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Supporting Students with Minoritized Gender Identities in Research: the Design and Assessment of an Initiative in Electrical and Computer Engineering

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Introduction

Women are historically underrepresented in engineering departments. According to 2021 ASEE Engineering and Engineering Technology, only 25% of engineering degrees, including Bachelor's, Master's, and Ph.D., were awarded to women in US institutions [1]. The underrepresentation of women in engineering may be due to a lack of diversity when recruiting students, as well as the fact that women have higher attrition rates than their men peers, so-called "the leaky pipeline" [2, 3, 4].

Many studies have attempted to understand this high attrition rate of women students in engineering careers. Some suggest that women students have fewer opportunities to develop their engineering interests or chances to be recognized as engineers compared with their men counterparts [5, 6, 7, 8, 9]. Others note that women students face additional professional devaluation and chilly climates in engineering departments [10, 11, 12]. Moreover, since women faculty are also underrepresented in most engineering departments, women students have fewer chances to be helped by faculty members who have experience overcoming these challenges [13]. Therefore, women students often suffer from high stress and lack a sense of belonging in engineering. They may feel disappointed with the learning experiences, leading them to explore opportunities outside of the engineering field [10, 14].

The experiences of people who identify as lesbian, gay, bisexual, transgender, and/or queer (LGBTQ+) in STEM are seldom addressed in studies and reviews [15, 16, 17]. To broaden the scope and study gender discrepancies in STEM, we provide a scoping review to include the experiences of all transgender and nonbinary people in this paper, in addition to those of cisgender women. Noted that a cisgender person is one who identifies with the gender they were assigned at birth, i.e., not transgender. While few efforts have focused on analyzing the academic and workplace experiences of transgender scientists [18, 17], prior studies have shown that LGBTQ+ people face similar challenges as cisgender women but with augmented difficulties [19, 20, 10, 11]. Additionally, queer and transgender students and professionals in STEM face various microaggressions in academic settings, such as being subjected to cis-normative language, incorrect pronoun usage [21, 22, 23], or being forced to use their deadname, which is the birth name they no longer use [24, 25]. In addition, STEM fields often present a chilly climate to women and people who identify as LGBTQ+ [26]. For example, STEM departments seldom provide an environment for students to feel safe being out regarding their gender identities. This

includes a lack of gender-neutral bathrooms and only binary gender options (man or woman) on school forms. The prevalence of cisgender culture within STEM also alienates those who identify as LGBTQ+ and cisgender women [12]. As a result, transgender and gender-nonconforming students suffer from mental health issues and are 10% less likely to continue in STEM majors than their cisgender peers [17].

For more comprehensive coverage of genders, this study includes Historically marginalized or Underrepresented Genders (HUGs) individuals, including cisgender women and anyone identifying with transgender and nonbinary groups [27]. Given HUG students' challenges when pursuing engineering degrees, we must implement pragmatic solutions for a more inclusive and supportive environment in engineering departments. Panel discussions on career-related topics can provide resources and opportunities that were not accessible to HUG students individually and clarify the myths they may have about research careers [28, 29]. Explicit discussions on the challenges and previous gender-bias experiences HUGs face are influential in increasing HUG students' engineering identities [6]. Mentoring services allow HUG students to meet with experienced STEM professionals from similar backgrounds and have been found to increase the retention of HUG students [30]. Furthermore, Safe Zone ally training is an effective way to positively change campus climate by educating people about the terminologies of gender minorities and the biases these minorities experience [31, 19].

To promote the pursuit of research careers among HUG students, we launched a student-led initiative, the HUG Initiative, in the Department of Electrical and Computer Engineering (ECE) at the University of Illinois, Urbana-Champaign, in which the proportion of HUG students is consistently near 15% for both undergraduate and graduate programs. The HUG Initiative is a pilot study that systematically identifies the needs and obstacles of HUGs in the ECE department. We conduct survey analysis to understand the baselines of HUG students in the department by measuring engineering identity, psychological safety, interest, obstacles to research careers, and demographics [32]. During the academic year, we held panel discussions on career-related topics, a research career mentoring program, and town hall meetings to intervene in HUG students' perspectives on engineering careers. We collected post-event feedback to examine how the events influenced the research-career aspects of HUG students. This paper is based on these survey results to answer research questions that include:

1. RQ1: What obstacles do HUG students in the ECE department identify as inhibiting them from pursuing an engineering research career pathway?

2. RQ2: What training and experiences are needed to help HUG students prepare for an engineering research career pathway?

3. RQ3: How can programmatic events be tailored to benefit research-career aspects of HUG students in engineering?

1 What obstacles do HUG students in the ECE department identify as inhibiting them from pursuing an engineering research career pathway?

