Creating Podcasts as Science Learning

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Science and engineering practices such as *obtaining, evaluating, and communicating information* consist of the actual ways scientists create and share knowledge. Emphasis on these practices is an important aspect of the *Next Generation Science Standards* (NGSS Lead States, 2013), helping teachers to undermine unhelpful divisions between "school science" and "real science."

Many scientists are working to reduce these differences between in-school and out-of-school science using collaboration and technology. For example, citizen science projects, designed with community equity, put community-based local knowledge and scientific knowledge in productive conversation (National Academies of Sciences, Engineering, and Medicine 2018). Similarly, scientists are working to extend the reach of their research by sharing science information through social media and other online platforms (e.g., TERC's 2019 NSF STEM for All Video Showcase; see Resources). These trends in science fields reflect similar opportunities for teachers to engage students in actual scientific practices in the classroom.

Creating community-engaged podcasts is one such opportunity. Podcasts are internet-based audio stories that examine issues, relay information, and discuss perspectives in the form of engaging narratives. Many teachers already use podcast *listening* to enhance content knowledge, supplement large-group instruction, design opportunities for students to revisit course content, or provide accessible instructional aids (Boles 2011; Sardone 2013). However, podcast *creation* is a powerful way for students to learn by finding and communicating scientific evidence (e.g., Nugent 2018). Podcasting can move students' learning past memorization and recall of science facts. By building a science story, students learn by communicating abstract concepts in an interesting way that describes or teaches something.

We focus here on student-led creation of science podcasts because it is a useful avenue for communicating the multifaceted and interdisciplinary nature of science, using stories to personalize abstract scientific facts, and inviting communities to participate in the conversation through interviews or having access to the finished product.

A guide for creating podcasts with students

This guide was prepared by a team of educators, scientists, and students and is based on our collective experience doing podcasts as well as other community engagement and science education work with schools around the world. Next, we outline steps for creating podcasts with students with examples from our Goa, India project.

Step 1: Setting goals

Knowing your instructional purpose for creating podcasts helps shape design decisions along the way. We often create podcasts as a way of connecting science learning to communities' knowledge and expertise. Regardless of the goal, playing several example podcasts for students is a helpful start. Students can deconstruct the story into elements of the introduction, body, and conclusion. This exercise initiates students into the process through reflection on the podcasts'

general structure, composition, audience, and message.

Step 2: Choosing a story focus

Choosing a topic for podcasts can seem deceptively simple. Unfortunately, complex science concepts in school curricula can make science feel overly abstract or separate from students' everyday life. One benefit of embedding science learning in storytelling is that it (re)connects science facts and concepts learned from textbooks with the experiences of students and the expertise of people they know.

Topic selection. Guidance from teachers is important for choosing podcast topics. Allowing students to choose a topic ensures interest and engagement; however, their topic of choice may be unrelated to teaching goals and may rehearse existing knowledge rather than explore new questions. Additionally, podcasts that relate to community-identified needs allow local informants to provide useful insights; however, students are not always engaged and interested in pressing community issues, and community interests may not always align with the demands of the school curriculum. Finally, podcast topics that build from school curriculum facilitate connections to other school learning and help educators to meet state and nationally mandated curriculum standards; however, students may not find curriculum-informed topics as engaging as topics they choose themselves. Understanding the instructional goal of the project will help you to strike a balance between these competing demands.

Concept maps. Creating concept maps with students helps them to visualize and organize a wide range of related topics that may arise in brainstorming sessions. Conceptual diagrams depict relationships between ideas and help to organize concepts within a topic. By using concept maps to keep track of ideas, students can brainstorm what information they already know, what they need to find out, and whom they might interview to gather evidence.

Audience. Students also should decide on their target audience in advance. Keeping in mind an imagined listener and how to keep their attention and interest will help students to include appropriate, relevant, and interesting concepts in Step 3. An audience that students have direct access to (e.g., peers in their classroom or the school; a community group) helps to make this consideration more concrete and meaningful.

