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Electronic Field Trips for Science Engagement: The Streaming Science Model

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Electronic Field Trips for Science Engagement: The Streaming Science Model

Abstract

While institutions of higher education work to engage PK-12 youth in STEM (science, technology, engineering, and mathematics) concepts and careers via in-person programming, PK-12 teachers and students face many logistical and access constraints for physically traveling to sites off of school grounds during the school day. Throughout the years, electronic field trips (EFTs) have offered a digital way for schools to engage in meaningful ways with museums, parks, laboratories, and field research sites. In order for EFTs to be effective, they should be cost effective and created collaboratively with teachers, students, subject matter experts, and instructional design and communication professionals. Streaming Science is an online science communication platform that aimed to develop and implement an effective EFT model. Three Streaming Science live interactive EFTs webcasted online were piloted from various locations during 2017-2019 to test wireless internet connections, mobile technologies, STEM content, and impacts on students' interest, attitudes, and learning. The model proved iPads and mobile applications in the field for web streaming were effective for connecting scientists with school audiences. In this professional development article, authors describe the Streaming Science EFT model, including recommendations for instructional design, the pre-production process, content development, teacher collaboration, student engagement, mobile hardware and software, and assessment.

Keywords

Science, STEM, mobile, electronic field trip, science communication, online engagement, distance education, Streaming Science

Cover Page Footnote/Acknowledgements

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Introduction

Cooperative extension systems, museums, and universities have a history of leveraging field site visits, fairs, and tours for in-person public audience engagement with science topics, contexts, and careers (Brooks, Hart, & Church, 2009; Karr-Lilienthal, Pegg, Brink, & Raymond, 2014; Shaby, Assaraf, & Tal, 2017). More than 100 U.S. colleges and universities have a land-grant mission that includes teaching, research, and public engagement through on and off-campus college courses and Extension programming (USDA, n.d.). Extension specialists and university scientists often visit schools to deliver educational programming, or they host workshops and camps at local offices or on campuses (Laursen, Liston, Thiry, & Graf, 2007; Myers, 2012). However, face-to-face engagement and learning is not always feasible given various constraints, such as funding, travel time, concerns about safety, and other logistics (Tuthill & Klemm, 2002). As an alternative, electronic field trips (EFTs) have emerged as a way to extend scientific research, information, and programming to a variety of informal, non-formal, and formal audiences (Cassady & Mullen, 2006). Additionally, EFTs provide access to locations that teachers and students typically are not allowed to physically visit, such as protected research labs and field sites or locations too far to visit in a school day.

EFT offerings have grown in tandem with the increase of internet accessibility, video streaming devices and services, and affordability. One EFT format includes a live-streamed video broadcast from a field location to one or multiple sites (Cassady, Kozlowski, & Kornmann, 2008; Stoddard, 2009). While the terms virtual and electronic are often used interchangeably when it comes to technology-mediated field trips, EFTs differ from augmented and virtual field trips in that EFTs often allow the participants to engage in a two-way conversation with experts, while augmented and virtual approaches are fully immersive 360-degree video and graphical experiences with multi-dimensional, immersive environments where participants can can view and navigate the environment with headsets and handheld controls (Huang, Rauch, & Liaw, 2010; Thompson, Krienke, Ferguson, & Luck, 2018). EFTs have proven effective in increasing youth's interest in STEM (science, technology, engineering, and math) and awareness of the nature of science and the scientific inquiry process, as well as changing youth's perceptions of scientists and science careers to include more diverse representations (Adedokun, Parker, Loizzo, Burgess, & Robinson, 2011a, 2011b).

Due to a plethora of video production hardware, software, and online hosting site options, there are numerous ways for science communicators and educators to create and deliver an EFT with various levels of interactivity. A range of production techniques exist for offering EFTs, including one-to-one connections from programs, such as Skype in the Classroom (n.d.) or Skype a Scientist (n.d.), to larger-scale television broadcasts such as EFTs from the National Park Foundation (n.d.) or the former Purdue zipTrips program (Purdue Today, 2011). The following professional development article aims to introduce the Streaming Science model for mobile, cost effective, and replicable EFTs connecting agricultural and natural resource scientists and extension educators with middle and high school students in classrooms and after school programs. The production process, live content format, equipment descriptions and examples from three of the program's EFTs, as well as replication recommendations and future program directions, are presented in the subsequent sections. Overall, examples of successful EFTs are provided as inspiration for others to consider this approach for introducing students to places, topics, and ways of working they might not otherwise experience.

