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”Racing the Sun”: A Narrative Analysis of Engineering Graduate Students’ Journeys Navigating Public-Inspired Science Work

Ms. Taylor Lightner, Virginia Tech Department of Engineering Education

Taylor Lightner is a Ph.D. candidate in the Department of Engineering Education at Virginia Tech, where she serves as a graduate research assistant. In addition, she is a student in the Disaster Resilience and Risk Management Program. Taylor received her B.S. in Industrial Engineering from Clemson University. Her research interests include broadening participation, interdisciplinary interactions, community engagement, and the societal impact of engineering infrastructure.

Mr. Siddhartha Roy, Virginia Polytechnic Institute and State University

Siddhartha Roy is a PhD student in Civil & Environmental Engineering at Virginia Tech. His research focuses on factors leading to failures in drinking water infrastructures; in particular, erosion corrosion of copper pipes in hot water systems. His advisor is Dr. Marc Edwards.

Dr. Jeremi S. London, Virginia Polytechnic Institute and State University

Dr. Jeremi London is an Assistant Professor in the Engineering Education Department at Virginia Polytechnic Institute and State University. London is a mixed methods researcher with interests in research impact, cyberlearning, and instructional change in STEM Education. Prior to being a faculty member, London worked at the National Science Foundation, GE Healthcare, and Anheuser-Busch. She earned B.S. and M.S. degrees in Industrial Engineering, and a Ph.D. in Engineering Education from Purdue University.

Dr. Marc Edwards, Virginia Polytechnic Institute and State University

Dr. Marc Edwards received his bachelor’s degree in Bio-Physics from SUNY Buffalo and an M.S./Ph.D. in Environmental Engineering from the University of Washington. His M.S. thesis and Ph.D. dissertation won national awards from the American Water Works Association (AWWA), the Association of Environmental Engineering and Science Professors and the Water Environment Federation. In 2004, Time Magazine dubbed Dr. Edwards the ”Plumbing Professor” and listed him among the four most important ”innovators” in water from around the world. The White House awarded him a Presidential Faculty Fellowship in 1996. In 1994, 1995, 2005 and 2011 Edwards received Outstanding Paper Awards in the Journal of American Waterworks Association and he received the H.P. Eddy Medal in 1990 for best research publication by the Water Pollution Control Federation (currently Water Environment Federation). He was later awarded the Walter Huber Research Prize from the American Society of Civil Engineers in 2003, the State of Virginia Outstanding Faculty Award in 2006, a MacArthur Fellowship from 2008 to 2012, the Praxis Award in Professional Ethics from Villanova University in 2010, and the IEEE Barus Award for Defending the Public Interest in 2012. His paper on lead poisoning of children in Washington D.C., due to elevated lead in drinking water, was judged the outstanding science paper in Environmental Science and Technology in 2010. Since 1995, undergraduate and graduate students advised by Dr. Edwards have won 23 nationally recognized awards for their research work on corrosion and water treatment. Dr. Edwards is currently the Charles Lunsford professor of Civil Engineering at Virginia Tech, where he teaches courses in environmental engineering ethics and applied aquatic chemistry.

“Racing the sun”: A narrative analysis of engineering graduate students’ journeys navigating public-inspired science work

Abstract

The role of science and engineering in society has been analyzed and debated for decades. There are calls for engineers to increasingly engage with the public to assist communities while others are opposed to or caution against such work. In order to navigate complex ethical dilemmas associated with work in the public sphere, engineers must maintain and ideally refine their social and emotional skills to improve decision-making processes. Although there are few examples in existing scholarship to build upon, this paper presents a model of public-inspired science work as an opportunity for socially relevant engineering. The purpose of this paper is to analyze three autobiographical narratives of engineering graduate students navigating public-inspired science work, applying Cruz and Kellam’s narrative analysis approach of the Hero’s Journey to reveal the students’ inspirations, challenges, and future goals. This work provides insights for others considering such opportunities as a part of engineering education.

