

## How Small, Interdisciplinary Programs Are Contributing to Diversity and Inclusiveness in STEM University Departments in the US

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# **How small, interdisciplinary programs are contributing to diversity and inclusiveness in STEM university departments in the US**

## **Abstract**

The science, technology, engineering and mathematics (STEM) fields are characterized by disproportionately lower participation by women and underrepresented minorities, particularly in graduate school. The United States population and workforce are becoming increasingly more diverse, yet underrepresentation in STEM fields persists. Broadening participation in STEM graduate education can both increase diversity in the STEM workforce and productivity of research labs, since research has shown that more diverse research teams are more productive than those who are homogeneous.

This paper examines how an interdisciplinary graduate traineeship approach can stimulate discovery, educational benefits, and workforce development, and also recruit, retain, and support diverse cohorts of STEM graduate students. The National Science Foundation Research Traineeship Program (NRT) at the university attracts students from diverse gender and ethnic backgrounds and cultivates a culture of inclusiveness, serving as a model for other graduate programs. A core aim of the NRT is to contribute to diversity and inclusion in graduate school settings.

This paper describes an investigation to better understand how the NRT contributes to diversity and inclusion of STEM graduate education. We studied the composition of NRT cohort groups, with respect to gender and ethnicity, and the views trainee-students have about program inclusiveness. Our methods involved reviewing the NRT program enrollment material and analyzing our annual NRT program trainee responses to a survey that was administered in fall 2019 ( $N=11$ ) and fall 2020 ( $N=15$ ). The survey asked trainees about their experiences with the NRT program. Enrollment data show that the first two NRT program cohorts are comprised of 50% women and 50% men, a ratio that aligns with the national population, yet differs from our College of Engineering enrollment (i.e., approximately 75% men and 25% women). The second NRT program cohort is comprised of 50% underrepresented minority. Survey results for cohort two show approximately twice as many trainees identify as white as those who identify as another ethnic group (Asian/Asian American other than SE Asian or Hispanic constitutes 33%). This ethnic composition is more diverse than our university graduate student population and its College of Engineering, which both include fewer than 10% of these minority groups.

Survey findings show that trainees rate the program as very inclusive, which they attributed to how their NRT program experience enables trainees to interact with people (e.g., trainees, guest speakers, project stakeholders) with diverse backgrounds. Trainees' responses from men focused more on how NRT program leaders designed the program so that it can offer these interaction opportunities, while women emphasized the small size of the NRT cohort group and opportunities to connect with others. The latter is similar to what other studies have found about how undergraduate women, more than men, attribute program inclusiveness to feeling a sense of belonging. Finally, survey findings provide evidence that cognitive diversity, opportunity to work with people who have different styles of problem-solving, is among trainees' favorite

aspects of the program. In addition, we discuss the structure of our NRT and recruitment strategies we have used to advance more diverse participation.

## **1. Introduction**

Women have been underrepresented in STEM at four-year institutions and the workforce. The number of advanced degrees earned by women have increased, with women earning larger share of graduate degrees [1] [2] yet national data show a large STEM gender gap: in 2018, 29% of master's degrees in engineering and computer information science were awarded to women and 24% of doctoral degrees were awarded to women [1] [3]. Twenty three percent of master's degrees in engineering awarded to women and 23.5% of doctoral degrees awarded to women in 2017 [4].

African Americans, Latinos, and Native American are historically underrepresented minorities (URM) among STEM degree earners. URM students do not join the STEM programs at four-year institutions at the same rate as non-URM students. There have been some gains, but national data continue to show that there is inequality in STEM degrees awarded to URM students and that the inequality increases as we go up in the degree level [5] [1]. The latest report from the ASEE 2019 "Engineering & Engineering Technology BY the Numbers" indicates that in 2019, women, black or African American, Hispanic or Latinx, and American Indian/Alaska Native students earned 27.5%, 4.6%, 8.8%, and 0.2% of the engineering master's degrees and 24.1%, 3.8%, 5.9%, 0.1% of engineering doctoral degrees, respectively [6], compared to the 2019 general U.S. population (i.e., 50.8% women, 13.4% black or African American, 18.5% Hispanic, and 1.3% American Indian and Alaska Native [7]).

The United States workforce in STEM continues to grow overall; however, women and URM remain underrepresented in the STEM workforce relative to their share of college-educated workforce and population [8]. Broadening participation in STEM can increase diversity in the workforce, address the projected deficit in qualified workers to meet the needs of a growing STEM-based economy [9], and help the United States to thrive in the 21st century. Moreover, research has shown that research labs that are more diverse are more productive than those that are not diverse [10]; thus, broadening participation will help sustain and also grow STEM research communities [11] [12].

A core goal of our NRT program is to train diverse STEM graduate student to solve the grand challenges of creating sustainable food, energy and water systems in rural communities. The NRT is an interdisciplinary traineeship that includes faculty members and students from three colleges: College of Agriculture, College of Arts and Sciences, and College of Engineering. To better understand the diversity of our interdisciplinary graduate traineeship program, we compared the diversity of our NRT program gender and ethnicity to the national diversity in STEM graduate education and to diversity of our College of Engineering. We also examined survey responses about inclusiveness.

