STUDENT PRODUCED AUDIO NARRATIVES: USING AUDIO TO ENHANCE ENGAGEMENT IN PLANETARY SCIENCE CLASSES FROM NON-SCIENCE MAJORS TO THE GRADUATE LEVEL. J. Gross[1,2,3,4], E. R. Kraal[5]. [1]Dept. of Earth & Planetary Sciences, Rutgers University, Piscataway, NJ 08854 (jgross@eps.rutgers.edu); [2]Dept. of Earth & Planetary Sciences, American Museum of Natural History, New York, NY 10024; [3]NASA, Johnson Space Center, Mail Code X12, Houston, TX, 77058; [4]Lunar and Planetary Institute, Houston, TX 77058; [5]Department of Physical Sciences, Kutztown University, PA 19530.

Introduction: The geosciences are experiencing a decrease in undergraduate geoscience majors, and thus, most likely are facing a severe shortage of graduates in both numbers and diversity, impacting the U.S. government, industry, and educational system [1]. Even though large, introductory courses serving non-STEM majors can be extremely valuable recruitment opportunities to increase the numbers and diversity of Earth and planetary science majors, it is often difficult due to large class sizes, limited faculty support, etc.

For students to select Earth and Planetary sciences as a major and a career, they must view the sciences as valuable, as accessible, relatable, and interesting. An effective way to achieve this is to engage with students in a new and powerful way by introducing student-produced audio narrative (SPAN) assignments into these introductory classes. Research has shown that student-created audio podcasting is an excellent medium for establishing connections in isolated college populations [2] and can inspire students from many backgrounds to engage in their education [3]. Through these SPAN assignments, the students can engage with Earth and Planetary science content by telling a scientific story using simple audio recording and production techniques. This new way of teaching can reach students who might otherwise never see the relevance and importance of the subject matter to their own lives [4-7].

Here, as part of a pilot study, we introduced SPAN into two different class settings: a 200 level planetary science class for non-science majors, and a 600 level graduate class for Physical Science majors (including Earth & Planetary Sciences, Astronomy, and Astrophysics). The overall goal of the SPAN assignments were to enhance the learning environment so that students feel an increased personal connection to STEM, particularly in the planetary sciences, as well as enhance the students communication skills, particularly for graduate students.

Methods and Results

In this National Science Foundation-funded project, the SPAN assignments are implemented by first introducing the students to the basic of storytelling through the listening of pre-existing audio recordings. Second, students are introduced to a variety of freely available audio recording apps so that they can use their cellphones. This ensures that all students have easy access and can implement their assignments. Third, the students are introduced to the freely available audio recording and editing program called "Audacity©" and are instructed on different editing techniques, such as adding sound effects, layering tracks, etc. Using free recording and editing apps and software these types of assignments can easily be modified and used in a variety of educational settings, particularly in large courses or classes without a lab.

Non-Science majors undergraduates teaching: Two project were completed in an introductory-level course titled "Planet Mars: The next frontier". In the first project students developed an idea how to communicate information about different types of meteorites to each other and the general public by creating audio narratives. These information included the formation scenarios of different types of meteorites, important/famous meteorite falls and finds, the importance of meteorite studies and what we have learned from them so far, etc. The students had to first research different types of meteorites and then chose one for which they wanted to tell a story about, ideal incorporating their own hobbies and interests. The goal was to communicate important facts and complicated scientific research to a larger non-science community by making it more relevant to daily life. The resulting SPANs were incredible, showed extensive student engagement, and ranged from Podcasts, to radio game shows, to poem readings, to writing and singing rap-music, to audio dramas featuring Star Trek Enterprise. This engagement even went far beyond the classroom as students got family, friends, and room mates involved in the production of their audio narratives, making it even more meaningful to their daily lives.

At the end of the semester, the students completed a second project: they had to plan a "Camping trip to Mars" and leaving a voice mail message to whomever they wanted about their trip once they arrived on Mars. For this project they had to incorporate everything they had learned about Mars in this class so that they could choose an exciting but safe place for their camping trip, interesting science to be carried out or interesting/fun recreational activities to be done such as climbing/canyoning etc. They had to think about potential problems they might encounter, appropriate landing sites and sequences, places to safely set up camp, etc. Thus, this project enforced the most important information about Mars they had learned in a playful way without them

realizing that they were internalizing the material we had covered over the course of the semester. The results ranged from students calling their "Moms, friends, teachers, professors" etc. to tell them about their trip. The "camping trip" itself ranged from scientific expeditions to the poles or Olympus Mons, to recreational trips exploring Valles Marineris.