Introduction

The role of science and engineering in society has been the subject of intense debate at the highest levels since at least the 1960s, spanning organizations including the Union of Concerned Scientists, the National Academy of Engineering (NAE) and the National Science Foundation (NSF) (Boucher et al., 2020; Hively, 1988; NAE, 2008; NSF, 1989). More recently, industry professionals, students, and faculty from various institutions participated in a March for Science on April 22, 2017 that pushed for “strengthening the bonds between scientists and the public, engaging in ongoing science education, fighting discrimination in our own institutions and our communities, and insisting their legislators propose and enact evidence-based policies” (March for Science (n.d.) in Morgan, Davis & López, 2017, p. 108). In the aftermath of the Flint Water Crisis, engineers that practice public-inspired science have been centered in these conversations (Akay, 2003; Ravesteijn et al., 2006; Cruickshank and Fenner, 2007; Edwards, 2016; Edwards and Pruden, 2016; Sedlak, 2016; Oransky and Marcus, 2017). At one level, Flint was an example of a community engagement by engineers that helped expose environmental crimes and injustice (Edwards, 2016; Edwards and Pruden, 2016a; Oransky and Marcus, 2017), allowing engineering trainees and opportunity to navigate complex terrain and consider their motivation for engineering careers (Bates, 2016; Kolowich, 2016), and at another level concerns have been expressed about jeopardizing precious funding and the social engineering contract, exacerbating power imbalances, and who is credited for success (Lambrinidou, 2016; Edwards and Pruden; 2016b; Sedlak, 2016; Roldan-Hernandez et al., 2020; Carrera and Key, 2021;). These diverse viewpoints indicate that the perils and promise of such work will continue to be debated.

Engineering education has been a leader in this call by encouraging students to participate in learning environments that create valuable knowledge, address real-world problems while upholding professional engineering ethics (Smith, Sheppard, Johnson, & Johnson, 2005). As such, there have been voluntary initiatives and programs such as engineering and sustainable development, community service, service-learning, and/or humanitarian engineering in the US (Schneider, Lucena, and Leydens, 2009). These learning models often include engineering organizations that dedicate their efforts to international community problems (e.g., Engineers Without Borders USA, Engineers for a Sustainable World, Bridges to Prosperity), and avoid domestic problems in the US that require longer-term commitment and navigation of implementation issues to bring results (Ottinger & Cohen, 2012; Brown et al., 2019).

Addressing community challenges with community engagement

Communities often face constraints of funding and limited access to technical expertise (Coyle, Jamieson, & Oakes, 2005). Engineers can help address some of these problems through community engagement, which provide students with an opportunity to immerse themselves in a complicated engineering design process or policy issue with implications for civic responsibilities. Community engagement can be a "response to inequitable distribution[s] of power and capital in a society. Examples of community engagement include philanthropic giving, volunteering, public artistic expression, or working collaboratively to solve a community problem" (Morgan, Davis & López, 2017, p. 109)**.** In engineering education, examples of community engagement include the rebuilding of decaying urban infrastructure, improving K-12 STEM education, incorporating Indigenous perspectives for land management, and fighting environmental injustices that impact low-socioeconomic communities (Tsang, 2000; Goldfinch and Kennedy, 2013; Gilbert et al., 2015; Edwards and Pruden, 2016a and 2016b; Harsh et al., 2017).

Many calls for engineers to engage with the public attempt to help "communities in need;" Schneider, Lucena, and Leydens (2009) referred to these initiatives as "engineering to help (ETH)" programs (p. 43). Riley (2008) and others argue that engineering students who possess "saving knowledge" that can solve problems and improve "communities in need" can cause detrimental results if they do not understand the context in which they are working in. Riley (2008) also argues that although the intentions in community engagement are often pure, there is often little recognition or awareness of past community engagement failures that can help new initiatives avoid harm to communities, and there is even controversy about what constitutes failure or success in an example such as the Flint Water Crisis. Schneider, Lucena, and Leydens (2009) encouraged the engineering education field to be aware of "significant critiques from fields such as development studies, feminist critical theory and cultural studies because they are useful for challenging and enriching theoretical frameworks used by ETH practitioners and guide future practice" (p. 43). Likewise, community partners and activist faculty might harm

communities, by elevating preferred narratives regardless of facts, or by turning a blind eye to citizen science misconduct (Roy and Edwards, 2018; Roy and Edwards, 2019; Roy 2020).

