Empowering Hispanic Engineers' Success Towards Graduate Education with Hybrid Mentorship

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Empowering Hispanic Engineering Students for Success in Graduate Education with Hybrid Mentorship

Abstract

Students from underrepresented communities in STEM often face challenges of cultural biases and systemic barriers that can hinder their academic and professional advancement. As these students navigate their academic journey, mentorship is key to providing them with guidance, support, and a sense of belonging to overcome such hurdles. Faculty are often a source of mentorship for setting academic and career goals, serving as a role model for attaining a career in STEM, and finding research opportunities. However, they may not always have the bandwidth to directly mentor undergraduate students specifically. Previous work on peer mentorship focuses on how mentoring exposes and prepares undergraduates for graduate education, and we contribute to this discussion by analyzing specific traits and strategies that make peer mentoring effective towards cultivating students' interest in graduate school. Our study explores success factors in peer mentoring of students from underrepresented groups in STEM.

We developed a mentoring program between Hispanic graduate and Hispanic undergraduate students to identify aspects of peer mentoring that may increase Hispanic representation in advanced STEM degree programs. We aim to address these questions: 1) How do interactions between mentoring pairs affect access to professional resources? 2) Which mentor qualities are successful in graduate school guidance? and 3) How can virtual activities engage students to build leadership skills and confidence in their academic pathways and future careers? The program structure has three key features to enrich the peer mentorship experience: (i) goal setting and reflections, (ii) academic/professional development, and (iii) community building. We evaluated the program through a series of surveys and interviews to collect information about undergraduates' knowledge on graduate admissions items, reflections on mentoring interactions, and accomplishments made during the program.

We recruited participants through in-person promotion during meetings of student organizations, referrals, and written/electronic advertising (e.g., newsletters, websites). Our cohort of 16 included 8 graduate student mentors and 8 undergraduate mentees. Three of the four graduating seniors in the cohort enrolled into STEM graduate programs with fellowship offers, one is working as an engineer, whereas the other 4 students are continuing their undergraduate studies.

Undergraduates shared that interactions with their mentor were key for providing information about graduate school, including advice on writing strong personal statements and finding external resources. Graduate students noted the importance of their role as mentors especially if they have similarities with their mentees. Participants' responses indicated that accountability, openness, and good communication are necessary in graduate school guidance. Their feedback at the end revealed that the program activities helped improve their leadership and communication skills. They also showed interest in expanding events and maintaining the program's initiatives to enable the Hispanic engineering community on campus to serve as a self-reliant resource. Our mentoring program demonstrates a promising structure in addressing Hispanic students' access to mentorship towards promoting interest in graduate school and the importance of ongoing support in this effort.

Introduction

Increasing representation of Hispanics in engineering fields is a priority for many universities and companies as they seek to build a diverse, talented workforce. Despite significant growth in the Hispanic population, which now makes up 19.5% of the U.S. population [28], Hispanic people remain underrepresented in STEM careers. The Hispanic population in the U.S. grew by 23% between 2010-2020 [11] and is still a major contributor in the country's overall population growth [28]. However, this demographic growth has not been matched by proportional representation in STEM fields. As of 2021, Hispanics accounted for 13.2% of master's degrees, 9.7% of doctoral degrees in science and engineering (S&E), and just 9.5% of the S&E workforce [19], highlighting a persistent gap between population growth and representation in STEM.

To address this disparity, universities and companies are implementing various strategies to support Hispanic students in their educational and career pursuits within STEM. Such efforts focus on highlighting opportunities, providing support systems, and fostering an inclusive environment for Hispanic students and professionals. Engineering undergraduate programs have also increased efforts to recruit and retain students from underrepresented groups. While more Hispanics are attending college, many still face barriers to graduation and even fewer continue to pursue advanced degrees [13].

Mentorship is an effective strategy for improving recruitment and retention for students from historically excluded communities in STEM. Tailored mentoring, which addresses the specific needs, abilities, and commitments of students, is especially impactful for Hispanic students, leading to significant improvements in their academic and career outcomes [2, 6]. Deep mentorship, differentiated to meet the unique circumstances of undergraduate students, allows mentors to become key influences in their mentees' lives [3, 22, 25, 26]. Effective mentorship can increase community cohesion, demystify the path to a PhD, and provide valuable insights into science and engineering careers [10, 25]. However, common limitations across mentoring initiatives include insufficient mentor training [3, 30], time constraints [3], and mismatches in mentor-mentee expectations [24], which can hinder the effectiveness of mentoring programs.