Instructional Design and Pre-Production Process

The Streaming Science EFT production process includes a blend of video production and systematic instructional design (ID) for content development. The first and most important step is to work directly with subject matter experts (SMEs) and teachers to ensure EFT topics are relevant, timely, and of interest to students. It is imperative to survey teachers for content suggestions, along with evaluating current and upcoming university STEM research and Extension programming for identifying overlapping teaching and learning priorities. From there, scheduling the EFTs also should be determined by school calendars, scientists', and Extension specialists' availability. It is important EFTs are not scheduled during standardized testing times and instead scheduled during points of the school year when teachers have some flexibility in curriculum and daily routines.

Developers should keep in mind the grade levels an EFT will target and typical schedules for those grades. For instance, early childhood (second grade and younger) learning periods are usually 20 minutes long, while elementary youth classes are approximately 40-minutes, and middle and high school class times range from 40-50 minutes. While some teachers are willing to deviate from daily bell schedules and gather in community school spaces for EFTs, others prefer to participate during regularly scheduled class periods. Hence, EFTs should be offered at multiple times during the day to accommodate the variety of timing challenges. To date, Streaming Science EFTs are usually offered at two times such as 10 a.m. and 2 p.m. for all in-school audiences or 2 p.m. and 4 p.m. to also include after-school programs. However, the timing variable is still under experimentation due to the variety of school and scientist scheduling accommodation needs.

Once topics, subject matter experts (SMEs), and schedules are set, the pre-production video work begins. The Streaming Science model aims to include visual interest within the EFT beyond simply views of scientists explaining their research. Hence, EFT producers begin meeting with SMEs to: 1) learn about their research, 2) develop a draft script of talking points reinforcing identified education standards and learning objectives, and 3) capture and edit photos and videos that bring to life the researchers' contexts and scientific inquiry steps. Concurrently, schools and after school programs are recruited to participate via direct email, social media, and media releases. Teachers register to participate in the EFT via a Google Form on the Streaming Science website. An email list of teachers is established from the registration form for sending updates and reminders before and after the EFT.

A Teacher's Guide is developed based on middle and high school Next Generation Science Standards (NGSS; n.d.), an effort across multiple states to develop and implement the same science learning benchmarks, and relevant state science education standards so that teachers can easily see how the EFT fits their curriculum and can be implemented in their setting. The guide also provides a program synopsis, specific learning objectives connected to the EFT content, suggestions for wrap-around lessons and activities, the web link for connecting to the program, and suggestions for how to play the program on classroom projectors, smartboards, and student laptops. The Streaming Science EFT model also includes pre- and post-assessment of participating middle and high school students' attitudes toward and content knowledge of the EFT subject presented, STEM career motivation and interest, and overall perceptions of their EFT experiences. A post-teacher survey provides feedback about teachers' experiences implementing the EFT, content alighnment and age appropriateness with grade level and curriculum, the quality of the content and video stream, and suggestions for future delivery formats and topics.

EFTs also provide an opportunity for project-based science communication teaching, learning, and research. One or two science communication undergraduate students supported development and implementation of the beginning Streaming Science EFTs by assisting in teacher

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recruitment, website and learning materials creation, video production, and assessment. Additionally, undergraduate students of the SMEs collaborated with science communication students on scripting content and participating in on-camera interviews within an EFT.

Hardware and Software

EFT production is now very cost effective thanks to accessible wi-fi services, mobile hardware, mobile applications, and affordable video streaming sites. The Streaming Science EFT model is designed to transport the participants via technology to scientists' and Extension specialists' real-world laboratories and field sites. Table 1 outlines the hardware and software Streaming Science uses.

Table 1

Production hardware and software used for Streaming Science live EFTs

Hardware	Software
iOgrapher Backpack	Adobe After Effects
iOgrapher Case	Adobe Photoshop
iPad(s)	Adobe Premier Pro
iRig Mic Lav	Big Lens (app)
Multi Use Tripod	DSLR Camera (app)
Samson Go Mic Mobile Digital Wireless System	FiLMic Pro
Sunshade for iPad	iPad Camera
Verizon MiFi JetPack	iTunes File Sharing
	Speedtest
	Switcher Studio
	UStream TV

