Developing Engineering Identity Through Story

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Abstract

The narratives we tell ourselves influence our behaviors and actions. However, engineering students may not even know what those narratives are and how those stories affect them. In many cases, students are subjected to a rigorous technical curriculum as soon as they step foot on campus and sometimes find themselves in fields that are predominantly white and male to which they may not feel they fully belong. For some students, these environments may make them question if they belong in engineering, on our campus, or in higher education at all.

Story is a tool that can allow students to make connections between their past, current, and potential future selves to develop their identities as engineers. A student who may not otherwise view themselves as an engineer—a curious person, an entrepreneur, a person with great ideas that society needs, or a part of the university's ecosystem—may be able to demonstrate their potential to themselves and to their community through their lived experiences via story. Providing time for students to develop and tell their stories is a powerful way to validate the vast experiences students bring with them to college. Likewise, faculty want to know their students, and students want to know themselves. Our own work with story in this context was inspired by the Kern Entrepreneurial Engineering Network (KEEN) on Stories project starting in 2020 and reflects our interest in instilling an entrepreneurial mindset in our students.

In this paper, we describe the storytelling opportunities we offer student engineers in both first year and upper-level classes and how students were supported to share their stories through podcasting. Using a pre- and post-survey we developed and a mixed-methods approach for analysis, we describe how our initial cohort of students were motivated to share their stories and enjoyed the podcast medium because it afforded connection in a low-pressure format. Some students also indicated that the story creation and podcasting process helped them find their identity.

Motivation

Our work with story reflects current concerns in higher education. Modern college students are increasingly perceiving stress and mental health as major concerns. Over 60% of college students describe experiencing moderate to high stress levels [1], [2]. As students are busy and feeling overwhelmed, they have limited structured opportunities for reflecting on and developing their purpose and professional identities. In STEM environments, students may find that they do not fit into a predominant narrative of just "being good at math" and thus lack an adequate justification for entering an engineering field. Similarly, they may find that they are underrepresented demographically, underresourced compared to some peers, or unsure how they belong in general, even if they are interested in their field of study. These students may find it difficult to feel comfortable taking advantage of opportunities available to them on campus; bringing their full selves to team experiences, extra-curriculars, or internships; or continuing their studies at all.

Storytelling is one tool that can be used to address concerns about belonging. Telling personal stories allows students to explore their reasons, ideas, hopes, fears, and feelings related to their identities as engineers and scientists. Students can connect their past selves with their current and imagined future selves to be able to understand their roles and paths forward in their careers [3]. Storytelling can be leveraged this way because stories tend to exhibit similar general themes that include redemption, contamination, or agency which can impact the storyteller's mental health. Redemption stories exhibit a negative to positive story arc (e.g., a negative thing happened, but I overcame and learned from it) while contamination stories exhibit the opposite (e.g., I was successful, but the story ends with bad things happening). Stories with agency reflect a storyteller's sense of control over situations. In fact, stories that contain components of redemption and agency generally showcase storytellers with positive psychological health [4], [5], [6], [7].

Giving students time to practice crafting stories about themselves in a technical curriculum is a reflective practice we can offer students in the moment and for their future selves. If engineering education is intended to allow students to become mature and contributing members of society, we must nurture all aspects of their learning. Learning must include elements related to self-directedness, passion-finding, leadership, and communication, among others. Studies demonstrate that when storytellers reframe contamination stories in a redemptive way, the storytellers can experience increases in their psychological wellbeing [4]. Leveraging this finding, two storytelling interventions in the medical field, life review and narrative medicine, are intended to improve quality of life in this way [7]. Life review enables reconstruction of stories to improve satisfaction for older adults [7], [8]. The goal of narrative medicine, on the other hand, is to improve patient outcomes through supporting patient-practitioner relationships by allowing future medical practitioners to improve listening, observation, and perspective-taking skills [7], [9].