To address these limitations, we developed a mentoring program structure at a large university aimed at increasing interest in graduate degrees among Hispanic undergraduate engineering students. The program paired undergraduate students with graduate student mentors for 1-on-1 mentoring. This pairing style is beneficial as graduate students can serve as relatable near-peer mentors to offer recent and relevant experiences of transitioning from undergraduate to graduate studies. Initially designed during the COVID-19 pandemic when academic teaching was primarily virtual, the program included a virtual element from the start and was later adapted to a hybrid format as campus restrictions changed. This structure was designed to benefit both mentors and mentees, with mentees gaining insights into graduate education and mentors refining their leadership skills.

To accommodate varying needs, the hybrid format provided mentoring pairs with flexibility to meet either in-person or virtually, adapting to individual preferences and schedules. The program included workshops that addressed key topics, such as the importance of mentoring, leadership

development, and career pathway opportunities. These workshops featured speakers who identified as Hispanic and held advanced degrees to increase the visibility of Hispanic professionals in STEM. Through our program, three of the four graduating seniors enrolled in STEM graduate programs with fellowship offers, graduate students developed a deeper understanding of effective mentorship practices, and undergraduates found that interactions with their mentors increased access to resources for both academic and professional growth.

Our contributions are as follows:

- We design and implement a structured program tailored to address the academic, professional, and social needs of Hispanic engineering students
- We present methods to increase engagement and interest in graduate education among underrepresented students in engineering
- We present an analysis of mentoring relationships between undergraduate and graduate student pairs, identifying key factors for success
- We create opportunities for graduate students to enhance their leadership skills through structured mentoring roles
- We identify traits that empower Hispanics in engineering to achieve their academic and professional goals

Our work has broader impacts by providing a mentoring program structure that enhances graduate school knowledge within a historically excluded engineering community. While we focus on Hispanic engineering students, the strategies and insights developed here can also be applied to improve mentoring relationships between graduate students and undergraduates from other marginalized groups in STEM.

Academic Programs Supporting Underrepresented Communities in STEM

Mentoring programs are recognized as a valuable strategy to support and retain Hispanic students in engineering fields. Several initiatives across the U.S. provide mentorship opportunities tailored to address unique challenges faced by underrepresented groups. The Meyerhoff Scholars Program (MSP) at the University of Maryland, Baltimore County is an exemplary program of effective intervention for underrepresented minority (URM) students in STEM [14]. MSP demonstrates a decades-long record of improving retention and graduation rates for underrepresented students while significantly increasing their likelihood of entering STEM PhD programs. A key feature of MSP that led to its success is peer mentoring which enabled sustained social and academic interactions between students. Unlike our program that pairs undergraduates with graduate students, MSP pairs undergraduate students, i.e., an underclassman with an upperclassman.

Purdue University's GradTrack Program takes on a community-driven mentoring circle structure to prepare URM undergraduate students for graduate school [1, 15]. Compared to our 1:1 graduate-undergraduate student pairs (both enrolled in our university), GradTrack pairs 2 graduate students with several (i.e., more than 4) URM undergraduate student mentees from

across the U.S. GradTrack was fully online with a focus on academic support for undergraduates and professional development for graduate mentors in their pilot year. In its second year, senior undergraduates were invited to visit Purdue, highlighting the importance of in-person interactions. In contrast, our program offers both face-to-face and virtual interactions for mentor-mentee relationships to develop into a close-knit community of Hispanic engineering students on campus. This flexibility facilitates personal connections and offers tailored support to address the unique cultural and academic challenges faced by Hispanic students in engineering [4].

Other programs aim to support students from marginalized and underrepresented groups in pursuing graduate education, regardless of their major. One notable program is the McNair Scholars Program, a federally funded program that selects students from first-generation, low income, and/or racially minoritized backgrounds to help them prepare for and attend graduate school [23]. McNair programs exist in multiple institutions and offer a range of activities for their students, including academic counseling, faculty mentorship, internships, tutoring, and research experiences. However, data from these programs showed that participants have high odds of enrolling in graduate school if they completed their bachelor's degree; less is known about participants who did not graduate with their bachelor's degree [23].

The Louis Stokes Alliances for Minority Participation (LSAMP) programs in higher education institutions are also federally funded. LSAMP's goal is to diversify the nation's STEM workforce by increasing the number of STEM degrees (at bachelor's and graduate levels) awarded to persons from underrepresented groups in STEM [18]. However, each alliance (consisting of at least four institutions) has different strategies to attain this goal and varying focus areas such as academic completion [8]. Peer mentoring might not be part of their strategy.