Step 3: Creating a storyboard

A storyboard is a sequence of drawings, notes, and/or dialogue ideas traditionally used by film and television producers as a graphic organizer of a story in development. Storyboards help to organize the order and flow of each component part of the audio story and to illustrate the connections between each part. In storyboarding, students narrow down whom they want to interview based on the kind of story they want to tell.

An effective way to teach storyboarding is to begin by guiding students through deconstructing an existing podcast or radio story. Working backward from finished product to distinguishable "ingredients" can help students to see the different parts of a podcast more clearly. When it is time for students to begin a storyboard for their own podcasts, it is helpful to start with a focal piece such as an expert or other person that students really

CONTENT AREA

Science

GRADE LEVEL

6–8

BIG IDEA/UNIT

Sustainability, ecology, and climate change are conducive to podcasting.

ESSENTIAL PRE-EXISTING KNOWLEDGE

Some familiarity with the content area is helpful.

TIME REQUIRED

Variable, but approximately four 45- to 60-minute in-class sessions

COST

No cost if smartphones and laptops are available

SAFETY

Students should only interview people they know and with permission of a parent or guardian

want to interview and build the storyboard out from there. Guiding questions might be: What does an audience need to know before they hear from this person? How should the podcast introduce them? What comes next?

There are many types of stories that students could choose for their podcast. The story type should be driven by the conceptual focus students developed. We have found the following types of stories conducive to exploring science concepts with middle school students.

"Differing opinions" stories. Two or more people share their perspectives on a topic (e.g., the debate over the dangers of eating genetically modified organisms), and students explore evidence and reasoning for the differing perspectives. These stories are most interesting when they focus on the key disagreements between points of view.

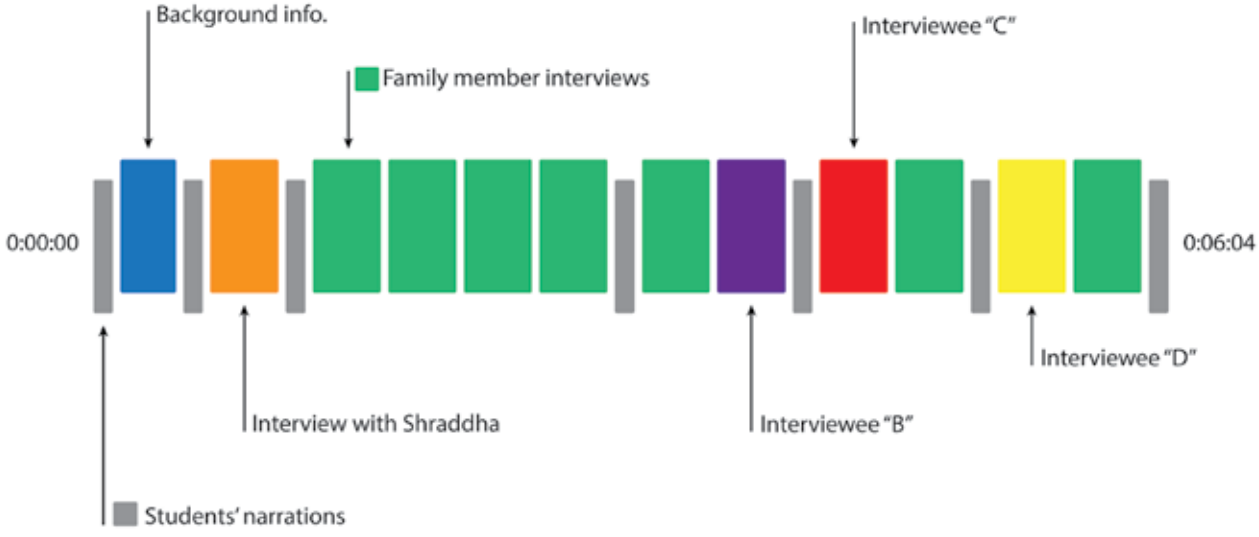
"Then-and-now" stories. These stories highlight change in an issue over time. An example might be plastics use in the 1960s versus today. Students might explore this topic broadly (i.e., the global effects of increased plastics use) or more narrowly (i.e., risks to marine life then vs. now). Then-and-now stories provide opportunities to include older community members' knowledge and perspectives balanced with students' complementary or contrasting perspectives. This was a popular choice among students given the number of students who chose to focus on the environmental impact of littering. They were able to capture stories about the India that their older family members remembered and compare it to present-day India.

