SPAN:
Student-Produced Audio Narratives

Problem Statement

The geosciences (and sciences in general) face a severe shortage of graduates in both numbers and diversity, impacting the U.S. government, industry, and educational system. Large, introductory courses serving non-STEM majors are valuable recruitment opportunities for increasing numbers of geoscience majors. This project will access these large, diverse groups of students by implementing an innovative, accessible, and timely curricular approach, focused on changing the students' perception of STEM and its relevance to their lives. Student-Produced Audio Narratives (SPAN) are assignments in which students engage with the geosciences by telling a scientific story using simple audio recording and production techniques. SPAN assignments are ideally suited to the challenges of introductory courses, such as large classes, minimal laboratory materials/access, and limited faculty support, especially in underserved programs. The proposed project uses a regional pilot study to examine how effective this relatively simple change to introductory course assignments can be in changing the way students perceive STEM topics in general, and geosciences specifically, in their own lives.

Project Purpose:
The U.S. needs more geoscientists, and greater diversity in the STEM workforce, but recruiting new geoscience majors is difficult. Therefore, we propose a simple but effective curricular change in large, introductory courses - substituting a student-produced audio narrative assignment in place of a standard course assignment. This new pedagogical technique has the potential to positively impact students' perceptions of science and increase their engagement with the learning environment.

Objectives:

1. Develop a collaborative regional network of faculty to design and implement student-produced audio narratives in their introductory-level classes, especially at two-year community colleges.
2. Create, implement and test flexible, adaptable assignments using student-produced audio narratives.
3. Research the impact of student-produced audio narratives on students' engagement and learning environment using novel educational research methods.

The focus of the IUSE Engaged Student Learning track is "*design, development, and research studies that involve the creation, exploration, or implementation of tools, resources, and models that show particular promise to increase engagement of undergraduate students in their STEM learning and lead to measureable and lasting learning gains."* This proposal *explores* and *implements* the *tool* of student audio production, *develops* an *implementation model* though a Partner Faculty network, and *measures* the *learning* outcomes using mixed methods to research students' perception of and *engagement* in science.

Motivation

> *Luis, a first-year student in Introduction to Geology, is taking the class to fulfill a science requirement. He does not think geology is particularly relevant to his life, but it seems interesting, and he is willing to give it a try. Partway through the semester his class is given an unusual assignment: each student will create an audio story, similar in structure to a podcast episode, about some aspect of the local watershed. Luis lives near a playground that has a quiet creek running through it, so he uses his mobile phone to record the sound of the water. Tracing the local topographic maps in his lab manual, he discovers there is a small dam a few miles upstream, so he heads to the dam and records the sound of the water above and below the dam. In his podcast, he talks about the differences along the stream between the dam and his neighborhood park. Other students work on such topics as the local water-treatment plant, fossils in the local bedrock that erode out in stream banks, and the boundary of the 200-year floodplain. In the end, the class seems much more relevant to his life than he expected, and he talks to his professor about taking another geology class next semester....*

Luis has just experienced first-hand the immediacy and intellectual connection that are often byproducts of engaging in the process of audio production. In creating an audio piece, even someone with little or no audio-storytelling experience can come to find the subject more real and personally relevant; this adds perspective and nuance to content learned from books and lectures.

Does Luis's experience matter? It turns out that in the geosciences, it may matter a great deal. In the coming decades, Geoscience related fields are facing a critical shortage in both the size and diversity of their workforce (Wilson, 2016). Since one-third of future geoscience majors pick their major either in community college or during their first year of a 4-year college, the experience of students in introductory classes where there are large numbers of students from diverse backgrounds is important (Wilson, 2016). However, faculty members who teach introductory courses, particularly those at two-year community colleges (2yCCs) and other underserved institutions, have limited resources and staff.

In this project, we will make it possible for faculty teaching such courses to engage students more deeply in geoscience and other STEM topics, increasing the likelihood that the students will ultimately choose more advanced study in these fields. In order to accomplish this goal, we will use one of the oldest and most powerful educational methods: narrative (Olsen, 2015). In collaboration with Partner Faculty, we will develop highly flexible curriculum assignments in which students create audio narratives on topics related to their general-education geoscience classes[1]. This pilot will test the hypothesis that introductory students who create audio narrative assignments will view geoscience topics as more personally relevant.

