/14/teaching-about-climate-change/

Garner, L. C. (2004). *Field trips and their effect on student achievement in and attitudes toward science: A comparison of a physical versus virtual field trip to the Indian River Lagoon* [Doctoral dissertation, Florida Institute of Technology]. Proquest. https://search.proquest.com/docview/305101767?pq-origsite=gscholar&fromopenview=true

GreatSchools.org. (n.d.). *Find a great school*. https://www.greatschools.org

Intergovernmental Panel on Climate Change (IPCC). (2014). Climate change 2014 synthesis report summary for policymakers. Retrieved from https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf

Kabir, M. I., Rahman, M. B., Smith, W., Lusha, M. A., & Milton, A. H. (2015). Child centered approach to climate change and health adaptation through schools in Bangladesh: A cluster randomized intervention trial. *PLOS One*, *10*(8), https://doi.org/10.1371/journal.pone.0134993

Kellert, S. R. (1984). Attitudes toward animals: Age-related development among children. In M.W. Fox & L.D. Mickley (Eds.) *Advances in animal welfare science*. The Humane Society of the United States.

Lindner, J. R., Rodriguez, M. T., Strong, R., Jones, D., & Layfield, D. (2016). Research priority 2: New technologies, practices, and products adoption decisions. In T. G. Roberts, A.

Harder, & M. T. Brashears (Eds.), *American Association for Agricultural Education national research agenda: 2016-2020.* Department of Agricultural Education and Communication. http://aaaeonline.org/resources/Documents/AAAE_National_Research_Agenda_2016-2020.pdf

Loizzo, J. L. & Beattie, P. N. (In Press). Self-study of a project-based graduate science communication course focused on electronic field trip development. *North American College Teachers Association Journal*.

Loizzo, J. L., Harner, M. J., Weitzenkamp, D. J., & Kent, K. (2019). Electronic field trips for science engagement: The Streaming Science Model. *Journal of Applied Communications (103)*4. https://doi.org/10.4148/1051-0834.2275

Morgan, J., & Gramann, J. (1989). Predicting effectiveness of wildlife education programs: A study of students' attitudes and knowledge toward snakes. *Wildlife Society Bulletin*,*17(*4), 501-509. http://www.jstor.org/stable/3782720

National Research Council (NRC)(2000). How people learn: Brain, mind, experience, and school: Expanded edition. The National Academies Press. https://doi.org/10.17226/9853.

NGSS Lead States. (2013). *Next generation science standards: For states, By states.* The National Academies Press.

Pate, R. R., Mitchell, J. A., Byun, W., & Dowda, M. (2011). Sedentary behaviour in youth. *British Journal of Sports Medicine*, *45*(11), 906-913. http://dx.doi.org/10.1136/bjsports-2011-090192

Plutzer, E., & Lee Hannah, A. (2018). Teaching climate change in middle schools and high schools: Investigating STEM education's deficit model. *Climatic Change*, *149(*3-4), 305-317. http://dx.doi.org/10.1007/s10584-018-2253-8

Public School Review. (n.d.). *Welcome to public school review*. Retrieved from https://www.publicschoolreview.com

Roth, C. (1992). *Environmental literacy: Its roots, evolution and directions in the 1990s*. ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Stevenson, K. T., Peterson M. N., Bradshaw A. (2016). How climate change beliefs among U.S. teachers do and do not translate to students. *PLOS One*, *11*(9). https://doi.org/10.1371/journal.pone.0161462

Stoddard, J. (2009). Toward a virtual field trip model for the social studies. *Contemporary Issues in Technology and Teacher Education*, *9*(4), 412-438. https://www.learntechlib.org/p/28305/

Thompson, K. L. ., & Gullone, E. (2003). Promotion of empathy and prosocial behaviour in children through humane education. *Australian Psychologist*, *38*(3), 175–182. https://doi-org.lp.hscl.ufl.edu/10.1080/00050060310001707187

Tuthill, G., & Klemm, E. B. (2002). Virtual field trips: Alternatives to actual field trips. *International Journal of Instructional Media*, *29*(4), 453-468. https://www.questia.com/library/journal/1G1-97173049/virtual-field-trips-alternatives-to-actual-field

Wagler, A. & Wagler, R. (2014). Arthropods and the current great mass extinction: Effective themes to decrease arthropod fear and disgust and increase positive environmental beliefs in children? *International Journal of Environmental and Science Education*, *9*, 197-214. https://doi.org/ 10.12973/ijese.2014.211a

Young, A., Khalil, K. A., & Wharton, J. (2018). Empathy for animals: A review of the existing literature. *Curator*, *61*(2), 327–343. https://doi-org.lp.hscl.ufl.edu/10.1111/cura.12257