The most crucial part of the delivery technology is to identify and establish a quality web streaming network. Streaming Science producers work with SMEs up to three months before an EFT to scout relevant and visual locations for going live. It is imperative to examine cell tower and signal range maps and to test Internet signal strength with a mobile application such as Speedtest (https://www.speedtest.net/apps) for determining download and upload rates. Recommended video sizes and audio rates can vary depending on bandwidth availability. It is critical to run a test stream from the field to potential viewing sites to ensure the quality is clear, audible, and stable. More rural and remote areas may lack signal strength, and video may not stream in full-quality high definition. However, teachers and students are often forgiving of video quality because their enthusiasm for engaging with the SMEs, seeing the locations, and learning the content often outweighs their streaming quality expectations. Streaming Science has used a Verizon MiFi JetPack 6620L for connecting to cellular service in the field and to link mobile video production devices together within their own network to prevent outside devices from bogging down the streaming speed. The weather also can slow or stop a webcast from a field site, due to fog, rain, clouds, etc. blocking the signal.

Traditional video cameras connected to elaborate Ethernet streaming carts can be expensive and clunky for hiking through outdoor science research sites where hardwired Internet is often unavailable. Therefore, mobile wifi, tablet devices, and smart phones make video streaming possible from a variety of locations, as well as cheaper to produce. Streaming Science

EFT producers use iPad multimedia kits for pre-production video/photo shoots and live online broadcasting. For pre-recorded video, producers use iPads coupled with cases, microphones, lights, and tripods from the iOgrapher (https://www.iographer.com/) mobile multimedia company, along with the built-in iPad camera application switched to the video setting or the FiLMic Pro (https://www.filmicpro.com/) application for more advanced video recording features such as aperture, focus, zoom, and audio monitoring. Apps such as DSLR Camera and Big Lens provide advanced features and filters for mobile photography. EFT producers also can edit video and photos via Adobe Creative Cloud's mobile apps, including Premier Rush, Spark, and the Photoshop/Lightroom mix. Streaming Science EFT producers also export media such as still photos, videos, and animations from the iPads and other sources to the desktop Adobe Premier Pro, Photoshop, and After Effects software for more in-depth, multi-layered, and fine tune editing that sometimes is not possible via the mobile apps. However, the mobile video editing apps are ideal for quick, in-the-field production work.

Once a rough script and pre-produced photos and videos are complete, videos are exported as an .m4v file format and loaded onto iPads via iTunes file sharing, along with photos. The media is then organized within the Switcher Studio app (https://www.switcherstudio.com/) for playback during the live EFT. Switcher Studio also can run Internet speed tests to ensure acceptable streaming quality. The app ultimately enables a set of iPads to operate much like a control room connected to and switching between media and studio cameras. One iPad functions in 'director mode' and can connect via Internet Protocol (IP) addresses to up to nine additional mobile devices in 'camera mode'. The director iPad can then switch between photos, videos, graphics, and devices in camera mode. Therefore, a scientist can appear on screen and talk to the viewers, or video, photos, and other media can play as the scientist describes the content. Switcher Studio can then stream to a variety of sites such as Facebook, YouTube, Periscope, and more. The hosting site must generate a real-time messaging protocol (RTMP) address that is then entered into the app. Feedback from teachers indicated many schools often block social media sites. Therefore, Streaming Science broadcasts via the UStream TV / IBM Watson Media (https://video.ibm.com/) streaming service. However, if a school has also blocked UStream, it is recommended to work with school technology specialists to adjust firewalls. UStream channels include options for viewer interactivity such as a chat box function or connection to Twitter. Streaming Science utilizes the chat function for participating students to type and send in questions to SMEs in real-time. Students also can vote for one another's posts, and questions can be sorted by votes and time received.

Live Stream Content Format and Crew Roles

The Streaming Science EFT content format is similar to that of the former Purdue zipTrips program, as the lead author previously worked on the project, and the format was successfully developed with a teacher advisory board, piloted, and implemented with schools throughout the country (Purdue Today, 2011). The EFT follows a live 45-minute interactive one-to-many web-broadcast format with content chunked into three ten-minute segments with a five-minute question and answer break between each segment (Table 2).

Table 2

Live EFT content format and timing

Activity	Run Time (minutes)
Introductions / Segment One	10

Question and Answer One	5
Segment Two	10
Question and Answer Two	5
Segment Three	10
Question and Answer Three / Wrap-Up	5
Question and Answer Continued	10-15
Sign-Off	5

Many schools only can commit to connecting for 45-minutes due to schedule constraints. However, teachers who arrange to fully adopt the EFT experience often gain administrator approval to adjust the daily schedule and allow students to remain online for further engagement with the SMEs. Most teachers project the webcast to a screen or via a white board to the front of their classroom, similar to Figure 1. Some allow their students to use laptops or mobile devices to submit questions, while other teachers prefer students to write out their questions and the teacher then submits the question online (Loizzo and Ertmer, 2014).