[1] This proposal uses AGI Workforce Report definition of Geoscience from Appendix A, geology, hydrology, planetary science, marine science/oceanography, atmospheric and space sciences, climate science, geochemistry, petrology, paleontology, environmental sciences and related fields (Wilson, 2016)

The importance of Introductory Students

The sciences need to expand recruitment efforts. A recent report by the President's Council of Advisors on Science and Technology forecasts a shortage of one million STEM graduates in the workforce in the next decade (President's Council of Advisors on Science and Technology, 2012). This is particularly true within the geosciences, where by 2026 there is predicted to be a shortfall of nearly 90,000 graduates to fill jobs created by growth and retirement turnover (Wilson, 2016). So this proposal focuses on introductory courses generally populated by non-geoscience majors. Exit surveys of geoscience majors reveal that nearly one-third of geoscience majors choose their major as a result of an early experience either in community college or the first undergraduate year (Wilson, 2016). If we can change an early-career student's view of geoscience, we can possible change their major and future career trajectory.

Nationally, 2yCC train 45% of all undergraduate students and many students take introductory-level geoscience courses to satisfy general-education requirements while enrolled in 2yCCs (Wilson, 2016; National Science Board, 2014). The growth in the number of students who become interested in the geosciences during 2yCC and pursue an undergraduate geoscience degree (from 14% in 2013 to 19% in 2015) shows the importance of reaching out in these types of introductory courses for increasing the number of scientists. Students who begin at a 2yCC and then transition to a BS geoscience program identified "their personal motivation to a bachelor's degree" as a key motivator in completing their degree (p 17, Wilson 2016). Capturing the interest and enhancing the motivation of these introductory students is important for recruiting more geoscience majors.

In addition, the diversity of geoscience graduates is not keeping pace with the population or with that of other STEM fields (Gonzales and Keane, 2011). Students enrolled in introductory courses often have greater diversity than typical geoscience majors, particularly those in 2yCC programs. For example, nationwide, underrepresented minorities (URM) comprise approximately 40% of the enrollment at 2yCCs, compared with 25% in 4 year colleges (Wilson, 2016 and National Science Board, 2014). Ultimately, only 11% of bachelor geoscience degrees in 2015 were awarded to URM (Wilson, 2016). These types of discrepancies indicate that the current curricular approach is not recruiting and retaining diverse students.

However, reaching introductory students is not easy. Geoscience faculty teaching introductory courses, particularly at 2yCCs, face challenges such as: difficulty providing research, field, and laboratory experiences; isolated faculty; and students' limited exposure to geoscience careers and opportunities (Wilson 2014). Nearly 40% of 2yCC faculty are 'lone wolves'—the only geoscientists at their institutions—and 40% of 2yCC faculty teaching geosciences are only part-time (Wilson, 2016).

In addition, the geosciences in particular have struggled with outreach and recruiting in minority communities (Gonzales and Keane, 2011). Experiences such as field courses, place-based experiences (in which students explore or solve problems their local community) and undergraduate research, while proven to be effective, are difficult to implement in many general education introductory courses. The reality for most faculty who teach general education, introductory courses involves large lecture halls, few or no teaching assistants and little teaching budget. Students are often juggling multiple jobs,

are first-time college students, and/or are taking care of a family. Weekend-long field trips and after-hours undergraduate research is not a feasible option for a large number of these students. However, given the established importance of early experiences and courses for students who might choose a major, and potentially a career, in geoscience, it is important to reach these first- and second-year students. Implementing a curriculum with high-impact pedagogies, such as those recommended in the President's Council of Advisors on Science and Technology (PCAST) 2012 report, specifically addresses student engagement and learning in introductory courses.

Why Audio?

Given the variety of media available, it is reasonable to ask why this project focuses on development of audio-production projects (instead of video production, for example, or production of flash-based animation). Members of the PI team have found that including audio-production projects in our own classes enables us to engage students in new and powerful ways, and to reach students who might otherwise never see the relevance and importance of the subject matter to their own lives (Epstein *et al.,* 2010a; Kraal and Regensburger, 2013, Guertin, 2012). Other faculty have had similar experiences. For example, research finds that student-created audio podcasting is an excellent medium for establishing connections in isolated college populations (Lee and Chan, 2007). Audio production can inspire students from many backgrounds to engage in their education (Campbell, 2005). Audio assignments can easily incorporate place-based experiences; community-college faculty have noted that place-based work in general is particularly effective in connecting with the diverse populations in their courses (Riggs, Houlton, and Granshaw, 2009).

Further, the argument for instructional practices that make use of multimodal representations of content has been well established in the literature (Dhingra 2008; Lundby 2008; O'Neill and Calabrese-Barton 2005; Robin 2006; Robin 2008). This research asserts that student-produced digital media cultivates a sense of ownership over the content learned, resulting in increased engagement with the learning environment. Audio assignments such as those incorporated in this project may have the capacity to encourage students' critical thinking and discourse as society moves to new media and communication technologies (Deal, 2007).