The author team does not include people who identify as African Americans, Latinx, and Native American, i.e., underrepresented minorities (URM), who are historically underrepresented among STEM degree earners. As such, we recognize that we have no first-person experiences

that allows us to relate to the experiences of URM students. The author team members are white and three people identify as women and one as a man. One woman is a mechanical engineer and the other two are social scientists. The man is a social scientist. As such we have first-person experiences that allow us to relate to women in STEM. Moreover, two of the authors hold dual citizenship and have first-person experiences that allow us to relate to being an outsider. In addition, all members of the author team work with STEM URM students, both women and men, regularly, and amongst us we participate in different types of learning circles focused on promoting equality in US universities and society. This research is part of our effort to continually expand our ability to advocate for URM students and women students in STEM, something that interests us, because we have seen how a diverse STEM student body translates into higher quality training for aspiring scientists and researchers.

The first section of this paper describes the composition of NRT graduate student cohorts, based on program applications, and the program's recruitment strategies. After this comes a description of the methods we used to collect more information about the racial backgrounds of graduate student cohorts, about why students apply to the NRT, about how students characterize the cognitive diversity of the program, and about their views on the degree to which the NRT offers an inclusive program experience. A discussion reviews how findings compare with other studies' results and speculates on the role that interdisciplinary programs like the NRT can have in STEM graduate programs in particular engineering programs to broaden participation.

## **2. Graduate student cohorts**

### **2.1 Cohort composition**

The first NRT cohort of 16 trainees began in Fall 2019 (Figure 1). In this cohort 11/16 (69%) of the trainees were doctoral students and 5/16 (31%) were master's students. Moreover, this cohort has one URM student and 50% women. Our second cohort of eight trainees began in Fall 2020 (Figure 1). It constitutes 5/8 (63%) doctoral students and 3/8 (38%) master's students. In addition, 4/8 (50%) of the trainees are women and 4/8 (50%) of the trainees are URM students. As shown in Figure 1, NRT diversity numbers are higher than the national numbers in 2017-2018 academic year. In 2017-2018 academic year, URM students received 8.7% of all STEM master's degrees and 6.6% of all STEM doctoral degrees. Thus, in 2017-2018 academic year, approximately 15% of all STEM graduate degrees were earned by URM students in 2017-2018 academic year [13]. In Fall 2018, approximately 24.1% of all first-time U.S. citizens and permanent resident enrollees in U.S. graduate school were URM students, including American Indian/Alaska Native (0.5%), Black/African American (11.8%), Native Hawaiian/Other Pacific Islander (0.2%), and Latinx (11.6%) [14]. American Indian/Alaska Native, Black/African American, and Latinx first-time graduate students remain particularly underrepresented in STEM fields. For example, only 5.9% of first-time enrollment in engineering were Black/African American students [14]. Although women comprise the majority of first-time graduate students overall in Fall 2018, in STEM men comprised 68% of first-time enrollees both at the master's and doctoral level [14].

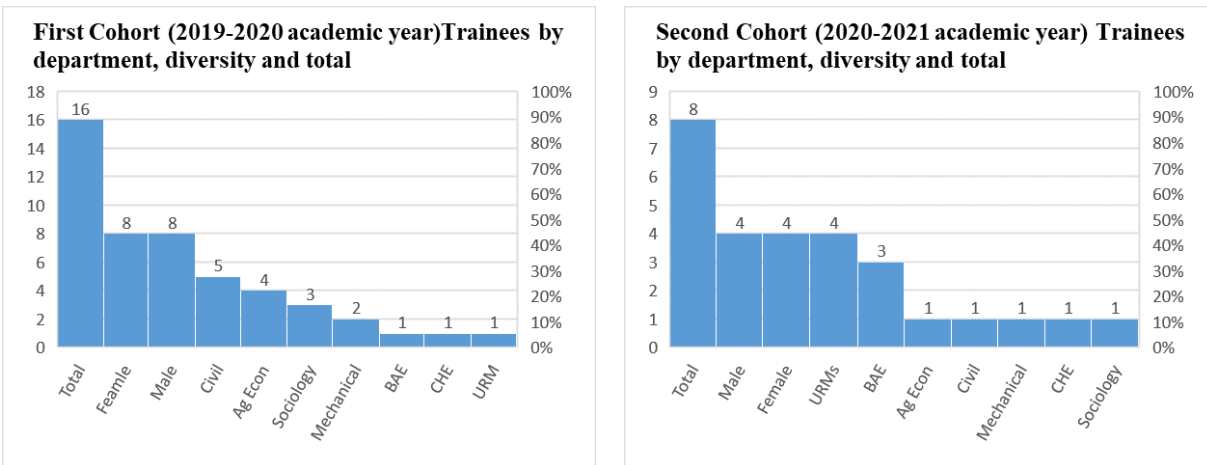


Figure 1: (left) First Cohort (2019-2020 academic year) and (right) Second Cohort (2020-2021 academic year) NRT trainees by department, diversity and total

## 2.2 Cohort recruitment strategies

The NRT program strives to broaden participation through multiple pathways. “NSF defines broadening participation in terms of individuals from underrepresented groups as well as institutions and geographic areas that do not participate in NSF research programs at rates comparable to others” [15]. To broaden participation, the NRT contacted McNair scholars in Biological and Agricultural Engineering, Chemical Engineering, Civil Engineering, Mechanical Engineering, Agricultural Economics, and Sociology. The NRT also contacted students, who participated in the California Forum for Diversity in Graduate Education. In addition, the NRT contacted alumni of our institution, who are faculty members at other institutions, and asked them to share information about our NRT with their students. We also posted messages on several listserv about our NRT program on campus and off campus (i.e. TRIO National, TRIO – Students Support Services, TRIO Talent Search, Rural Sociological Society, the Agriculture, Food, and Human Values Society, and the International Association for Society and Natural Resources, and the Society for Human Ecology). Moreover, we presented at diverse student organizations on campus, and collaborated with university administrators and staff in agriculture and engineering. We also established NRT Ambassadors Program. The ambassadors meet with prospective students, answer any questions they have about our NRT, and share with them their NRT experience. The most successful recruitment strategy for broadening participation of underrepresented groups in STEM fields has been directly connecting NRT faculty and NRT ambassadors to prospective students through Zoom meetings and email conversations. The NRT first and second cohorts comprised of 50% women and 50% men. Our first NRT cohort comprised of one URM students while our second cohort comprised of half (50%) URM students.

