

Board 359: Reaching DEI targets in STEM: Lessons from a National Science Foundation Research Traineeship (NRT) with Outstanding Demographics

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Reaching diversity, equity, and inclusion targets in STEM: lessons from a National Science Foundation Research Traineeship (NRT) with outstanding demographics

1. Introduction

A National Science Foundation Research Traineeship (NRT) that is currently in its fifth year at the University of Kentucky (UK) aims to enhance graduate education by integrating research and professional skill development within a diverse, inclusive, and supportive academy. The first of several previous contributions provides an overall description of the NRT and its evaluation [1]. Subsequent contributions have delineated in more detail the description, assessment, and outcomes of individual NRT components, including i) an onboarding event, a career exploration symposium, and a multidisciplinary introductory course [2]; ii) a transferable skills course, an interdisciplinary research proposal and project, and a multidisciplinary symposium [3]; and iii) a graduate certificate, field trips, internships, and international experiences [4]. In this contribution, we share the lessons learned from an investigation into how this NRT – which attained outstanding graduate trainee demographics – managed to reach its diversity targets and help broaden participation in STEM.

Albeit there is more literature on diversity, equity, and inclusion (DEI) in STEM at the graduate level, only a few reports investigate how inter-/trans-disciplinary programs like the NRT contribute to DEI in STEM graduate education, those authored by Shamir *et al.* being particularly noteworthy [5, 6]. In their recent publications, these authors describe their NRT recruitment strategies and provide the demographics of their traineeship as well as that of several control groups to show the extent to which their NRT broadened participation. In addition, Shamir *et al.* report both quantitative and qualitative data on the rating that trainees gave the inclusivity of the NRT, as well as on the reason for this rating and how these data break down in terms of both gender and ethnicity. Shamir *et al.* also assert that the demographic diversity of the trainees contributes to cognitive diversity, which includes exposure to problem-solving approaches in other disciplines. Notably, these authors recognized that the number of participants in their NRT resulted in a small sample size, which limited their ability to reach conclusions that could be generalized. Moreover, Shamir *et al.* recognized that the reasons their NRT attracted diverse students and fostered inclusivity remained unclear, identifying several areas for further investigation including recruitment strategies and mindful program leadership. Against this backdrop, this contribution aims not only to add to the sample size and compare results to those of Shamir *et al.* to reach more generalizable conclusions, but also to provide some insights within the areas these authors suggested for further investigation.

2. Methods

2.1. Recruitment approach

To recruit a diverse cohort of trainees and help broaden participation in STEM, this NRT took a dual approach to recruitment. On the one hand, incoming graduate students already accepted into departments affiliated with the NRT in general – and those from diverse backgrounds in particular – were targeted. This strategy was most effective since students were already committed to the NRT’s institution, so recruitment simply required NRT faculty and trainees to reach out, describe the traineeship, and tout its benefits. On the other hand, NRT faculty and trainees from diverse backgrounds attended conferences organized by professional societies and organizations dedicated to gathering, representing, and supporting underrepresented minority scientists. At these venues, NRT faculty gave oral presentations on the traineeship and/or facilitated professional development workshops, while NRT trainees presented the results of their work and/or served in graduate student panels, all this allowing for trainee representatives to interact with and attract prospective applicants. NRT faculty and trainees attending these conferences also staffed a table in the resource/graduate school fair or expo of these conferences, further interacting with prospects, handing them flyers, and encouraging them to apply to the traineeship.

2.2. Assessment and evaluation

Trainees were asked to report their demographic data in their application to the traineeship. As part of the NRT external evaluation, students participated in focus groups to discuss how they were recruited into the NRT program and to share their perspectives on why the program succeeded in recruiting diverse cohorts of students. Two student focus group discussions were conducted, the first one in fall 2022 and the second in spring 2023. The first focus group included Cohort 1 and 2 trainees who had participated in an international experience. The second focus group included trainees from all three cohorts who were interested in discussing transdisciplinary and interdisciplinary research and course work as well as NRT recruitment.