The Current Mentoring Environment

Recently, virtual mentorship was adapted to facilitate meaningful and productive mentoring experiences during the COVID-19 pandemic [27]. Virtual mentoring has allowed for easier communication as time and physical location no longer need to be critical issues when establishing mentoring relationships [12]. Post-COVID-19, these efforts remain valuable for connecting mentors and mentees, but traditional face-to-face mentoring still plays a key role in building personal relationships and creating a sense of community.

With the goal of increasing awareness of and interest to pursue graduate degrees, we created a mentoring program that allows for virtual and face-to-face mentoring of Hispanic undergraduate students by Hispanic graduate students in STEM. In our university's context, the College of Engineering (COE) had 14,607 registered students as of Fall 2023, of which 946 self-identified as Hispanic (6.47%). Of these 946 Hispanic students, 20 were non-degree students (0.13% of COE), 723 were undergraduates (4.94% of COE), 120 were master's students (0.82% of COE), and 83 were doctoral students (0.56% of COE) [29]. The hybrid mode of a 1-on-1 mentoring experience provides flexibility for meeting and sharing of information. The program started with participants meeting virtually during the pandemic and as campus regulations changed after, program participants shifted to hybrid mentoring.

Table 1. Student Eligibility and Review Criteria

	Eligibility	Review Criteria
Undergraduate Student	Self-identify as Hispanic	Motivation for learning about or pursing graduate school
	Enrolled in a STEM degree program	Interest level in master's or doctoral degree programs
Graduate Student	Self-identify as Hispanic	Willingness to mentor a student towards their academic or professional goals
	Enrolled in a graduate STEM degree program	Program fit from the applicant's motivation to be a mentor

The mentoring pairs interacted in-person and virtually throughout their participation. To enrich the peer mentorship experience, the program was structured to build community through monthly events and to support academic and leadership development through goal setting with reflections and workshops with invited speakers, respectively.

This mentoring program was developed to identify aspects of peer mentoring that may increase representation in advanced STEM degree programs. It is intended to grow the skills, knowledge, and confidence of Hispanic engineering students to help them succeed in applying to graduate programs if they chose to do so. These questions guide our study:

1. How do interactions between mentoring pairs affect access to professional resources?
2. Which mentor qualities are successful in graduate school guidance?
3. How can virtual activities engage students to build leadership skills and confidence in their academic pathways and future careers?

We aim for undergraduate students from historically underrepresented communities in engineering to gain knowledge of graduate school through their interactions with their mentors and participation in the program activities.

Participant Recruitment and Selection

For one month, we recruited participants through various methods, including in-person promotion during student organization meetings, referrals, and written electronic advertising (e.g., newsletters, websites). Physical flyers were posted around engineering buildings, and a digital version was sent to students in the College of Engineering via the weekly newsletter.

We specified the eligibility and review criteria for program participants in the interest form (see **Table 1**). Interested individuals were asked to complete the interest form taking into consideration the criteria. The interest form included questions regarding background, motivation to join the mentorship program (1:1 mentor-mentee ratio), and their top 3 goals or skills to take away from program participation.
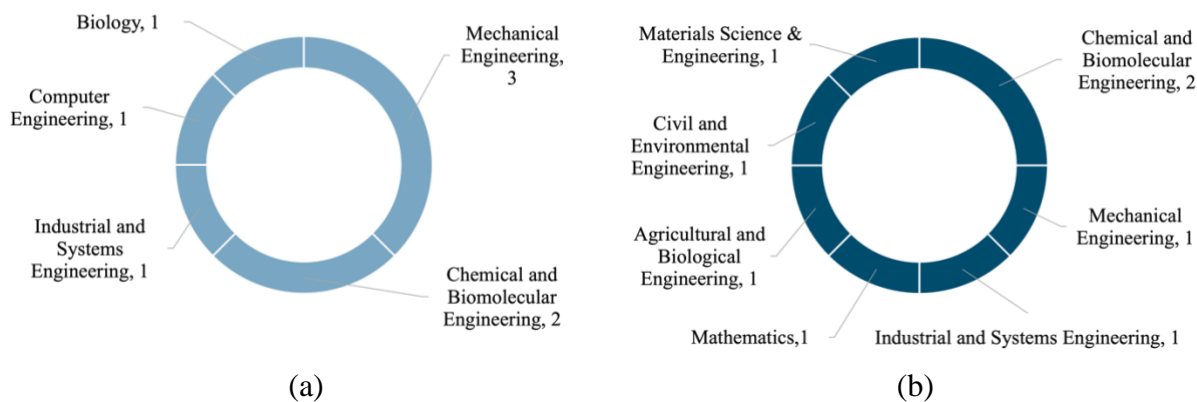
Figure 1: Fields of Study represented by (a) undergraduate and (b) graduate student participants

Students were matched based on their academic and professional goals as well as their interest in advanced degrees. Ideally, we paired undergraduates with graduate students in the same field or discipline (e.g., mechanical engineering undergraduates with mechanical engineering graduate students) or with graduate students who had relevant experiences (e.g., internships, research) that the undergraduates found interesting. In cases where there was minimal overlap in interests, we paired undergraduates with graduate students who could mentor on a general level, focusing on providing guidance and information about graduate school.

