

Understanding Student Experience and Motivation in a New Human-Centered Engineering Program – Insights from the First Cohort

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Abstract — This work-in-progress research paper emerges from the development of a new Human-Centered Engineering undergraduate degree program in a liberal arts college. As part of a more extensive study, in this paper, we report on the experiences of the inaugural cohort of students in the program. We focus on students’ experiences in their first year, emphasizing how they experience the “human-centeredness” of the program and how they experience co-creating the program along with the faculty. We frame our inquiry with the following research questions:

RQ1: What is the experience of individuals in the first cohort of a new engineering undergraduate program positioned to be “human-centered”?

RQ 2: How do the students co-create the program with faculty?

As a team of three researchers, we conducted grounded coding from data collected via semi-structured interviews and focus groups. The students share their experiences of being what one student terms “trailblazers,” initiation of their engineering identity formation, and finding human-centered ways to practice engineering and work with their peers. The students also share experiences of feeling included in parts of creating the new program and seeing change happen when they provide feedback. This study contributes to the limited literature on the development of new engineering programs and adds to the discourse on human-centeredness in engineering education.

Keywords — *Engineering Education, Human-Centered Engineering*

I. INTRODUCTION

In this study, we report on the development of a new Human-Centered Engineering undergraduate degree program in a liberal arts college. The establishment of this program, along with initiatives to foster design and innovation and integrate science and society at the university, provide an opportune time to explore several research directions. These directions include building new programs at the convergence of STEM and the

liberal arts, the unique characteristics of a non-traditional engineering cohort, and developing innovative curricular interventions to scale.

In this work-in-progress paper, we focus our attention on the student experience in the first year of the program and the students’ conceptions of their role in co-creating the program along with the faculty. Such an inquiry allows us to explore student formation at the intersection of engineering knowledge and humanist paradigms and develop curriculum innovations that are often too difficult to implement in programs with large class sizes. We believe that understanding the student experience and the factors that contribute to the non-traditional makeup of the cohort can contribute to the essential areas of inquiry of identity, retention, and participation within undergraduate engineering education research. While current literature in undergraduate engineering formation reports on outcomes and efficacy of programs and curricular interventions, there is limited work documenting, critiquing, and synthesizing the development of brand new engineering programs – especially non-traditional ones such as the one at Boston College.

II. OVERVIEW OF BOSTON COLLEGE PROGRAM

In the fall of 2021, the inaugural cohort of undergraduate Human-Centered Engineering majors arrived at Boston College. This cohort’s experience of engineering education has been non-traditional in several ways. First, the engineering program is housed within the Morrissey College of Arts & Sciences rather than in a separate school of engineering, an institutional arrangement which influences the curriculum. Second, the inaugural cohort of less than thirty-students took almost all of their first-year engineering and non-engineering courses together.

There have long been calls for engineering education to integrate technical training with the sociotechnical context of engineering practice [1, 2]. Interdisciplinary engineering education asks students to integrate knowledge and practice

across disciplines [3]. This program seeks to achieve such an integration, while also prioritizing the need to train engineers as “emerging leaders” who are able to reflect on their own role in the classroom and beyond [4].

It is not uncommon to contextualize engineering as a practice that caters to societal and human needs [5, 6]. ABET criteria for accrediting engineering programs require “consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors” [7]. It further calls for factoring in “the impact of engineering solutions in global, economic, environmental, and societal contexts” [8]. One could argue that Human-Centered Engineering is Engineering, but studies have shown that how students experience and define human-centeredness varies widely [9, 10]. Zhang and Dong proposed a conceptual model of human-centered design and human needs [11]. More recently, Hira, Bhattacharya, Gaudette and Govindasamy contextualized human-centeredness as a design value for the new Human-Centered Engineering Program which provides “students with opportunities to understand complex sociotechnical problems and appreciate the impact their engineering will have on society from multiple perspectives” [12].

Including students in the co-creation of the curriculum can uncover and challenge instructors’ assumptions about the teaching and learning process [13]. Although this is an understudied area of research in engineering and, more broadly, STEM education, a recent study, reported a significant increase in students’ perception of autonomy and feelings of being cared about when included in the co-creation of assessment criteria for an upper-division STEM lab course [14].

III. RESEARCH APPROACH

In this paper, we present preliminary findings from the first year of the program with a focus on understanding:

- RQ1: What is the experience of individuals in the first cohort of a new engineering undergraduate program positioned to be “human-centered”?
- RQ2: How do the students co-create the program with faculty?