3. Results

3.1. Trainee demographics attained

The dual approach to recruitment described in section 2.1 resulted in the following aggregate demographic data for all trainees recruited to date: 10% Asian, 39% Black/African American, 8% Hispanic/Latinx, 39% White/Caucasian; 44% men, 54% women, and 2% other (non-binary); 69% Domestic, 31% International; 31% first generation college; 8% have a disability; 10% LBGTQ+. Figure 1 offers a graphical representation of these data. Notably, the latter were self-reported by students, which allowed the evaluation team to collect demographic data that were not collected by the university (e.g., LBGTQ+). Table 1 includes these data in aggregate as well as by cohort. These outstanding trainee demographics both attest to the effectiveness of the recruitment strategy employed and evince that this traineeship is effectively broadening participation in STEM.

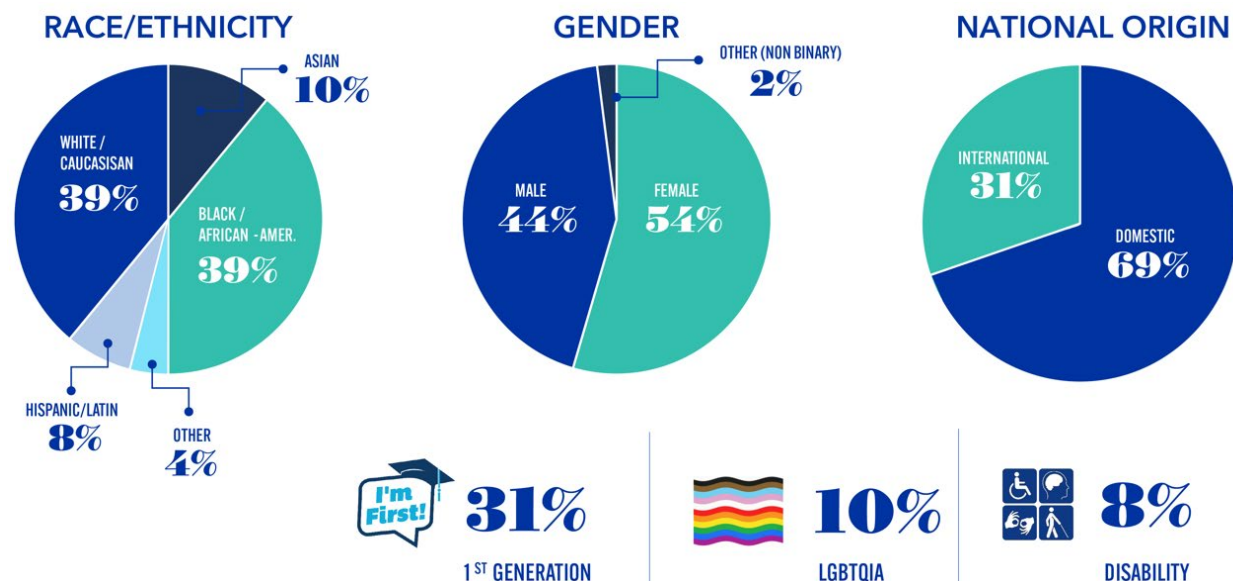


Figure 1. Graphical representation of the demographics of all trainees recruited into the UK NRT

Table 1. UK NRT Student Reported Trainee Demographics

	All Cohorts		Cohort 1		Cohort 2		Cohort 3	
	n	%	n	%	n	%	n	%
Gender								
Male	21	44%	10	59%	7	44%	4	27%
Female	26	54%	7	41%	9	56%	10	67%
Other	1	2%	0	0%	0	0%	1	7%
Total	48	100%	17	100%	16	100%	15	100%
Race and Ethnicity								
Asian	5	10%	5	29%	0	0%	0	0%
Black or African American	19	39%	5	29%	7	44%	7	44%
Hispanic or Latino	4	8%	1	6%	1	6%	2	13%
White or Caucasian	19	39%	6	35%	7	44%	6	38%
Two or more races*	1	2%	0	0%	0	0%	1	6%
Prefer not to disclose	1	2%	0	0%	1	6%	0	0%
Total	49	100%	17	100%	16	100%	16	100%
LGBTQ+ Status								
Yes	5	10%	0	0%	1	6%	4	27%
No	42	88%	17	100%	14	88%	11	73%
Prefer not to disclose	1	2%	0	0%	1	6%	0	0%
Total	48	100%	17	100%	16	100%	15	100%
Disability Status								
Yes	4	8%	3	18%	0	0%	1	7%
No	44	92%	14	82%	16	100%	14	93%
Total	48	100%	17	100%	16	100%	15	100%

