Developing a Podcasting Platform to Support Engineering Education

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Abstract

Learners of all ages are managing consistently growing knowledge bases and sources of information. The Web 2.0 era of user generated content has brought new creative solutions to these challenges, including podcasts. At scale, podcasts can create social connection among listeners. Social connection among instructors has long been recognized as an important factor in professional development, leading to improved teaching. For students, social connections also support student academic success and sense of belonging in engineering. An opportunity exists for engineers to create value for both faculty and students in disseminating research-based pedagogical best practices and technical engineering content through audio storytelling in the form of podcasts.

Podcasts are still an emerging medium for engineering education, but there exists a rich history of use to learn from in other disciplines. Podcasts have become an increasingly utilized tool in medical education and have been evaluated for their professional development value in teaching. Some preliminary studies have been conducted for engineering students for English language learners and to increase motivation for technical content. Educational podcast audiences report that personal anecdotes and humor enhance the educational experience. We believe the same opportunity exists in engineering to add personal context to technical engineering material for students and "between the lines" anecdotes for faculty seeking to learn from colleagues in shorter and more personal ways to supplement traditional scholarly articles.

This paper details our effort to create a podcasting toolkit, assessment strategy, and episodes that engineering teaching faculty, researchers, and students can use to share their work with colleagues within a college of engineering and in other colleges on campus and beyond. We will describe the multidisciplinary team that was assembled to conduct this work including engineering and journalism faculty, experts in assessment, and education podcast producers. We will present the podcasting toolkit that was assembled to lower the barrier of entry for faculty to use podcasting in their courses and research. We believe that podcasts have the potential to impact the listeners' curiosity and connections with each other and materials. After listening to a podcast episode, we anticipate that listeners will become more curious about the topic discussed during the podcast episode. They will also make connections between the content and participants of the podcast and their own existing knowledge, actions, and networks which, in turn, can lead to building more value in what they do. We share practical strategies for an engineering podcast with the goal of empowering more engineering faculty to explore this emerging communication medium.

Introduction

For years, internal and external programs have provided support for faculty to develop educational innovations to benefit engineering students in the classroom [1]. Common dissemination methods for these types of projects include news articles, internal lunch and learn workshops, and education conference papers. However, there is still room to further disseminate these impactful projects to a wider audience to allow for educational innovation "at scale". We asked: Outside of faculty communities of practice, how do educational innovations spread to new faculty? And how can

engineering educators leverage the Web 2.0 [2] era of user-generated content and social connection to enhance the impact of educational innovations for faculty, staff, and students?

Learners of all ages are managing consistently growing knowledge bases and sources of information [3]. Faculty developing engineering education innovations often face a disconnect between research dissemination and practice. Disciplines including science communication and public health have recently written about the challenges in disseminating research to practitioners [4]. The aforementioned Web 2.0 era has brought new creative solutions to these challenges, including podcasts [3]. At scale, podcasts can create social connection among listeners. Social connection among instructors has long been recognized as an important factor of professional development, leading to improved teaching [5]. For students, social connections also support academic success and sense of belonging in engineering [6]. An opportunity exists to create value for both faculty and students in disseminating research-based pedagogical best practices and technical engineering content through audio storytelling in the form of podcasts.

Podcasts are an emerging medium for engineering education, but there exists a rich history of use to learn from in other disciplines. Podcasts have become an increasingly utilized tool in medical education [7]. Most popular among emergency and internal medicine residents, over 90% report listening to podcasts over textbooks or journal articles as a method of weekly extracurricular education [8], [9], [10]. Podcasts are also increasingly used to provide continuing medical education (CME) credits to professionals. The internal medicine podcast *Annals on Call* has thousands of CME credits claimed by independent physicians. Competency-based medical education relies on self-directed forms of learning [7]. Several studies have shown that individuals who have access to podcasts as supplemental materials outperformed their peers during knowledge testing [11], [12]. Some U.S.-based medical schools and residency programs have also begun integrating podcasts in formal curricula in flipped classrooms [7].