Data and analysis presented in this work-in-progress study comprise individual semi-structured interviews and focus groups with students of the first cohort of the new program. In total, we collected data from five participants by conducting three semi-structured interviews and a small focus group with two students in weeks 10 and 11 of the students’ second semester in the program. Three researchers performed inductive coding based on the research questions [15, 16, 17] of the study and discussed the emergent themes. Of these themes, we selected three themes for RQ1 and two themes for RQ2 relevant to the goals of this paper. We used pseudonyms in lieu of actual names. We do not disclose more information on participants because of the likelihood of participants being identified. In the following pages we share excerpts of the student participants’

narratives and a brief discussion answering the above stated research questions.

IV. PRELIMINARY FINDINGS

- A. *RQ1: What is the experience of individuals in the first cohort of a new engineering undergraduate program positioned to be “human-centered”?*

Coding theme: A friendly community of “trailblazers”

The students share how being in the first cohort and being co-creators and “trailblazers” of the program is motivating and exciting for them. Theodore shared, “I realized that it was a unique ... opportunity, rather, of all being kind of like trailblazers of this program, and then also like, co-creators.” Helen shares Theodore’s excitement by saying:

I think I like being in an experiment ... I like testing the limits and doing stuff not so traditionally, just because it’s more exciting. There’s more opportunities, there’s more stuff that you can change and make it your own, which I like.

Nathaniel describes his excitement about being a member of the first cohort. He says, “It’s just really exciting to be the first of anything ... I like how much we control, (the control) we get over things ... I feel like in the past these aren’t things you are normally asked about as a student, which is new, but also it’s cool to start to think about.” The students also feel that they could make close interpersonal connections within their cohort since they took four courses together and knew that all the students admitted into the major had similar interests in human-centered engineering. For example, Jessica states how “it was a lot easier (in the) first few weeks to make friends because it was nice already knowing the people going in and knowing they had similar interests and passions as you do.” Like Jessica, Nathaniel states, “that was definitely nice to get off the bat ... We can make friends with (others) whom we are kind of forced to see all the time. And that was definitely really nice.” Helen, however, adds how seeing the same people every day can sometimes be uncomfortable and make her second think about having hard conversations with her peers:

it’s hard to have some (of) these conversations with your peers, because especially like we see each other every day ... I’m gonna see you tomorrow, I don’t want to think about that very deep conversation we had and how it kind of upset each other.

Coding theme: Reflecting on identities as engineers and individuals

While some students share standard experiences about learning how to identify as engineers, other students reflect more pointedly about the intersection of their identity as engineers and as students of color. Theodore describes thinking concretely about his engineering identity:

So I also think that this program does a great job of like, just like having us know, like, our identity as engineers. And

so I think I'll have like a really strong sense of identity, which will help me choose like the next path in grad school.

Ingrid describes how her identity as an engineer developed while working collaboratively on hands-on projects: "this is what it means to work in teams. It ended up being really, really impactful. And I really enjoyed it. And I felt that I don't know those key terms really actually made the experience of being an engineer so much more enjoyable." Working on collaborative design projects with community members as part of coursework gave students a taste of why they chose to become engineers. Jessica shares that "doing that project made me realize what I'm doing this for and why I like engineering and why I like this program specifically at the end of the day."

Other students, however, describe their surprise at being in a program that values diversity but does not reflect that in the inaugural cohort. Helen describes her expectations: "Going into the program, I was like, I know, every engineering program in the country is male dominated. I know, it's largely white, if it's not largely white, we see a lot of Asian and East Asian representation, just that's just because the way it is, there's that's just how it the way it is right now." While she hoped the "program has the chance to be racially diverse," in fact, "...when I walk into a classroom at Boston College, I recognize that I'm always one of the few brown people in the room." She wonders whether or not her "peers recognize" that "wow, this room is really white."

Coding theme: Human-centered "mindset" and way of being

The students are experiencing the program's focus on human-centeredness in both the engineering skill sets they are acquiring and in how they are being encouraged to develop relationships with their peers. Theodore shares that he was pleasantly surprised to realize the focus of the introductory courses on the human-centered engineering "mindset":

I was really surprised at how much more of the soft skill side of our skill set we worked with, you know, design thinking and the analysis lab ... this is kind of good that we're getting like all like the mindset and like framing work kind of out of the way first, so we can like have that mindset going forward ... I think if I would have known about this program earlier in my college application process, I would have applied early decision or something like that, it just seems like such an amazing, you know, mission and an idea.

Helen was also happy to learn that the professors encouraged them to work with each other instead of competing with each other. She shares, "my only expectation (was) that it would be very competition based ... (Though) our professors say you guys can work together and everything's gonna work out well. And I think we've definitely done that."

