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A Multi-Phasic Approach to Increase Diversity Among Doctoral Candidates in Biomedical Engineering

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Introduction

The purpose of this paper is to evaluate efforts to increase ethnic and racial diversity among doctoral biomedical engineering candidates at The University of Texas at Austin. Over the past four years our graduate program has used a multi-phase approach to increase the recruitment of doctoral students who identify as Black/African American, Hispanic, American Indian or Alaska Native, Native Hawaiian and other Pacific Islanders (shortened to "diversity groups" in the remainder of our paper). Increasing diversity at all levels of graduate education remains a pressing concern. Contemporary researchers continue to note the value of increasing diversity within their programs, especially given the increasingly diverse nature of the U.S. population [1]. Compared to other engineering disciplines, biomedical engineering graduate programs confer a high proportion of bachelor's, master's, and doctorate degrees to women (49.9%, 45.9%, 39%, respectively) [2]. As such, our paper will focus primarily on ethnic and racial diversity among U.S. and permanent resident applicants and students.

In 2019 our program recognized a critical need to rethink how we recruited graduate students. Our graduate program was not ethnically nor racially diverse as compared to the U.S. population, and at the time, our program had conferred only 18 doctorate degrees within the last 30 years to students who identified as a member of a diversity group. This included only three doctorate degrees to students who identified as Black, of which one also identified as female. Our strategies to attract students from the diversity groups at the time were limited to a few diversity fellowships offered by our institution and email outreach to undergraduate McNair Scholars. Interestingly, while we perceived that a strategy this limited in scope was not maximally effective, others found that those in positions to execute recruitment activities viewed assistantships, grants and scholarships and the use of a recruitment or admissions website as the most effective tools [3, 4]. It is worth noting that in our discipline it is common for graduate students to be fully funded, including a stipend or salary, full tuition remission, and health insurance for the duration of their doctoral studies, although the quality of the financial offers, in terms of stipend levels versus cost-of-living indices, tend to vary between programs.

Over the next academic year, we identified several areas where we could remove real and perceived barriers for applicants to our program. Examples include active recruiting at conferences, an updated rubric for conducting graduate application reviews, applicant preparation, and preliminary discussions about removing the GRE in the admissions process. Significant changes were implemented during the 2021 admissions cycle (for those applying in fall 2020), including attendance at six major conferences, fine tuning of the admissions committee's review process, and creation of resources for applicants such as tip sheets and webinars. Due to the COVID-19 pandemic, we opted not to require the GRE for admissions in 2021, leading to a permanent removal of the GRE in our admissions review.

A review of the literature highlights strategies that may help increase students from diversity groups in graduate education. Research Experiences for Undergraduates (REU) programs fill the void of research exposure for many students from diversity groups who may otherwise not be

exposed to research [5]. Our department has hosted an NSF-funded REU program for the past 7 years. Of the 54 total participants, 43% have been students from diversity groups. Early data suggests a majority of these students do not go on to enroll in graduate programs, although more complete data is needed. This could be explained by the fact that participants are in earlier stages of their undergraduate degree (rising sophomores), as opposed to other programs that primarily recruit rising juniors or seniors.

Our ultimate goal is for the graduate program to mirror the ethnic and racial makeup of the U.S. According to the 2020 census, the U.S. population is 13.4% Black or African-American, 1.3% American Indian and/or Alaska Native, 5.9% Asian, 0.2% Native Hawaiian or other Pacific Islander, 18.5% Hispanic or Latino, and 60.1% White only [6]. As of spring 2022, our program is still far from meeting this goal. Black and African-American identifying students are underrepresented by nearly ten percentage points, and Asian identifying students are overrepresented. Despite our institution's recent designation as a Hispanic Serving Institution (HSI) by the Department of Education, our program's Hispanic identifying students are also underrepresented.

Approach

In the past four years, our philosophy toward admissions shifted to a focus on active recruitment. Research highlights the importance of fostering the confidence of diversity groups in academia by establishing personal connections, encouraging a community-based ethos between currently enrolled students, faculty, and potential applicants, and reflecting an institutional commitment to diversity [7]. Doctoral programs might consider recruitment not as an annual endeavor, but a long-term, day-to-day strategy. Early exposure, responsiveness to student needs (e.g., financial needs), commitment to diversity (e.g., hiring and retaining faculty members from diverse backgrounds), community relationships, and program location have all been identified as important factors to consider in the extant literature [7]. We aimed to meet these standards by focusing on individualized communication, including multiple contacts with applicants. Strategic planning for improved recruitment led us to explore the challenge of lack of diversity through organized efforts in three primary categories: the Application Phase, Admission Phase, and Acceptance Phase.

Methods

To evaluate our efforts, we divided our recruitment strategy into three phases: the application, admissions, and acceptance phases and considered the racial and ethnic makeup of entering cohorts for assessment.