In fact, audio has a number of unique qualities that suit it particularly well to a project reaching out to students in underserved programs:

- **Low barrier to entry:** With only a small amount of equipment, even just their own mobile phones, students can immediately begin producing audio of surprisingly high quality. No attention need be paid to lighting, visual background and other elements, as is the case in video production. Audio files are also small enough to be transferred and manipulated easily.
- **High ceiling to achievement:** Even given the low barrier to entry, audio production is still a craft that rewards persistence and hard work, and it is characterized by development of expertise over time.
- **Novelty:** Most students have produced papers, given presentations, taken short videos, perhaps even created websites. Very few of them have engaged in audio storytelling, and so they are not bound by their prior experience and expectations.

- **Appeal:** Today's students surround themselves with audio experiences, and the opportunity to become producers, as well as consumers, of audio is appealing to them. In 2016, nearly 21% of Americans older than 12 had listened to a podcast within the last month, and that number increases annually (Pew Research Center, 2016). 'Downloading podcasts' is also one of the key internet activities across all age demographics (Zicluhr, 2010).

Members of the project team have extensive experience incorporating audio-project assignments into geoscience classes in a wide variety of contexts and styles (e.g. Epstein *et al.,* 2010a, 2010b; Kraal and Regensburger, 2013, Guertin 2012). These projects demonstrate some of the multiple ways in which audio production can inspire students from diverse backgrounds. The PI team, in close collaboration with Partner Faculty, is well equipped to bring this innovative curriculum approach to introductory courses at both 4 and 2yCC geoscience faculty and classrooms.

Audio projects can change the learning environment

The overall goal of SPAN is to change the learning environment so that students feel an increased personal connection to STEM, particularly in the geosciences. To accomplish this we will work with faculty in a regional pilot to create audio-production assignments that can easily be integrated into their introductory or general-education classes. We will then assess how the assignments influence the students' learning outcomes, such as their attitudes towards STEM topics and the relevance of STEM/geoscience to their lives and careers.

Our implementation model is collaborative and iterative (see Table 1). During the fall semester of the first project year, we will conduct two one-day workshops, bringing together Partner Faculty in order to teach them both technical and storytelling aspects of audio production and to help them craft audio assignments tailored to their own classes. Between workshops, the group will communicate via online meetings, and Partner Faculty will also share drafts of audio assignments they have created for comment and critique. During a winter workshop, SPAN personnel and Partner Faculty will work to finalize each partner's audio assignment(s) and deal with any technical issues that may have arisen. Faculty will use the assignments in their spring-semester classes, and then the group will reconvene for a two-day workshop in the summer, in order to assess results and adapt assignments going forward. Partner Faculty will then use audio assignments in both fall and spring semesters of the second project year, during which we will hold in-person workshops, along with online meetings as appropriate, in order to continue aiding Partner Faculty and to maintain the overall collaboration. Throughout the process, faculty and students will participate in a variety of assessments designed to measure the program's effectiveness. The program will be adapted in response to early assessment results. Final assessment results will be published and disseminated widely.

Our proposal hypothesizes that students who participate in a SPAN assignment will be positively impacted with regard to their perception of science. We hypothesize that students will see STEM topics in general, and geosciences in particular, as more relevant and accessible after completing SPAN assignments. We further hypothesize that these assignments are a useful pedagogical approach to integrate into course curriculum to increase engagement of students in general-education and introductory courses.

Table 1: Grant Timeline

Fall 2017	
Training Workshop #1 (1 day)	Objectives: *Held at Kutztown University* - Introduce team - Basics of sound gathering and editing - Audio narrative techniques
Online collaboration	Partner Faculty will practice making and editing their own audio projects and share with colleagues
Faculty Training Workshop #2 (1 day)	Objectives: *Held at Kutztown University* - Scaffolding student assignments - Curriculum development - Partner Faculty draft SPAN assignments
Online collaboration	Partner Faculty will develop and share their SPAN assignments for colleagues' comments
Winter 2018	
Faculty Training Workshop #3 (1 day)	Objectives: *Held at Penn State Brandywine* - Final revision of SPAN assignments - Assessment overview
Spring 2018	
Implementation	Partner Faculty teach their courses and implement the SPAN assignments. Pre/Post assessment by PI team.
Online collaboration	Monthly online meetings to discuss implementation.
Summer 2018	
Collaboration Workshop (2 days)	Objectives: *Held at Kutztown University* - Share SPAN assignment results - Evaluate using assessment data - Adapt curriculum assignments based on assessment
Fall 2018	
Implementation	Partner Faculty teach their courses and implement the SPAN assignments. Pre/Post assessment by PI team.
Online collaboration	Monthly online meetings to discuss implementation.
Winter 2019	
Collaboration Workshop (1 day)	Objectives: *Held at Penn State Brandywine* - Compare outcomes from each semester and between different assignments. - Adapt curriculum assignments based on assessment
Spring 2019	
Implementation	Implementation of revised assignments. Pre/Post assessment by PI team.
Online collaboration	Monthly meetings to discuss implementation.
Summer 2019	
Collaboration workshop (2 days)	Objectives: *Held at Kutztown University* - Evaluate assignments with final assessment data - Overall comparison of assignments from within and across courses. - Group reflection and analysis of assessment data. - Prepare meeting abstracts and presentations.
Meeting presentations	All PI's and Partner Faculty will travel conferences to present results, experiences, and assignments.