B. RQ2: How do the students co-create the program with faculty?

Coding theme: Feeling included and having a voice

Students share positive experiences when asked about their feedback on the program. Theodore describes the faculty's interest in co-creation as unique: "that's one of the things about the program that I've been, like, pleased or like impressed with the most, I think it's like, I just felt like they really like value our feedback." Ingrid appreciates how faculty integrate that feedback into courses:

And our professors are very open for us to share what we think and make changes accordingly, if applicable, and then also to explain to us sort of like the trajectory of each class, what the goals are, and then again, to kind of curate our experiences, challenge us, if, of course, maybe isn't too challenging enough, or kind of figure out ways that they can help supplement our knowledge better.

Nathaniel explains how this adds up to a broader feeling of inclusion: "But I like how much we control, we get over things. And you guys can ask what we'd like on a lot of stuff."

Students appreciated how their voices were included in faculty searches. Nathaniel shares how much he valued offering insights: "But it's been stressed a couple times, like that. You guys care about what we think about the professor's... I feel like my input goes into the hiring process....That just feels nice." Ingrid finds this aspect of the program "very, very unique." Theodore details how he liked being included in faculty candidate lunches and teaching demos. Helen says that she "like[s] having that voice and having feeling like, you know, change can be made."

Coding theme: Anticipating iteration and seeing change

Students report being aware of how their experiences are the basis for future iterations in the program. Theodore observes that "from a student perspective, that they're still kind of like figuring stuff out" but that he "bought into the experiment," so it makes sense to him. Students describe surprise in how coursework changed or might change in the future. Ingrid, in discussing a surprisingly difficult problem set which might be adapted in the future, shares: "So even if you see a little bump in the road, it's really not that big of a bump, and you just kind of walk right over it." Jessica, in describing the structure of a design course, remarks on how it was modified in real time: "we were originally going to do what we're going to do with five projects. And he was and then (the instructor) was just like, Okay, we ran out of time, for this one I was supposed to have you make water bottles, but you're not going to do that anymore." Helen, similarly, wishes that there was a stronger framework for her coursework: "So a lot of the classes, it's funny, because we're like, oh, you can tell this is the first time we're doing this class, just time. You know, sometimes we really gets lost in like, you know, why are we doing this? Why are we like, you know, jumping from this to this and that, like, where's the direction?"

Despite the experience of being in the first iteration of the process, students share how they value the changes being made. Nathaniel recalls reflection sessions being moved to a different time to accommodate students' schedules and being asked what

modifications (e.g. “lighting and coat racks”) might make the building more livable. Jessica shares how a discussion about a lack of printing facilities led to a new engineering-only printer. Helen describes how she hopes that her feedback might be used in the future: “So I’m sure by the time I graduate, things will be different. And you know, I’ll be able to see the opinions that I voice right now will change and impact the lives of future students.”

V. DISCUSSION

Concerning our first research question, the sampling of student perspectives provides insight into students’ experiences in the first cohort. Students are acutely aware of being the inaugural class and appreciate not being alone in their efforts. They are building community with fellow students undertaking this journey while actively taking advantage of the unique opportunities the experience presents. We also see evidence that the program’s decision to connect the first-year experience within engineering and design thinking topics encourages students to develop engineering identities. Furthermore, the students present insights into how their engineering identities are being shaped by the sociotechnical context and campus context in which they are learning. Based on the limited data, though the students readily refer to human-centered engineering, they do not fully agree on or conceptualize what technically it means, at least not yet. It will be interesting to see how that understanding evolves. This observation makes it clear the faculty can help the students make connections and improve their understanding of what is and what is not a differentiating characteristic of human-centered engineering (e.g., the professional skills, including teamwork).

In response to our second research question, we see evidence that students feel included and enjoy being part of the co-creation of the program. They know that courses are new and different from what students in other engineering programs may be exposed to. Interestingly, we gathered insights that students accept without question that knowledge delivered in science/math courses is valuable but questioned why they learned specific topics in their engineering courses. It may be worth exploring whether this difference (evaluation of active vs. passive learning) is a common feeling across our students or if the data we have represents an isolated case.

It is important to recognize the limitations of the data we have collected. The sample is small but represents nearly 20% of the current cohort. But perhaps more importantly, the students self-selected to participate in the study. Therefore, we may be missing the experience and perspectives of other students who may not have engaged with the co-creating efforts in the program.

The study we report on in this paper was approved by the University’s Institutional Review Board (IRB), and all students’ names used are pseudonyms.

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