Walther, Brewer, Sochacka, and Miller (2019) note that an engineer's ability to work in complex, multicultural environments is influenced by empathy. For this reason, engineering community engagement initiatives should aim to foster opportunities for empathy, so engineers, while being guided by science, do not only see communities for what they lack but through a lens that sees their "multiple social, cultural, and other assets and capacities, and most of all, [the community's] own dreams and aspirations" (Schneider, Lucena and Leydens, 2009, p. 47). Achieving these worthy goals while balancing a need for scientific objectivity, truthfulness and fairness to all parties will create ethical dilemmas, and result in praise from some parties and criticism from others.

Opportunities for public inspired work

To respond to communities' current and future complex challenges, engineers apply social and emotional analysis to make strategic decisions and design with empathy. Research has revealed that engineering education does not encourage or cultivate socially relevant thoughts given the evidence of a lack of meaningful interpersonal relationships within the field (Seymour and Hewitt, 1977). Furthermore, the concerns of a culture of disengagement from social and political issues is prevalent in engineering trajectories (Cech, 2014).

Public-inspired science can include elements of 1) science as a "public good," 2) citizen science to empower people, 3) service learning, and 4) social justice and investigative science (Edwards, 2016). Allowing engineers to pursue public-inspired work can potentially be an opportunity for engineering to remain socially relevant. Public-inspired science has a premise that scientists and engineers can enter into a range of collaborations with communities that link data collection to evaluation of health risks and problem solving (Edwards & Pruden, 2016a). This public-inspired science/engineering model has the potential to make engineering a more desirable career because students can more apply engineering principles through working on real-world problems that can only be solved in collaboration with the public.

Furthermore, public-inspired science/engineering could potentially address issues of retention in engineering fields. Rulifson and Bielefeldt (2017) noted that a perceived lack of care for the public was one contributing factor for students not attracted to or leaving engineering. With a push towards ETH programs, the engineering field has an opportunity to redefine itself as "inherently creative and concerned with human welfare, as well as an emotionally satisfying calling" (NAE, 2007). This redefinition of engineering that emphasizes research outcomes over research outputs (e.g., number of papers and citations, h-index, journal impact factor, etc.) might help address retention issues of underrepresented groups in engineering (Edwards and Roy, 2016; Capobianco and Yu, 2014; Schreuders, Mannon and Rutherford, 2009). Using narrative inquiry, this paper analyzes publicly available stories of engineers, some from underrepresented

minority groups, participating in public-inspired science work and describes how they make sense of their own community engagement experiences.

Purpose and research questions

The purpose of this paper is to analyze narratives produced by graduate students inspired to cater their engineering expertise to the needs of the public. Narratives are defined as "discourses with a clear sequential order that connect events in a meaningful way for a definite audience, and thus offer insights about the world and/or people's experiences of it" (Hinchman and Hinchman, 1997, p. xvi). We utilize the narrative method because it centers on the experiences of individuals (Case & Light, 2011) to address the following research questions:

- How do graduate students describe their experiences with public-inspired science?
- What contextual and individual factors do their narratives reveal that influence the personal journey to public-inspired work?

Theoretical framework

John Dewey's Theory of Experience describes the profound interrelationship between experience, education, and life (Case & Light, 2011) and it also aligns with the narrative analysis methodology. This theory claims that experience consists of the principles of continuity (past, present, and future) and of interaction (between an individual and their environment). It emphasizes how experiences can provide momentum towards interest and motivation in one's journey. Accordingly, the experience can be fully understood only if one considers the interaction between the individual and the environment (Boklage, Coley, & Kellam, 2019). This framework is ideal for utilizing Joseph Campbell's Hero's Journey on engineers (Broome & Peirce, 1997). Campbell noted the power of a narrative in which an individual encounters a significant life problem and embarks on an "adventure" to resolve it. It provides a template with significant stages of intentional and unintentional change as students navigate their personal accounts of public-inspired science work.