The project will have a number of deliverables:

- Tested audio assignments created for a variety of geoscience classes and curriculums that could be adapted by faculty at other institutions for their classes.
- Assessment results detailing the benefits and possible complications of introducing student-produced audio assignments into introductory and general-education classes.
- Papers and presentations created by SPAN personnel and Partner Faculty, for use in disseminating knowledge gained through this project and broadening the influence of this innovative educational approach.

Work Plan

Objective 1: A Regional Partner Faculty Network
Develop a collaborative regional network of faculty to design and implement student-produced audio narratives in their introductory-level classes, especially at two-year community colleges.

To rapidly and inexpensively initiate this pilot project builds a Faculty Partner Network (focused on the mid-Atlantic region)—with all partners in driving distance of the Philadelphia area. To facilitate collaboration with all-team meetings, training, and evaluations as events held at either Kutztown University or Penn State Brandywine (each within an hour drive from Philadelphia) or as virtual meetings. This will build a close, collaborative network while minimizing travel cost and focusing grant funding on the classroom implementation though Partner Faculty compensation, evaluation, and dissemination beyond the initial pilot group.

This proposal is based on a team of Faculty Partners who collaborate to design, develop and implement of SPAN assignments within their own existing course curriculum. They will represent a diverse ranges of the geosciences courses and institutions from the Mid-Atlantic region. These institutions have already expressed interest in participating as Partner Faculty - The City College of New Jersey, Rutgers University, Harrisburg Area Community College, Montgomery County Community College, and Delaware Valley Community College. Ultimately 6 faculty will participate. Through the workshop training (described below), Faculty Partners will design and implement SPAN assignments within their regular courses, participate in revisions of their individual assignments, and contribute to the evaluations/assessment. Faculty Partners will receive semester stipends of $750 or a course buy-out (according to their preference and rules of their individual institutions). Each will also receive a $200 workshop support kit (books, pedagogical resources, auxiliary audio equipment to integrate with mobile devices, and technology to facilitate curriculum development and collaboration). In addition, they will receive travel stipends to all SPAN meetings and a $2,000 stipend to attend a national meeting to present their own results at the conclusion of the pilot. This work plan minimizes overhead and paperwork for Partner Faculty while supporting their professional development and contributions.

Objective 2: SPAN Assignments
Create, implement and test flexible, adaptable assignments using student-produced audio narratives.

For effective, widespread implementation, the SPAN assignments must be easily deployable in different courses. This pilot program works with Faculty Partners to develop assignments appropriate for their course curriculum and integrate assessment for the educational research component (described in Objective 3 below) into the process. Faculty will not be creating new content or courses, rather they will be employing a new pedagogical technique to use the tool of audio as an assignment within their existing courses. The geoscience content objectives of a SPAN assignment (for example learning about the water cycle, identifying rocks and minerals, climate science) is at the full discretion of the individual faculty.

It is worth noting that incorporating any novel assignment requires classroom time, and these SPAN assignments are no exception. Many instructors include projects (papers, posters, field trip reports, and presentations) to support the content and objectives of their courses. Most of these projects require instructional time (e.g. how to narrow a topic, appropriate referencing, revising drafts, and components of an effective poster) and all represent student time working on an assignment. Among our project goals is to make student-produced audio assignments available to more instructors in a variety of courses and to probe existing evidence that they represent a particularly powerful and engaging pedagogy.

For example, a Natural Hazards class might traditionally include a paper on a specific natural hazard or location. If an instructor chooses to replace this with an audio project, the students could produce simulated public service announcements (PSAs). In a PSA, the information must still be researched and accurate, but rather than simply writing an essay about it, the information must be transitioned to public communication. To create an effective PSA, students could incorporate sounds, script dramatic roles, or even interview geoscience experts – all with the goal of communicating accurate geoscience information about a natural hazard. The content objectives are similar (understand a natural hazard, its relationship to geology, and possible public responses), and either assignment would require preliminary assignments and secondary skills instruction. However, the student experience of creating an audio piece is different, and potentially more engaging. Indeed, as described in Objective 3, this project is specifically devoted to rigorously examining these effects in geoscience courses.

