Reauthoring Engineering Identities as Belonging to a Community Engaged Profession

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Abstract: In this scholarly practice paper, we critically examined if and how engineering students in a first-year design course internalized their professional identity as engineers who were engaged in their communities. We describe the course, which used human-centered design projects as a mechanism to partner with community organizations. Based on a thematic analysis of three reflective essays (n = 105) for each student (n = 35), we found four distinct patterns related to identity development in relation to community engagement. We discuss implications from the findings regarding how educators can support students' development as community-engaged professionals.

With this paper, we tell the story of a first-year engineering design course that is used to teach human-centered design through community partnerships. Specifically, we systematically consider how the curricular choices made in the course affect the professional identity development of students. Although a central aim of this particular course is to foster students' identity development as engineers and whole persons who are engaged within their communities, we recognize the local curricular decisions of this particular course are embedded in a complex scholarly dialogue surrounding engineering and community engagement. On the one hand, service-learning and community engagement have enjoyed widespread attention and recognition as powerful examples of engineering education. Yet, on the other hand, critical scholarship has argued that the professional norms and ideals within engineering as essentially disconnected from the community stakeholders who are most affected by engineering practice.

The purpose of this paper, then, is to critically examine if and how the curricular decisions of a first-year engineering design course enabled students to identify as pre-professional engineers who desire to be engaged within their communities. As authors, we each occupy a role in relation to the administration of the course. The first author has served as the course coordinator and an instructor for the first-year engineering design course since 2015. And the second and third authors were teaching assistants in one of the semesters that the course was offered. However, although each of the authors is part of the instruction team, we maintain an analytic tone throughout the paper, reflecting on the complexity of how curricular activities interacted with students' professional identities.

The intent of this paper is not to define a localized set of curricular decisions as a "best practice" in relation to community engagement. Rather, we aim to generate constructive dialogue regarding engineering educators who are fusing engineering with community engagement. In what ways might these curricular experiences inadvertently reinforce traditional scripts of engineering as a socially disconnected profession? And what are the opportunities to help students reauthor their identities as engineers who are engaged within their communities?

Background

To define community engagement in the context of educational partnerships, we adapt the definition provided by the National Institute of Health regarding community engagement in research. That is, we conceptualize community engagement as "a process of inclusive participation that supports mutual respect of values, strategies, and actions for authentic partnership of people affiliated with or self-identified by geographic proximity, special interest, or similar situations to address issues affecting the well-being of the community of focus" (p. 1383) [1]. As noted in the definition, community engagement is a dynamic relational process rather than a static transaction of services.

Prior literature within engineering education research shows that community engagement is an orientation that is often valued within the engineering domain [2-5]. National networks such as EPICS [5, 6] and Engineers Without Borders (EWB) [4, 7] have provided frameworks and training to integrate a focus on community engagement through designing engineering projects. And indeed, the first-year engineering design course that is the focus of the present paper was, itself, adapted from the Purdue EPICS program based on the lead author's previous experiences of instruction and course administration in the program. Some have characterized the nature of community engagement within engineering as primarily connected to engineering projects that are completed by students to gain insight into design and other professional skills [3, 5, 8, 9]. Additionally, within the engineering profession broadly, there have been consistent calls for engineering within the United States to adopt a posture that is more empathetic toward stakeholders of their practice [10, 11]. Engineering programs that incorporate elements of community engagement are often seen as facilitating a professional orientation among engineering students to enact their career roles as more profoundly connected with the stakeholders of systems that they are to design.

However, running counter to the narrative of engineering as an engaged profession is the dominant narrative that the engineering profession promotes a culture that prioritizes individual merit [12, 13] and is disconnected from the social environment that it is embedded within [14, 15]. Such a perspective is well-articulated by Faulkner, "At the core of engineers' identities and engineering practice lies a sense of the technical which specifically excludes the social" (p. 763) [14]. Critical scholarship has helped to elucidate problematic and sticky features of the engineering cultural narratives, highlighting how professional education often perpetuates messages that prioritize individual agentic outcomes rather than facilitate communal relationships.

Master Narratives Framework

To make sense of the juxtaposition between the dominant narrative of what it means to be an engineer and the aspired narrative of the community-engaged engineer, we rely on the master narrative identity framework [16]. As put by McLean and Syed, master narratives are "culturally shared stories that tell us about a given culture, and provide guidance for how to be a 'good' member of a culture" (p. 320) [16]. They note that an individual's personal narrative of identity operates in negotiation with relevant master narratives that characterize groups that the

individual must contend with (e.g., an engineering student's personal identity in relation to what they perceive it means to generally be an engineer). In negotiation with the master narrative, an individual might find that they align with an alternative narrative that runs counter to the master narrative. However, the alternative narrative might surprisingly buttress the strength of the master narrative [16].