Methodology

The autobiographical narratives analyzed in this study represent three engineering graduate students' journeys in navigating public-inspired science as members of the Virginia Tech US Water Study research team. The students all completed a course "Engineering Ethics and the Public" co-developed by an engineer and medical anthropologist with funding from the National Science Foundation. As part of the course or their graduate experience, students engaged with the public in an on-going ethical dilemma. Some students delivered a monologue of their experiences at a live event produced by the US Water Study team and Story Collider, a non-profit that "helps people […] tell their true, personal stories about science," (Story Collider, n.d.) and was open to the public. The stories showed the diverse motivations, impact, and

experiences when engaging in engineering work that addresses the public's needs. The narrative analysis was guided by Cruz and Kellam's (2017) approach and used Joseph Campbell's Hero's Journey as a coding scheme for the participants' stories (Table 1).

Table 1. Coding Scheme for Narratives

Monomythic code	Interpretations inspired by Cruz and Kellam (2017)
Call to Adventure	A indicator that started the participants' public-inspired experience
Supernatural Aid	Any assistance the participant received that gave them the courage to pursue public-inspired work.
First Threshold	The first challenge that arose and complicated the public-inspired work.
Belly of the Whale	A transformative experience that caused the participant to never want to be the same.
Road of Trials	The series of events that the participant witnessed once they engaged with this work.
Meeting with the All-Knower	The all-knower is a person who conveys essential knowledge to the participant that aided them to find resolutions through the experience.
Meeting with Temptations	When the participant experienced something that distracted them from the overall goal of this public-inspired experience.
Apotheosis	When the experience of public-inspired work became their new normal or the climax of the narrative.
Ultimate Boon	When the participant felt as though public-inspired work was their life's purpose
Return Threshold	Noted if the participant mentioned going back to the world and cultures of engineering the way they knew it before the experience.
Master of Both Worlds/Freedom to Live	When the participant is able co-exist in both the "real" world and the world of engineering. This was their reason for being attracted to public-inspired work. They may mention something in relation to code-switching to the identity of a space they are in.

Data collection method: Context and participants

This event was held on the Virginia Tech campus on March 1, 2019 through a joint collaboration between the US Water Study team and Story Collider. The US Water Study team is hosted in the Department of Civil and Environmental Engineering, and led by faculty (Drs. Marc Edwards, Amy Pruden, and Siddhartha Roy), and citizen scientist from Flint MI, Ms. LeeAnne Walters. Story Collider is a nonprofit organization whose purpose is to share "true, personal stories about science." Their beliefs are centered on the idea that science is essential in everyday

life and storytelling impacts the way science is conceptualized. They collect stories and disseminate them to various audiences to make narratives easily accessible to communities of interest (Story Collider, n.d.).

The audio recordings of this event, available for free on Apple iTunes (US Water Study, 2019), were transcribed through Temi. Of the five available recordings, three stories were selected to be analyzed. One excluded narrative consisted of two storytellers, and it was difficult separating their personal narratives from each other. Another narrative was randomly selected to be excluded from this analysis to account for limited space. The storytellers, chosen by story and research mentors (co-authors MAE and SR on this paper), had diverse experiences and academic backgrounds (Table 2).

Table 2. Storyteller's information

Storyteller	**Race and Sex**	**Educational Background at the time of the event**	**Community Engagement Experience**	**General Research Area**
#1	Black female	Material Science & Engineering, B.S.	Lead in drinking water in Cicero/Berwyn IL	Lead in drinking water and public trust in scientist-community collaborations
#2	White female	Environmental Engineering, B.S. Biological Systems Engineering, M.S.	Appalachia roadside spring water quality	Drinking water quality and source water selection in Central Appalachia
#3	Black female	Biosystems Engineering, B.S. Construction Engineering and Management, M.S.	Demark, SC water crisis (2008-18): poor water quality due to the adding of illegal pesticide Halosan to source water wells.	Efficacy of point-of-use and point-of-entry filters and the barriers hindering their widespread adoption in at-risk communities

The storytellers were given three months to write their narratives with the target event date of March 1, 2019. They met with their story mentors (co-authors ME and SR on this paper) in November and December 2018 to discuss ideas and preliminary monologue content, followed by phone meetings with two Story Collider coaches every other week starting mid-January until the event to discuss experiences they thought were essential to their personal stories and crafting their monologues. They were asked to deeply reflect on their role as engineers and scientists in society and contrast their ideals to real-world experiences and challenges while working with

their respective communities. The storytellers were further advised to hone in on one central message that they wanted the audience to take away with them, and attempt to mold their story around that message. The monologues were performed without notes and were all less than 10 minutes. Finally, the team met for a grand rehearsal one day before the event with mentors, Story Collider coaches, and each other.