Planetary sciences graduate teaching: While the goal for the audio narratives in the undergraduate non-science major class involved learning scientific subjects in a fun way, making planetary science topics more relevant, and incorporating planetary topics into students hobbies and their interest, thus, making them more relevant to their daily life, the audio narratives for the graduate level class had the purpose of increasing the effectiveness of their communication skills. Conveying complicated scientific topics to the general public in an easy digestible, relatable way, yet still scientifically correct is a challenge many graduate students (and scientists in general) face. Throughout the semester the students had to create three audio narratives each. Through these audio projects the graduate students had to think about their audience, be creative about how to convey a planetary topic in a fun yet informative way, and how to "think outside the box" by incorporating their own graduate thesis, which in most cases was a earth science thesis. Each student selected an individual topic from the three overarching projects (e.g., "misconceptions in planetary sciences"). They had to develop and record a short audio narrative that was accessible to the general public. The approximately 2-5 minute audio narratives were then edited through an extensive peer review process. The resulting audio narratives ranged from "podcasts with interviews" to "radio show games" involving family members, to "cooking show"-style narratives.

Discussion: One of the major challenges in the Earth and Planetary sciences at the moment is recruiting new, and diverse, geoscience majors. Students often bypass STEM majors because these fields are perceived as being boring, difficult and lacking any creative outlets [7]. However, audio narratives have numerous qualities that counteract these perceptions:

1) Easy access: Rutgers University has a student body with very diverse backgrounds. However, no matter their background, students usually all own cell phone which they can use to record, edit, and produce audio in high quality, making the assignment easy to implement.
2) Creativity: The undergraduate students especially commented on how they appreciated the opportunity for creativity and choice in the science audio assignment. They produced podcasts, game shows, even wrote and recorded their own music, poems, songs, literature, etc. Students commented on how much they enjoyed creating their recordings and how it helped them understand the subject better.
3) Ownership and pride: SPAN assignments have the effect that the students take ownership of their research topics in the case of the graduate level class as well as over the content learned in the undergraduate level classes [8]. This sense of ownership in these specific courses led to almost 100% attendance of the non-science majors in the class (and 100% attendance in the graduate level class) throughout the entire semester, supporting the suggestion that student-produced audio can result in an increased engagement with the learning environment [8].
4) Communication skills: For the graduate students in particular, but also for undergraduate students, communication skills are of critical importance in the sciences but also in a non-academic workplace [4]. However, communication skills are also one of the proficiencies that have been identified as being lacking in many recent graduates [7]. Through SPAN, the students have to actively think about the type of audience they want to reach and how to communicate their scientific topic to this audience effectively since the finished SPAN products require the listener to engage their imagination to visualize what is being told.

Conclusion: Audio narrative provides a creative outlet for students to learn how to effectively communicate complicated scientific topics and how to express opinions and thus, have the potential to encourage students' critical thinking [4,9]. The planetary science community benefits from such skill sets in both graduate students as well as undergraduate students who are deeply engaged and connected to the field through audio [10]. Student produced audio narrative projects can result in powerful student engagement independent of content, bring about a sense of curiosity and pride and with the effective use of the technology, it may increases the likelihood that non-science majors will choose to major in STEM fields [8].

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References: [1] Kraal and Sirrakos (2016) GSA, No. 65-10. [2] Lee and Chan (2007), Turkish J. of Online Ed., Vol 8, 85-104 ; [3] Campbell (2005), Educase Review, November/December, 32-46.; [4] Epstein et al. (2010) Proceed. Am. Soc. for Eng. Educ. Ann. Conf., #948; [5] Guertin (2012), GSA, Vol 44, 7-611; [6] Kraal and Regensburger (2013), GSA, No. 192-3. [7] Losco et al. (2019), GSA, Vol. 51, 5. [8] Kraal et al. (2019) AGU Fall Meeting ED53D-0877; [9] Deal (2007),http://www.cmu.edu/teaching/technology/whitepapers/; [10] Kraal (2013), GSA, Vol. 45, No. 7-469.