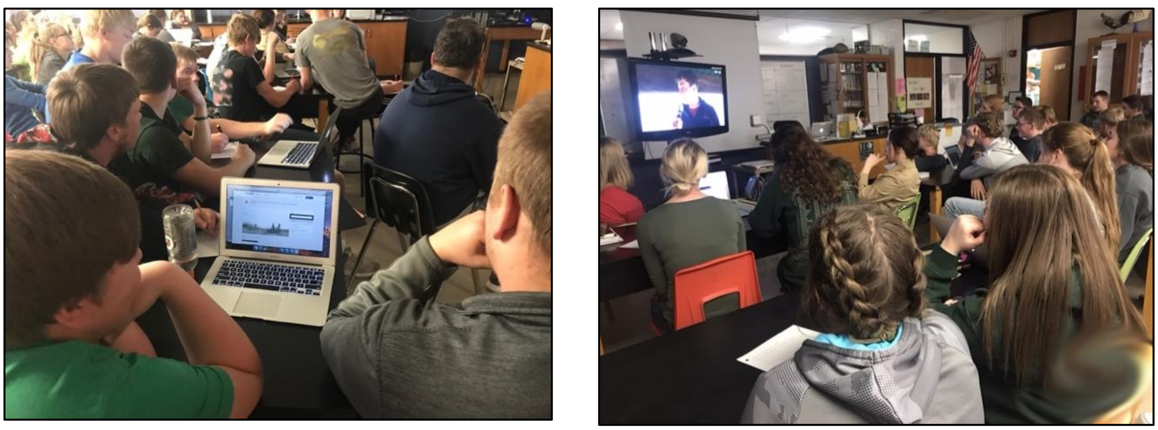

Figure 1. High school students in Nebraska view an electronic field trip (EFT) and submit questions to subject matter experts (SMEs) in real-time.

Behind the scenes, the size of the Streaming Science live broadcast crew has varied from three to up to eight members operating the equipment and facilitating the question and answer segments. Figure 2 depicts a Streaming Science technology, SME, and behind the scenes crew configuration. It would be possible to have only one person serve as the director and sole camera person. Ideally, there should be at least three crew members to operate multiple iPads for a variety of camera shots and angles, a floor director for tracking time, and one to two people monitoring, sorting, and asking students' questions. Typically, the same science communication student who assisted in pre-production and instructional design steps served as the on-air host(ess) for interviewing SMEs and transitioning between scientists. The goals are for the college-aged host(ess) to serve as the bridge between the participating middle and high school students and the SMEs, guide the flow of content to match outlined learning objectives and standards, and to ask clarifying and follow-up questions about scientific terminology and processes.