Data analysis method

The graduate students' pre-constructed narratives are considered data in this retrospective study. Cruz and Kellam's (2017) narrative analysis approach was utilized to uncover patterns that were common across the narratives. The first stage of this approach consisted of the lead author (TL) becoming familiar with the recorded audio and transcripts through multiple passes. Through this stage, we were able to identify each participant's self-selected events within their journeys. Next, these events were coded using *a priori* codes from Cruz and Kellam's (2017) modification of Campbell's 16 monomythic codes (Table 1). These codes were further revised to match the interpretation of public-inspired science stories (Table 1). This analysis process was chosen to identify patterns and commonalities (or differences) across different graduate students' narratives. The last stage of this analysis was member checking (Borrego et al., 2009): participants were asked how they want this information to be presented in the study. Furthermore, they were able to review the coding analysis and provide input.

Limitations

The pre-constructed narratives limit these findings because there were constructed to depict their entire navigation towards public-inspired work. Therefore, the stories were not created to be analyzed in this paper. They were created to be disseminated to a broad, diverse audience. This method limits the amount of information that can be extracted from the participants. It is also important to note that these personal experiences with public-inspired science were early in the students' graduate career, and that many of the students continued to participate in other citizen science projects and later produced documentaries of their work (Battle, 2020; Kriss and Hockman, 2020; Patton, 2020; Purchase, 2020; Lopez, 2021).

Measures of quality

In this study, participant narratives were interpreted by a researcher (TL); the following measures of quality were implemented to reduce the bias of these interpretations. First, these narratives were written by the participants and recited in monologue form. This structure mitigated some potential bias that could come from the researcher interpreting and applying structure to the stories. Second, member checking was implemented in the final stage of the data analysis to ensure that the interpretations were an accurate depiction of their experiences.

Findings

Theme 1: The students appeared to have innate motivation to do public-inspired work prior to joining the US Water Study Team.

Monomythic Codes: *Call to Adventure* and *Belly of the Whale*.

Participant 1 was inspired to use her engineering knowledge to benefit the public for personal reasons. Her *Call to Adventure* came when she experienced a major disappointment regarding her fertility. Participant 1 explained how, growing up in poverty, no one in her circle went to the doctor, except when they perceived that they were gravely ill. When she did go to a gynecologist for her first women's check-up at 17 years of age, she learned that her uterus had never developed. This disappointment was coded as the *Belly of the Whale* portion of the narrative because it was an experience that truly changed her life forever. Following this revelation, she sought opportunities to make sure children would not grow up in poverty as she did, and applied to college. Through an internal dialogue, she was able to clear this hurdle by going on an *adventure* to create a uterus. She explained:

> *So I said, "Okay, doc, okay, family, okay, ma, I don't have a uterus. Okay, God. I know what you want me to do. You want me to create one." Yes, I said it. "You want me to create an artificial uterus. I can do that. No problem." So I went to Virginia Tech. I studied material science engineering, long, I guess. I studied material science engineering with a biomed concentration and I was going to make that artificial uterus. Only, I didn't. Thank goodness I picked up some skills along the way.*

Participant 1's story reveals that some students come into engineering with the motivation of doing public-inspired work in disadvantaged communities. In Participant 3's case, while struggling for inspiration in her engineering program, she heard the story of an elderly African American couple from Denmark, SC in her engineering ethics class: Denmark residents had been fighting discolored and unsafe water for 10 years and were repeatedly dismissed by the authorities. Participant 3 volunteered to visit Denmark, SC on a water sampling trip out of curiosity. She emphasized, "The story was so bizarre that I wanted to see it for myself." During the visit, the community members' stories came to life and she saw them as more than just people trying to get safe water; she saw them as her family and grandparents that she had just not met before. This motivated her to gain a deeper understanding of the work she was doing in her research:

> *I adopted Denmark for my class study after the trip and I went through that binder that were all the records [the elderly couple] collected. I was looking for evidence of historical documents to give some context to this injustice they experienced*

This was coded as her *Call to Adventure* and it transpired because she cared deeply about Denmark residents being impacted by a potential injustice.