Podcasts have been evaluated for their professional development value, and some preliminary studies have been conducted with engineering students. An investigation into why educators engage with podcasts as professional development developed the *Educational Podcasts Motivation Scale* [13] and identified five factors grounded in the Uses and Gratifications framework [14]. This work found that the flexibility, social connection, and learning aspects are the primary indicators of educators returning to podcasts [15]. In engineering education, podcasts have been used with a variety of motivations. Podcasts on technical electrical engineering topics were used at State Agrarian and Engineering University in Ukraine to improve listening and speaking skills of English as a foreign language learners [16]. A study of a student-produced podcast surveyed for skill development, education and community, finding ‘community’ was the highest outcome from the project [17]. For students using podcasts in technical courses, the *Reduced Instructional Material Motivation Survey* has been used to understand motivation levels for engaging with podcast-based material [18]. One study found that motivation was high independent of learning style [19]. Therefore, podcasts have the potential to bring many favorable outcomes to engineering educators:

- to enable faculty to develop curiosity in each other’s work
- to allow students to develop curiosity about disciplinary work that informs their education
- to promote the pursuit of educational careers to engineering graduate students
- to build connections and community within and outside our College of Engineering.

Educational podcast audiences indicate that they prefer the incorporation of dialogue compared to monologue lectures. Additionally, they report that personal anecdotes and humor enhance the educational experience. We believe the same opportunity exists in engineering to add personal context to technical engineering material for students and "between the lines" anecdotes for faculty seeking to learn from peer educators in shorter and more personal ways compared to traditional scholarly articles. Studies report that medical school learners value podcasts that have credible content, short summaries of key points, and high audio quality. The ability to change listener speed and navigate to desired content were also benefits to the podcast platform for these professionals [3], [7], [20]. We believe a similar disruptive approach can work well for the engineering educators as well.

Proposed solution: An Engineering Education Podcast Platform

We convened a community of practice to advance excellence in teaching methods through a podcasting (digital storytelling) medium. For the project, we assembled a team with diverse skills including experts in engineering education, assessment, journalism, and podcasting. Since this is the first, to our knowledge, podcasting effort in our college, we set out to produce a Podcasting Development and Assessment Toolkit in year one. We took an engineering approach to this project, with each episode serving as an iterative design cycle. "Season 1" is focused on creating value for engineering instructors in our college by producing short episodes disseminating best practices from successful innovative education projects. For each faculty listener, there is the potential to impact many students when innovations are adopted in listeners' courses. We also explored a student-facing podcast effort connecting technical content in courses with podcast episodes by experts to create connections and value for engineering students, as well as collect student feedback on the podcasting course materials and its ability to create connections for students.

This project had three goals:

(1) Creating a **podcasting toolkit** to reduce the barrier to podcasting for faculty at our university.
(2) Disseminate engineering education innovations funded by the college to the campus community and beyond through a **podcast hosted by the community of practice**.
(3) Experimenting with **podcast course materials** in engineering courses.

(1) Results of the Podcasting Toolkit

Our team met with experts and stakeholders to learn about logistics related to podcasting, communication strategies in academia, and podcast-based learning. From these experiences we learned about time requirements to prepare and edit podcast interviews (average estimates of ~10-15 hours), equipment needs, team roles.

Interview Preparation

Producing podcast episodes consists of several phases including development, research, planning, conducting interview(s), editing, and assessing. The development phase includes topic selection and story arc refinement, to ensure a clear vision heading into each episode. Next, the interviewer

should research the topic, guest(s) and other relevant materials needed for question preparation. Interviewers may conduct pre-interview with the guest to learn specifics for the episode, as needed. A team member from the Journalism Department in the College of Media prepared a lecture called, "Interviewing 101", to provide faculty with a step-by-step guide for preparing for interviews.