1.1 Method: Survey Responses

During the first year of the initiative, we collected baseline information on the research experiences of all the ECE students. Participant recruitment for this Institutional Review Board-approved survey (IRB #23267) was conducted via email, digital, and printed flyers and lecture advertisements among all the ECE students, including undergraduates and graduates, during the Fall 2022 semester. The participants were asked to identify their race, ethnicity, and gender identity. Respondents that declined to provide demographic information are referred to hereafter as 'unknown.' In addition to demographic data, the survey included items that shed light on the students' perspectives on research careers, including careers in academia and industry. The following questions are analyzed in this paper:

- Have you considered pursuing a career in academia, such as becoming a faculty member?

- Are you interested in working in R&D (research and design) in the industry?

- What do you think is your greatest obstacle to pursuing a research career? (Select all that apply.)

In total, 221 students completed the survey, with 151 undergraduate and 70 graduate students. Based on the answer of gender identities, we separated the students into four categories: cisgender men, cisgender women, transgender/non-binary, and unknown. There were 78 (35%) students who self-identified as cisgender men, 55 (25%) students as cisgender women, 17 (8%) students as transgender/non-binary, and 71 (32%) were unknown for the undergraduate participants, as shown in Figure 1. By combining the cisgender women and transgender/non-binary students, 43 undergraduates and 27 graduates who completed the survey self-identified as HUG students.
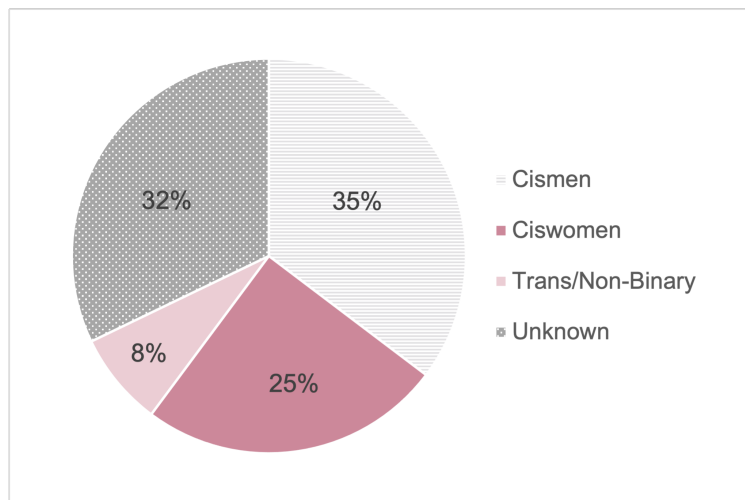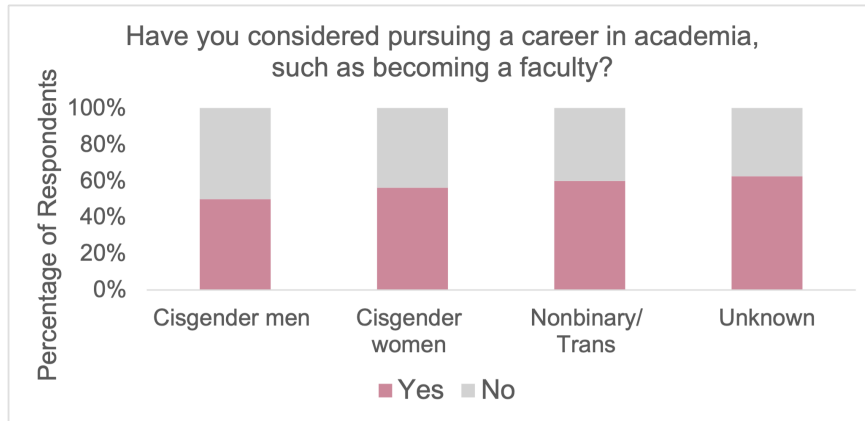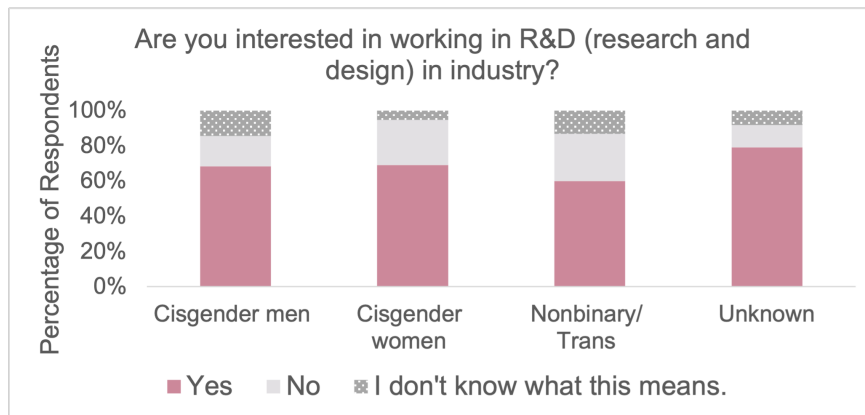

Figure 1: Gender identity demographics of survey respondents.

1.2 Baseline: Consideration to Pursue a Research Career

(a) Research career in academia.


(b) Research career in industry.

Figure 2: Survey response on consideration of research career by genders.