Table 2: Examples of a variety of audio-production assignments

Example Assignment	Description
Audio Collage	Sound-rich assemblage of quotes and in-situ audio on a single topic (e.g. tides, plate boundaries, sea-level change, mineral extraction, water rights).
Workforce Exploration	Interview-style exploration of geoscience careers as they relate to the content of the course, perhaps created as “profiles” of local geoscience professionals.
Public-Service Announcement	Creative announcement on topic in which the content of the course is relevant to public issues.
Documentary	Assignment that could take the place of a typical term paper. Detail- and reference-rich audio stories.
Science “Minute”	Short, content-based piece focused on communicating specific information.
Place-Based Exploration	Detailed exploration of geoscience features of local relevance.

We anticipate a wide variety of assignments – from short, compact experiences to longer, extensive projects. Table 2 highlights some examples of directions that SPAN assignments could take. We will disseminate the assignments by uploading them to a site such as SERC Starting Point, which focuses on introductory courses. Because this is a two-year pilot, part of this project is to determine the best dissemination approach using Partner Faculty and assessment results.

Today, the technology for recording audio, such as interviews, ambient sounds or a script, is easily available. Almost any mobile device – smart phone, iPad, tablet, or computer – can record sound, with no special equipment required. Similarly, audio-editing software, such as GarageBand and Audacity, is available free of charge. For a modest price, it is possible to obtain auxiliary equipment to record and produce sound with extremely high quality. As with any medium, deliberate instruction, practice and revision are required for effective use.

The goal of this project is ***not*** to produce a wide array of audio productions for public broadcast. Geoscience topics are intricate and can require extensive expertise to explain to general audiences, and so it would be unreasonable to expect non-specialist, lower-level undergraduates to be able to take on this task. Rather, the central idea is to engage students in the ***process*** of audio production on geoscience topics, in order to enhance their personal connection to the field. These audio-project assignments are intended to be a complement to other coursework, such as papers, tests and presentations. Based on past PI experience, an undergraduate student will occasionally produce an audio work of extremely high quality, both in production values and—importantly—in the accuracy and completeness of its content. For those rare cases, there are mechanisms for instructors to distribute pieces, but again, such pieces are not the focus or intended outcome of this project.

Objective 3: Educational Research Assessment
Research the impact of student-produced audio narratives on students' engagement and learning environment using novel educational research methods.

Integral to this pilot program is the embedded, mixed-methods evaluation of the SPAN project. The overarching educational research questions are:

- How do SPAN assignments impact students' perceptions of their learning environment and their attitudes toward STEM topics? And specifically, what is the impact of components such as narrative and place-based experiences in students' perceptions and attitudes?

- What are specific obstacles and opportunities for students and faculty related to these types of experiences, and how can they inform future changes?

To test these questions, we will employ a mixed-method evaluation approach integrated throughout the pilot. Our approach includes a validated student questionnaire and semi-structured key-informant interviews. Please note, Partner Faculty will be responsible for evaluating the course and content objectives independent from this assessment. This project does not evaluate the audio assignments independently. Evaluating content delivery and audio-assignment quality are not addressed as an aspect of this study. Rather, we focus on the student response to instruction.

Questionnaire Assessing Connections to Science (QuACS)

The PI Team (lead by educational researcher Sirrakos) has already developed and validated the Questionnaire Assessing Connections to Science (QuACS), (Kraal and Sirrakos, 2016). The purpose of the QuACS is to assess the impact of place-based learning and student narrative activities in terms of students' perceptions of the classroom learning environment and their attitudes toward science. The QuACS was field-tested during March/April 2016 using a sample of 495 undergraduate students who were enrolled in an introductory-level science course. The 495 students were sampled from nine classrooms across five institutions of higher education. The preliminary version of the QuACS consisted of seven scales each with 7 items, for a total of 49 items. Data analyses supported the factor structure and internal consistency reliability for a refined version of the QuACS consisting of six scales: *Personal Relevance, Innovation, Future Intentions to Study Science, Self-Efficacy in Science, Scientific Storytelling,* and *Place-based Learning*. For the two learning environment scales of Personal Relevance and Innovation, all items were retained. For the five attitude scales, the optimal factor structure emerged for a refined version in which (1) all of the 14 items in the two originally-separate Self-Efficacy scales (*Science Self-Efficacy* and *Communicating Scientifically*) came together to form a single Self-Efficacy scale and (2) two items from Place-Based Learning were removed because they did not meet the factor analyses criteria. (GSA and submitted citation) Table 3 provides a summary of the structure of the QuACS along with associated sample items.

This questionnaire is uniquely designed to assess changes in learning environment perceptions and students' attitudes as a result of including place-based learning and scientific storytelling (narrative) activities in introductory-level science courses at colleges and universities. In addition, studies have found that today's college students acquire and process information very differently from the previous generation of college students (National Survey of Student Engagement, 2013). This shift has prompted researchers to explore the impact of educational innovations to enhance student engagement, attitudes, and perceptions of the learning environment (Aldridge & Fraser, 2008; Zandvliet & Fraser, 2005). However, Fraser (2007, p.112) asserts that "Despite the potential value of evaluating educational innovations and new curricula in terms of their impact on transforming the classroom learning environment, only a relatively small number of such studies have been carried out around the world." With the QuACS's development, researchers will have an additional tool from which to select, thus encouraging more research involving the evaluation of educational innovations.