"Impact/improvement" stories. Impact stories explore how a conservation effort, new technology, or scientific discovery has created change. These stories are similar to a then-and-now story in shape, but focus a listener's attention on an intervention and its results.

"Invisible/unseen-connections" stories. The purpose of unseen-connection stories is to show subtleties or underexplored relations between stories that are otherwise well known. This might be the perspective of a marginalized community, or it might be a little-known side effect of an otherwise popular community activity.

"Empathy" stories. Empathy stories are designed to create a sympathetic emotional response in the listener by focusing on the personal story of an individual or set of individuals whose stories both elicit strong emotions and are underrepresented in common conversations about the topic. This was a popular choice of story type among many Goan students, whose podcasts focusesd on the relatively recent issues of littering and its environmental impact. In a podcast about the environmental impact of construction, our students included interview segments with their grandparents somberly

FIGURE 1: Storyboard for Urban Deforestation podcast (a then-and-now story)



reflecting on the nature they used to enjoy (e.g., picking various fruits, sitting under trees, watching monkeys jump between trees) before construction took over Goa.

It is tempting to think of storyboards as static scripts. However, once students begin collecting audio, they may find that the story shape is changing. As students conduct interviews and listen to their results, they may revisit the storyboard to edit its layout and organization. Not only is this to be expected, it can dramatically improve the story and the science learning taking place!

Step 4: Designing and conducting interviews

After creating storyboards, students devise questions to ask their planned interviewees. Including additional questions about relevant demographics can be helpful when editing the story (e.g., asking interviewees to state their name, age, profession, country of origin, etc.). It is easy to forget who's who when reviewing recorded audio, especially if multiple people were interviewed. These background questions provide an easy way of keeping track. Student interviewers should always inform interviewees if they are being recorded and should provide information about how the recordings may be used and distributed. We recommend providing students with a brief letter to be given to interviewees that explains the project and provides the teacher's and school's contact information.

Languages. In communities where several languages are spoken, it is wise to prepare to conduct the interview in the language of most comfort for the respondent. Multilingual podcasts are a great way to leverage the strengths of multilingual classrooms and communities. Students can translate interviewees' responses in the final podcast or not, based on the target audience.

Practice. Interviewing can be intimidating due to limited familiarity with equipment, feelings of shyness, or limited experience asking questions of individuals outside of school. Provide ample opportunity for students to practice interviewing with one another or with other familiar people.

Step 5: Collecting audio

The following are tips for collecting useful and high-quality audio material to be used in podcasts.

Ensure audio quality. Audio quality is important. Students should aim to not only conduct interviews in a place with limited background noise, but also speak clearly and slowly and ask interviewees to do the same. Practice in advance with microphone handling.

Include many voices. If it is possible, having a wide range of relevant voices and opinions is conducive to capturing an equally wide breadth of perspectives on the topic of choice. Discussing connection between contrasting perspectives is a key instructional opportunity.

Collect relevant ambient sound. Ambient audio recordings provide context in the same way that good stage design and costumes provide context in a play—eliciting feelings and setting tone. For example, a podcast about water ecosystems might use an audio clip of running water or a clip of people crossing a stream to add a feeling of "being right there" for listeners. These audio recordings can be made by students themselves or found on the internet. Making these recordings is a great way to practice and improve audio recording quality.