Storytelling practices enable students to learn about themselves, to connect to their classmates and instructors, and to confidently describe their talents, all of which are invaluable to their development [3]. Moreover, storytelling also honors the knowledge students bring to the classroom from their 18 or more years of lived experiences. Students are whole people who come wanting to make connections with their past and future lives. Reflection allows students to recognize what they have learned in their lives thus far, what they want to still learn, and how they can best learn. By reflecting, students can process and internalize the experiences and attitudes they bring with them to further develop their skillsets and mindsets [3]. These opportunities can empower students to launch their careers in more intentional ways, whether they are early in their college careers or ready to graduate.

This project was predicated on the research question: How can storytelling help STEM students discover their science and engineering identity? To enable students in this endeavor, we focused on creating a low-barrier process for storytelling through podcasting. Podcasting is intimate yet distanced, allowing students to comfortably share stories in a way that, like radio, is direct, yet still controlled and separate.

Furthermore, podcasting is an amenable medium for the listener to connect with others, which may motivate some students to participate in podcasting. In addition to being portable and

allowing productive multi-tasking, the podcast medium benefits listeners because listeners establish parasocial relationships with hosts and other presumptive listeners [10]. These connections can feel important because of the one-to-one ratio of listener to storyteller that feels attentive. The audio medium is unique because the listener hears the content in the way the author wants it to sound, but it still engages the imagination and fosters connection more than video content [11]. These connections are associated with an increased sense of meaning and relatedness [10], [12]. Moreover, podcasters' motivations can be described by the theory of produsage, describing how the podcasters care about community, feedback, and continual improvement [13]. These motivations may apply to students since they were inspired to polish and share their stories as part of the project.

Background

The Importance of Storytelling

Storytelling is a ubiquitous and independent emergent activity across cultures and across time [14]. In fact, it can be considered an evolutionary adaptation by enhancing the fitness of the storyteller, conveying survival-related knowledge, and facilitating social cohesion. Not only does storytelling build culture through these mechanisms, storytelling allows for sensemaking of new or different experiences which reinforce cooperation and important knowledge acquisition [15], [16]. In modern society, self-defining stories are routinely used to create meaning and purpose. McAdams writes, "the I becomes an autobiographical author; the Me becomes the story it tells" [17].

As such, in modern society, storytelling can be leveraged in a variety of ways to support social cohesion, identity discovery, and sensemaking to positively impact even the engineering classroom. For example, the Academic Pathways Study found that for some engineering students, an engineering career was not necessarily the expected end goal (14% definitely not, 12% probably not, and 8% unsure) [18]. This data highlights that learning, even in an engineering curriculum, should be broad enough to support students headed to a variety of careers that may be related or adjacent to STEM fields.

In fact, students' expectations for the value of engineering and students' expected success in engineering were found to decrease over the first year of study for first-year engineering students, especially for women students [19]. Reasons for these feelings could be related to idealistic expectations of college or engineering in general, more difficult assignments than experienced in high school, or comparing to peers in a high-achieving peer group. In addition, students' self-efficacy decreased over the first year of study, particularly for women students. However, both men and women experienced similar decreases in their value-related beliefs of engineering [19].

Importantly, researchers suggest that the potential impacts of the decrease in these expectancies and value-related constructs on students' persistence through college and career are real. Students' expectations of success were found to predict achievement and students' beliefs in the importance of engineering were found to predict career plans [19].

To address these concerns, researchers have identified the impact of storytelling on students' empathy and self-identity [3], as well as their understanding of social disparities [20]. At Georgia

Tech, a dedicated course on storytelling in the biomedical engineering curriculum benefitted students by facilitating intentional development of identity and self-concept. As a result of the course, the instructors also found that students wanted to share their newfound ideas more broadly [3]. In addition, the researchers compared self-reported measures for students in the storytelling course to a control group to understand how story changed with respect to students' feelings of entrepreneurial mindset, redemption, contamination, agency, self-concept clarity, and autobiographical reasoning. They found that story creation enabled students to develop increased feelings of agency, entrepreneurial mindset, and autobiographical reasoning [7].