This study focuses on our second cohort for 2022-2023, relative to prior work on a first cohort [4]. The program was administered in both instances by three graduate students in engineering departments. A total of 36 students applied for the program (8 undergraduates, 28 graduate students), and we selected 8 mentor-mentee pairs to participate. Out of the 28 graduate student applicants, only 10 were eligible after screening as most did not self-identify as Hispanic. As for the number of undergraduate applicants, perceptions of program advertisements may have resulted in low interest, such as the requirement of having already made the decision to apply to graduate school to participate. Another factor may prior commitments to other research-oriented programs made in the semester prior. Among our 16 selected students, 69% were male and 31% were female. All graduate students were in PhD programs: 7 in engineering and one in mathematics (**Figure 1b**). Among undergraduates, 7 were in engineering and one was in biology (**Figure 1a**). There were 4 seniors, one junior, one sophomore, and one freshman. The processes of our study were approved by our university's Institutional Review Board.

Program Structure

Through the program, we increased interest in pursuing graduate degrees among Hispanic undergraduate engineering students by facilitating mentoring from graduate students. We also anticipated that the mentoring process would help graduate students develop and strengthen their leadership skills. To achieve our program objectives, we focused on three key program features:

1. Goal setting and reflection,
2. Academic and professional development, and
3. Community building

Goal Setting and Reflection – Once mentor-mentee pairs were finalized, each pair met to discuss and set goals for the year. Participants addressed any questions the undergraduate students might have, whether technical, academic, professional, or personal. Graduate students were also encouraged to set their own goals as mentors, focusing on leading their undergraduate mentee to learn about graduate school and sharing their personal experiences. Participants were expected to meet for two hours per month to review progress towards their goals.

At the end of the fall semester, participants were asked to complete an accountability survey to provide feedback on improving their mentorship and the program itself. At the end of the year, participants reflected on their experience being in the program as mentors and mentees.

Academic and Professional Development – Throughout the year, mentors and mentees were required to participate in one-hour workshops covering various topics such as the importance of mentoring, development of leadership skills, and career pathways. We partnered with other university units to facilitate discussions concerning mentorship and leadership, including various engineering departments, the Graduate College, and Engineering Undergraduate Research.

The workshops addressed key areas such as differences between undergraduate and graduate coursework, various types of graduate degrees, interview strategies, and the benefits of undergraduate research opportunities, including Research Experiences for Undergraduates (REU) summer programs. We held a workshop focused on the graduate school application which covered writing personal statements, obtaining references, and creating a standout curriculum vitae/resume. A series of panel discussions were also hosted to answer questions such as how to find the right graduate program, search for funding opportunities, explore one's research interests, and what are the crucial skills to be a competitive graduate student applicant. To enhance role model visibility, we invited Hispanic professionals with advanced STEM degrees to share their experiences and career paths with the participants. For further professional development, we engaged the expertise of leadership development staff on campus to assess the participants' mentoring skills in team settings and work environments.

Community Building – We organized social events to build community and foster a sense of belonging amongst participants. We incorporated social time in these three events: Internship Prep and Social, Feedback Dinner, and Reading Day Lunch. During these events, we allocated time for participants to catch up, get to know each other more, and chat. To facilitate interaction, participants engaged in board games, interactive online games using their phones, and ice breaker games, creating a comfortable atmosphere with their mentors and peers. Meals are opportunities for social interaction such as talking about concerns and emotions, sharing experiences, and making plans [20]. Following these social events, the mentors provided feedback to their mentees on their applications for REU programs or graduate school.

Table 2. Length and Frequency of Meetings and Modes of Communication (*n* = 11)

Time Spent Per Month on Mentoring Relationship		Frequency of Meeting Per Month		Modes of Communication	
Less than 1 hour	18%	Less than once	18%	Email	91%
1 hour	45%	Once	36%	Text	55%
2 hours	36%	Twice	45%	Zoom	45%
				In-person	9%

Evaluating the Mentoring Relationships

To answer our research questions, we examined the participants' responses to a series of surveys that included open-ended questions. 14 of the 16 participants (88% response rate) completed the initial survey at the start of the academic year and 11 (69%) of them completed the accountability survey which was administered at the end of the fall term. 10 of the 14 (71%) participants who completed the initial survey did the final survey.