Application Phase

In the application phase, our primary goal was to reduce real and perceived barriers to the application and increase the diversity of our applicant pool. One such real barrier we sought to alleviate is the financial barrier of applying to graduate school, as it can be a costly endeavor; to apply to one graduate school, an applicant conceivably needs to pay an application fee, pay to sit for the GRE, and in some cases, pay for expensive GRE preparatory courses. We sought to

remove these financial barriers by (1) offering low-paperwork fee waivers to applicants and (2) eliminating the use of the GRE in graduate admissions, two actionable solutions supported in the literature [8]. At the beginning of each recruitment cycle, our department commits a number of application fee waivers for those who ask for them. While our institution does offer need-based fee waivers, we have found that applicants who request them do not always qualify based on their financial aid history, which often relies on parents' income and may not reflect their current financial situation. Overall, fee waivers offered by the department are underutilized.

Early 2020 and the onset of the COVID-19 pandemic brought unprecedented challenges to students applying to graduate school, especially with regard to the GRE. Test center closures meant students had to take the exam remotely and only after they had worked through a checklist of hardware and software requirements. It was apparent the inequities we believed already existed within the standardized testing model would only be exacerbated by circumstances caused by the pandemic [9]. Thus, we opted not to require the exam for the 2021 admissions cycle (for those applying in 2020). We used this opportunity to test our hypothesis that removing the GRE from graduate admissions would lead to a more diverse applicant pool and subsequently observed a four-fold increase in applicants from diversity groups. In spring 2021, the GRE was formally removed as a requirement in our graduate admissions process.

While historically our candidates for admission have cited a professor or mentor as their reason for applying (over half of our U.S. applicants in 2021), we hoped to appeal to a broader pool of prospective students through targeted recruitment. It has been our experience that actively seeking to connect with prospective students is more effective than relying on our online marketing, informational website, or rankings. Academic research in targeted diversity recruitment efforts promotes success in establishing personal connections with potential applicants through attending and exhibiting at conferences where they are likely to be present in large numbers, such as the national meetings of the minority professional engineering organizations [5]. Owing to the pandemic, we had the opportunity to attend several virtual conferences during the 2021 and 2022 recruiting cycles. Attending conferences virtually allowed us to evaluate the effectiveness of attending a variety of meetings without added travel costs for faculty or staff. In 2021 we attended six annual conferences, five of which are research conferences for students from diversity groups: Biomedical Engineering Society (BMES), Society of Hispanic Professional Engineers (SHPE), Annual Biomedical Research Conference for Minority Students (ABRCMS), American Indian Science and Engineering Society (AISES), Society of Women Engineers (SWE), and Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS). For each conference, program faculty signed up in one-hour intervals to meet with prospective students. In our virtual booth materials and conversations with prospective students we highlighted diversity fellowships at our institution, offered application fee waivers, and collected contact information for personalized feedback. In 2021 we returned to SACNAS, ABRCMS and BMES. We also participated in panels and information sessions as part of a BME Collective initiative to share prospective student contacts among several biomedical engineering programs.

We recognize the importance of creating relationships with other institutions such as Historically Black Colleges and Universities (HBCUs) and Hispanic Serving Institutions (HSIs). Faculty at minority-serving institutions like to ensure that their students will continue to have a supportive

and enriching environment, and therefore prefer to send their students to a graduate school where they have some first-hand knowledge of the environment [5]. Through faculty connections we have been able to partner with the National Society of Black Engineers chapter at an HBCU in our state to offer an admissions information session and partnered with an HSI in our state to introduce undergraduate engineers to medical physics, a research area in our department that has a number of new faculty.

Another common barrier we identified was a lack of quality mentorship for some applicants. Applicants from diversity groups may not have the same mentorship opportunities as their peers, and thus may have been exposed to fewer resources to guide them through the graduate school application process. Our solution was to create application tip sheets and recorded webinars. We created a step-by-step application guide to help applicants through the mechanics of the application and supplemented with a recorded presentation on the same topic. Similarly, a member of our admissions committee created a how-to guide for writing a personal statement accompanied by a recorded webinar. Our statement of purpose is structured such that applicants answer four required and two optional writing prompts, and includes both a broader impacts statement and, more recently, a COVID-19 statement. Applicants are also given the opportunity to explain any part of their application that they think does not represent their current abilities. The prompts are specifically designed such that the applicants' answers match up to the committee's four primary review criterion: academic preparation, research and work experience, broader impacts and contributions to diversity, and maturity and perseverance. The how-to guide strives to inject transparency into the admissions process such that applicants understand exactly which metrics they will be evaluated against. Along with these on-demand efforts, we also hosted two live webinars: one with faculty and one with graduate students. The session with faculty focused on how to submit a competitive application, while the session with graduate students served more as an information session on life at a student at our institution.