Recording

Given the popularity of podcasts as a media platform multiple podcast studios exist on campus, available for use free of charge. So far, we have found that having two individuals present (one for questioning and guest engagement, and one for working the soundboard) works best. Following the recording, episodes can be edited on Adobe Audition (paid) or Audacity (free). Finally, once an episode description and show notes are composed, students will post the show for listeners to download. Table 1 details the test recordings completed over one semester, reflections from team members on the recording and documentation of best practices that develop as a result of the reflection.

Table 1. Iterative process for interviewing faculty

Interview #	*Reflection from team*	*Iterative changes*
1	The host and guest sounded like they enjoyed the conversation.	No changes
2	The host had a good energy level from the start. The guest sounded a bit nervous at times.	After this interview we planned to cover pre-interviews so that guests can be prepared with the questions that will be asked (optional).
3	The guest had many interesting stories unrelated to education but great to listen to	The session inspired our development of minisodes talking about faculty life outside of the university to build community for peer faculty and students.
4	The audio picked up noises from various body movements in the studio, such as placing arms on the table.	We now have guidance in the toolkit to not wear any jewelry or loud clothing into the recording studio
5	This session was recorded "on site" using a mobile microphone. This was our only session not in a recording studio. Audios levels for each speaker were very different, making it difficult to edit.	We decided to always have two team members in the studio, one for interviewing and one for audio engineering. Also using a studio allows for audio levels to be set at the beginning of the recording, limiting editing issues.
6	The guest was well prepared ahead of time to speak on the topic (had pre-interview). The interaction between the host and the guest felt natural. The host did not have enough time to ask all the main questions.	Map out a rough timeline for the interview progress to ensure all key points are addressed before the end of the session. Have the host learn how to take control of and steer the conversation without sounding rude.
7	The familiar rapport between the host and the guest was evident in the natural flow of the conversation. Audio balance between host/guest was good, but audio gain was too high, where the microphones picked up sound from both speakers. Interview time was well managed by the host, all the key questions prepared ahead were discussed. Some jargon/ideas referenced could be better explained. This could be because the host and guest work in the same research field.	Have a professional sound tech help with setting up the studio ahead of time. Close familiarity between a host and guest can lead to some details not being discussed or follow up questions being left out because of the familiarity.

Figure 1. Two available podcast studios on campus that are free to use.

Social Media and Marketing

Team members attended "Podcasting 101" workshops hosted by the University Library, and one of the important elements of a successful public facing podcast they highlighted is having a recognizable cover art and musical component. So far, we leveraged *student involvement* to develop a social media strategy and cover art and *artificial intelligence* to create intro and outro music. Engineering student team members started surveying popular and education podcasts for their social media presence and cover art. After creating a summary of common features, they used a free-to-use online graphic design tool to draft cover art for the podcast. Their focus was on clear visuals, simple designs, and university branded colors. They sent multiple iterations of designs to the team for comment. Once they settled on a theme, we partnered with a graphic designer on campus to develop a final design. For intro and outro music, we used artificial intelligence to create a 15 second music clip that we use in intro and outro segments of the podcast. We found that these features were eagerly taken on by students in the group, but the value of relying on a professional here cannot be understated.

Assessment

The impact of this project on students and the community will be assessed using online questionnaires, interviews with our listeners, and traffic information such as the number of downloads, website visits, and listener comments. The survey data will be useful for the project team to learn how the project can be improved and where to guide the future direction of this project. The purpose of this work is to create a podcasting medium that engineering instructors, researchers, and students can use to share their work with colleagues within the college and in other colleges on campus and beyond. After listening to a podcast episode, we anticipate that listeners will become more curious about the topic discussed during the podcast episode. They will also make connections between the content and participants of the podcast and their own existing knowledge, actions, and networks, which, in turn, can lead to building more value in what they do. Therefore, in order to assess the impact of the produced podcasts on the listeners' curiosity, connections, and perceived value, we will track the number of listeners and their comments.

The listener-feedback data collection process will begin with recruiting students and faculty on campus to join the survey group. Once the survey group has been identified, the team will reach out to the group to complete an IRB-approved consent form and a survey within two weeks from the day they listened to the podcast. The questionnaire will include the following questions:

- Which topics covered in the podcast do you find most interesting and why?
- Which topics covered in the podcast will you further explore at your own time?
- Are you planning on reaching out to the podcast hosts for further advice or resources?
- Describe at least one action that you will do or do differently after you listen to this podcast.