How do interactions between mentoring pairs affect access to professional resources?

At the start of the fall semester, we collected information about the participants' expectations of the program, their knowledge of graduate admission requirements, and topics they would be interested in learning about. We then asked them about the frequency of meetings, mode of communication, topics discussed, and what they have learned so far by the end of the fall semester. **Table 2** shows the amount of time, frequency of meetings, and modes of communication used by participants.

From **Table 2**, we noted that the pairs met at least once a month for at least an hour. Most of the participants also communicated electronically either through email, text, and Zoom. For mentors, reaching out to the mentee is considered a welcoming gesture to establish the first meeting [15]. We expected that most communications would begin this way and hoped that the mentor pairs would eventually meet in person. However, having seen this data at the middle of the year, we encouraged them to have face-to-face time as well and to attend the workshops and social events.

We also asked participants their perceptions about the ease of accessing resources given the options for face-to-face physical interaction and virtual meetings. We define professional resources as different means and supports, sources of information, to enhance academic and non-academic growth of students. We also took into consideration that information is available online and that mentors may provide direction or guidance on where to find resources.

All the participants reported that when they met, they discussed professional career goals and academic development (e.g., studying tips), research opportunities, and skill development for their respective fields. Mentees shared that through their meetings with mentors, they gained information about graduate school, tips on how to get involved in research, and the different career paths they can take. Below are some examples of their responses:

"I have learned a lot about grad school and the different paths I can take. I think it's really valuable to have someone who has already completed undergrad and can share their experiences with you."

"I have learned about different research opportunities extending from the university (national labs, companies, other schools). [My mentor] has also helped me draft up emails to professors that I am interested in doing research with."

"I have learned about graduate school applications and considerations of whether to apply for the PhD after graduation. I have also learned more about writing about personal goals and reflecting on whether a new opportunity for me will benefit me in the long run."

Mentors, on the other hand, expressed learning more about planning and sticking to a regular meeting time with their mentee. They also mentioned that they intend on being more responsive, attentive, and sensitive to their mentees' needs and suggested having more opportunities to meet the people in the program:

"You have to really plan ahead, commit to meeting times, and come prepared with content to discuss. The events could be more frequent and have time built in for mentor-mentee discussion."

"I think being on time for meetings is something that we can work on."

"I need to be more responsive and attentive, because I dropped the ball when our meetings fall during conferences or holidays."

"I have learned to set boundaries while also providing the help that the student needs."

At the end of the year, the mentees highlighted that the program's professional resources, research exposure, and mentor interactions contributed to their academic success and graduate school aspirations. These interactions provided not just information but also personalized guidance for their professional development:

"…I feel that undergrads don't get a lot of exposure to grad students on a day-to-day basis, so having someone that you know you can go to and ask questions to has been a really big help."

"I think it's great to have a space for these mentoring conversations because there are a lot of options as an undergraduate that I didn't even know to ask about."

"Mentoring helps students comprehend and reflect more about how their degrees will help them pursue their passions."

Table 3. Interest Levels of Undergraduate Students in Graduate School at the Start (T_1) and End (T_2) of Program Participation

	T_1 ($n = 6$)			T_2 ($n = 4$)		
	Mean	Median	StdDev	Mean	Median	StdDev
Interest in Graduate Education	4.67	5.00	0.75	4.25	4.50	0.83
Interest in master's degree (MS)	3.83	4.00	1.33	4.50	5.00	0.87
Interest in doctoral degree (PhD)	4.00	4.50	1.15	2.75	3.00	0.43

Scale: 1=Not at all interested, 5=Extremely Interested

Table 4. Means for Familiarity with Graduate School-related Matters at Start of Program

	Mean	Standard Deviation
Graduate Programs	2.83	1.47
Application Process	2.83	1.17
GRE	2.67	1.63
CV/Resume	2.83	1.33

Scale: 1=Not at all familiar to 5=Extremely familiar

Which mentor qualities are successful in graduate school guidance?

Mentoring requires regular interaction between a more experienced mentor and a less-experienced mentee, where the mentor provides undergraduates support for personal, academic, and/or professional growth [9, 16, 27]. We initiated this program for Hispanic engineering students to receive and benefit from mentoring to increase interest in graduate education.