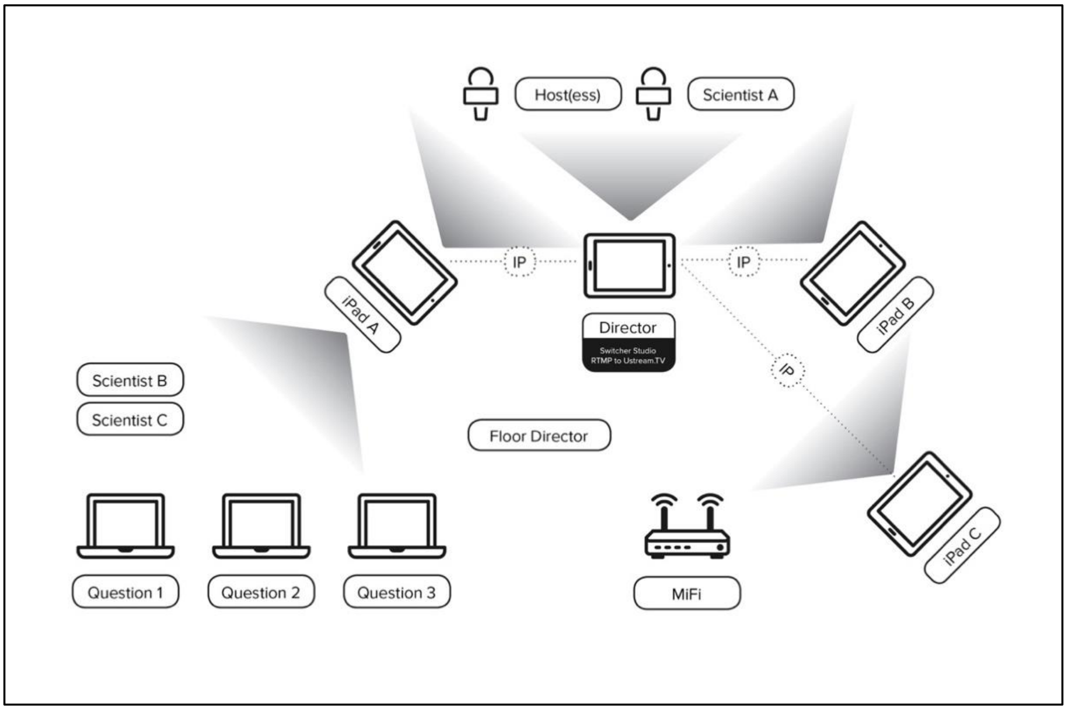

Figure 2. Diagram of the mobile technology used and crew configuration for 2016-2018 Streaming Science electronic field trips (EFTs).

Example Streaming Science EFT Contexts

From 2016-2018, Streaming Science collaborated with funders, SMEs, and science communication students to test and develop its mobile EFT model. Overview information is outlined below about the context of each EFT, including partnerships, content, and reach.

Ranches, Rivers, and Rats (2017 & 2018)

- Funder: University of Nebraska Food for Health Collaboration Initiative, with support from Nebraska EPSCoR
- Partners: Platte Basin Timelapse
- SMEs: University natural history and aquatic scientists
- Location: Calamus Outfitters – a working cattle ranch in the Sandhills of Nebraska
- Content: Nebraska Sandhills and ranching, water resources and water cycle, biodiversity, kangaroo rat research, and STEM careers
- Engagement:
    - 2017 (pilot): 7 schools, 114 student questions submitted for SMEs
    - 2018: 14 schools, approximately 47 questions submitted

- Assessment Focus: Sandhills exposure, biodiversity, water cycle and ecosystem interaction drawings, environmental attitudes, STEM interest and nature of science

Figure 3. Behind the scenes photos of crew members and SMEs operating iPads and reviewing student submitted questions for the ‘Streaming Science: Ranches, Rivers, and Rats’ 2017 EFT from Calamus Outfitters in the Nebraska Sandhills.

Sun Rays and Windy Days (2017)

- Funder: Nebraska Extension Innovation Seed Grant
- Partners: Nebraska Extension, UNL Department of Biological Systems Engineering, and UNL Department of Agricultural Leadership, Education, and Communication
- SMEs: Extension energy specialist and Extension youth education specialist
- Location: solar panel array at university animal science building
- Content: alternative energy sources – solar and wind, Extension opportunities for youth
- Engagement: 7 schools and home schools, 82 questions submitted
- Assessment Focus: STEM interest, nature of science, and careers

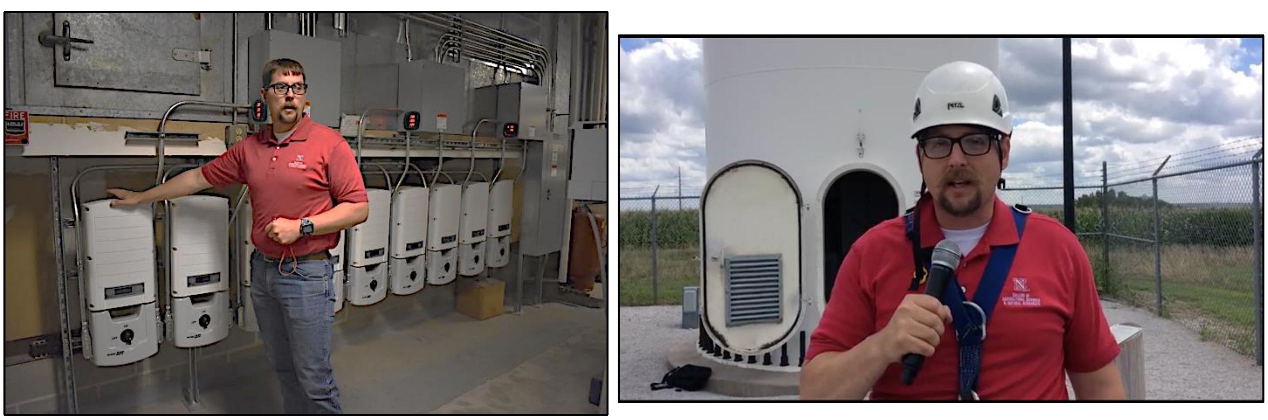

Figure 4. In the ‘Streaming Science: Sun Rays and Windy Days’ 2018 EFT, John Hay, UNL Biological Systems Engineering Extension Educator introduced participants to the solar panel system in the university’s animal science building and the inside of a wind turbine owned and operated by the Lincoln Electic System.