While storytelling influences thoughts and behaviors, a given person's story is told in the context of not only their lived experiences but the overarching stories of their culture [21]. College campuses espouse master narratives that may or may not support students. Marginalized students consider how their stories jive, or not, with the normative stories their institution's tour guides tell. Providing a platform for individual storytelling—which includes the creation and the sharing of stories—becomes all the more helpful for some students and perhaps even critical for other students. This work aims to meet this need.

Previous Storytelling at Rose-Hulman

Two of the authors include elements of storytelling in their instruction. In the first-year writing seminar for all majors, students were asked to write personal narratives that capture their experiences in a variety of contexts. Some of the writing topics included:

- Write about how you became interested in majoring in STEM: this topic focused on an early experience that inspired their interests in the field;
- Write about a shining moment in your past: this topic focused on reliving a special moment of achievement and recognition;
- Introduce your readers to a mentor who supported you: this topic often highlighted the contributions of a teacher, parent, or other mentor who helped to guide the student.

Students wrote a different story every week, first as a draft (followed by a review session with student peers and the instructor) and then as a revised text. Students did not receive a grade for their weekly writing; instead, the course focused on writing feedback that could allow the student to develop their own writing process.

In a required junior-level Thermodynamics course and in two upper-level elective courses in Civil and Environmental Engineering, students were asked to write stories in preparation for attending the Career Fair and interviewing for summer internships or full-time positions. The faculty member first modeled a story to introduce the assignments. To learn about good storytelling elements, the students deconstructed the modeled story by identifying key elements of the story including a hook, the boundaries, the transformation, and examples of sticky details.

Two class periods were dedicated to story creation where students wrote their stories, shared ideas with peers, or worked with the instructor. Students were asked to first develop a general personal story (day one of course), and a few weeks later, a story about how they overcame a failure or a story about their future selves. Students received grades for their submissions, but the focus was on providing detailed feedback on how the students handled the expected story

elements. Feedback was provided within a week so students could be prepared for upcoming job and internship interview opportunities.

While both of these approaches—the freshman writing seminar and the civil engineering approaches—seemed helpful and engaging for students, we felt there was a need to provide a platform for students to be able to share their stories more broadly with their peers, their campus community, and the world. This work is intended to fill this gap and give students voice.

Intervention Approach

Our intent for the Story@Rose podcast process was to keep the barrier for participation extremely low, while ensuring a high-quality experience for the storytellers and a high-quality product for the listeners.

In our classes, we modeled storytelling and shared guidance on what makes a story a story. We framed stories based on simple story parameters including a hook, boundaries of the context, transformation, and lots of sticky details. The stories our students prepared could be presented in approximately five minutes and were generally personal in nature. Even with different prompts, many of the stories revolved around redemptive themes of overcoming adversity of some kind.

In developing our approach to recruiting and obtaining recordings to create a podcast, we prepared processes for two different cohorts of students. First, we created a process for students whom we had taught in previous classes who could record a previously written story. This process is what we employed for our initial cohort of students described in this paper. In addition, we created a process for students who might be interested in participating after hearing the podcast or learning about the project in some way, but who did not necessarily have storytelling experience.

Initial Cohort of Students

For the initial cohort of students, we first invited students to an informal gathering to explain the purpose, process, and the research aspect of the project. Three points of motivation were offered: students may be better prepared for the Career Fair and interviewing; students could add the experience and podcast to their resumes; and through story sharing on the podcast, students could have an important positive impact on other students' experiences. The first two points of motivation were similar to what we offered students in our classes. The inclusion of the third, however, is an important distinction and a key motivator for us in pursuing this project to begin with. The podcast is an opportunity to not only put voice to the stories students write but allows the stories to be heard by others in the students' own voices.