Our survey of undergraduate students' interest in graduate education shows some variation in the responses, specifically when comparing the means and standard deviations between groups (see **Table 3**). It is important to note the small sample sizes, which amplifies the effects of individual responses, making averages more sensitive to individual differences. The median increases from 4 to 5 for interest in master's programs, showing a stronger preference for master's degrees in the smaller group from T_2. While interest in master's programs increased, there was a decrease in mean interest for PhD programs from T_1 (4.00) to T_2 (2.75). The standard deviations, however, show more consistency in responses from T_2 for the interest levels in a PhD (0.43) compared to the more varied responses in T_1 (1.15). This apparent decrease in PhD interest is noteworthy given that all 8 mentors were PhD students, suggesting that exposure to PhD mentors did not necessarily increase interest in PhD programs among undergraduates. While there are differences in the mean scores, the small sample sizes make it challenging to generalize these findings. We also note that these results are based on responses from only half of the participants, further limiting the generalizability of these observations.

We also analyzed how familiar undergraduate students were with the types of graduate programs, application process, and requirements. At the start of the program, undergraduate students rated their familiarity with these graduate school related matters using a scale of 1 (not at all familiar) to 5 (extremely familiar). On average, undergraduate students seem somewhat familiar with these (see **Table 4** and **Figure 2**).
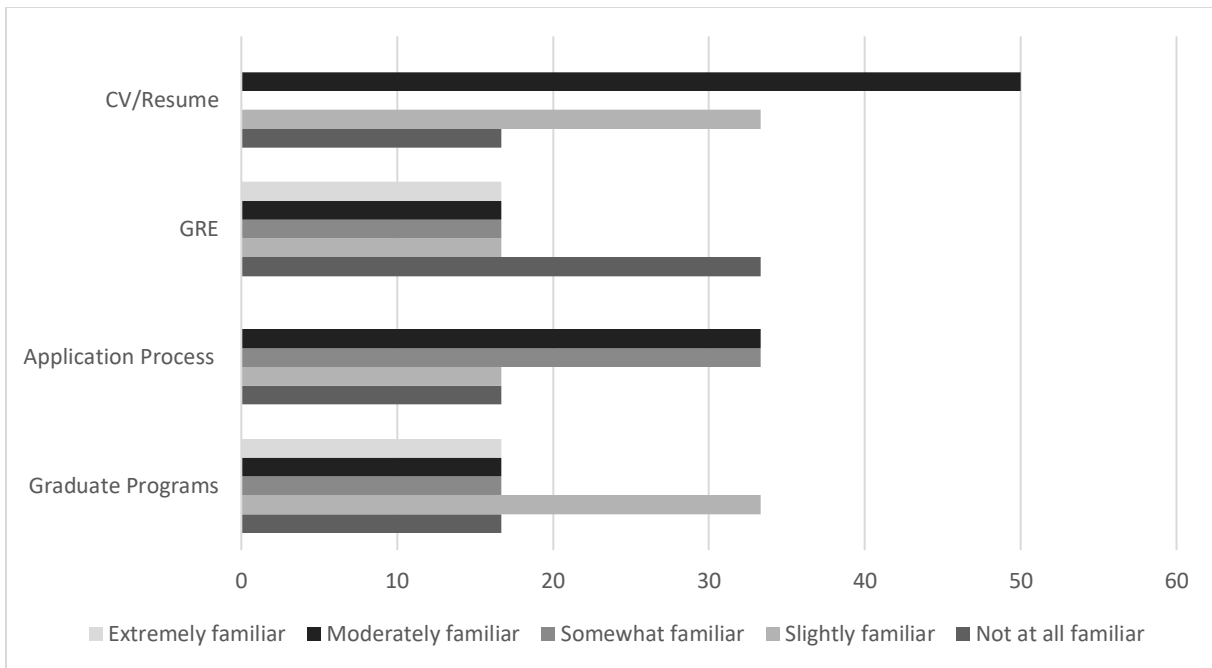
Figure 2. Percentage of Students' Familiarity Ratings with Graduate School-Related Matters at Start of Program

Undergraduate students were most familiar with the curriculum vitae (CV) and resume and least familiar with the types of graduate programs, as shown in **Figure 2**. Familiarity with the CV and resume was expected since these are typical application requirements for jobs, schools, and scholarships. The university also provides several resources and opportunities for building their resumes through workshops and career services. The data on familiarity with the types of graduate programs validated our goal to provide targeted resources to Hispanic undergraduate students. Exposure to information about graduate school, an understanding of academic careers, and having a community of peers with similar ambitions can help cultivate an environment that inspires Hispanic students to pursue graduate school [13]. From the start of the program, we specified the eligibility criteria, i.e., self-identification as Hispanic and enrollment in a STEM degree program (undergraduate or graduate), as shared attributes.