## 3. Methods for investigating diversity and inclusiveness in the NRT

Interdisciplinary approaches expand knowledge in research communities beyond disciplinary boundaries and are national policy priorities [12] [16]. In this spirit, our NRT aims to provide interdisciplinary research experiences and cultivate an inclusive interdisciplinary collaborative

research community that is diverse both academically and ethnically. To investigate the degree to which our NRT cultivates a diverse and inclusive community, we examined our NRT enrollment data and compared it to the College of Engineering, the College of Agriculture and the College of Arts and Sciences at our university enrollment data, and administered a survey to trainees.

In our study, we investigated why students apply to the NRT and if student trainee's experiences differ based on gender or ethnicity. They are some empirical studies that directly examining the question of gender and ethnicity to interdisciplinary research and inclusiveness [17] [18].

### **3.1 Instrument development**

The initial development of the NRT annual program survey occurred in December 2019. The NRT program external evaluator drafted survey items based on NRT team priorities and interests and worked with several team members to review and test the survey. The survey was then programmed in Qualtrics Survey Software. Revisions for the Fall 2020 Trainee Survey were based on the analysis of first year data and on NRT team input. New items were added to the survey to enable the NRT team to better understand 1) how trainees view the degree to which the program, and the larger university community, were inclusive and 2) the racial and ethnic identities of trainees. The inclusiveness item, which asked respondents to rate the degree to which our university and our NRT program practice inclusiveness, was based on an operational definition of Inclusive Excellence from the American Association of Colleges and Universities [19]. The survey also asked the respondents to explain why they rated the inclusiveness of our NRT program the way that they did. The demographic item that asked about survey participants' racial and ethnic background was based on categories used with University of Wisconsin-Madison responsive surveys.

### **3.2 Data collection**

The NRT annual program survey for the 2019-2020 academic year was administered by the NRT external evaluator, who emailed a survey invitation to 16 trainees on February 18, 2020. Email reminders were sent to trainees through Qualtrics on Friday, February 21 and on Wednesday, February 26, about completing the survey before the survey was closed on March 2. During this time, several reminders were sent by NRT program leaders about the 'opportunity' to take the survey. Eleven trainees completed the survey: six men and five women.

The NRT annual program survey for the 2020-2021 academic year was administered by the NRT external evaluator, who emailed a survey invitation to 20 trainees (Few of our first cohort students graduated) on December 1, 2020. Qualtrics email reminders were sent to trainees on Monday, December 14 and on Wednesday, December 16 about how the survey invitation was open until December 18. During this time, several reminders were sent by NRT program leaders about the 'opportunity' to complete the survey. Fifteen trainees completed the survey: eight men and seven women. Of those fifteen respondents, eleven identified with a White, of European Descent ethnic group and five identified with either an Asian/ Asian American other than Southeast Asia ethnic group or a Chicano (a/x), Latino (a/x), Hispanic ethnic group. It is worth noting that two respondents indicated they identified with more than one ethnic group and one respondent did not provide information about their ethnicity.

### **3.3 Analysis**

Quantitative survey data analyses involved calculations of arithmetic mean and standard deviations, as well as comparisons of frequencies between groups. These data are described in bar charts. Qualitative survey data, in the form of written comments, were synthesized and analyzed for themes and patterns. To improve the validity of these analyses, these data were discussed during an interpretive session with NRT program leaders, many of whom interact with trainees each week.

In addition, to get an idea of how diverse the NRT trainee cohorts are with respect to gender and ethnicity, we compared NRT trainee survey data and NRT Enrollment data with enrollment data from university's College of Engineering Data [20]. To further examine evidence that the NRT cultivates a community of inclusiveness, we compared our results to the few empirical studies that relate gender and ethnicity to interdisciplinary research and inclusiveness [17] [18].

## **4.0 Results and Discussion**

Below is a description of results of the study. Findings shed light on why trainees applied to the NRT program, how inclusive trainees thought the program was, how opportunities for cognitive diversity are a favorite aspect of the NRT among trainees, how trainees have mixed views about the usefulness of interdisciplinary mentoring, and just how diverse the NRT program really is.

### **4.1 Why did trainees apply to the NRT program?**

We asked the trainees in the annual program survey why they applied to our NRT program. Even though the sample size is small, the data suggest some possible patterns that we will continue to track over the next few years. The strongest pattern is that more trainees from three groups, women, men, and Whites (and also many Asians/ Hispanics), chose 'To grow as an interdisciplinary researcher' than any other reasons for applying the program.