In the context of the first-year engineering design course that we examine in the present paper, we might consider the master narrative to be that an engineer is someone who is technically competent and professionally separate from a broader group of other individuals. The idea that engineers can be culturally conscious and socially connected individuals through processes of community engagement is an alternative narrative that is derived from the master narrative. In education, we educators who aspire that community engagement can be mainstay orientation for engineers might unintentionally support the master narrative through messages that we convey. For example, we might convey that, by default, engineers are disconnected from the community, but that students can aim to be a different kind of engineer that is relationally embedded in their context. By conveying such a message, we might unintentionally indicate to students that "real engineering" involves technical competence and a disregard for people. How, then can we shift the default of what it means to be an engineer through community engagement experiences? How can we help students reauthor their professional identities as belonging to a profession that is essentially—and not extraneously—engaged within communities?

We examine our attempt to guide students into reauthoring what it means to be an engineer in the context of a first-year engineering design course. We begin by describing the institutional context of the course.

Context of First-Year Engineering Design Course

The course that occupies the focus of the present paper is known locally as Introduction to Engineering and is offered in the fall semester at Harding—a private, non-profit, religiously affiliated, teaching-focused university. It is a required course in the degree plans for five engineering majors that are offered at the university: biomedical, civil, computer, electrical, and mechanical. Typically, students are enrolled in the first-year engineering design course in their first year of undergraduate. Almost all of the enrolled students would have only graduated from high school in the previous spring.

The university carries an unequivocal religious affiliation, and students enrolled in the course are also experiencing other activities that facilitate dialogue around their faiths. The culture of the university tends to embrace holistic thinking toward identity, where decisions about career and academic outcomes are linked to faith and spirituality. Although we authors have developed this paper to reflect the context in which we naturally find ourselves, we also note that this context provides a unique opportunity to generally examine identity-thinking within first-year curricula. The context of the first-year engineering design course places students and instructors in a juxtaposition of two cultural paradigms of thinking about identity: one that prioritizes faith as a central framework to inform professional identity (institutional culture) and another that prioritizes a rarified form of technical competence (engineering culture).

Description of First-Year Engineering Design Course

We begin our description of the course by stating the enduring understanding that underpins the curricular activities. As put by Wiggins & McTighe [17] the term *enduring understanding* refers to "the big ideas, the important understandings, that we want students to 'get inside of' and retain after they've forgotten many of the details" (p. 10). In the first-year engineering design course, *we desire for students to author their roles in engineering as individuals who live out a community-engaged practice and who connect their professional role to their central values as holistic individuals*. To that end, we have framed the course to be anchored in an extensive design experience that is facilitated through community partnerships.

Since 2015, the course has been offered in three different sections, including one honors section. Each section is partnered with a different community partner in order to generate conceptual solutions that address authentic problems or opportunities that are experienced by the community partners (see Table 1). Within a section, students are divided into teams of three or four students, and each project team works with the community partner to design a relevant solution. Examples of these projects are included in the table below.

Table 1: Design tasks and example projects associated with each course section

Community Partners (Course Section)	**Design Task**	**Example Projects**
Habitat for Humanity (Section 1)	Design a solution to problems that stakeholders regularly experience at the local ReStore.	• A disposal system for transporting waste that accumulates from rejected donated goods • Workspace to repair damaged items that are donated
Elementary School (Section 2)	Design an educational playground system that can be used by students for free play and also for aiding instruction in science or math concepts.	• Playground system that teaches concepts related to weather/climate • Playground system that teaches concepts related to sound
Poverty Simulation Center (Honors Section)	Design a learning system that helps visitors of the center learn about conditions of chronic poverty in majority world settings and common approaches to improving these conditions.	• A learning system that teaches visitors about conditions and solutions related to food storage • A learning system that teaches visitors about solutions related to physical disabilities that reduce mobility in rural environments

One section is partnered with the local Habitat for Humanity chapter and works on problems that are experienced by stakeholders at the local ReStore, which is a store that sells donated items in order to help fund local housing construction projects. Another section partners with a local elementary school to conceptually design educational playground systems, which we define as a physical system used to teach a concept or set of related concepts and foster desirable forms of play between 2 or more individuals. Finally, the honors section partners with an outdoor poverty-

simulation center that is owned by the university, which is often used to train various professions that would interact regularly with majority world environments. They partner with the organization to design systems used to help visitors to the center learn about various problems that accompany poverty along with common solutions to these problems.

Student teams learn to follow the human-centered design process that has been documented previously by the Purdue EPICS program [18], and they primarily focus on developing specifications through human-centered methods and generating design concepts. The project is completed over the course of twelve weeks. We intentionally launch the project in the third week of the semester to allow the instruction team time to form the student teams and coordinate with the community partners on desired projects. We end the design project by the penultimate week of the semester to allow students and the instruction team one week to reflect on what was learned throughout the design experience.