Label and organize audio files. Maintain a set of notes that link the file number from the recording device to the content of the file. Create and apply a consistent naming convention for audio files, and practice secure downloading and backup. This is particularly important when working collaboratively and sharing files.

Step 6: Editing audio to create podcasts

With several interviews recorded, students can return to the storyboard and locate segments of recorded audio that fit the storyline (see Figure 1; also see Resources for audio recording of podcast created from the Figure 1 storyboard). This process is iterative; students will likely need to adjust the storyboard to include information they had not considered prior to collecting interviews. The evolving storyboard document guides the way to the final podcast and story.

Narration. After collecting and organizing interviews, students can create the narration by recording themselves speaking parts of a narration script that they create.

To make audio editing easier, it is helpful to record these narration segments one by one. Important aspects of podcast narration include: (a) an introduction that introduces the narrator and the topic, setting the stage for the interview segments; (b) the segments of the podcast in between interviews where students should connect pieces together through explanation (e.g., ". . . however, the next person we spoke with disagreed . . ."); (c) introductions of interviewees as they appear; and/or (d) additional information or analyses that add to what was said or will be said next.

Editing. There are a variety of podcast editing tasks; however, the most important ones are making efficient use of playback duration and improving audio quality. Students may want to edit out unnecessary space fillers within interview clips (e.g., silences, "ums") to create a more seamless narrative. Some portions of the collected audio will sound louder than others, so adjusting the playback volume of individual audio clips may be needed. This can all be accomplished using an audio editing tool such as Garageband or the open-source program Audacity. For additional guidance, online tutorials for both programs are easy to find. Students could also incorporate sound effects to signal a change in tone or emotion, music to signal moving on to another segment in the podcast, background sounds to add depth, etc.

What to do with factual errors. There may be instances where interviewees say something during interviews that is factually inaccurate. This is an excellent opportunity to deepen scientific knowledge. Students may choose to either include this in their podcasts as a talking point for discussion (respectfully and with purpose) or remove it entirely. We collectively made the decision to remove interview segments that misrepresented a concept or issue given time constraints that prevented us from reflecting on this misinformation and developing narrative to address it.

Time and planning considerations

For students and teachers new to podcasting, we suggest approximately 10 hours of classroom time and some outside-of-class time to collect interviews. To create a podcast, students may need access to a recording device that can capture audio clips for transfer to a computer and an audio editing tool. Audio recording devices can be costly depending on the number of devices purchased and the level of device sophistication ($20–$400 each). A free alternative is an audio recording application on a cellphone, and some apps are available that assist with editing (e.g., Anchor; see Resources). Additionally, organizing audio files requires the use of a computer with an audio editing tool downloaded. Our suggested programs, Garageband and Audacity, are free.

Conclusion

Podcasting is a flexible activity that educators can use to address many different standards, and it can also highlight local knowledge and engage students with their communities in ways that many conventional classroom activities do not. Although we did not develop formative assessments, developing a rubric that incorporates peer listeners would be most aligned with the public and communicative nature of a podcasting project. Having classmates listen to final podcasts and answer goal-linked assessment questions (e.g., What new information did you learn? Was the podcast interesting?) would be most helpful for addressing whether podcasts met the aims of this kind of activity. Listening and valuing the knowledge of others, developing a story that integrates this knowledge, and engaging with issues of local relevance are all practices for equitable science that podcasting can be used to promote. Through this process, students practice communicating abstract concepts and building "real science" connections. ●

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RESOURCES

2019 STEM for All Video Showcase—*https://stemforall2019.videohall.com/*
Anchor's free platform"The Easiest Way to Make a Podcast"—*https://anchor.fm/*
Audio recording of podcast created from the Figure 1 storyboard— *https://soundcloud.com/andrewcoppens/urban-deforestation-podcast?in=andrewcoppens/sets/weaving-strands-of-knowledge*

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