In the 2019-2020 academic year survey, five women and five men said that they applied to our NRT program 'to grow as an interdisciplinary researcher' (Figure 2). Eleven trainees completed this survey: six were men and five were women. Thus, all five (100%) of the women and five of the men (83%) said that they joined our NRT program 'to grow as an interdisciplinary researcher.' Moreover, all (100%) of the women said that they joined our NRT program 'to advance their academic career' and 'to learn about how to work with the policy making process,' while three (50%) of the men said that they joined our NRT program 'to advance their career' and only 33% of men joined our NRT program 'to learn about how to work with the policy making process.' In addition, four women (80%) and four men (67%) said that they joined our NRT program 'to address real-world food, energy and water system problems.'

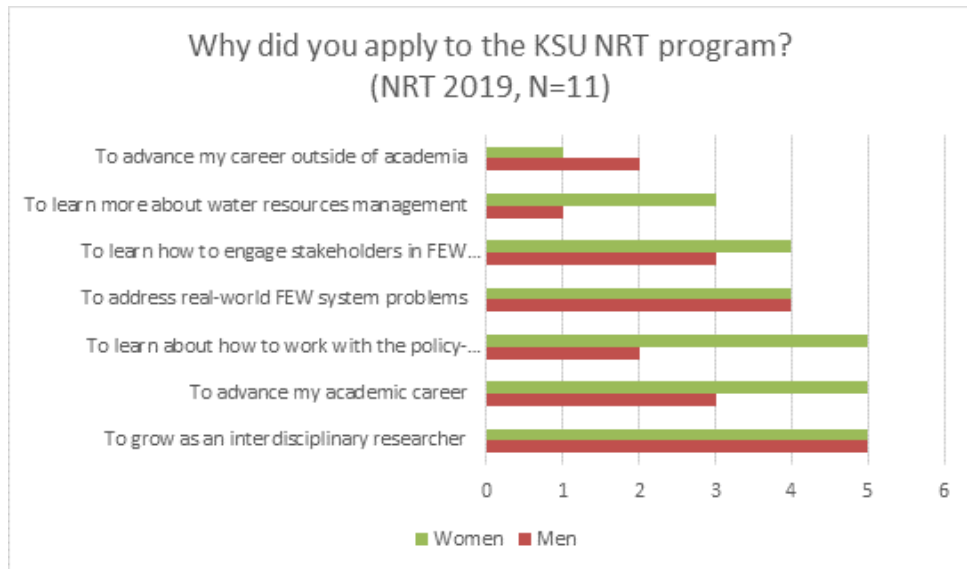


Figure 2: Why did you apply to the NRT program in 2019

In the 2020-2021 academic year survey, seven women and six men said that they applied to the NRT program to grow as an interdisciplinary researcher (Figure 3). Fifteen trainees completed this survey, and of the fifteen trainees eight were men and seven were women. Thus, all of the women said that they joined our NRT program to grow as an interdisciplinary researcher while five men (75%) of the men said that they joined our NRT program to grow as an interdisciplinary researcher. Moreover, five women (71%) said that they joined our NRT program to advance their academic career and to learn more about water resources, while five men (63%) said that they joined our NRT program to advance their career and four men (50%) joined the NRT program to learn about water resources. Additionally, three women (43%) said that they joined our NRT program to learn about how to work with the policy making process while two men (25%) said that they joined our NRT program to learn about how to work with the policy making process. In addition, six women and six men said that they joined our NRT program to address real-world food, energy and water system problem, which constitutes 86% of women and 75% of men.

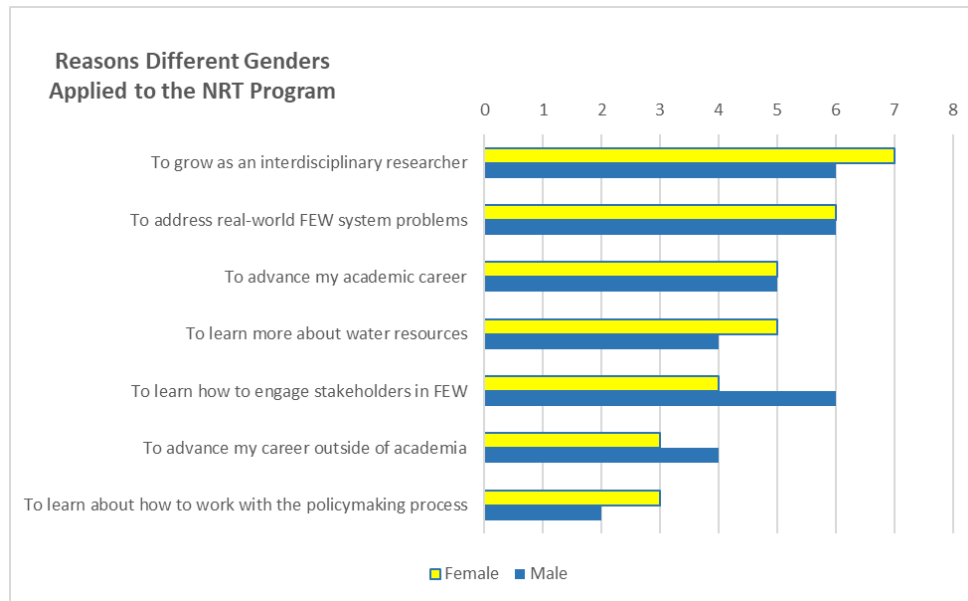


Figure 3: Reasons different genders applied to the NRT Program in 2020

In both analyses, more subjects selected two reasons for applying than any others: ‘To grow as an interdisciplinary researcher’ and ‘To address real-world FEW problems’. Even though these results by themselves do not provide evidence that women are drawn to the NRT program more strongly than men because it offers a chance to do interdisciplinary work, it is an interesting result that the authors will track over the coming years.