The participants emphasized how important shared attributes are to the mentoring relationship and to supporting undergraduate students' goals:

> *"I am enthused to help people who share similar backgrounds and aspire to achieve shared goals."*

> *"As a Latina, I don't know anyone in my family that has gone to graduate school. Similarly, I don't know many people who have ever reached that level of higher education. By meeting people who are in graduate school and have a similar cultural background as me, can help me become more motivated and informed on what graduate school really is and how it is important for academic and professional goals."*

> *"...it is always rewarding to meet and learn from a person that is likely to have a similar background, face similar challenges, and pursue similar objectives."*

> *"By meeting people who are in graduate school and have a similar cultural background as me, [it] can help me become more motivated and informed on what graduate school really is and how it is important for academic and professional goals."*

To determine which mentor qualities are effective in mentoring undergraduates towards graduate school, we analyzed participants' comments about the mentoring program. Graduate students emphasized the importance of their roles as mentors, noting that they would have benefitted from a similar mentoring program during their undergraduate journey. Typically, undergraduate mentees enter a mentoring relationship expecting mentors to serve as role models for academic success [5]. While the effectiveness of role-modeling depends on the mentee's desire for it, psychosocial support from mentors is particularly beneficial for Hispanic college students [5]. These expectations and preferences help shape the overall mentoring experience.

Representation and shared cultural experiences are important to the participants. One mentor expressed,

> *"...it's a great opportunity to connect with Hispanic and Latine students, since there's not many to begin with, and to provide role models for them. I would have loved to have a mentor that looked like me, but I greatly appreciated that my mentors who were predominantly white were strong allies. I think representation will help younger students to truly believe this is an attainable path of pursuing graduate school or being a successful professional."*

Other mentors and mentees reflected on their underrepresentation in the field as well and alluded to the importance of having someone to talk to about their concerns and plans:

> *"I think that we sometimes lack role models that went through graduate school so it is important to be aware that it is an option and why or why not it could be a good fit for you and that is something a graduate mentorship can provide."*

> *"I've never taken a class from a tenure track Hispanic professor - let alone a female tenure track Hispanic professor. It's hurtful to see mostly non-tenure track Hispanic/Latine professors. I think this lack of representation in the faculty does impact the number of URMs in my academic program."*

> *"... [there] is a limited number of us in these positions for younger students to look up to. It's more meaningful when it's someone that looks like you."*

> *"Hispanic/Latine students to have a mentor who has already been in their position…can help them succeed in their undergraduate degrees and their post-academic careers."*

> *"Mentoring helps students comprehend and reflect more about how their degrees will help them pursue their passions."*

> *"I feel that undergrads don't get a lot of exposure to grad students on a day-to-day basis, so having someone that you know you can go to and ask questions to has been a really big help."*

"It's important to always have a resource who can answer big and small questions"

"I think it's really nice to have someone who is a grad student that I can talk to about grad school and other stuff like that."

A notable success story from a mentoring pair centered on the mentor helping the mentee in mechanical engineering craft a strong graduate school application while the reflecting on realities of graduate school life. The mentor, a materials science student, aimed to build a strong mentoring relationship while supporting his mentee in clearly communicating his research interests. During their bi-weekly meetings, the mentee found his mentor's honesty about work-life balance, pay, and "*things you should value as a grad student*" valuable. The mentee expressed, "*I know what I'm getting myself into better,*" and felt less stressed about the application process thanks to the program's support. The mentee was admitted into a top 10 PhD program in mechanical engineering, crediting the mentorship for his success.

Consistent with previous research [9], mentors who successfully support undergraduates from underrepresented groups are those willing to invest time and effort in the relationship, share relevant knowledge and expertise, and support the undergraduate's goals. Mentees benefited from their graduate student mentors' experiences, writing assistance, and application tips as they grew comfortable seeking advice. Despite our small cohort, participant responses suggest that shared attributes contributed to successful mentoring relationships, potentially influencing engagement in graduate school discussions and fostering a sense of community.

How can virtual activities engage students to build leadership skills and confidence in their academic pathways and future careers?

We hosted virtual events and invited speakers from out of state to present talks to the students to demonstrate the various career paths possible with a graduate degree. One speaker from the Pacific northwest spoke about being in a tenure track position in academia but left for a job in industry. He shared about his career journey and helped students reflect on what they see themselves doing in the future. He emphasized choosing your own path and leaning into mentors to guide you towards your right path even if it is not what was originally planned. Another speaker who worked at NASA discussed career advancement with a graduate degree, sharing personal experiences to highlight its necessity for finding fulfillment in his engineering role.