Bats and Beyond (2018)

- Partners: Florida Museum of History and Natural Resources and UF Department of Agricultural Education and Communication
- SMEs: museum mammologists and doctoral student
- Content: university bat houses, bats empathy, museum collections, Bahamas bat research, and climate change impacts
- Location: campus bat houses
- Engagement: 98 views, 45 concurrent views, and 57 unique views across Florida, Louisiana, Oklahoma, New Mexico, Maine, Texas, and Trinidad and Tobago, 84 questions submitted
- Assessment Focus: wildlife empathy, climate change attitudes, and STEM interest

Figure 5. In the 'Streaming Science: Bats and Beyond' 2019 EFT, Dr. David Reed, Dr. Verity Mathis, and doctoral student Lauren Hammer work with agricultural communication graduate students to introduce participants to the university bat houses, museum collections, and bat research in the Bahamas.

As each Streaming Science EFT is offered, the instructional design and production processes continue to be adjusted and modified. It is imperative to continually stay in contact with schools, to survey teachers and students for feedback, make content improvements, and adapt to new technologies as they develop.

Lessons Learned and Replication Recommendations

Science communication professionals, scientists, and Extension specialists could easily replicate the Streaming Science EFT model in a variety of settings and contexts by using the instructional design steps, video production processes, live webcast content format, technology, and assessment approaches outlined in this article. There is also much room to adjust the scale of the model, format, and delivery technologies used. While teachers are often quick to register for the Streaming Science EFTs, live views, teacher post-survey results, and YouTube views show a majority of them view the recording with their students at a later date so as to play portions of the program within their regular class schedules. However, for the schools that do connect, the teachers and students truly implement the experience as if it were an actual field trip and highly engage in the webcast. Hence, there is an opportunity to continue to explore teachers' implementation choices, the timing of the EFTs, and expanding offerings to after school programs and clubs with more flexible schedules.

Additional observations, lessons learned, and recommendations from the first three Streaming Science EFTs include: 1) the importance of establishing close partnerships with SMEs, teachers, and students for successful development and implementation; 2) the need to support teachers' efforts to address national and state science standards, as well as clear direction and help for using technology in the classroom; 3) the recognition that Internet access and mobile technologies are constantly changing - EFT program creators should follow updates from app developers and streaming companies; 4) the observation that middle and high school students are quick to engage, and it can be challenging to keep up with the pace of their interactivity during live EFTs; 5) the need for EFT content to be expanded to include wrap-around student activities to scaffold learning, specifically for follow-up after the program; and 6) the ways that EFT assessments may be thoughtfully designed to discover insights into students' interest, content knowledge, attitudes, along with student and teacher feedback for future programs.

Future Directions

The Streaming Science project aims to expand partnerships and school collaborations for continued EFT offerings and engagement in agricultural and natural resource topics. While grant funding can provide immediate resources, a sustainable funding model needs to be identified over time. In regards to leveraging EFTs within a project-based learning model for teaching science communication, students should be fully incorporated into project development and implementation to learn about non-formal science education, video production, science communication and evaluation. A graduate-level project-based learning instructional technology course with EFT development as the focus was recently piloted at the University of Florida. Graduate students followed the Streaming Science model and created the 'Bats and Beyond' EFT. Results about the students' and SMEs experiences and learning will be shared in a future presentation and publication. Future points of development and research for Streaming Science EFTs also include developing a smaller 'Scientist Online' one-on-one engagement with schools, expanding the larger model to include after school programs, potentially testing EFTs with adult learners, developing citizen science wrap around activities for middle and high school students to create and upload multimedia projects to the Streaming Science platform, and mobile video training and instructional design guidelines for Extension specialists to create localized EFTs. As institutions of higher education aim to investigate and apply interactive digital approaches for extending science information to public audiences, EFTs are an evolving and replicable approach for reaching learning and engagement goals. Overall, this article provides one model that may continue to be researched and expanded upon to grow education, research, and Extension programming to increase connections between scientists, educators, and students and foster science interest, learning, and literacy.

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