We also compared responses from our two ethnic groups regarding reasons for applying to the NRT program. Because of the unequal size of White (11 subjects) and Asian/ Hispanic (5 subjects) groups, percentages offer the best comparison data. Figure 4 shows that, the top reasons (4 of 5 (80%)) that Asian/ Hispanic subjects selected for applying to the program were, ‘To advance my academic career’ and ‘To address real-world FEW system problems.’ These reasons also received relatively high ratings from White subjects. The top reason chosen by all (100%) White subjects was ‘To grow as an interdisciplinary researcher.’ Interestingly, the reason, ‘To grow as an interdisciplinary researcher,’ was chosen by fewer, three (3/5 (60%)), Asians/ Hispanics, because males in this ethnic group did not select this option. The only reasons that more Asians/ Hispanics than Whites chose were ‘To advance my academic career’ and ‘To advance my career outside of academia.’

Questions of validity for the percentage comparisons between ethnic groups exist for several reasons: several female subjects identified as both White and Asian/ Hispanic, one subject did not indicate their ethnicity (N=14), and the way that, when completing the survey, some respondents selected all reasons, while others chose just two or three.

Even though study statistics are not significant and are somewhat limited in their validity, reflecting on both the gender and ethnic comparisons brings out several statistics that we plan to continue to monitor as subsequent cohorts participate in the NRT. The strongest finding is that

women, both White and Asian/ Hispanic, appear to be more strongly attracted to the interdisciplinary nature of the NRT program than men. Men from both ethnic groups, on the other hand, seem to be more driven to participate in the NRT program in order to advance their careers.

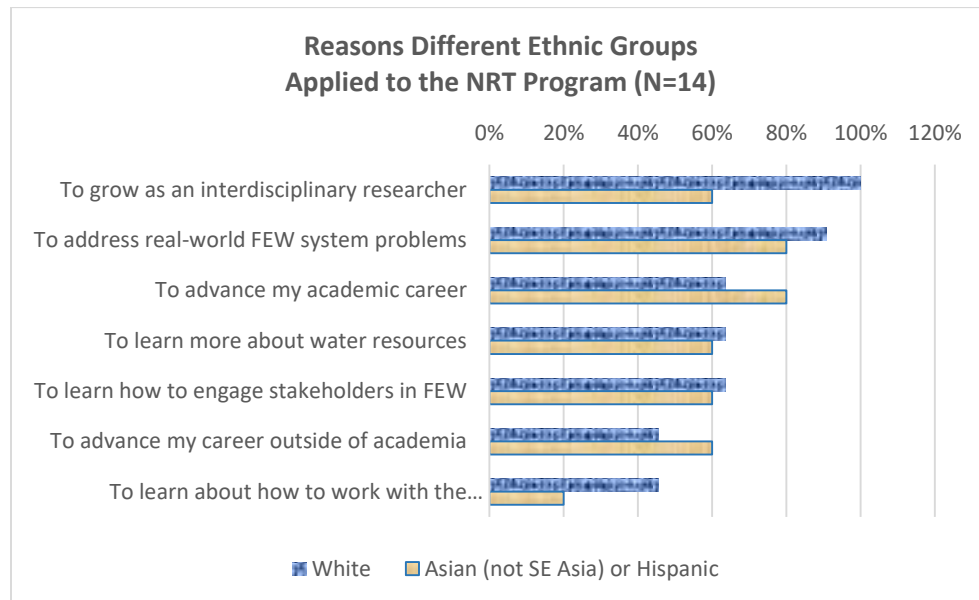


Figure 4: Reasons different race groups applied to the NRT Program in 2020

## 4.2 How inclusive did trainees think the NRT program is?

To examine the inclusiveness of our NRT program, we asked survey participants for feedback. First, we presented respondents with a definition of inclusiveness from American Association of Colleges and Universities (AAC&U) in the 2020-2021 NRT annual survey and asked them to provide feedback. The AAC&U definition that respondents saw is as follows:

“The active, intentional, and ongoing engagement with diversity—in the curriculum, in the co-curriculum, and in communities (intellectual, social, cultural, geographical) with which individuals might connect—in ways that increase awareness, content knowledge, cognitive sophistication, and empathic understanding of the complex ways individuals interact within systems and institutions” [19].

AAC&U identifies four elements of Inclusive Excellence: “1. A focus on student intellectual and social development. Academically, it means offering the best possible course of study for the context in which the education is offered. 2. A purposeful development and utilization of organizational resources to enhance student learning. Organizationally, it means establishing an environment that challenges each student to achieve academically at high levels and each member of the campus to contribute to learning and knowledge development. 3. Attention to the cultural differences learners bring to the educational experience and that enhance the enterprise.

4. A welcoming community that engages all of its diversity in the service of student and organizational learning” [19].

#### 4.2.1 Quantitative results

Next, we asked survey participants to rate the inclusiveness of the NRT program, using a scale of 1 (not at all inclusive) to 5 (extremely inclusive). The average of ratings was 4.2 or ‘very inclusive.’ On a scale of 1 (not at all inclusive) to 5 (extremely inclusive), respondents rated the NRT program (4.2) on average, or as ‘very inclusive.’ A closer look at our NRT inclusiveness ratings from subjects of different demographic groups offers a comparison among different genders and race groups (Figure 5). All groups rated the NRT program as very inclusive, with some variation. Women’s average rating was 3.9 (SD=0.9) and the average rating from men was just slightly greater at 4.5 (SD=0.5). Asians and Hispanics (Asian/ Asian American other than Southeast Asia ethnic group or a Chicano (a/x), Latino (a/x), Hispanic) rated our NRT program with an average score of 4.2 (SD=0.8), which was nearly the same as the average rating from Whites of 4.1 (SD=0.8).