For this project, quantitative data will be collected through pretest and posttest administrations of the QuACS. The PIs will distribute the questionnaire to Partner Faculty for administration. It is expected that the questionnaire will be administered near the start of the semester (pretest) and again near the semester's conclusion (posttest). Each administration of the QuACS will take approximately 15 minutes to complete. The PIs will consult with Partner Faculty prior to each administration of the questionnaire to remind them of the established protocol for administering the questionnaire. Data collected from the pretest and posttest will be analyzed to reveal any significant pretest-posttest differences. A Kutztown University graduate student, under the supervision of PI's Kraal and Sirrakos, will process the returned questionnaires. Data analyses results will be made available to Partner Faculty at the conclusion of each semester in order to evaluate, revise, and modify SPAN assignments where appropriate. These assessments

track the students' *perceptions and attitudes* as influenced by the SPAN assignment; the faculty will independently evaluate of the students' understanding or mastery of the geoscience content.

Table 3. Summary of QuACS

Scale	Source	Description	Sample Item	Number of Items
Personal Relevance	CLES (Taylor & Fraser, 1991)	The extent to which school science connects with students' out-of-school experiences.	This course provides me with a better understanding of the world outside school.	7
Innovation	CUCEI (Fraser & Treagust, 1986)	The extent to which the instructor utilizes a variety of new activities, teaching techniques, and assignments.	New and different ways of teaching are used in this class.	7
Future Intentions to Study Science	TOSRA (Fraser, 1981) MATS (Hillman, Zeeman, Tilburg, & List, 2016).	The extent to which students indicate their intentions to study science in the future or pursue a science-related career.	I intend to study science in the future.	7
Self-Efficacy in Science	SATS (Aydeniz & Kotowski, 2014) Some items newly developed by researchers.	The extent to which students believe that they can be successful in science and communicate scientific information to others.	I am confident I can do well in this science course.	14
Scientific Storytelling	Not Applicable (Newly developed by researchers)	The extent to which students believe that scientific storytelling assists them in making connections to science.	Combining scientific information from several sources into a story is an interesting way to learn science.	7
Place-based Learning	Not Applicable (Newly developed by researchers)	The extent to which students believe that the local community is a good source of science learning.	The local community is a useful resource for learning science.	5

Data collected from the pretest and posttest will be analyzed to reveal any significant pretest-posttest differences. Pretest-posttest differences will be analyzed using descriptive statistics, a Multivariate Analysis of Variance (MANOVA) with repeated measures, an Analysis of Variance (ANOVA), and a calculation of effect sizes to indicate

the magnitude of pretest–posttest differences with significance being determined at $p<0.05$.

Interviews

In addition to the quantitative data, we propose the collection of qualitative data through semi-structured key informant interviews. A key informant interview explores the views of a small number of Individuals who have particular knowledge about the matter being investigated. Further, conducting the interview using a semi-structured format provides the flexibility of basing questions on themes rather than using a set of rigid questions. This freedom will allow the interviewer to shape questions to the particular context of the interview and the individual being interviewed (Lindlof & Taylor, 2011). Essentially, these interviews will support the quantitative survey data and explore the 'how' and 'why' of students' perceptions and attitudes.

These interviews will be conducted via video conference or telephone. The interview questions and themes are guided by the grant's purposes and intended outcomes. The interviewer will approach each interview with the following questions as possible starting points:

- Did you enjoy completing the audio-production assignment? Why?
- How did completing the audio-production assignments impact your attitudes toward geoscience/STEM?
- What do you perceive as the advantages and limitations of using audio-production assignments in learning science?

As suggested by Morgan (1997), these questions will likely be followed up with more questions asking students to provide specific examples. Follow-up questions will add greater texture and detail to interpretations of the quantitavie data.

For each semester of implementation, we propose selecting three students from each of the six classes, for a total of 18 interviews. Given the number of interviews, we anticipate collecting about 10 hours' worth of interview data each semester. An hour of interview data takes approximately four hours to transcribe and four hours to code. Therefore, the total time needed to transcribe and code a semester's worth of interviews is about 80 hours. We are planning for three semesters of implementation with student interviews being conducted during each round. Thus, the entire interview process will take approximately 270 hours (30 hours for data collection, 120 hours for transcribing, and 120 hours for coding). The interviews will be conducted and coded by the KU graduate student under the supervision of PIs Kraal and Sirrakos. Qualitative data collected from the interviews will be analyzed using content analysis to identify common themes among the responses. NVivo software will be used for qualitative data analyses.