Students were then given access to resources through our learning management system, and they were asked to record their stories in the recording studio on campus once they felt ready. We offered to help workshop story ideas, to be a listener for practice sessions, and to help with technical issues during the process. To support students in following through with recording their stories, we hosted three drop-in "recording parties" where the involved faculty and staff were available at the recording studio to answer questions and cheer on students in recording their stories. Students' recordings were then compiled by the campus learning technology office staff who provided editing services, added music, and performed voice overs to connect the various

stories and their topics. Importantly, final drafts of the episodes were shared with students before being released to give students a right of refusal for release of their story even after it was recorded. We believe this step is crucial for fostering psychological safety within the project culture.

Future Cohorts of Students

For all iterations of this work, the goal is to allow students to feel heard and to feel empowered to support each other. For future cohorts who have not had formal instruction on creating stories in one of our classes, we plan to expand our pre-recording gatherings to a 50-min workshop. As we learned from having students craft stories in class, peer-to-peer feedback is a safe way for students to take the risk of telling a story and see how it impacts their audience. Students were very capable in helping each other add important details to their stories, clarify story elements, and encourage development of critical story components.

Even while providing structure in the form a workshop, to keep barriers low for participation in the podcast, after attending a workshop and preparing an initial story draft with peer feedback, students will have the option to record an audio file on their phone so faculty can help them flesh out their stories further, as needed. Again, once students feel that they are ready to record, they can schedule time in the recording studio to do so.

Celebrating Success

To build community and support successful story creation, it is important—and fun!—to celebrate success through release celebrations. Since one key purpose of the project was to hear out loud the stories that students prepared in classes, release celebrations are an opportune time to showcase some of these student stories. Because personal narrative stories can make the storyteller feel vulnerable, it is of utmost importance to develop and nurture a culture of trust and comradery to protect the participants, and for sustainability of the project. We organized a listening party with a bonus live story from an enthused participant. In addition, we provided Story@Rose swag to students who participated, because we believe that this practice builds community and honors the participants.

Methods

We hypothesized that we could support students' sense of belonging and identity as scientists and engineers by providing storytelling opportunities. To test our hypothesis, we put a process in place for developing a student story-driven podcast. We assessed how recording stories impacted students' views of their identities and their feedback on the overall process using a pre- and post-experience survey. The survey asked students how they would describe themselves, how they felt about their identity as a professional scientist or engineer (STEM professional), and what impact the storytelling process had on them (Table 1). In the future, we plan to follow up with interviews of participants to better learn students' motivations for participating in the project and the impacts participating had on them. The survey was disseminated in our learning management system following an approved, exempt IRB protocol.

Because of the difficulty in assessing the impact of listening to the podcast (primarily a result of not being able to track who downloads and listens to each podcast episode), we focused on

assessing the impact of telling the stories, by the storytellers who recorded for the podcast. In the future, we may assess the impact on listeners.

Table 1. Survey questions for pre- and post-experience surveys.

Pre-experience survey questions:
1. Think for a second about what makes you, you. Fill in the following blank with the first five things to come to mind. 2. The rest of this survey will refer to **STEM professionals**. STEM stands for Science, Technology, Engineering, and Math. You should think about yourself as a professional in your primary major. As a STEM professional, you could be a Scientist, Biologist, Chemist, Civil Engineer, Mechanical Engineer, Computer Scientist, etc. Do you agree or disagree with the following statements: a. I am a STEM professional. b. I belong at Rose-Hulman. c. I belong in a STEM profession. d. Others would say I am a STEM professional. e. Others would say I belong at Rose-Hulman. f. Others would say I belong in a STEM profession. 3. Is there anything else we should have asked you about or that you wanted to share with the researchers?
Post-experience survey questions—same questions as pre-survey but with the following additions:
1. Do you agree/disagree with the following statements? a. Telling my story changed my view of my identity. b. Telling my story helped me to find my identity. 2. What do you think worked well about the process of telling your story? 3. What could be improved about the process of telling your story? 4. What's the one sentence summary of your story? 5. Who do you want to hear your story? My family, My friends, Rose-Hulman students, Rose-Hulman faculty, STEM students, STEM faculty, Everyone, Other 6. Who do you plan to share the episode with? My family, My friends, Rose-Hulman students, Rose-Hulman faculty, STEM students, STEM faculty, Everyone, Other 7. Do you agree/disagree with the following statement? a. I would tell my story as a podcast again. 8. What did you think worked well about telling your story as a podcast? 9. What could be improved about telling your story as a podcast?