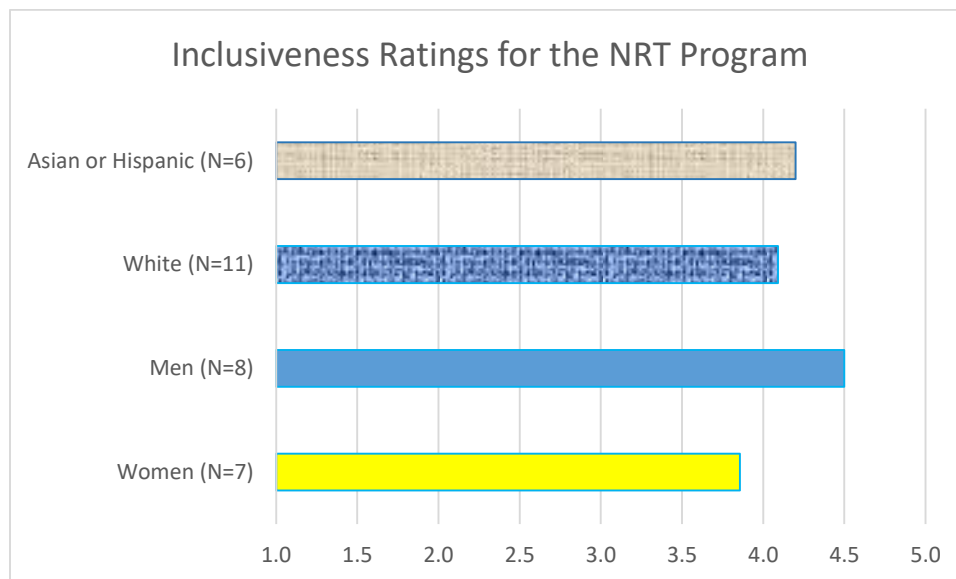


Figure 5: Inclusiveness Ratings for the NRT Program based on gender and ethnicity

The greatest difference seen in inclusiveness ratings is between gender groups, where men rated the NRT program more than a half rating point more inclusive than women did. A closer look at ethnicity ratings in each gender group show that ethnicity did not play a role this difference. Results show a trivial difference between Asian/ Hispanic women (4.0, N=2) and White women (3.9, N=7) and slightly lower ratings from Asian/ Hispanic men (4.3, N=3) than White men (4.5, N=4).

Still, a pattern is evident about the dominant role of gender, both for reasons subjects applied to the NRT program (section above) and about how inclusive they view the NRT program to be. This pattern suggests that women’s strongest reason for applying to the program is to grow as an

interdisciplinary researcher and men's strongest reason is to advance their careers. Moreover, women seem to view the NRT program a bit as less inclusiveness than men.

#### **4.2.2 Qualitative results**

We also asked the respondents to comment about the reasons behind their inclusiveness ratings. Four-fifths, or twelve, survey respondents wrote at least one full sentence and about half wrote even more. The content of responses was about NRT interactions and networking, cohort composition, and place. Men wrote twice as many comments as women about NRT interactions and networking; gender groups offered the same number of comments about cohort composition and place. Responses from women and from those who identified as Asian (not Southeast Asia), and Hispanic focused more on the diversity of the cohort participants, while responses from men emphasized what the NRT leadership is doing or should do to promote diversity of the cohort group. Most responses from women emphasized the diverse racial and academic backgrounds of people the trainees interact with, within their cohort and also others they encounter through the NRT program. These exchanges, responses note, encourage sharing of a variety of provenance-related perspectives and also views from various academic disciplines in a way that several respondents saw as "enriching" learning. Other responses from women described the advantage afforded by the small size of the NRT cohort group for communicating and networking. One describes how the small size allows individuals to connect in a variety of ways, something that can be difficult to find in the larger university environment: "The open discussions within classes, seminar and small groups allow increased connections that can sometimes be lost when considering the university at large."

Several responses from men were also about how NRT offers trainees opportunities to communicate with people from diverse backgrounds. Interestingly, most responses from males focused on how NRT program leaders played a role in creating and shaping interactions and networking. NRT leaders, they report, are welcoming and helpful, communicate with students respectfully, do a good job of scheduling guest speakers from diverse ethnic background and experiences, and actively engages students from minority backgrounds to understand their perceptions. One such response: "{NRT} faculty communicate with students in a manner that conveys respect for individual life experiences."

In addition, responses from women tended to emphasize the wide variety of ethnic and academic backgrounds in the cohort. Responses from men tended to focus on how it seems that NRT program leaders are taking great care to develop the program. For example, they noted, recruitment efforts are designed to attract diverse candidates. Furthermore, the number of written comments in the survey about inclusiveness that related to place from male participants matched the number of comments from females one-to-one.