We will quantitatively and qualitatively evaluate the impact of SPAN assignments on students, determine the role of narrative and place-based experiences, and identify challenges and opportunities for future expansion and implementation. This will generate new knowledge on the role of audio assignments as well as narrative and place-based experiences within science courses. This research can inform not only our SPAN assignments, but also other curricular development.

Project Outcomes

The project will have multiple important outcomes in areas including individual students, Partner Faculty, introductory courses, the field of geosciences, and STEM educational research:

- Audio assignments created for a variety of geoscience classes and settings, which could be shared and adapted by faculty at other institutions for their classes.
- Increased number of engaged introductory students from diverse populations who may be more likely to choose geosciences or other STEM fields as majors.
- Faculty development focused on engaging introductory students, particularly focused on supporting 2yCC faculty and underserved populations, supporting Partner Faculty publication and presentations.
- Assessment results detailing the benefits and possible complications of introducing student-produced audio assignments into introductory and general-education classes.
- Educational research using a new, validated survey of students' perceptions of science that can be applied with media projects, narrative projects, and/or place-based learning.

Broader Impacts

This project contributes to the creation of a larger and more diverse future geoscience workforce by empowering faculty teaching introductory courses to engage traditionally underserved students in geoscience fields. By developing a new approach to utilizing a curricular tool in the geoscience classroom (student-produced audio narrative assignments), and providing faculty development for implementation, the pilot project will impact over 900 introductory science students. The innovative curriculum will reach many more students through dissemination and continuation at partner colleges. Analysis of these audio assignments using a mixed-methods approach will provide crucial tools and information related to media-based educational programming. In addition, the newly validated survey and the application to a large curricular study will be of great value to educators seeking to develop media assignments and/or assess the impact of narrative and place-based experiences in STEM introductory courses.

Project Personnel

Dr. Erin Kraal (Kutztown University of Pennsylvania) Dr. Kraal will serve as the lead PI on the project, coordinating the Partner Faculty, Co-PIs and evaluation. She will coordinate the workshop and collaboration meetings, oversee budgeting and stipends, distribute assessment materials, and maintain collaboration among the entire grant team. Dr. Kraal is an associate professor in the Physical Sciences Department, which has a significant first-generation college population and an undergraduate-only geology major. She has integrated audio production into her large general-education course for the past 5 years, involving over 600 students in the development of "Telescopic Topics," co-produced with KUR, the on-campus radio station. She is a Geoscience Counselor for the Council on Undergraduate Research, and a campus leader in the freshmen experience through summer 'jump start' programs and living-learning communities.

Dr. Ari Epstein (Massachusetts Institute of Technology) Dr. Epstein will co-lead the training workshops, focusing on audio production and narrative. He will also advise Partner Faculty during implementation. Epstein developed and teaches "Terrascope Radio," a class in which students produce high-quality radio pieces on topics relevant to earth-science and environmental issues. Terrascope Radio productions have been heard by tens of thousands of listeners across the U.S. Epstein also developed and directed the award-winning Terrascope Youth Radio (TYR) program, an NSF-funded outreach program in which urban teens, mentored by MIT students, created audio on environmental topics. TYR-produced work has been heard by tens to hundreds of thousands of listeners.

Dr. Laura Guertin (Penn State Brandywine) Dr. Guertin will co-lead the training workshops. She is a professor of Earth science at Penn State Brandywine, a two-year feeder campus in the university system. She has been involved in undergraduate research, pedagogies involving technology (including audio) and faculty development at 2-year colleges on multiple funded projects. For several years, her non-science majors in her introductory-level Earth science courses have generated podcasts, many which have been added to the Pennsylvania Earth Science Teachers Association (PAESTA) podcast series. Dr. Guertin has served as a councilor in the National Association of Geoscience Teachers and continues with the Geoscience Division of the Council on Undergraduate Research. She blogs about geoscience education, educational technology, and science communication for the American Geophysical Union at GeoEd Trek (http://blogs.agu.org/geoedtrek/).

Dr. George Sirrakos (Kutztown University of Pennsylvania) Dr. Sirrakos, a faculty member in KU's College of Education, will lead the project's integrated educational-research program. Dr. Sirrakos will develop evaluation instruments and guide the use of the results of data analysis to inform the iterative aspects of the project. Dr. Sirrakos has experience in carrying out mixed-method research designs to assess students' perception of their learning environment and their attitudes toward science. He also has experience in developing and field-testing learning-environment and attitude questionnaires.