First Generation Status

Yes	15	31%	7	41%	5	31%	3	20%
No	33	69%	10	59%	11	69%	12	80%
Total	48	100%	17	100%	16	100%	15	100%

National Origin Status

International Student	15	31%	3	18%	8	50%	4	27%
Domestic Student	33	69%	14	82%	8	50%	11	73%
Total	48	100%	17	100%	16	100%	15	100%

*Note: Trainees self-reported demographic information; * Student identified as Black and Hispanic/Latinx*

3.2. Trainee and non-trainee demographics

To compare NRT trainee demographic data to university non-trainee demographic data within the same departments, institutional research (IR) data were used for both groups. IR data were gathered for 206 graduate students (158 non-trainees and 48 trainees) and include race and ethnicity, gender, and first-generation college status.

As shown in Table 2, across all NRT cohorts, 44% of trainees identified as non-white compared to 13% of non-trainees. It should be noted that the IR data categorizes students as unknown when they are international students or when the students do not provide their ethnicity, so the values above could be higher. Below is a cohort comparison of race and ethnicity by trainee status as shown in Table 2:

- 47% of Cohort 1 trainees identified as non-white compared to 21% of Cohort 1 non-trainees. 12% of trainees were categorized as international students compared to 33% of non-trainees.
- 38% of Cohort 2 trainees identified as non-white compared to 10% of Cohort 2 non-trainees. 13% of trainees were categorized as international students compared to 34% of non-trainees.
- 47% of Cohort 3 trainees identified as non-white compared to 15% of Cohort 3 non-trainees. 20% of trainees were categorized as international students compared to 29% of non-trainees.

Table 2. Graduate Student Race and Ethnicity by Trainee Status

	Cohort 1				Cohort 2				Cohort 3			
	Trainees		Non-Trainees		Trainees		Non-Trainees		Trainees		Non-Trainees	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Asian	4	24%	5	12%	0	0%	5	8%	0	0%	2	4%
Black or African American	4	24%	3	7%	5	31%	1	2%	4	27%	2	4%
Hispanic or Latino	0	0%	1	2%	1	6%	0	0%	3	20%	2	4%

White or Caucasian	6	35%	19	44%	6	38%	31	50%	5	33%	29	53%
Two or more races	0	0%	0	0%	0	0%	0	0%	0	0%	2	4%
International Student	2	12%	14	33%	2	13%	21	34%	3	20%	16	29%
Unknown*	3	18%	15	35%	4	25%	25	40%	3	20%	16	29%
Total	17	100%	43	100%	16	100%	62	100%	15	100%	55	100%

Note: IR data categorizes Race and Ethnicity together; IR data codes international students or students who did not provide an ethnicity value as unknown. For our purposes, international students who did not have an ethnicity value were selected out from the unknown category data and are represented as a separate category.

Figure 2 offers a graphical representation of these data.