54% of students considered a research career in academia, and 69% of students considered a career in industry. As shown in Figure 2, 60% of HUG students, including cisgender women and nonbinary/trans people, considered becoming faculty members after graduation. 67% of HUG students were interested in working in a research position in the industry. On the other hand, only 50% of cisgender men students would like to pursue a research career in academia, and 70% of them were interested in industry. This gender discrepancy indicates that HUG students are more likely to consider academic positions, while non-HUG students intend to work in the industry.

1.3 Baseline: Obstacles to Pursue a Research Career

We further asked about the obstacles to pursuing a research career and separated the respondents by graduate and undergraduate students. As shown in Figure 3 (a), 54% of undergraduate respondents expressed their concerns about a lack of research experience, followed by concerns about joining the workforce due to their financial pressures (28%) and not being interested in the

field of study (16%). On the other hand, 47% and 40% of graduate respondents were concerned about a lack of research experience and the need to join the workforce to support themselves or their family, followed by not being interested in this field of study (23%) and lack of faculty (20%) and peer support (15%). When compared with undergraduate respondents, graduate respondents express more concerns about financial pressure to join the workforce (40% vs. 28%) and lack of faculty (20% vs. 5%) and peer (15% vs. 7%) support. Overall, the survey results, shown in Figures 2 and 3, indicated that although HUG students were generally interested in pursuing a research career in both academia and industry, but had concerns about the lack of research experience, the need to join the workforce due to financial pressure, and the lack of peer and faculty support.
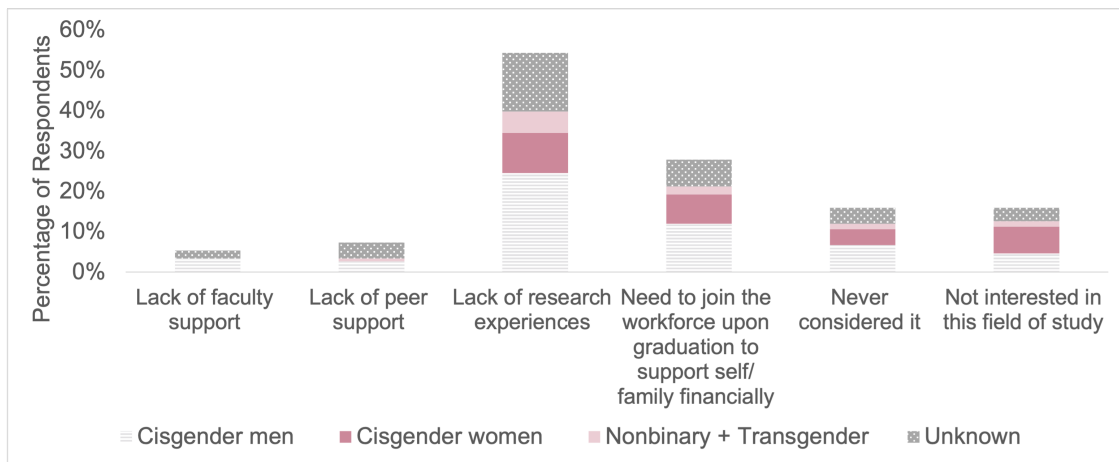
(a) Undergraduates' responses.
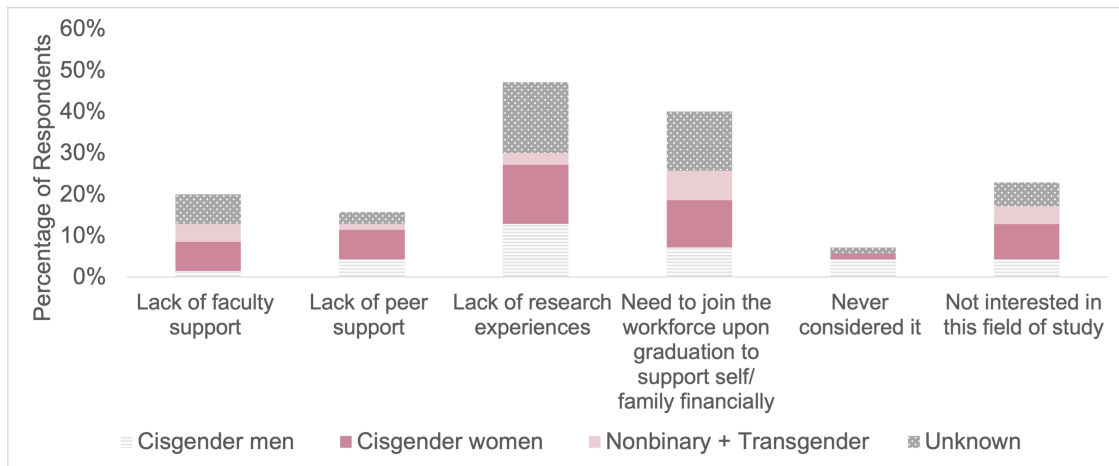
(b) Graduates' responses.