Throughout the course, students interact frequently with community partners through structured, semi-structured, and unstructured mechanisms. The course structures four significant opportunities for the students to interact with the community partners. Toward the end of the second week, students in each class visit the site of the community partner to learn about their respective mission to improve the local community. In this visit, students meet key stakeholders with whom they will be interacting throughout the remainder of the semester. Furthermore, the students deliver the status of their design work directly to the community partners with the aim of evaluating how well the students' work aligns with the experiences and viewpoints of the community partners. These design reviews occur during the eighth week and twelfth week of the semester.

In the first design review presentation, students present how they understood the focuses of their projects through their interviews with community partners and observations of the setting. They also presented how the requirements and specifications that they developed connected with the stakeholder experience. In the second design review, the students present a single system-level design concept that they have determined, after iterations of interacting with the community partner, to best meet the partner's needs. Finally, after receiving feedback from the community partner in at least two design reviews, the students generate a rapid prototype with materials of their own choosing in order to demonstrate the spatial and functional features of their concept. Students from each section present these conceptual prototypes to their community partners in a single showcase held on an evening at the end of the fourteenth week of the semester.

Although the instruction team facilitates at least four significant interactions between the students and the community partners, students must also interact through other means in order to satisfy the course requirements. Students in sections that are partnered with either Habitat for Humanity or the local elementary school are required to volunteer at least five hours with the partner at times of their own choosing. Students in the honors section who partner with the poverty simulation center interact with the partner at a notably immersive level by participating directly in the simulations throughout a single weekend. Through these interactions, students gain an internalized sense of how their design activities interact with core values that are held by their section's community partner. Additionally, students from each team must complete

multiple unprescribed interactions with community partners to successfully complete the requirements of their project.

While these projects are also meant to develop students' design skills, we focus the discussion of this paper on how the projects enable students to identify as engineers who are engaged in their communities. However, to summarize the design learning that accompanies these moments of community interactions, we outline an overall schedule of the twelve-week design activity in Table 2.

In order to assess the learning that was related to student identity development, we assign three reflective essays throughout the semester. The first reflective essay, submitted in Week 2 of the semester, prompts students to reflect on how they came to the university as an engineering major. Students are prompted to examine their journey holistically and are given full credit for elaborating on reflective claims with specific autobiographical examples. The second reflective essay, submitted in Week 13 of the semester, prompts students to consider what they have learned about their role as engineers and how they envision their role to connect (or not) with their core identities, particularly in relation to faith or core values. The final reflective essay, submitted in Week 15 of the semester, prompts students to evaluate holistically what they learned about engineering itself, how they learned it, and how they envision themselves moving forward (or not) in their professional domain. We assessed these reflective essays in relation to their reflective quality, that is, how well-evinced reflective claims were supported by recounted autobiographical narrative [19].

Assessment Question and Methods

In order to evaluate if and how the design project was supporting the central aim of the course—to foster identity development within students as community-engaged professionals—we conducted a systematic assessment of the reflective essays that were described in the previous section using thematic analysis [20]. We anchored our assessment in the following questions:

- Q1: How do students describe their identity as engineers in relation to being engaged within their communities?
- Q2: How do students develop in their identity-thinking throughout the course of the semester?

Our analysis procedures began with organizing the three reflective essays into a structure that allowed for the analysts to read the essays by any individual student in a sequence across three time periods. If a student did not submit a certain reflective essay, they were not included in the analysis. Although the course included 44 students who were split across the three sections named in Table 1, we analyzed 105 total reflective essays that were written by 35 students due to submissions that were missing from nine students. The essays were divided between the second and third authors of this paper, both of whom were teaching assistants in two of the three sections in the course. In order to ground our findings in data from the reflective essays rather than interpersonal experiences with the students, the second or third author only analyzed students that were not in their designated sections.

Table 2: Schedule of learning and community interactions that occur in a team's design project.

Week in Semester	Student Interactions with Community Partner	Design Learning
Week 2	**Initial site visit** with the community partners.	
Week 3	**Student-led visits** with the community partner to volunteer or gain more information about the design problem.	**Project identification**. Student teams develop a project charter based on their visits
Week 4		
Week 5		**Specification development**. In this phase, students in each team: ● develop requirements based on interviews with a range of stakeholders, ● describe the problem based on observations and simulations of the stakeholders' experiences, ● generate profiles of 3-4 diverse stakeholders that are affected by the problem.
Week 6		
Week 7		
Week 8	**Design review** delivered to community partner stakeholders regarding background research on requirements and stakeholders.	
Week 9	**Student-led visits** with the community partner to volunteer or gain more information about the design problem.	**Conceptual design**. In this phase, students in each team: ● generate 30-40 conceptual sketches per group using systematic ideation techniques, ● sketch 3 potential system-level design concepts that best align with the stakeholder experiences, ● use a decision-making matrix to evaluate each possible design concept in relation to the requirements ● use readily available and low-cost materials to construct a functional and spatial prototype of their concept.
Week 10		
Week 11		
Week 12	**Design review** delivered to community partner stakeholders regarding the conceptual solution	
Week 13		
Week 14	**Design showcase** where students display proof-of-concept prototypes to community partner stakeholders.	