For students like Participant 2, doing work that is explicitly catered to helping communities is the very reason they were attracted to engineering. She expressed her excitement thus,

> *A couple of months ago, I got an email from one of our community partners asking if I'd be interested in a community drinking water quality meeting in McDowell County, West Virginia. For an engineer, that's working with Appalachian communities on drinking water, this is like the jackpot of all opportunities.*

Describing this opportunity as the "jackpot of all opportunities" reveals that students are not trying to always tailor their experiences to corporate jobs or pad their resumes. The chance to potentially assist with characterizing and/or fixing problems and positively impact a community's future is intrinsically fulfilling and, therefore, reason enough to do hard engineering work.

***Theme 2*:** The students often encountered internal fears and past struggles that challenged their propensity to be effective in public-inspired science work.

Monomythic Codes: *First Threshold, Road of Trials, Meeting with Temptations,* and *the Belly of the Whale*

In Participant 1's case, she provides a detailed account of the poverty she experienced at a very young age and how she was consistently looking to escape. She said,

> *I was racing the sun. I was racing the descent into darkness. You see, where I grew up, electricity, food to eat, clean water much less water in itself that was a privilege.*

This understanding of her circumstances at a very young age ignited hope and self-directed efforts towards a better future; for this reason, the experience was coded as her *First Threshold*. She then experienced more personal trials (detailed in Theme 1 above) that led her to pursue engineering. After not being able to create an artificial uterus, she worked as an engineer for a while but still sought to make an impact on the public. She quit her engineering job to become a teacher but that still did not feel enough. Unfulfilled in her desire to impact the lives of children like her, she adopted two boys. She then found herself going back to engineering due to the salary necessary to provide for her children. This event reveals how engineering can provide opportunities for social upward mobility, including for underrepresented populations. Yet, there was no personal fulfillment. She found her proverbial light at the end of the tunnel when she ran into a professor (co-author ME on this paper) in an elevator during a "Beloved Community" meeting who alerted her to an opportunity for research. This chance encounter experience was coded as *Supernatural Aid*. She was offered a spot on the US Water Study team and the five words, "you will change the world", which directed her efforts towards public-inspired science.

Each storyteller had a distinctive *Road of Trials* in their journey. However, each narrative ultimately deals with the struggle of being one's true self. Public-inspired science allows these

students to find outlets and do the work they imagined themselves doing as effective engineers. Participant 2's *Road of Trials* consisted of her driving the country roads to West Virginia for a meeting for a meeting with community members concerned about their drinking water quality. The *First Threshold* was noted when she tried to get more information about the meeting, but the community partner did not know where the meeting would be. This triggered a worry of personal safety in her as she awaited further instructions but that did not stop her from embarking on the journey. She stated, "I'm sitting in my cubicle and I'm weighing my options and I'm thinking, all right, like, I don't know where I'm going. I don't know who I'm going to meet here. Yeah. Alright, I'll do it."

This navigation of community engagement reveals that the journey may not always be clear and neatly laid out, but it is still worth the time and energy as any worthwhile journey in life. She got lost but eventually made it to her destination. Participant 2 felt immediately welcome when she made it to the community meeting and described what she believed an engineer's role should be in these circumstances—a listener:

> *I just start listening. People are telling me different things about their water quality, about what their water tastes like, what it smells like, what it looks like. But they're also telling me about, rashes and spots and scars that they have that they think is related to their water quality. And they're telling me where they're getting clean water because they can't get it out of their tap. But we're not just talking about water quality. We're also talking about their kids. We're talking about their families, their houses, what they do for work, what it was like growing up in Appalachia. And I'm making friends at this meeting, I'm not just meeting people that I'm supposed to be doing research with. I'm making connections.*