Figure 3: Survey responses to the obstacles for pursuing an engineering career. Respondents were asked to select as many options as applied to them and were categorized by their self-reported genders.

2   What training and experiences are needed to help HUG students prepare for an engineering research career pathway?

The HUG Initiative was launched in the ECE department at the beginning of the Fall semester of 2022 to address the gender discrepancies in research careers. This initiative is a student-led initiative to create a more Diverse, Equitable, and Inclusive (DEI) learning environment in the department of ECE by introducing research opportunities and resources for HUG students to access on campus. The HUG Initiative first reviewed previous literature on HUG students' challenges and obstacles for HUG undergraduate and graduate students to stay in the research career pathway, including low STEM identity, advisor–advisee relationship, and unwelcoming climate in the department [27]. Additionally, Chen et al., the survey study of the HUG Initiative, showed that HUG undergraduate students generally obtain research-related information via the Engineering College rather than from faculty and peers in the department, suggesting that providing HUG students additional opportunities to connect, learn, and gain insights into research labs and internships might improve their motivations to attend graduate school [32]. Therefore, the HUG Initiative proposes three key elements that could support HUG students in pursuing a research career: (1) skill set development, including the ability to conduct research, presentation, and writing skills, (2) networking within the department and research field, and (3) community support. We adopt several intervention approaches that combine these three elements, including panel discussions to demystify what it means to be a researcher and to provide resources on research opportunities, mentoring programs to match undergraduate students with graduate mentors, and town hall meetings to increase awareness of gender minorities from the ECE department and Engineering College.

2.1 Intervention: Panel Discussions

During Fall 2022 and Spring 2023 semesters, the HUG Initiative held six panel discussions and invited senior students and faculty members as panelists to advise on finding research opportunities and share their experiences in research skill development, especially challenges they have encountered. These panel discussions aim to help HUG students gain understanding and motivation toward having research careers and further build connections with panelists for future advancement opportunities. Each of the panel discussions was limited to 60 minutes. We advertised the initiative events through email, flyers, social media, and lecture advertisements. The panel registration was opened one week before the event for all ECE students. During registration, the attendees' pronouns and any questions they would like to ask during the panel were collected. Based on the responses, we prepared name tags with pronouns for attendees and a handout for attendees that shared campus resources related to the panel topic. This preparation was done to accommodate the limited time of the panel discussion. and collected the attendees' pronouns and questions they would like to ask during the panel. Each event was documented in a script, then posted on the HUG Initiative website. After each panel, a QR code for a post-event survey would be displayed on the screen to collect attendees' experiences. We also sent an email reminder to all attendees after the event to fill out the survey. The post-event survey asked the attendees to rate their overall experience of the events (from 1 to 5) and share the objectives they learned. This post-event feedback was used to understand the influence of events on attendees' perspectives and improve the HUG events.

Panel Discussions	Time of Events	Mean	Std. Dev
Start a Research Project	Beginning of Fall 2022	4.7	0.46
Q1: How would you approach a professor about a research opportunity?			
Q2: What is your goal to have undergraduate research experience?			
Q3: How do you select students to join your research team?			
Q4: What is your expectation for an undergraduate researcher?			
Q5: Is it possible to get paid while doing undergraduate research?			
Graduate School Application	Week 4 of Fall 2022	4.8	0.4
Q1: Why are you doing the graduate school?			
Q2: What is the biggest difference between undergrad/grad school?			
Q3: How did you choose the graduate school and find fellowship information?			
Q4: Do you get paid as a grad student?			
Q5: How do I get a strong recommendation letter?			
Q6: What if I don't have a high GPA or GRE score?			
Obstacles of Graduate School	Week 8 of Fall 2022	4.6	0.92
Q1: What's the best/worst thing about grad school?			
Q2: What factors should students consider when choosing a lab/advisor/field?			
Q3: When you chose your lab, was your advisor your first choice?			
Q4: As a woman, do you feel you need to prove yourself in grad school?			
Q5: What lesson do you learn the most in grad school?			
Q6: How to determine priorities when you're overwhelmed by tasks?			
Research in Academia	Week 4 of Spring 2023	4.5	0.25
Q1: Please tell us about your career path and how it led you to your current position.			
Q2: What do you like best about your job? What is the most satisfying part about your job?			
Q3: What are some of your biggest challenges in this position?			
Q4: Is it true that there will seldom be days off?			
Q5: What are the most important things to do as a student?			
Stress Management Workshop	Week 8 of Spring 2023	3.5	0.25
Research in Industry	Week 10 of Spring 2023	5	0
Q1: What do you like best about your job?			
Q2: What are some of the biggest challenges you've faced in this position?			
Q3: What is your typical day like?			
Q4: What advice do you have for students considering a career in the industry?			
HUGEE Mentoring Program	Fall 2022 & Spring 2023	4.73	0.44
Town Hall Meeting	End of Fall 2022 & Spring 2023	4.5	0.5

Table 1: Listed titles, times of events, questions asked during HUG panel discussions, and attendees' overall satisfaction, described as mean and the standard deviation, with HUG events as ranked on a 5-point scale.