After the completion of the survey, the participant will be presented with the opportunity to further share their experience by participating in a 30-minute focus group interview. The interviews will be studied with thematic analysis. In particular, the discussions will first be recorded and transcribed. Then, the transcripts will be scanned to identify recurring key phrases and patterns in participants' responses. The phases will be grouped into themes to understand the overall sentiment and insights on listeners' reception of the podcast episodes.

Budget

Podcasting is widely attractive because it can be done for a very low cost. While this is true, we aimed to put together a list of potential costs that faculty may be interested to understand before embarking on a podcasting effort.

- Faculty may consider hiring graduate or undergraduate assistants to help with producing, editing or interview prep.
- While Canva and other software are easy to use, it may require hiring a graphic designer or graphic design student to develop cover art.
- Focus groups can help faculty to refine the podcast for their audience. Incentives for participation in focus groups may increase participation or be required by IRB offices.
- For podcasting on location, recording equipment including headphones, microphones and SD cards may be necessary.

Our team was able to arrange free or in-kind support for the following items:

- Use of campus podcasting studios and equipment (FREE)
- Audacity or Adobe Audition programs (FREE with campus licenses)
- Social media apps for marketing (FREE)
- Marketing effort from departments (in-kind)

With the development of our Podcast Toolkit, this project can be used to disseminate results for other internally or externally funded projects. For example, the National Science Foundation (NSF) encourages PIs to develop new and creative forms of dissemination to increase the impact of a project's efforts. NSF has directly funded audio storytelling projects to support marginalized student narratives in engineering. NSF also hosts their own podcasts to disseminate work supported by the agency. Both the Research in Formation of Engineers (RFE) and the Broadening Participation in Engineering (BPE) solicitations state, "PIs should think creatively about who needs to hear about the research for it to have an impact and develop a strategy to reach that audience". After leveraging internal funding to conduct preliminary work in this area we anticipate exploring external funding to support this or related projects and providing a platform for researchers in to share their externally funded project results.

(2) Community of Practice Podcast

The community of practice was supported by an education-innovation grant funded by the College of Engineering. The grant proposal process is modeled after research grant funding, where collaboration, creativity, enthusiasm, measurement, persistence, and ongoing refinement are key criteria for evaluations. Once the proposals have been accepted for funding, the awarded project teams are required to attend annual gatherings to share interesting findings and recommendations. As the community grew with new teams and projects being added every year, effective and meaningful interactions between teams have become a challenge. A platform such as podcasts is an enticing channel for distributing information and promoting collaboration through shared experiences. Hence, a community of practice podcasts on teaching innovations funded by the college was born.

Every member of the community is fully involved in every step of the podcasting process outlined in the toolkit section, from interview training, studio visits, writing interview questions, to conducting interviews. The episodes are organized into seasons, where every season has seven to eight 30-minute episodes. The first season will have episodes on the conception and overview of the grant program to increase awareness and visibility of the program, and completed projects that have sustained impact in the college. Besides the dissemination of teaching innovations, the community also envisioned the podcast to be a channel for students to get to know their professors outside of the classroom. Every episode has a featured segment where the interviewee can share something personal, such as where they can be found outside of teaching and doing research, or their favorite beverage of choice

The development of the podcast also provided opportunities for students to be involved. Marketing and social media, logo design, and audio recording and editing are some of the examples where enthusiastic students participated in the podcast creation process. The student research assistants can also provide feedback to the team on how to broaden our reach to the student body. Once an episode is finalized, it is first evaluated by the community through a checklist that examines the quality of the content, production, host and guest performance, listener engagement, originality and creativity, consistency and frequency, and accessibility. Table 2 shows details evaluation criteria within each quality control category. The second layer of evaluation for the impact of the podcast will be direct interviews with undergraduate students, graduate students, and engineering faculty members in small focus groups to obtain a variety of voices and opinions in the college.