Admissions Phase

In the admissions phase, our primary goal is to reduce individual bias in the application review process. Our program uses a centralized admissions committee to review and score applications. We aimed to integrate the principles of a holistic review practice into the multi-phase approach we developed. Increasing data support the importance of adapting the admissions process to prioritize holistic review over a triage strategy. The holistic review model in admissions aims to review each candidate's application in its entirety, rather than utilizing strict cutoffs on quantitative metrics such as standardized test scores or GPA, whereas triage strategy uses a quantitative cutoff, such as for GPA or GRE scores, to eliminate a portion of the applicant pool from further consideration [10]. As part of our philosophy around transparency in the admission process we also added a holistic review statement to our website. To facilitate a holistic review, our faculty converged on four primary criteria used to review applications: academic preparation, research and work experience, broader impacts and contributions to diversity, and maturity and perseverance. Using this framework, each application is reviewed by two faculty committee members and scored. Committee members have the opportunity to rescue low-scoring applications and bring them to the group for discussion.

During the 2021 cycle we made use of pre-admissions informational interviews. The primary objective was to give applicants from diversity groups and first-generation college graduates the chance to both ask additional questions about our program and the admissions process and provide additional information to our committee members about their experience and preparation for graduate school. While the interviews were optional, a high proportion of invited applicants (71 of 87) accepted our invitation. Notes from each interview were provided to the admissions committee to use along with applicant materials for review. The feedback from the committee members on the effectiveness of the interviews was mixed. Some committee members found the additional perspective helpful, while others were unsure how to use the information in their reviews. Of the 71 applicants who participated in an informal interview, 31 were offered admission and 9 matriculated into our program. Based on feedback from the admissions committee, we changed our approach in 2021. Instead, informational interviews were offered to applicants from diversity groups and first-generation applicants after they had been selected for admission.

Acceptance Phase

In the early cycles of our improved admission efforts, we were successful in increasing the number of applicants and admits from diversity groups, but we saw no corollary increase in those who accepted the offer and matriculated. Based on post-admission feedback from students who did not accept our offer of admission, we hypothesized that increasing student support resources and visibility of these resources, along with visibility of diverse faculty, were needed to both increase the number of applicants from diversity groups and to increase the likelihood that students from the diversity groups would choose to enroll in our program when offered admission.

This phase of our effort was supported by a small seed grant from the institution which provided resources to accomplish two primary goals: to add a diversity webpage to the larger departmental website to highlight our commitment to diversity and inclusive practices and to develop a website for Graduates for Underrepresented Minorities (GUM), a student organization that supports students from diversity groups. Both projects were completed and launched in early 2021 prior to our graduate recruitment events. In addition, we held DEI town halls as part of our recruitment events that same year, highlighting other initiatives in the department such as a student-led anti-racism discussion group.

We also recognize the value of quality financial offers on increasing matriculation of students from diversity groups [11]. Although all doctoral students in our program are fully funded, we continue to maximize the use of institutional diversity fellowships each year. There was at least one student from a diversity group in a recent cohort where improving the financial offer was key to their matriculation in our program.

Results

The results of our work over the past four years have been largely positive. As a result of our efforts in the application, acceptance, and admissions phases between 2017 and 2021, we saw a four-fold increase of applicants from diversity groups, from 18 to 79. Similarly, we saw a

corollary four-fold increase of students from diversity groups who were offered admission, from 5 to 22. Finally, the number of students from diversity groups who accepted the offer of admission and matriculated into our program increased from 1 to 5. This represented a yield rate of 23% for students from the diversity groups, compared to a yield rate of 49% for students not from diversity groups.

In the 2021 cohort, 20% of doctoral students identified as a student from a diversity group, which represents one of the most diverse doctoral cohorts in our program's history. While the total proportion of students from diversity groups in our doctoral program is currently 11%, we are encouraged by the increased matriculation rates of the most recent incoming cohort.

We acknowledge that the results were no doubt confounded by the pandemic and resulting economic environment in the U.S. Applications to graduate programs tend to increase during economic turbulence, such as high unemployment rates [12]. The 2021 admissions cycle presented our program with a record number of overall applications, supporting this position. We received reports from undergraduate students in our own program that they were concerned about job prospects after graduation in 2020. We expect that continued assessment will present a clearer picture of whether the increase in students from diversity groups was a result of an overall increase in graduate applications, a result of our efforts, or both.

Future Work

As our graduate program becomes more diverse, a primary and immediate concern is retaining students from diverse backgrounds through successful program completion. Strategies to build a more inclusive program are already underway, including a new department-specific DEI website that highlights resources, student organizations and programs specifically designed for students from the diversity groups and first-generation students. We are also building inclusivity by offering a DEI Panel Discussion during our recruitment events on campus, before admitted applicants make a decision to accept their offer of admission. These strategies mirror successful retention efforts of graduate programs across disciplines [5]. **Conclusions**

The collective efforts of faculty, staff and graduate students in our program have increased our capacity to support students from diversity groups at all stages of the admissions process. Fundamental to our process is a core belief that diversity in biomedical engineering as a field is a prerequisite to a competent and effective workforce, and that it is our duty and responsibility to ensure that our admissions practices are not acting as a gatekeeper.

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