Results

Students prepared stories through a first-year composition class centered on storytelling or a required thermodynamics course or technical elective course in civil and environmental engineering (CE) where some storytelling instruction was included in the course. Participants were solicited from these courses, and eight participants from various majors recorded their stories for the podcast (Table 2). Of those eight students, seven completed the pre-survey and five completed the post-survey. While it is impossible to assess for significant change with the current level of participation, we present our findings that share the impact of the Story@Rose podcast on our storytellers.

Table 2. Participant demographics including who completed the pre- and post-surveys. Y1 Writing refers to the first-year writing seminar. Y1 refers to a student in their first year, Y2 refers to a student in their second year, etc.

PID	Major	Story Prep	Year	Pre-Survey	Post-Survey
P1	Computer Engineering	Y1 Writing	Y1	X	
P2	Mechanical Engineering	Y1 Writing	Y1	X	
P3	Civil Engineering	Y1 Writing	Y1	X	X
P4	Mechanical Engineering	Y1 Writing	Y1	X	
P5	Computer Science	Y1 Writing	Y2	X	X
P6	Civil Engineering	CE Elective	Y5		X
P7	Mechanical Engineering	Y1 Writing	Y1	X	X
P8	Civil Engineering	Thermodynamics	Y4	X	X

Post-survey data revealed that students enjoyed telling their stories as a podcast and appreciated the intimate yet separate format that podcasting provides. When asked if they would tell a story as a podcast again (Post-9), all students agreed (2/5) or strongly agreed (3/5). They appreciated how podcasting allowed them to tell their story the way they wanted it to be told; for example, the listeners get to hear their inflections, their pauses, their sighs. Podcasting differs significantly from only seeing the story on paper (P5, P6). Participants also appreciated how recording removed the pressure that would come from telling a story publicly (P8). Sharing their story on a podcast is an opportunity to share it in an intimate setting (P3), just like a student would if they were sharing it with a friend or a family member.

Participants wanted to share their stories broadly, including with other storytellers. All five post-survey respondents said they wanted everyone–from family to peers to faculty–to hear their stories (Post-5). P5 and P8 both wished they could have had the opportunity to hear and share stories from other storytellers. They were interested in an opportunity to share story ideas (P8) as well as hear and learn from other students' stories (P5, P8). Some participants overlapped with others during the recording parties, so they knew others were also recording their stories, but at those sessions, students did not get together in groups, nor did they hear the collection of stories before they were combined into podcast episodes.

Several students noted that practicing their stories would have helped smooth out the process of recording (Post-9). Although most retold versions of the stories they had previously developed in class, some students wanted to tell iterations of stories, so they came in without practice. Students pointed out how practicing would have helped them to tell their story better (P3), deal with technical issues (P3), or help them to keep it from getting too long (P7).

We did not see a significant change in students' sense of belonging or identity, but some students agreed that it helped them to find it. Their pre- and post-rating of whether they felt they belong within STEM, their university, or as a STEM Professional (Pre-2 and Post) did not significantly change. They also did not feel that telling their story changed their identity (Post-1; 1 agreed, 3 neither agreed nor disagreed, 1 disagreed), but they did seem slightly inclined to agree that

telling their story helped them find their identity (Post-1; 3 agreed, 2 neither agreed nor disagreed).

Discussion

Impacts on Faculty

With focus on the future, we have been positively impacted by the generosity of students willing to share their stories for others to hear. As faculty, we have been specifically impacted by hearing firsthand accounts of students' decisions that make them who they are. One key lesson is that students bring a variety of lived experiences that can inform how they process information and learn new material. It can be easy for faculty to forget that students are young adults and have been sensemaking for 18-22 years already.