Through listening, she was able to bridge the gap between researchers and communities (Lambrinidou et al., 2014) because she saw them as human beings. This can be a challenge in a field where objectivity is the main goal in research. Participant 2 struggled with carrying the emotional anguish of the community members as she drove back home from her meeting; this was coded as the *Belly of the Whale* portion of the journey:

> *We made plans to test their water but I couldn't stop thinking about this one couple. They have three young kids at home all under the age of eight. They were worried about the health and safety of their kids with the water that they have access to in their home. And probably more than we can imagine, there are parents in Appalachia and across the US that unfortunately do have to worry on a day to day basis if the tap water that they're providing for their kids is poisoning them. That's a heavy thing but that's also part of making connections with people. When you make connections with people, you get this window into their lives and their struggles.*
>
> *As scientists and engineers, that's important for us. That's our why. When you have a window into someone's struggles, you can't help, but internalize some of those struggles*

yourself and that's what motivates you to keep doing your research and to seek solutions. But it also weighs on you because you're not just living your own life, you're kind of living the struggles of the people you're working with.

As shown in Participant 2's narrative, internalizing the struggles of community members can also be a source of motivation towards doing relevant engineering. Thus, Participant 2 sees the public's challenges first-hand and empathizes with them, although psychologists have made the case that such emotional empathy can be a poor guide for decision making (Bloom, 2017). Participant 3 also struggled with empathizing with her community partners, who, as discussed in Theme 1, she considers family. This became a hindrance when writing a scientific report on Denmark's water quality where she began to question her credibility which is coded as the *First Threshold*:

I was looking for evidence of historical documents to give some context to this injustice [the elderly couple] experienced, but when it came to writing up my findings I began to freeze. I'm just a 24-year-old engineering PhD student. Of course, I spent hours and months doing research on this but, still, ten years ago when all of this began I was just 14 years old when the couple first started noticing brown and stinky water from their taps. Who was I? I questioned whether or not I was even doing the right thing. It was an ethics class after all. But what bothers me is that 14-year-old me wouldn't have questioned it at all. I was a feisty little thing who would have helped these people no matter the cost. I wouldn't have known how to help and nor would I had the power to do anything about it, but 24-year-old me has been trained as an engineer for the past seven years where engineers must be objective and impartial. We must present facts with hard evidence. We leave out opinions and minimize emotions because emotions make you biased. And if you're biased, you jeopardize your credibility. Essentially, I think that we're taught to minimize our humanity. But the real question is was I too emotionally involved? Was this ethical? As you can see, I struggled. I struggled to be objective as possible.

This struggle to be objective is a common experience in engineering disciplines. In Participant 3's training to be an engineer, she considered a lack of emotion, in the way it is presented in modern engineering education, as being trained to "minimize our humanity." This one-sided struggle may push some out of engineering, but through this public-inspired work, Participant 3 felt she could maximize her humanity. If we want students to be able to be their authentic selves in engineering disciplines and be socially relevant, we must create experiences where their humanity is valued and respected while also using objectivity to pursue the truth about a problem facing a community.

Theme 3: The students have dedicated their graduate professional life to public-inspired science and are seemingly exploring future careers that involve more public-inspired undertakings.

Monomythic Codes: *Apotheosis, Ultimate Boon, Meeting with the All-Knower, Master of Both Worlds/Freedom to Live,* and *Return to Threshold.*

Participant 1's first assignment was to go to Chicago, a location that "lead the nation in lead service lines but they also lead the nation in lead-poisoned children." To Participant 1, this opportunity to go to Chicago, coded as the *Apotheosis,* was exactly what she was looking for and the impact she imagined herself having:

> *This was a way for me to use my engineering degree to tap into that nine-year-old girl that knew what it was like to be the most vulnerable and to try and give back in some way. This was my way to love any child.*

Similar to Participant 2's *Call to Action*, this was the singular opportunity these students were looking for when they came to engineering. Participant 1's story ended by emphasizing that this gravitational pull towards addressing the public's needs was her purpose; this was coded as the *Ultimate Boon*. After two years of working in Chicago, Participant 1 imagined going to other places in the US in the future and this would be her opportunity to "prevent anyone else from descending into darkness." This is an altruistic motivation to persist in engineering and public inspired science work.