Our program, though in its early stages, gives insight into the positive outcomes for the undergraduates and their graduate student mentors. Towards the end of the program, participants were asked about their takeaways from online events. Graduate students were able to connect with their peers and gain a broader understanding of the professional landscape beyond academia. Notably, the *Focusing on Your Strengths* workshop left both groups feeling empowered to capitalize on their strengths in pursuit of their professional goals.

We encouraged undergraduates to engage with their mentors after the events to discuss their insights in flexible and convenient settings. Mentors found that these virtual meetings not only enhanced their leadership and mentoring skills but also highlighted the importance of effective communication, both verbal and written, in mentorship and their future careers. In addition to

guiding students, mentors provided valuable feedback and assistance with the graduate school application process:

> *"I think [my mentee] play[s] a big role in holding myself accountable. Because being a mentor requires to have first-hand experience and be able to pass that."*

> *"My mentee presented challenges that we both work on together, so he helped me expand my knowledge of the academic career path, other graduate school application procedures as well as industry experiences."*

> *"My mentee gave me the opportunity to review the essays of her grad school applications, which made me put into practice the writing strategies I used when I was in her situation. Interacting with her was also beneficial. I mostly led the conversations during our meetings, and I think they flowed smoothly."*

> *"The mentoring experience was very valuable. I would like to become a professor one day, so being exposed to this environment was important to build the skills needed for my future goals."*

Meaningful interactions between mentoring pairs in hybrid formats facilitated professional growth and development of both the undergraduate and graduate students. Participants' responses indicated that accountability, openness, and good communication are necessary in mentoring relationships:

> *"It was nice to receive help from someone that has gone through similar experiences within life and it helped me get to know other Hispanic students on campus. We can all help each other out."*

> *"Being in the program helped me see grad school as a thing that I can do. This helped me learn about cost of living [when comparing graduate programs] and how to choose what to pursue."*

> *"[My mentor] told me to not only look at the money aspect but that the professors are what really matter, not really the school name."*

Consistent with prior work [13], we found the most common challenges for undergraduate Hispanics considering pursuing advanced degrees include the lack of representation of their racial and ethnic identity within academia and being unaware of the academic rigor and expectations of graduate school. With our mentoring program, graduate students helped their undergraduates find information about graduate school related matters and guided them in applying to graduate programs.

Limitations

While there were several applicants, the number of undergraduates was a limiting factor in selecting participants. Given our small sample size, it is challenging to conduct meaningful

subgroup analyses to understand how the program might impact groups of participants. For example, undergraduates with prior research experience may have already had similar guidance for pursuing graduate programs. We also consider self-selection bias, as Hispanic engineering students who chose to participate may differ systematically from those who did not, potentially possessing characteristics such as higher motivation or stronger support-seeking aptitudes.

Conclusions and Future Work

Our mentoring program demonstrates promising results in addressing Hispanic students' access to mentorship and promoting interest in graduate school. The program's structure includes 1-on-1 mentoring relationships between graduate and undergraduate students, connections with professionals in academia and industry, and guidance on research opportunities. This approach created a supportive community for undergraduate students from similar cultural backgrounds to discuss STEM careers and academic plans. Notably, three out of four graduating seniors enrolled in STEM graduate programs with fellowship offers, while graduate student mentors improved their leadership skills and connections with Hispanic engineers on campus. These relationships have the potential to evolve into lifelong mentorships, with the next step being for participants to decide whether to continue their mentoring relationships beyond the program.

Building upon our success, we highlight possible extensions for future initiatives:

- *Group mentoring:* What traits of graduate student-led group mentoring enable underrepresented students' success in being admitted into STEM graduate programs? Understanding how this mentoring model facilitates networking, social connections, and a broader support system may scale up such mentoring efforts and impacts.
- *Learning communication strategies:* In addition to setting expectations and clear goals from the start, how can mentoring groups overcome challenges from learning communication strategies? Fostering open communication, where both mentor and mentee feel comfortable sharing their thoughts, concerns, and feedback, can greatly enhance the effectiveness and trust within mentoring relationships.
- *Improving hybrid interactions:* Mentor interactions are key to establishing trust and feeling motivated for undergraduates, but it is challenging with an online environment. What overlooked topics engage students from marginalized communities in STEM to feel supported and connected to their community? How do these interactions improve their STEM or engineering identity [17]?

By addressing these aspects, similar programs can improve their effectiveness and broaden their impact on participants' personal and professional growth. These initiatives are crucial for increasing graduate school enrollment among underrepresented communities, ultimately contributing to a more diverse and robust STEM workforce.

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