Impacts on Students

At our Story@Rose initial gatherings, we found that students who opted to participate felt strongly that the process of creating their stories was an important and impactful experience. Students felt driven to share their stories and were happy to join the project to showcase their work and support other students who might be moved by listening to their stories. We may learn more about their motivations to share their stories by analyzing what they share and with whom want to share.

Students described appreciation for the podcast format consistent with motivations described previously that podcasters tend to feel that there is importance in community, feedback, and continual improvement [13]. The storytellers were clearly motivated to share their stories. Many participants also wished to hear stories and get story ideas from others' at the time of or just preceding recording, which points to students being motivated by a desire for these elements described in the theory of produsage [13]. This is an important finding because it elevates the need for us to foster a sense of community around the Story@Rose podcast participants and increase the opportunities for peer feedback. This finding motivated us to hold recording and release parties and find ways to celebrate the vulnerabilities and connections the students experience by participating. In addition, students also appreciated the podcast medium because it shielded them from the pressures of performing publicly, yet still met their desire to connect with others through their story.

Moreover, our findings were consistent with findings from the Georgia Tech experience in that students wanted to share their stories widely [3]. The Story@Rose podcast fulfills this wish to connect by allowing students a platform to express what they learn about themselves through the reflection and story creation process.

Researchers at Georgia Tech also found that their storytelling course facilitated intentional development of identity and self-concept [3]. While students did not significantly *change* their belonging or identity in our study, some students' responses indicated that the process helped them *find* their identities. Based on previous work, storytelling is expected to impact identity [3], and we look to monitor if this metric becomes clearer as the project matures with development of a story community on campus and more students joining the study. While the freshman writing seminar course was story-intensive, story creation in the CE technical electives was certainly less extensive than Georgia Tech's term-long course with multiple rounds of storytelling [3].

Additionally, discovering a sense of belonging may not be as strong at Rose-Hulman because our small size and co- and extra-curricular programming already enable a close-knit community. In addition, Georgia Tech researchers found that story creation enabled students to develop increased feelings of agency, entrepreneurial mindset, and autobiographical reasoning [7], and we anticipate that our students experienced similar impacts. We plan to examine students' stories with respect to these aspects in the future.

Plans for the Future

With respect to the Story@Rose podcast, we look forward to expanding both our ability to recruit students as future podcast participants and further the reach of the podcast. Future cohorts may include students new to story creation and we look forward to testing our process for including new storytellers. Through our assessment, we will collect students' feedback on the process of podcasting using the survey and follow up with participant interviews as needed.

We will analyze the impact of students' stories with respect to agency, entrepreneurial mindset, and autobiographical reasoning since other studies found improvements. We will also consider assessing the impact of the podcast on the listeners. We may leverage interviews or focus groups for further understanding of impact. Most importantly, we look forward to sharing materials and findings to help enable other interested faculty to create storytelling opportunities to expand impact. We look forward to learning the larger impact of the podcast experience on our students as the project grows.

Conclusions

Stories are useful for sensemaking and identity development for STEM students. Podcasting is an intimate yet distanced approach to sharing stories that enables connections. Students enjoyed the medium because it afforded them agency to share their stories in an intimate format using their own voices without feeling performance pressure. Students agreed that stories are meant to be shared; they certainly wanted to share their stories with a broader audience, consistent with previous findings. While students rated no change in their belonging at Rose-Hulman or in a STEM field, some students note that the sense-making experiences in this project helped them find their identities. Our students are becoming the engineers they are meant to be by using story as an exploration tool and podcasting as a way to share and connect.

Invitation

We invite you to listen to the Story@Rose podcast on your favorite podcast player (Apple Podcasts, Google Podcasts, Spotify, Pandora, Amazon Music, etc.). The podcast episodes are also available at rose-hulman.edu/storyatrose. You may even enjoy subscribing so you never miss an episode. If you have suggestions or ideas for collaboration, please reach out to us at marincel@rose-hulman.edu, jelen@rose-hulman.edu, williams@rose-hulman.edu.

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