The first author initially met with the two analysts to discuss a scheme that could generally code the data based on his prior work in identity research [21-23]. Specifically, the two analysts would code statements of the essays that were related to the following identity relevant constructs:

- *global-identity*: Statements that answer the question "who am I?" in relation to core values.
- *engineering-beliefs*: Statements that describe conceptual beliefs that the student holds in relation to engineering.
- *engineering-identity*: Statements that describe how the person understands themselves to be an engineer (or not).
- *course-activities*: Statements that connect activities of the course to changing the perception of engineering beliefs or identity.
- *conscious-development*: Statements that contrast the current version of self to previous self.

Each analyst would apply codes to a sequence of three documents that were written by a single student. After the three essays of one student were read, the analyst wrote an overarching summary pertaining to that student's development in identity-thinking. The codes that they had just applied to the students' reflective essays served as a filter to structure how the analyst generated the summary of the student's identity development [24]. Every summary was generated in a single document so that summaries from every student could be read and discussed by the author team.

After the second and third author completed their analysis of each student, the lead author reviewed their findings as indicated in the coded documents and identity summaries of each student. The author team then met to identify key themes of identity-thinking that were grounded in the reflective essays. Once they identified the four themes that are discussed in the next section, they reviewed the summaries and documents once again to articulate key connections between student reflections and the themes. The approach to data analysis aligned well with the focus of the central questions (Q1 and Q2) that were stated earlier in the present section. We were particularly examining connections between curricular experiences that were afforded by the first-year engineering course and transformative patterns of identity development within students. However, we do note the substantial limitations of using reflective essays that were prescribed as assigned tasks when analyzing identity development. While we did find that analyzing the reflective essays provided coherent and grounded explanations of identity development, we also recognized that the depth of the data was likely mitigated by the possibility that students were concerned about completing a course requirement in addition to authentically reflecting on their curricular experiences.

Findings

Based on our thematic analysis of the reflective essays, we identified four themes that characterized how the design experiences within the course connected to the professional identity development of students in their identity-thinking. The design experiences within community engagement contexts did seem to contribute to a shift in students' thinking. Although they initially viewed engineering as a domain where they could express their individual abilities, they came to understand their participation in the profession as a way to fulfill a socially connected purpose (Theme 1). These experiences also provided them with the tools to better internalize their professional identities as connected to central values that informed their holistic identities

(Theme 2). However, several students did not describe the interactions with community partners as transformative to their identity development. Rather, they focused on their expanded view of engineering competence, particularly in relation to design and collaboration (Theme 3). Finally, we noted that some students did connect their identities as engineers to the relationships that they had with community partners. But it is possible that these interactions enabled them to see themselves as more distinguished than others in their community contexts rather than embedded within these settings (Theme 4).

As we narrate the patterns in the subsections that follow, we note that all students were de-identified in relation to their reflective essays. Furthermore, we provided pseudonyms for students to correspond with each course section and community partners. Students from the section that partnered with Habitat for Humanity are represented by pseudonyms that begin with H (e.g., Hector, Heath). Students from the course that partnered with a local elementary school are represented by pseudonyms that begin with E (e.g., Ewan, Emilia). And students from the section that partnered with the poverty simulation center are represented by pseudonyms that begin with P (e.g., Paul, Parker).

Theme 1: From expressing individual abilities to serving a broader purpose

As demonstrated in their reflective writings, the students shifted in their understandings of their identities as engineers. At the beginning of the term, students described their choice to major in an engineering degree field as an expression of their individual abilities or interests. For example, Hector initially reflected how he had entered engineering based on a childhood where he would "take things apart and put them back together." His interest in working directly with technology was further galvanized through participation in a series of high school robotics courses. Generally, several other students identified with Hector's trajectory. Many students were initially motivated to pursue engineering through interests or abilities that had been recognized and validated by others. Such interests included various passions, such as interacting with constructible toys (e.g., Lego bricks), experience with machine shops, or participation in robotic organizations. Other students had felt validation and recognition regarding their abilities in physics, mathematics, or other science courses. Enoch described a sense of confidence based on his performance in advanced calculus courses, which fueled his motivation to pursue engineering. Likewise, Holt described how he had felt motivated to pursue an engineering degree based on his strong performance in an advanced physics course. In many of the student accounts, the impetus to pursue an engineering role began as something that was focused on individual students expressing interests or abilities that had been socially validated by others, either through group participation or through academic performances.

However, as the semester progressed, the students' participation in community partnerships began to affect how they came to see themselves as engineers. For example, Hector recounted how his view of being an engineer had expanded to include an others-oriented mindset. Following a statement of how he had come to appreciate volunteering with his community partner as a way to "practice the servant aspect in a community," he described how he had come to see his "career as being able to design something that could help people . . . in a way that would possibly change their life." Similarly, by the end of the semester, Enoch broadened his

stated motivation to pursue an engineering degree based on his desire to "talk and listen to the needs of someone else and then potentially be able to make something that will help with that [person's] need." Many other students generally aligned with a similar trajectory as Enoch and Hector. Their frequent interactions with community partners seemed to coincide with a shift in their thinking regarding their own participation in engineering. As put by Paul, "This course has shown me 'another dimension' of sorts of the world of engineering . . . I have been shown that a *good* engineer is proficient in mathematics and science, but a *great* engineer knows how to connect science and math to real people and the world around them."