These responses were about both the situational space created by the NRT program and the geographic spaces that trainees focus on for their research projects. Female responses described how the NRT offers a place for trainees to learn about each other's diverse background. One survey response shed light on how, even though some trainees value how the NRT program offers opportunities for trainees to interact with people from diverse academic and ethnic backgrounds, at least a few trainees do not see the same kind of diversity in their study areas in

rural Kansas. Even though this is based on just one response, it gives NRT leaders new insight into trainees' thinking. This clue into trainees' perspectives presents an opportunity to better understand their views about stakeholder diversity. Questions, such as how trainees think about the term 'diversity,' can be brought into discussions around diversity in Kansas, for example, when NRT faculty and trainees discuss a documentary about diversity in the NRT's study area.

Sense of belonging in higher education has been studied to examine the relation to academic success, motivation and persistence. Sense of belonging in undergraduate education has been found to affect among other things undergraduate students' retention and persistence. However, only few studies have examined sense of belonging within graduate education [21] [22]. Similarly, from the above analysis of inclusiveness we see that women see inclusiveness differently than men and that they attribute the inclusiveness quality of the program to a diversity of participants and opportunities to connect. URM students and other ethnic groups rated the NRT program with an average score of 4.2 (SD=0.8), which was almost exactly the same as the average rating from Whites of 4.1 (SD=0.8).

### **4.3 Opportunities for Cognitive Diversity are a favorite among trainees**

Responses to NRT annual survey provide evidence that respondents value the cognitive diversity of the NRT program [23]. Cognitive diversity is the inclusion of people, who have different styles of problem-solving, and can offer unique perspectives because they think differently. Trainees wrote that learning about new perspectives on systems issues by interacting with fellow trainees was their 'favorite part' of the NRT. Trainees like being able to connect with students from other disciplines. For example, a trainee said: "{My favorite part of NRT so far has been} the connection and interaction with students from various backgrounds, expertise, and ways of thinking."

Another popular part of our NRT program that trainees wrote about was the opportunity to see the challenges they study through a broader lens than their discipline affords, which happened through interactions with other NRT trainees, stakeholders and faculty. For example, a trainee said: "My favorite part has been getting to learn the perspective of economists, sociologists, and policy makers as opposed to only looking at it from {my discipline's} perspective. "

The cognitive diversity in the NRT program is thought to augment the work to formulate lasting solutions to the wicked problems facing communities around the world, such as producing more food with limited natural resources, producing energy with less water, converting waste into value-added products.

### **4.4 How diverse is the NRT program?**

To get a gauge of how diverse the NRT program is, we compared the composition of the NRT program, by gender and by ethnic group with the College of Engineering Data at our university [20]. As shown in Figure 6, 67 women (25%) and 197 males were full time graduate students in the College of Engineering in 2019-2020 academic year, and 64 women (27.7%) and 167 males are full time graduate student in the College of Engineering in 2020-2021 academic year [20]. Three women and nine males were NRT trainees in the College of Engineering in 2019-2020

academic year, and four women and two males are NRT trainees in the College of Engineering in 2020-2021 academic year. We compared these numbers to the gender distribution in the total population of engineering graduate student at our University.

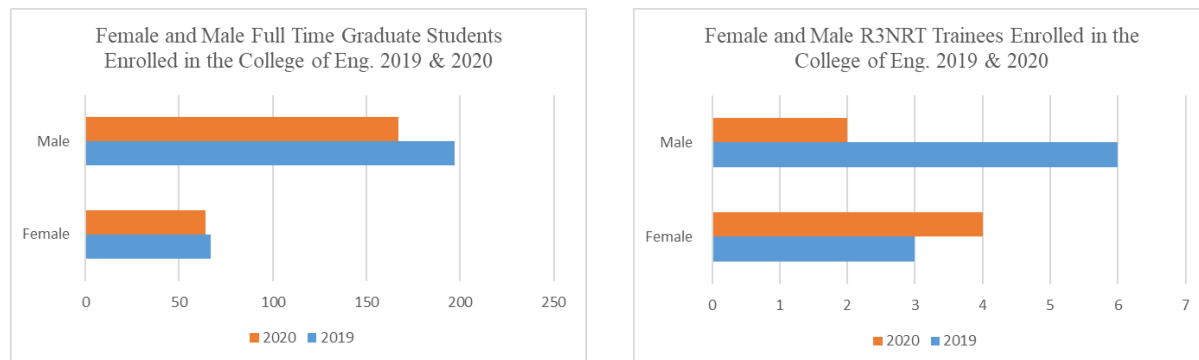


Figure 6 (left) Female and Male Full Time Graduate Students Enrolled in the College of Eng. and (right) Female and Male NRT Trainees Enrolled in the College of Eng.

To analyze the likelihood of the gender distribution in our NRT to occur by chance, we applied a binomial distribution, and compared to the probability of an engineering graduate student to be a female student in the entire student population outside of our NRT. In 2019, given that the probability of an engineering graduate student to be a female student was 0.253, the binomial probability to have three or more women in the program is 0.237. In 2020, given that the probability of an engineering graduate student to be a woman was 0.277, the probability to have four or more female students is 0.046. In 2020 the probability value is statistically significant and may indicate that interdisciplinary work and inclusiveness increases the number of women in engineering. In 2019 the probability value is not statically significant. It is possible that the high probability value in 2019 is the result of being the first cohort.