Table 1 summarized all the questions being asked during the panel discussion, the times of events, and the attendees' satisfaction as rated on a 5-point scale. This information aims to provide a reference for future organizations on how to hold successful panel discussions on these topics. The times of events were designed to follow the academic calendar to provide a space for HUG students to ask for help. The following paragraphs summarize each panel discussion and learning experiences attendees shared. The complete discussions for questions and photos were shared on our HUG Initiative website: https://hugillinois.wordpress.com/.
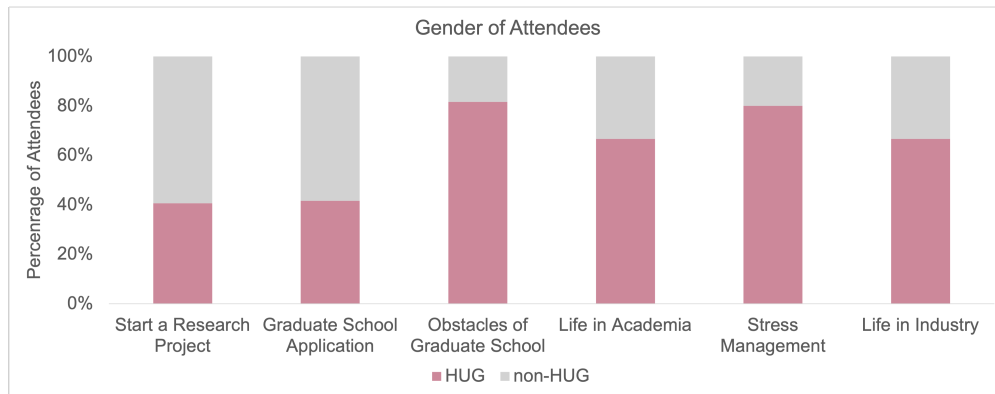
(a) Genders that attendees of HUG events self-identified.
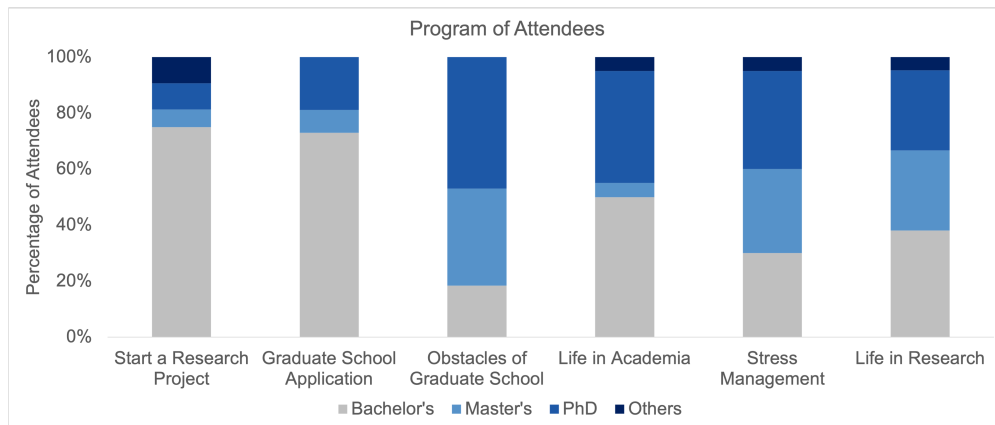
(b) Programs that attendees of HUG events enrolled in.

Figure 4: Demographics of attendees of the 6 HUG events, including (a) genders they self-identified and (b) programs they enrolled in.

Panel: How to Start a Research Project focused on undergraduate research experiences and provided a strategy to search for a research lab at the beginning of the Fall 2022 semester. Four HUG panelists were invited, including two senior undergraduates with at least one year of research experience, one senior graduate, and one faculty member who had experience working with undergraduate researchers. 32 students registered. As shown in Figure 4, 41% of the registered participants self-identified as HUG students, and 75% of students were undergraduates.

The undergraduate panelists mentioned that research experiences allowed them to make more connections with fellow undergraduates, graduate students, as well as professors. Throughout the

process, they learned what would be a good fit. Moreover, undergraduates can apply for on-campus scholarships and travel grants to present their research work at conferences. As shown in Table 1, participants felt satisfied with the panel discussion, with a mean rate of 4.7/5.0 and a standard deviation of 0.46. The following quotes are a sample of participants' comments demonstrating the positive impact of the panel:

- *"The panel provided good starting resources for finding advisors and how research goes."*

- *"Research will give us credit hours or pay. We aren't expected to make a breakthrough but rather try experiments that we are told. Moreover, it's possible to get a research position earlier than junior/senior year."*