Table 2. Podcast quality checklist.

Evaluation Criteria	Met	Partially Met	Un-met
Quality of Content			
The Podcast episode covers a topic that is relevant to the target audience.			
The Podcast episode includes information supported by research or reliable sources.			
The Podcast episode maintains a clear structure and flow that makes the content easy to follow.			
Quality of production			
The audio in the Podcast episode is clear and free of background noise, echo, or distortion.			
The volume levels in the Podcast episode are balanced between the host(s) and the guest(s).			
The Podcast episode have smooth transitions between segments with no unnecessary silences or interruptions.			
The Podcast episode includes music or sound effects that enhance rather distracts from the content.			
The Podcast episode includes polished and smooth transitions.			
Host and Guest Performance			
In the Podcast episode, the host take actions to connect and build rapport with the guest.			
In the Podcast episode, the host asks thoughtful questions and follow up questions.			
In the Podcast episode, the host asks critical follow up questions.			
In the Podcast episode, the host gives the guest an uninterrupted space to express ideas.			
In the Podcast episode, the guest offers unique, insightful ideas.			
Listeners' Engagement			
In the Podcast episode, listeners are invited to interact by asking questions or leaving comments or implementing actions or connecting through social media.			
In the Podcast episode, listeners' are encouraged to share the episode with others.			
In the Podcast episode, listeners' are provided with options to use the content.			
Originality and creativity			
The Podcast episode includes new takes and perspectives on the content presented.			
The Podcast episode follows a creative structure that makes it stand out.			
Consistency and frequency			
The length of the Podcast episode is appropriate i.e. focused without being rushed or drawn out.			
The Podcast episode follows the release schedule.			
The Podcast episode aligns with the quality and style of the previous episodes.			
Accessibility			
The Podcast episode is available on multiple platforms.			
The Podcast episode provides a transcript/subtitles.			
The Podcast episode presents a clear summary or description for listeners to preview.			
The Podcast episode includes language and vocabulary that is accessible to the audience.			
The Podcast episode is easy to download.			

Outcomes and Findings to Date

To date, we have developed a "Getting started" toolkit for faculty at our institution who may want to record an educational podcast. This includes guidance on interview prep, recording details, and options for editing. We have recorded and produced multiple episodes and "minisodes" to experiment with the platform and test the utility of our toolkit. Table 1 shows our iterative design process in which engineering faculty new to conducting podcast interviews documented reflections and iterative improvements to their podcasting process. Additionally, the team documented key areas where it makes the most sense for faculty to recruit experts for the podcast production process.

In the future, the team plans to collect questionnaire data and conduct focus groups with the podcast episodes to gain feedback on the appeal these episodes have for faculty looking to learn about education innovations from peers. Potential audiences for a public podcast season may be fellow engineering educators both at our own and peer institutions, high school students and their parents or guardians who are interested in our institution, high school teachers and guidance counselors, and faculty at feeder institutions such as community colleges. Alumni may also be interested in these episodes as a means of keeping up to date with the exciting innovations that are happening on campus. So far, classroom use has been limited to prescribed podcasts by the instructors as supplemental course materials to go along with lectures and journal articles read in class. We also envision flipping course content for capstone design courses. Student feedback will be critical to the evolving use of podcasts in classroom settings.

Overall, the podcast toolkit, evaluated by team members, lowers the barrier to creating podcast content. Engineering design cycle (design, build, test) followed by team members found critical areas of improvement for new podcasters and best practices for those just starting out. We also found for students and faculty alike, personal anecdotes, stories, and casual conversations are a main reason to listen to an engineering education podcast. In the future, continued evaluation for faculty and students will aid in validation of assessment rubrics, an open area of development for educational podcasts.

Acknowledgements

The authors would like to thank the Strategic Instructional Innovations Program in the Academy for Excellence in Engineering Education in the Grainger College of Engineering at the University of Illinois Urbana Champaign.

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