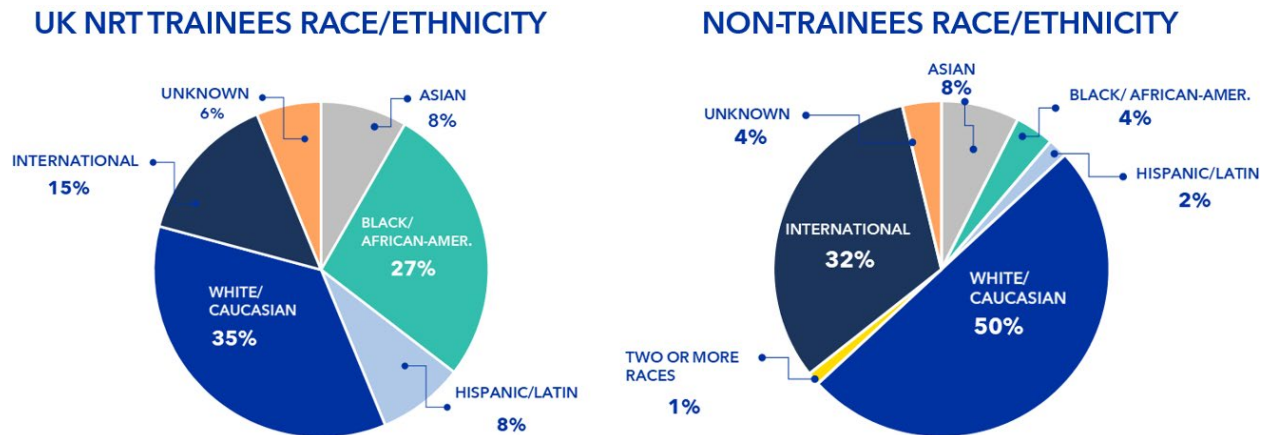


Figure 2. Graphical representation of the race/ethnicity of UK NRT trainees and non-trainees

As shown in Table 3, across all cohorts, 54% of trainees identified as female compared to 42% of non-trainees. Below is a cohort comparison of gender by trainee status as shown in Table 3:

- 41% of Cohort 1 trainees identified as female compared to 40% of Cohort 1 non-trainees.
- 56% of Cohort 2 trainees identified as female compared to 45% of Cohort 2 non-trainees.
- 67% of Cohort 3 trainees identified as female compared to 40% of Cohort 3 non-trainees.

Table 3. Graduate Student Gender by Trainee Status

	Cohort 1				Cohort 2				Cohort 3			
	Trainees		Non-Trainees		Trainees		Non-Trainees		Trainees		Non-Trainees	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Male	10	59%	26	60%	7	44%	34	55%	5	33%	33	60%
Female	7	41%	17	40%	9	56%	28	45%	10	67%	22	40%
Total	17	100%	43	100%	16	100%	62	100%	15	100%	55	100%

Figure 3 offers a graphical representation of these data.

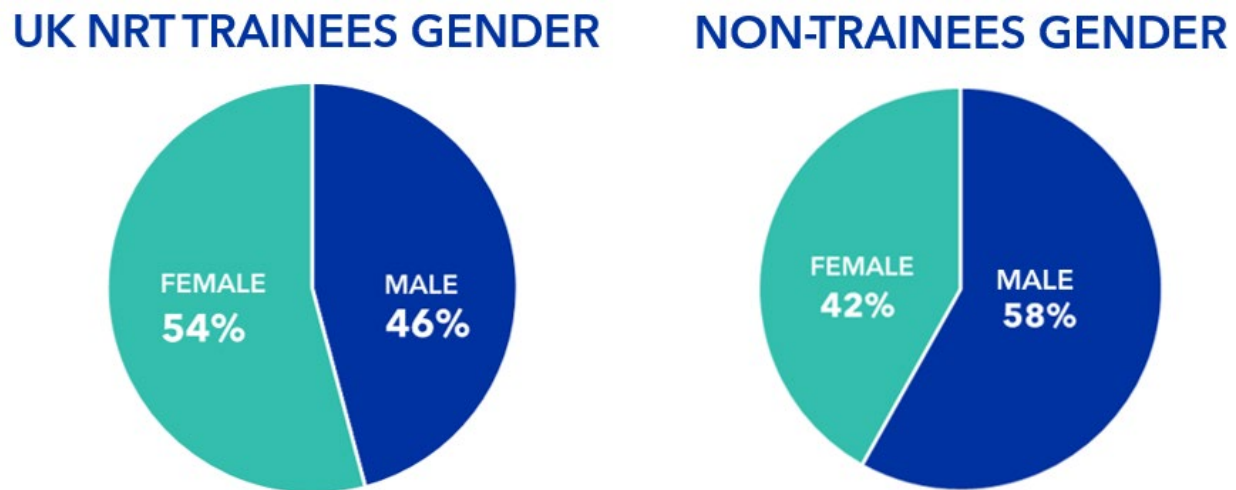


Figure 3. Graphical representation of the race/ethnicity of UK NRT trainees and non-trainees

To put these numbers in the national context, it should be noted that in the U.S. the number of graduate degrees in STEM fields for women is approximately half of graduate degrees earned by men. During the 2020-21 academic year, women earned 37% of master's degrees and 35% doctoral degrees in STEM fields [7].