- *"I was glad to hear what expectations professors and grad students have."*

- *"Just how willing professors are to work with undergrads."*

- *"Research isn't scary."*

Panel: Graduate School Application was held in week 4 of the Fall 2022 semester to follow the NSF Graduate Research Fellowships Program (GRFP) deadline. Three panelists were invited, including one junior graduate, one senior graduate, and one senior faculty member. 37 students registered. As seen in Figure 4, 40% of the registered participants self-identified as HUG students, and more than 70% were undergraduates. The graduate panelists recommended joining a lab with a more diverse culture, as diversity often leads to a better working and learning environment. Moreover, HUG students felt it was challenging to ask for solid recommendation letters for graduate school. The faculty panelist was strongly willing to write recommendation letters for students who asked them. However, they suggested some strategies to get a stronger letter, such as attending their office hours to make good impressions or doing undergraduate research. Overall, participants appreciated the opportunity to discuss graduate school applications. As shown in Table 1, the mean satisfaction rate was 4.8/5.0, with a standard deviation of 0.4. Some comments from participants included:

- *"Panelists told us about the actual experience and the reasons why they chose the grad school. They were honest about making little money during grad school in exchange for passion and freedom of research topics."*

- *"First time to learn information from the professor about the selecting process."*

- *"Research/projects that you did are important and can make up flaws in GPA."*

Panel: Obstacles of Graduate School provided graduate school orientations for first- and second-year graduates by sharing graduate school experiences and collaborating with another initiative in the university. 49 students registered. In this event, we put a line in the registration form stating that "This program is designed for HUG students. If you don't identify as HUG, we kindly ask you to quietly observe, refrain from asking questions, and not take up space during the event." As shown in Figure 4, more than 81% of the registered participants self-identified as HUG students, and 80% of students were graduates. This indicates that creating a space dedicated to students with minoritized identities is helpful in increasing the representation of HUGs in the events. During the panel discussion, the panelists suggested not constantly competing with colleagues in graduate school since people varied their timelines. They also mentioned that it was

not uncommon to switch research groups, especially at an early stage of graduate school. Since graduate school interviews were very short, the students might not know if the group was a good fit during those several minutes. At the end of the panel, there were discussions about "As a HUG student, do you feel like you need to prove yourself in grad school?" Two of the panelists self-identified as cisgender women. They agreed and said people were skeptical about their abilities, but they let their skills speak for themselves. Overall, participants felt satisfied with the conversation about graduate school. Shown in Table 1, the mean satisfaction rate was 4.6/5.0 with a standard deviation of 0.92. Some comments from participants included:

- *"I learned that I am not the only person suffering in grad school."*

- *"Heard advice on how to deal with excessive workload and socializing."*

- *"I learned that it's possible to switch advisors. I didn't know people actually did that."*

- *"We don't need to feel anxious for not being the top student."*

- *"That you must be the top of your class/ best at what you do to apply, and that getting used to not being the best helps."*

Panel: Life in Academia was designed to share the experiences of postdocs and tenured or teaching professors from graduate school to their current positions. The event was held in week 4 of the Spring of 2023 when the on-campus job fair and the deadlines for campus scholarship applications were scheduled. Three panelists were invited, including an associate professor, a teaching assistant professor, and two postdocs. 21 students registered. 67% of attendees self-identified as HUG students, and 50% are undergraduates. The panelists shared that their favorite parts of working in academia are that you learn every day, work with clever people, and see students' success. However, they also mentioned that learning every day is a double-edged sword, as it can be a stressful experience. Thus, time management becomes a critical skill for determining where you fit. When asked about work/life balance, the panelists agreed that the schedule of academia is different from industry but shared that working in academia is a personal decision: "I don't know any academic that suffers from working 24/7. It's a self-inflicted wound and a personal choice."

Panel: Stress Management Workshop collaborated with the campus counseling center to discuss stress management for university students. This workshop was held on week 8 of the semester of Spring 2023, which was the midterm week, and aimed to provide on-campus resources to HUG students to help relieve their stress during the midterm week and create a safer community among the HUG Initiative. During the workshop, the speakers introduced how to self-recognize stress and provided guidelines for coping with stress. They also gave a tutorial on box breathing for relaxation and introduced available on-campus resources. Some comments from participants included:

- *"I learned how to manage my stress and to relax when tired."*

- *"Everyone gets tired, and everyone has different ways of managing stress."*

- *"There are definitely resources available on campus if you need them."*

Panel: Life in Industry collaborated with the campus research park, a technology hub for

corporate research and development operations and start-up companies. We invited three entrepreneurs to share their experiences working in the industry and start-up companies. When asked about past experiences, most panelists don't have a linear path toward a career. One panelist decided to quit the corporate job after ten years of experience and delve into a start-up company. Another panelist didn't intend to start a company at the beginning. However, he went to a pitch competition and was able to take the patent to market. Afterward, he took a break from school to become a full-time entrepreneur. When asked about any advice for students, the panelist suggested HUG students take advantage of resources on campus and encouraged engineering students to interact more with business schools to learn how to prepare for pitching and competitions. Shown in Table 1, the mean satisfaction rate was 5.0/5.0, indicating that all responses rated 5/5. Some comments from participants included:

- *"Satisfaction in life comes from working on something that you're passionate about; not just working."*

- *"Make connections and get involved in leadership positions."*

- *"It's possible to find grant funding to build up a business from scratch."*

2.2 Intervention: Mentoring Program

The HUG Initiative held a mentoring program every semester to create a space for HUG students to connect with other students in the department and discuss their career perspectives privately. The HUG Encourage & Elevate (HUGEE) Mentoring Program was developed to help undergraduate mentees grow their professional network, learn to navigate professional challenges, and build their career pathways. We paired graduate students (as mentors) with undergraduates (as mentees) based on their similar areas of research interests. First launched in the Fall of 2022, the mentoring program was open to all ECE students, but students identified as HUG had a higher priority to be paired either as mentees or mentors. 14 undergraduates registered as mentees, and 6 self-identified as HUGs. We then selected 14 students for the graduate mentors (mostly Ph.D. students), and 8 of them self-identified as HUGs.

The success of the Fall 2022 mentoring program enabled us to relaunch a semester-long mentoring program in the Spring of 2023. 12 graduate mentors and 10 undergraduates were registered, with 54% identifying as HUGs. Herrera et al. indicated that the group mentoring program might appeal to people with minoritized identities who expressed concerns about the "intimacy" of one-on-one mentoring and the substantial time commitment it requires [33]. Moreover, Alleyne et al. suggested that the effect of group mentoring began to decrease when the group size exceeded the one-to-four or five ratios [34]. To compare the differences between group and one-on-one mentoring among the HUG student community, we paired groups of 4–5 mentees to mentors in groups in the semester of Spring 2023. They are grouped by (1) matching fields of study/interest for students interested in research careers or graduate school applications, (2) pairing mentees who are on the trans/nonbinary spectrum with mentors who are LGBTQ+, and (3) balancing gender and race identities within each group for mentors and mentees.

Mentees appreciated the opportunity to discuss graduate school or research experience and found the conversations informative. Graduate mentors also benefited from participating in the

mentoring program. However, the group mentoring format received the opposite feedback from HUG students versus non-HUG students. HUG students preferred to keep a one-and-one mentoring format to ask questions with privacy, whereas non-HUG students liked the chill vibes of group mentoring luncheons. Shown in Table 1, the mean satisfaction rate is 4.73/5.00, with a standard deviation of 0.44. Some comments included:

- *(Mentee)"Super helpful on the application process and what to expect from casual interviews; how letters of rec help."*

- *(Mentee)"Yes, I need high GPA, sad ;(Yes, I need papers ;(, but also possibility of reaching out to professors who you don't really know that well, it still can work out if I want to start undergrad research."*

- *(Mentee)"Really insightful talking to mentor about how interviews with professors work."*

- *(Mentor)"Good dialogue with current undergrads."*

- *(Mentor)"Most of them didn't seem to realize grad school is not required for a good career in industry."*

- *(Mentor)"This mentoring program provides a duo conversation with an easy flow of thought, no constraints of what to talk about, and being able to actually talk about experience (out of the class as well)."*

2.3 Intervention: Town Hall Meeting

At the end of Fall 2022 and Spring 2023, the HUG Initiative held two public town hall meetings. These meetings aimed to share our findings with ECE students, faculty members, and staff and hear thoughts from the participants on how to support HUG students in pursuing their research careers. We invited all the participants from the previous HUG events, faculty members, and staff members in Engineering College. 29 participants registered, and 62% of the participants self-identified as HUGs. In addition, 78% of the registered participants were students, and others were faculty and staff members. We set up an online anonymous comment tool during the event and displayed the QR code on the screen for interactive communication. When we asked the participants how to build an inclusive environment in ECE, the participants shared,

- *"Post more social events."*

- *"Provide a safe space for students"*

The discussion during the town hall meeting was fruitful. This was the first time we shared the safe zone concept in the ECE departments, which is a safe environment against a hostile homophobic and sexist campus climate [35], and received positive feedback from the audience. The attendees shared the comments in the post-event survey,

- *"I didn't realize we had so many non-binary and trans students at the school."*

- *"Ideas on how to create a safe space for HUG students."*

- *"Keep doing the mentor/mentee sessions."*

3 How can programmatic events be tailored to benefit research-career aspects of HUG students in engineering?

The HUG Initiative adopts interventions, including panel discussions, mentoring programs, and town hall meetings, to provide HUG students opportunities to develop their skill sets, increase networking within the department and research field, and advocate community support for HUG students. Based on the post-event feedback from attendees, we evaluated the impact of these interventions on the career perspectives of HUG students. The panel discussions covered topics for students from first-year undergraduates to last-year Ph.D., and therefore, the attendees of HUG events include students enrolled in the Bachelor's, Master's, and Ph.D. programs. The mixed participation of student attendees creates potential networking opportunities between undergraduate and graduate students. Most attendees were satisfied with the events (an average of 4.66 on a five-point Likert scale) and appreciated the insightful conversations. Participants specifically appreciated the discussions on concerns HUG students had, including lacking information on research labs, asking for a strong letter for graduate school application, and pressure to perform well in graduate school. The post-event survey indicated that HUG students learned much career-related information for the first time from the graduate and faculty panelists. They also felt relieved when they realized they were not the only ones facing the challenges in their research career pathways.