To characterize how the ethnic composition of the NRT program compares with that of the College of Engineering, we looked at survey and enrollment data [20], respectively, for the 2020-2021 academic year. Findings showed that the composition of the NRT program is more diverse than the College of Engineering and the university graduate student body. That is, for the NRT program, five of fifteen survey respondents, or about one-third (33 %), identified as URM (Asian or Hispanic). Looking at the university, graduate students enrolled full time, who identified as Asian or Hispanic totaled 168, which is 8 % of the total number of full-time graduate students enrolled at the university. We see a similar situation in the college of Engineering, where 9 full time graduate students identified as Asian or Hispanic, which is 4 % of the total full-time graduate students enrolled in the College of Engineering.

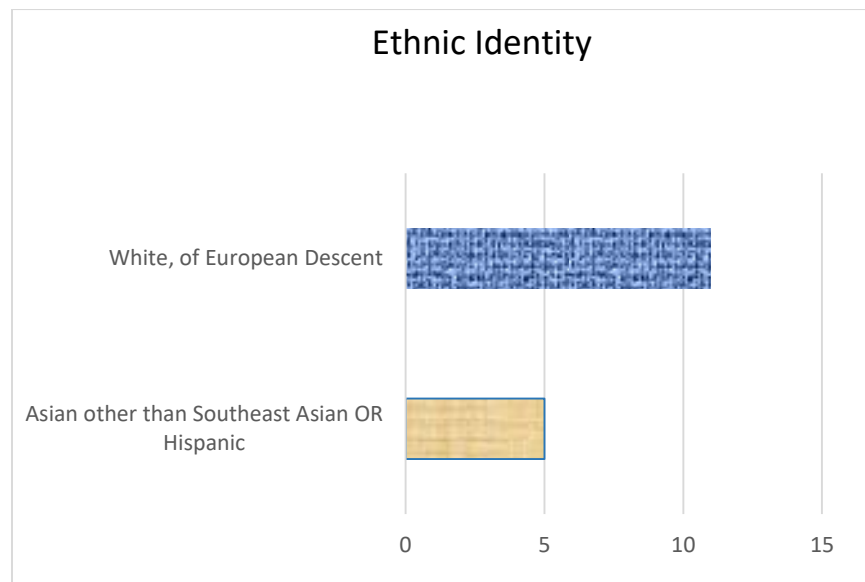


Figure 7: NRT Ethnic Identity in 2020

#### 4.5 Trainees are mixed about the usefulness of interdisciplinary mentoring

Mentoring and advising are critical aspects of graduate student experiences and can have an impact on their professional life and creating a graduate program that puts the inclusion and success of students first [18]. In addition to meeting with department advisors, the NRT team established team-based faculty and peer mentoring for trainees to develop critical professional skills [24]. The team-based faculty mentors provide vocational counseling and career planning for trainees to pursue industry, government, and academia positions and foster a sense of professional community [25]. Students meet with their advisor and two team faculty mentors outside their discipline to develop their Individual Development Plans (IDP), which include short- and long-term career goals, critical skills to be developed, activities which could develop those skills, and target dates to achieve those skills. Findings from our NRT annual program survey shows that, even though some trainees found NRT mentoring to be redundant with mentoring from their disciplinary advisor, trainees rated faculty involvement as somewhat useful for student career development [23]. For their overall NRT program experience, NRT trainees wrote about how they valued the opportunity to work with professors, and also peers, from different disciplines.

### 5. Conclusions

This investigation sought to better understand how the NRT, an interdisciplinary graduate research traineeship, contributes to diversity and inclusion of STEM graduate education. The study produced evidence that our NRT program student body is more diverse than our university College of Engineering student body, and also more diverse than the university student population. Results also suggest that women's strongest reason for applying to the NRT program

is to grow as an interdisciplinary researcher and men's strongest reason is to advance their careers.

Findings also show that trainees see the NRT program as inclusive. Trainees rated the program as being very inclusive, which they attributed to how the program enables trainees to interact with people (trainees, guest speakers, project stakeholders) with diverse academic and ethnic backgrounds. Men tended to emphasize the role that NRT program leadership played in offering these experiences. Responses from women tended to emphasize the small size of the cohort group and opportunities to connect with a diverse group of peers and professionals. Interestingly, women rated the NRT program as a bit less inclusive than men.

Additionally, survey findings provide evidence that cognitive diversity, the opportunity to work with people who have different styles of problem-solving and can offer unique perspectives, is among trainees' favorite aspects of the program. While the reasons the NRT program attracts diverse students and fosters an inclusive community are unclear, findings point to areas for further investigation: differences in gender ratings, recruitment strategies, mindful program leadership, the small size of the program, and the opportunities to connect with a diverse group of peers and professionals.

It is worth noting that the small size of the NRT program cohort and smaller size of the survey participant group limit our ability to draw conclusions and generalize to other programs and populations. However, we believe that students join our NRT because of our interdisciplinary training. Students enjoy exploring a research topic from an interdisciplinary lens and working with a group of people, who have different perspectives, backgrounds, and knowledge. This allows our students to solve a problem in more of a holistic way. We also believe that students join our NRT to expand their career opportunities. Working with different professors, who can provide mentorship and career advancement opportunities, open the door to unique career paths.

As we continue to collect data from subsequent cohort groups, the precision of our investigation will improve. For example, written responses from trainees attribute the inclusive nature of the NRT program to the small size of cohort groups, the leadership style, and the opportunity to connect with peers and professionals from diverse academic and ethnic backgrounds. Next year's survey could ask in more detail about these factors. Sampling from subsequent generations of NRT cohorts will also help us develop a larger database, allowing us to produce more solid evidence to support conclusions.

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