We also note that several students did enter the course with a pre-existing motivation to pursue an engineering degree in order to generally improve the lives of those around them. For these students, the community partnerships within the course facilitated a more nuanced appreciation for connecting their career identities with engaging their communities. For example, Emilia, who had initially expressed a general desire to use her degree to help her home country, later described how she had developed more ownership of her aspirations:

> My original plan when I [chose] my major was to help my country grow and be more [prepared] in the industrial side . . . I was really insecure and scared about that idea. But now[,] thanks to the project that took place in this class[,] I could see how we actually have abilities that can make a lot of things that can help others. It gives me confidence about what I can do. (Emilia)

Likewise, Haden, who had initially framed his purpose in choosing an engineering degree as a way to "save lives," developed a nuanced appreciation for the role of stakeholders in his project. He stated how his project with a community partner "helped to show that we were designing for and working with people, not just creating solutions." Through the course of the semester, Haden shifted his thinking of stakeholders as people who are passive recipients to those whose perspectives and experiences interacted actively with the students' project work.

Thus, throughout the semester, the students shifted their identity-thinking from an individualistic perspective toward a connected mindset, or at least an altruistic mindset, in relation to their community. While some of their orientations toward the community might have contained some problematic orientations, as we discuss in Theme 4, the interactions with community partners provided tangible evidence to the students that engineering project work does not occur in an isolated vacuum. They could experience, rather than imagine, how their design work was both affected by, and would potentially affect, the lived experiences of their community partners.

Theme 2: From disconnected to integrated identities

As previously noted, the introductory engineering course was offered in the context of a religiously affiliated university in which dialogue about faith was a mainstay occurrence for students. Accordingly, several of the students identified their Christian faith as a core framework for understanding their overall identities. However, throughout the course, the views of their identities as engineers shifted from something that was generally disconnected from their core identities to something that was well-integrated. As put by Parker:

> My identity is centered around my faith . . . This class has made a significant impact on my faith. I have a much greater grasp of the fact that our work is an avenue in which God's love can be shown to others. This has been made very clear in the form of human-centered design. Before college, I always saw engineering as a very product-centered practice rather than a career with a very strong focus on the individual stakeholders of the product.

Parker, who initially pursued an engineering career based on his prior experience in machine shops, had come to connect his professional identity with his central perspective on understanding who he was. In this regard, his faith not only affected, as he stated elsewhere, his general "moral foundation." By the end of the course, Parker had come to integrate his faith and moral perspective as a lens through which he could interpret decisions of professional practice. Several other students reflected this same pattern of increasingly integrating their identities in their professional domains with a central framework of their faith. Emily stated, "[P]utting my faith into work is going to be very important to me. . . . When I begin my career working with prosthetics or developing devices that cure osteoporosis, I will remember who I am and what my purpose is in this field." Similarly, Pruitt reflected how "[g]oing through this semester . . . and the work that I have been doing for [the community partners] has been really good to be able to connect Jesus and my work."

Several students did not identify their faith as the only central framework for understanding their holistic identity. For example, three students who had come from various nations in Central America each reflected on how they had particularly pursued an engineering degree to bolster the infrastructure of their respective country. Each had begun the semester with a holistic identity that was characterized by someone who was deeply connected to improving their regional or national community. Throughout the semester, they each reflected on how their professional identity in engineering could facilitate their more central goals of improving their national contexts. For example, as put by Eduardo, "I see myself using my knowledge in designing . . . buildings that will empower [an]other's life."

While we found that the interactions with community partners in the context of their design projects generally provided mental templates for them to connect their professional identities to their core values and faiths, we also found two interesting counterexamples to this theme. In one case, Payton, who stated that his faith is "a major part of who I am," reflected on his dissatisfaction in seeking a connection between his faith and his professional identity. He described how he had visited with someone who was affiliated with engineering about finding such integration and "[t]heir answer boiled down to this: as an engineer, your income would be pretty sizable . . . work hours less than those in a different profession. Money and time. I wasn't impressed by that answer." Thus, although Payton was motivated to find integration between his professional role and the central identity of his faith, the community engagement experiences within the course were less impactful than the narratives about engineering that he heard from others who were affiliated with his chosen profession.