Results from prior NSF support

Results of Dr. Epstein's prior NSF support include the creation and operation of Terrascope Youth Radio (TYR), which has become a major influence in the spread of STEM-oriented programming throughout the U.S. youth-radio community.
(a) NSF Award #DRL-0714655; $716,676; 8/15/2007-7/31/2013
(b) Title of project: Terrascope Youth Radio
(c) Completed work:
Intellectual Merit:
In this project urban teens, mentored by MIT undergraduates, have created "a wealth of radio programming and other audio pieces" (Gareis *et al.,* 2012). Accomplishments include:
Producing nationally distributed, hour-long specials on teens and the environment, consisting entirely of youth-produced content.
Creating a wide variety of STEM-oriented radio/audio pieces of high quality, including pieces listed in Generation PRX's annual "Best Youth-Made Radio" compilations for 2010, 11 and 12.
Working with Northeast Public Radio to create a series of "Clearwater Moments," broadcast to tens of thousands of listeners during the network's afternoon news programming.
Collaborating with local Cambridge and Boston institutions to produce "green audio tours" of the City of Cambridge, Boston Children's Museum and other local sites.

Broader Impacts:
This project reaches out to a traditionally underserved community, empowering members to tell STEM-related stories in their own voices to their own peers. It has created a new, readily replicable model for a STEM-oriented youth program and for university-community collaboration. Accomplishments include:
Inducing other youth-radio programs to produce content on STEM-related topics.
Training dozens of teens to produce STEM-oriented radio of the highest quality, and conducting in-person outreach to well over 1,000 of their Cambridge peers, the great majority of them from groups that have been historically underrepresented in STEM fields.
(d) Publications to date resulting from NSF award:
A. Epstein, B. Mire, T. Ramsey, K. Gareis, E. Davidson, E. Jones, M. Slosberg, and R. Bras, 2010b. "Terrascope Youth Radio: Engaging urban teens in a unique university-community partnership." Proceedings of the American Society for Engineering Education Annual Conference, June 2010, paper 2010-963. American Society for Engineering Education, Washington, DC.
(e) Evidence of research products and their availability:
Work produced by the teen participants of TYR is available at
http://www.prx.org/group_accounts/64694-terrascopeyouthradio ;
http://www.prx.org/pieces/38828-fresh-greens-teens-and-the-environment ;
http://www.prx.org/pieces/59969-fresh-greens-2-0 ; http://web.mit.edu/tyr/ ; and elsewhere.

Results of Dr. Guertin's prior/ongoing NSF support:
NSF Award #DRL- 0962792; $7,611,019.00; 9/15/2010-8/31/2017. Title: Targeted Math Science Partnership: Middle Grades Earth and Space Science Education

Intellectual Merit: This project is an integrated plan to improve teaching and learning of ESS by partnering Penn State faculty members in ESS and Education with teachers and guidance counselors in Pennsylvania's urban and rural school districts. The research focus of this proposal is determining how students' understanding of fundamental concepts in ESS develops and can be supported across the grade levels as a learning progression. We will contribute empirically-based understandings of learning progressions across the critical middle grades. We will focus on development of students' understandings around key big ideas, and document how current and future teachers develop understandings of the conceptual and pedagogical tools needed to support student learning of these complex ideas. We are focusing on select big ideas from the Earth Science Literacy Initiative and the PA Standards in energy, climate change, plate tectonics and solar system astronomy.

Broader Impacts: The broader impacts of this work include: (1) Professional development for in-service teachers in underserved districts who will develop new content understanding and curricular material in workshops focused on scaffolding the integration of the new Standards Aligned System (the Big Ideas framework). (2) A state-wide network of ESS educators providing continuing learning opportunities to support student success, and indicative of increasing numbers, diversity and quality of ESS teachers. (3) Community-developed performance standards in ESS for dissemination throughout Pennsylvania and beyond. (4) Pre-service teacher education with a focused ESS curriculum that incorporates internships in underserved urban and rural schools and both authentic research and research design experiences. (5) New opportunities for Upward Bound Math Science students and teachers from partner institutions to conduct research at Penn State through. (6) Formative information about learning progression in key ESS content areas for middle grades students and pre-service teachers.

Publications to date resulting from NSF award:

- Rubin, K., Plummer, J.D., Palma, C., Spotts, H., & Flarend, A. Planetary properties: A systems perspective. Science Scope, v.37, 2014, p. 68-72.
- Rubin, K., Plummer, J.D., Palma, C., Flarend, A., Spotts, H., McDonald, S., & Ong, Y.S. Assessing student progress along a Solar System learning progression. Science Scope, v.38, 2014, p. 27-33.
- Plummer, J.D., Palma, C., Flarend, A., Rubin, K., Ong, Y.S., Botzer, B., McDonald, S., Furman, T. Development of a learning progression for the formation of the Solar System. International Journal on Science Education, v.37, 2015, p. 1381?1401.

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