Impact is an essential topic of study within the field of Engineering Education along with interest and motivation. These students have revealed the importance of this work by sharing their personal experiences. The students in this dataset did not come to any ultimate resolutions in their Hero's Journey because their stories are ongoing. Participant 2 asked her advisor in Biological Systems Engineering, "When do you stop feeling bad? When do you stop internalizing the struggle of the people you are working with, when do you stop feeling so bad about it all?" This questioning was coded as the *Meeting with the All-Knower.* Since in these situations, the advisor and community members are the perceived experts of these experiences. Her advisors' response was, "You don't, but that's a good thing." Participant 2's story ends here, and this was coded as her *Return to Threshold.* It's clear in this story that she may never stop struggling internally with being an engineer while doing public-inspired science work and that discomfort is something she has to be okay with to continue to do this work. Participant 3 also had to come to a similar realization when she said,

> *I was so concerned about being so young and inexperienced and feeling under qualified, even though I am, as I take on something so much bigger than myself, but I just can't afford to do that anymore. To question myself, to freeze, to shrink back and wait for someone who is more fit to do this, because [the elderly couple] already had to wait ten years for a 14-year-old girl to grow up.*

If relevant expertise can be marshalled, being overwhelmed by imposter syndrome and self-doubt that come with this work could unnecessarily prolong the communities' fight and suffering and even delay resolution and/or justice.

Implications

It is evident that many students are motivated to do public-inspired work even before entering an engineering classroom and forge careers in this domain. The literature has historically focused on motivational or logistical challenges that engineers face when engaging with communities (Niles et al., 2020; Boucher et al., 2020; Bielefeldt & Canney, 2019; Garibay, 2015), as opposed to personal experiences and public-inspired work of engineers that were captured in this paper. Underrepresented students, who have experienced social suffering might be more inclined to pursue careers that address equity ethics (Naphan-Kingery et al., 2019). This work reveals how public-inspired experiences with diverse communities might help in maintaining motivation and retaining (underrepresented) students in engineering.

The storytellers also demonstrated key knowledge skills necessary to engage with the public and described the internal obstacles they needed to overcome to be effective. They were able to step out of the conventions of engineering and achieve their definition of success or engagement through public-inspired science work. Engineers' work influences countless lives; however, most engineers may feel underqualified in engaging with diverse communities in meaningful ways—based on the current student outcomes (knowledge, skill, and attributes) outlined by their ABET training standards (ABET, 2018). The current standards include skills like considering context, communicating with a range of audiences, and recognizing ethical responsibilities. However, Engineering Education researchers have highlighted how these standards under-emphasize the critical outcomes necessary to engage with diverse communities (Lucena, 2013; Riley, 2008; Cech, 2012; Leydens & Lucena, 2017). Most interestingly, the necessary skills were still illuminated in these students' narratives.

In the future, more research is needed to understand how community engagement impacts a student's development of ethical responsibilities and struggles stemming from ethical dilemmas, and the benefits and detriments of such work to the communities and the profession. This research would provide much-needed insight into how engineers can incorporate ethical decision-making in their engineering identities. Research on the career trajectories of undergraduate engineering students participating in public-inspired science work could also provide insights into how these experiences impact the way they pursue and perceive their engineering practice. Some students might even aspire to such work throughout their traineeship and careers benefiting the communities they inhabit or work in.

Conclusion

This study reviews an avenue for community engagement to be a prominent role in science and engineering within society. Public-inspired science can establish a direct connection between scientists and the public and provide opportunities for scientists and engineers to create

evidence-based policies with communities when executed properly. It is evident in this review that engineers value this work but unfortunately, the narratives analyzed in this work appear to be anomalies within the typical range of work that engineers engage in. Public-inspired work can allow (underrepresented) students to passionately utilize engineering for the common good and even address social inequities. As engineering educators, we should find and create valuable opportunities to engage with disadvantaged communities, if we believe service is central to engineering, and use these collaborations as potentially transformational training for our engineering students.

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Conflicts of interest

The authors declare no conflicts of interest.

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