In another counterexample, students did follow the same pattern of finding an increasingly connected identity between their core faith or values and their profession. But finding such a

connection ultimately led them away from engineering. For example, Heath reflected, "[Engineering] attracted me because I feel there is a certain prestige that comes with being an engineer that was really appealing to me. . . . However, this semester[,] I realized that engineering wasn't for me . . . [I] need to focus on careers that will actually be a good fit for me rather than just focusing on prestige." Heath gave voice to a pattern that we found in a small number of students across the section. Although the experiences of the course had supported a holistic evaluation of their career pursuits based on their central identities, in a few cases, such evaluations made them decide to leave the major in pursuit of a profession that would be more integrated with their core values than engineering.

In summary, pursuing design in the context of community engagement helped students to connect their professional identities to more central forms of identity (e.g., faith, core values). By providing the opportunity for empathetic mindsets in design, social interactions with stakeholders, and volunteer service with community partners, students came to realize a compelling template by which they could connect their professional role to holistic virtues that informed their personal identities. While the counterexamples demonstrate that these curricular experiences did not predict a uniform outcome, we did find that the students generally came to integrate their professional identities with frameworks that informed who they were as holistic individuals.

Theme 3: Finding competence in engineering to include collaborative and design processes

The previous two themes describe how the students were affected in their identity thinking as a result of the community engagement opportunities that accompanied their design projects. However, a pervasive pattern that we found in the reflective essays focused on how the students shifted in their thinking of what it meant to be a competent engineer. As discussed in Theme 1, students were initially motivated to pursue an engineering career because they had previously been recognized as competent skills that they believed to be central to engineering (e.g., tinkering, high performance in mathematics). But as they progressed in their design projects, they came to see that competence in engineering included collaborative and designerly processes.

Ewan, for example, initially framed his competence in engineering as something that prioritized individual agency: "I view the word '[e]ngineer' as a title, one worn with pride. To be an engineer is to be a problem-solver, creative, and unique. I strive to exemplify these traits in every aspect of my day to day life." At the end of the semester, however, his view of engineering competence shifted to incorporate specific design behaviors, which nuanced his image of what it meant to do competent engineering work. As he stated: "Writing out rough drafts for specifications, cranking out simple sketches, and compiling stakeholder profiles was a very new experience to me that taught me what it really means to be an engineer." Additionally, he had come to view these processes as essentially collaborative. As Ewan described: "All throughout high school, I had been the kid that would have to do all the work in a team-project . . . [I]n this class, I got a real-world sneak [peek] at what being on a committed engineering team looks like. I'm excited to be able to work together in groups of competent people, all striving for the same goal."

Likewise, at the end of the semester, Preston recognized how he had shifted his perception of what it meant to be a competent engineer: "I came into this semester thinking that engineering ability was only based on how good I was at math and physics but that idea was shot down fast. Despite needing that expertise, . . . [e]ngineering majors need to communicate effectively, support other team members, empathize with stakeholders, etc." Unlike Ewan, who indicated a positive experience with his project team, Preston's essays indicated that he had a difficult experience on the team. While both students gave voice to a general pattern in the data—that students would come to develop a nuanced understanding of engineering competence to include design and collaboration skills—the experiences that informed their conclusions were notably different. Furthermore, while Ewan developed a deeper commitment to his engineering role, Preston voiced an appreciation for the skills required of engineering students and professionals but ultimately came to the decision to no longer pursue an engineering degree.

As earlier stated, the core aim of the project was to facilitate a new identity as engineers for the students. But fusing community engagement within design projects is complex, and the key point that several students learned has little to do with their mindset as community-engaged engineers. Rather, the involvement with community partners seemed to buttress other key areas of learning that they find are important, such as design and collaboration skills.

Theme 4: Finding professional esteem in community partnerships

Prior themes highlight how students came to generally view their role in engineering as something that was deeply connected to their communities (Theme 1) and their own whole persons (Theme 2). By the end of the semester, the students found a new sense of validation in their professional roles. As put by Howard, "To work on a project almost all semester, changing this and improving that, and to finally see it come to life and hear that we did a good job. That is a great feeling. . . . To hear [community partners] say that they are no doubt creating our system . . . it doesn't get any better than that." Howard described how the validation from community partners helped him to feel validated based on his competence in completing the project. Such a feeling of validation was also described by other students, particularly in relation to their experiences of the final design showcase. For example, Ethan stated, "All of the hard work put into designing and building our prototype paid off when I saw it sitting on the table at the design showcase. In my future career, I hope that I can have this same feeling but with something on a much larger scale and something that will help out in the world." Additionally, Everett reflected how he "really enjoyed getting to show off something that [he] had worked to design and [see] the potential that it could actually fix the problem." And Peter mentioned how his project helped bolster his esteem as an engineering student: "I felt a sense of importance because I was helping people learn about the struggles of others."

We find the esteem that students came to feel upon completing their conceptual prototypes to be both a problematic and functional phenomenon in relation to their identity-thinking as engineering students. Perhaps this esteem was problematic, because the students may have come to feel more disconnected from the community through completing their design projects. By being recognized as successfully delivering what is seen as "engineering work," they were established as unique from the community. Combined with this uniqueness is possible isolation

from empathetic attitudes toward stakeholders. Although the design task was intended to facilitate an empathetic posture toward the expertise of real stakeholders, it is possible that they instead came to view stakeholders as deficient.