Besides the panel discussions, the HUGEE mentoring program helps build a connection between graduate students and undergraduates. Meeting with an experienced graduate student with a similar research interest area encouraged undergraduates to consider graduate school. Most undergraduate mentees appreciated the opportunities to demystify their perspectives on research labs, graduate school, and career pathways. In addition, the graduate mentors had the opportunity to practice guiding undergraduates to choose their research lab and provide resources. The mentors also shared their experiences and motivations with mentees. In the Fall of 2022 and Spring of 2023, we adopted different approaches, one-on-one and group settings respectively, to the mentoring program and compared the feedback we received. HUG students feel more comfortable having a small group setting and favor having a conversation with 1–4 people. The group mentoring setting worked better if students shared similar identities, i.e., gender or race identities. HUG students intended to look for in-depth conversations with peers and long-term mentoring relationships from the mentoring program.

To foster conversations between attendees and build a safe space, the HUG Initiative further deployed several techniques during the events, including:

- Sharing pronouns: When introducing panelists and attendees themselves, we also encouraged them to share the pronouns. Name tags were printed with the attendees' names and pronouns to avoid using cis-normative language.

- Brief introduction on the diversity of genders at the beginning of each event.

- Emphasize the participation of HUG students: We put a line in the registration form stating that "This program is designed for HUG students. If you don't identify as HUG, we kindly ask you to quietly observe, refrain from asking questions, and not take up space during the event."

- Implementing an online anonymous comment tool: From the experiences of the first two panel events, we found that HUG students favored asking questions and providing feedback anonymously instead of raising their hands in front of audiences. Thus, we included the interactive Q&A online tool, allowing attendees to ask questions anonymously.

- Discuss HUG students' challenges in pursuing a research career pathway in each panel discussion.

When compared to the post-event survey feedback and the demographics of attendees, adopting these techniques increased the participation of HUG students. The involvement of HUG students increased from 40% at the first panel of "Start a Research Project" to more than 70% for all the panels after "Obstacles of Graduate School." Increasing the representation of HUG students in the event led to more feedback and conversation on their concerns during the events. Building a safe environment is extremely important for HUG students and can create a sense of belonging. Most of the HUG event attendees were willing to attend all the HUG events and have extra conversations with panelists and other attendees after the panel discussions.

Finally, the HUG Initiative raised awareness of building an inclusive environment in the ECE department by holding events. During the town hall meeting, we shared the findings from our survey and post-event feedback. It was the first time for many non-HUG attendees to realize that there were many transgender and non-binary people in the department. The idea of creating a "safe space" in the department also drew the attention of the faculty members and staff, as they started to think about how to support better learning and working experiences of students in the department. The open discussion on the challenges HUG students faced motivated HUG students and other non-HUG populations to contribute to the DEI in the ECE department.

Conclusion

Launched in the Fall of 2022, the HUG Initiative aims to promote the pursuit of research careers for students identified as Historically Underrepresented and marginalized Genders (HUGs) in the ECE department. The survey indicated that HUG students are more likely to consider research careers; however, they generally felt a lack of research experience and had additional concerns about a lack of interest in the ECE study, the need to join the workforce upon graduation, and the lack of support from peers and faculty. To help HUG students gain understanding and motivation toward having research careers and further build connections with panelists for future opportunities of advancement, we held panel discussions of experience sharing. Six 1-hr events were held in the Fall of 2022 and Spring of 2023 to demystify what it means to be a researcher (researcher identity) and provide students with resources to find research opportunities. In addition, mentoring programs were held during the semesters to provide another venue for HUG students to ask career-related questions in a private conversation. The post-event feedback shows that providing HUG students more opportunities to connect, learn, and gain insights on career- or research-related information increases the sense of belonging of HUG students to the DEI initiative as well as the ECE department.

This student-led initiative is a pilot study that systematically identifies the needs of HUGs in the ECE department and evaluates the influences of events on the retention of HUG students in the research career pathway. This model is scalable to a larger audience and can be deployed in

different STEM departments, institutions, and other underrepresented groups. An analysis comparing pre-study and post-study surveys and student interviews will be conducted to learn about the influence of the HUG Initiatives on HUG students' perspectives for research careers. More importantly, this work presents the potential of student leaders in the DEI activity, as the core value of the HUG Initiative is for students and by students. Including voices from different educational stages helps understand the obstacles students face in their career path. With the support of experienced faculty members and the institution, the HUG Initiative can conduct educational research focusing on students' experiences to build a more inclusive atmosphere in the department.

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