Yet, we might also argue that the exchanges of validation were functional in helping students to adopt a perspective of engineering as a community-engaged profession. As described in Theme 1, students had begun their undergraduate studies on the foundation of hearing validation toward perceived engineering interests and strong math or science abilities. Perhaps the validation of community partners did not simply buttress the self-esteem of pre-professional engineers. Instead, such validation may have provided them with specific evidence to support the narrative that engineers occupy an important (but not the only important) role in the context of solving community problems.

Discussion and Implications

The findings of the present scholarly practice study depict how tension was operating within the community partnerships associated with the first-year engineering design course. On the one hand, the students' reflective essays demonstrate some indications that they did indeed shift their thinking about what it meant to be an engineer in ways that were more connected to their communities (Theme 1) and in ways that were more connected to their whole selves (Theme 2). We contend that both of these patterns were linked. By finding engineering as a domain that could serve a pro-social purpose, the individual students found a career context that became aligned with versions of themselves that transcended their interests and academic performances. Developing a relationship with community partners, albeit through a prescribed assignment, provided the students with a template for what engineering work could mean for them as whole persons. And these students with no or little prior experience in postsecondary engineering education were well-positioned to author their own narratives of what it would mean for them to be an engineer [16].

On the other hand, the findings also show how the relationships community partners introduced elements of complexity in design work. Accordingly, some students focused on what they learned while navigating new ways of thinking about design and collaboration rather than attending to how their community involvement affected their professional identities. We do not find this pattern surprising, as Zoltowski and colleagues have shown that human-centered processes of empathy are deeply intertwined with complexity in design thinking and behaviors [25]. But when students focused on the features of completing a design task rather than engaging in a design situation with community partners, they were perhaps reinforcing the master narrative that claims engineers "ought to" focus on the work that needs to be done with only sufficient attention dedicated to stakeholders.

We found further evidence that several students found the design exercise to be a feature of individual (or even team) accomplishment (Theme 4). For some students, the role of community partners seemed to be crucial for supporting the master narrative that engineers, through their rarefied skillset, come to the space of community problems with more expertise than community stakeholders and should be lauded for their solutions. Such a pattern aligns with findings from

existing research that critiques engineering problem-solving as a method that does not give space to engage in the social complexity of design challenges [26, 27]. However, we also recognize that the validation received from community partners could play a functional purpose in helping engineering students author their paths as community-engaged professionals. As indicated in the first theme, many students found their way into an engineering major due to ways that they had been recognized as resembling an engineer. As Godwin and colleagues [28] point out, such external recognition supports students' motivation to identify as engineers. Thus, while there are ways that leveraging community relationships for developing esteem can work against an individual's commitment to engagement in their community, we also recognize that validation on community-engaged engineering work can functionally support the narrative of being an engineer that is attuned to living community relationships.

The primary implication of the present case is for educators to name the tension that is at work in courses that infuse community engagement into the curricula. Such tensions do not necessarily pose a problem that needs to be solved but rather a social reality that accompanies the processes of education. As put by Parker Palmer, "Teaching and learning require a higher degree of awareness than we ordinarily possess—and awareness is always heightened when we are caught in a creative tension. Paradox is another name for that tension, a way of holding opposites together that creates an electric charge that keeps us awake" (pp. 72-73) [29]. By articulating the paradoxes inherent in our programs, which can pull students toward different identity outcomes, we make them available to discuss and adapt our curricular activities. For example, based on the findings from the present case, the lead author intends to reframe the course's design showcase as a way of not only celebrating the accomplishment of student design teams but also as a way of giving validation to the long-term work of engagement that our community partners regularly execute. We desire for students to be supported by validation as they come to identify as engineers who are essentially community-engaged. However, such validation must accompany a sense that engineers are living out of their expertise alongside (rather than apart from) other partners in the community.

References

[1] S. M. Ahmed, and A. G. S. Palermo. "Community engagement in research: Frameworks for education and peer review," *Amer. J. of Public Health*, vol. 100, no. 8, pp. 1380-1387, 2010.

[2] A. R. Bielefeldt, K. G. Paterson, and C. W. Swan. "Measuring the value added from service learning in project-based engineering education," *Int. J. Engng. Ed.*, vol. 26, no. 3, pp. 535-546, 2010.

[3] J. D. Thompson, and B. K. Jesiek. "Transactional, cooperative, and communal: Relating the structure of engineering engagement programs with the nature of partnerships," *Mich. J. of Comm. Service Learning*, vol. 23, no. 2, 2017.

[4] K. Litchfield, and A. Javernick-Will. "'I am an engineer AND': A mixed methods study of socially engaged engineers," *J. of Engng. Ed.*, vol. 104, no. 4, pp. 393-416, 2015.

[5] J. L. Huff, C. B. Zoltowski, and W. C. Oakes. "Preparing engineers for the workplace through service learning: Perceptions of EPICS alumni," *J. of Engng. Ed.*, vol. 105, no. 1, pp. 43-69, 2016.

[6] EPICS, *EPICS – Purdue University – Engineering – Purdue*, Accessed on February 4, 2020: https://engineering.purdue.edu/EPICS
[7] Engineers Without Borders – USA, *Home – Engineers Without Borders – USA*, Accessed on February 4, 2020: https://www.ewb-usa.org/
[8] J. L. Huff, C. B. Zoltowski, W. C. Oakes, and R. Adams. "Making sense of design: A thematic analysis of alumni perspectives," in *Proc. of the 2013 ASEE Conf.*, Atlanta, GA, USA, June 23-26, 2013.
[9] K. Litchfield, A. Javernick-Will, and A. Maul. "Technical and professional skills of engineers involved and not involved in engineering service," *J. of Engng. Ed.*, vol. 105, no. 1, pp. 70-92, 2016.
[10] J. Walther, S. Miller, and N. W. Sochacka, "A model of empathy in engineering as a core skill, practice orientation, and professional way of being," *J. of Engng. Ed.*, vol. 106, no. 1, pp. 123-148.
[11] National Academy of Engineering. *Grand Challenges for Engineering*, Accessed on February 4, 2020: http://www.engineeringchallenges.org/
[12] S. Secules, A. Gupta, A. Elby, and C. Turpen. "Zooming out from the struggling individual student: An account of the cultural construction of engineering ability in an undergraduate programming class," *J. of Engng. Ed.*, vol. 107, no. 1, pp. 56-86, 2018.
[13] E. A. Cech. "Culture of disengagement in engineering education?," *Sci., Tech., and Hum. Values*, vol. 39, no. 1, pp. 42-72, 2014.
[14] W. Faulkner. "Dualisms, hierarchies, and gender in engineering," *Soc. Studies of Sci.*, vol. 30, no. 5, pp. 759-792, 2000.
[15] L. Bucciarelli. *Designing engineers*, Cambridge, MA, USA: MIT Press, 1994.
[16] K. C. McLean, and M. Syed. "Personal, master, and alternative narratives: An integrative framework for understanding identity development in context," *Hum. Dev.*, vol. 58, no. 6, pp. 318-349, 2016.
[17] G. Wiggins, and J. McTighe. *Understanding by design*, Alexandria, VA, USA: ACSD, 1998.
[18] EPICS. *EPICS Design Process*, Accessed on February 4, 2020: https://sharepoint.ecn.purdue.edu/epics/teams/Public%20Documents/EPICS_Design_Process.pdf
[19] P. King, and K. Kitchener. *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco, CA, USA: Jossey-Bass, 1994.
[20] V. Braun, and V. Clarke. "Using thematic analysis in psychology," *Qual. Res. in Psych.*, vol. 3, no. 2, pp. 77-101, 2006.
[21] J. L. Huff, "Psychological journeys of engineering identity from school to the workplace: How students become engineers among other forms of self," Ph.D. dissertation, Engr. Ed., Purdue Univ., W. Lafayette, IN, USA, 2014 [Online]. Available: https://docs.lib.purdue.edu/dissertations/AAI3669254/
[22] J. L. Huff, J. A. Smith, B. K. Jesiek, C. B. Zoltowski, and W. C. Oakes. "Identity in engineering adulthood: An interpretative phenomenological analysis of early-career engineers in the United States as they transition to the workplace," *Emerging Adulthood*, vol. 7, no. 6, pp. 451-467, 2019.
[23] J. L. Huff. "Identity in practice: Examining personal identities of engineering graduates as they transition to the workplace," in *Proc. of the Res. in Engr. Ed. Symp.*, Cape Town, South Africa, July 10-12, 2019, pp. 359-368.
[24] J. Saldaña. *The coding manual for qualitative researchers*. London, UK: Sage, 2009.
[25] C. B. Zoltowski, W. C. Oakes, and M. E. Cardella. "Students' ways of experiencing human-centered design," *J. of Engng. Ed.*, vol. 101, no. 1, pp 28-59, 2012.
[26] J. Lucena, J. Schneider, and J. Leydens. *Engineering and sustainable community development*. San Rafael, CA: Morgan and Claypool, 2010.
[27] A. Mazzurco, and S. Daniel. "Socio-technical thinking of students and practitioners in the context of humanitarian engineering," *J. of Engng. Ed.*, Advance online publication, 2020.
[28] A. Godwin, G. Potvin, Z. Hazari, and R. Lock. "Identity, critical agency, and engineering: An affective model for predicting engineering as a career choice," *J. of Engng. Ed.*, vol. 105, no. 2, pp. 312-340, 2016.
[29] P. Palmer. *The courage to teach: Exploring the inner landscape of a teacher's life*. San Francisco, CA, USA: Jossey-Bass, 1998.