As shown in Table 4, most of the students – regardless of trainee status – reported that they were not first-generation students (90%). Interestingly, as shown in Table 1, this number differed when students self-reported this information. Across all cohorts, 31% of trainees reported that they were first generation students. These numbers could differ due to the way that IR defines or collects first generation data.

Table 4. Graduate Student First Generation Status by Trainee Status

	Cohort 1				Cohort 2				Cohort 3			
	Trainees		Non-Trainees		Trainees		Non-Trainees		Trainees		Non-Trainees	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
First Generation	2	12%	1	2%	1	6%	9	15%	2	13%	5	9%
Non-First Generation	15	88%	42	98%	15	94%	53	85%	13	87%	50	91%
Total	17	100%	43	100%	16	100%	62	100%	15	100%	55	100%

3.3. Insights gained through assessment and evaluation

A commitment to DEI on the part of NRT leadership and faculty contributed to the attainment of these noteworthy demographics. Students reported joining the NRT due to the PI's commitment to DEI as well as the diversity of the faculty. The NRT core faculty (n = 10) were 60% male and 40% female and 70% White and 30% people of color, according to self-reported data. These faculty were primarily from the College of Agriculture, Food, and Environment, the College of Engineering, and the College of Arts and Sciences (n = 839) where faculty were 62% male and 38% female, and faculty were 74% White, 5.7% Black or African American, 4.1% Hispanic or Latino, and 0.6% two or more races, according to IR data.

The PI, faculty, and trainees played a significant role in attracting students to the NRT. Trainees reported learning about the program from various sources including: a graduate advisor suggesting the NRT program; a graduate student sharing a brochure about the NRT; learning about the NRT at a conference; and learning about the program from current trainees with diverse backgrounds. Trainees reported that they were drawn to the program because they saw students who looked like them, and several trainees said that their NRT classes were the most diverse classes in their schedules. Faculty reported in a focus group discussion that they also believed trainees were attracted to the diverse representation as well as the recruitment by students who were already trainees. One participant commented, "I believe that the second cohort basically saw that there was a fair amount of student-to-student recruitment [by diverse students]." Faculty also observed that trainees tended to take other courses together outside of the NRT curriculum, which increased diversity in these other courses.

Shamir *et al.* reported that trainees valued the cognitive diversity of their NRT, a finding that was reproduced in the evaluation of this NRT [5]. Students were drawn to the wide range of expertise collectively provided by the NRT faculty, who represented several disciplines, were affiliated with multiple departments, and could thus provide a broader understanding of – and a more multi-, inter-, and trans-disciplinary approach to – STEM research and training. A student cited access to different faculty as a draw to the traineeship: "...the varying expertise within the different faculty really drove me to want to be a part of the program." The students participating in the focus group recognized interdisciplinary experience as a significantly valuable tool for promoting further learning and research. This interdisciplinary experience also exposed students to research on topics outside of their fields and opened new avenues for future research. Similar to findings reported by Shamir *et al.*, trainees commented that problem-solving skills were boosted by working on interdisciplinary challenges [5]. One student said, "It's a great opportunity to apply the knowledge from different disciplines into the solutions of a single problem." Finally, the participants shared that engaging in interdisciplinary discussions with people from different fields aided them to create meaningful and useful connections.

A frequent topic among the participants was the experience of encountering cognitive diversity in the form of new ideas and cultures outside of the U.S. The participants appreciated the opportunity to work with people from diverse cultural and academic backgrounds and shared that it was a meaningful experience that broadened their perspective. They admitted that working and learning experiences in the U.S. were Western-centric, but the international experience made

them realize there are many interesting phenomena to consider around the world. One participant addressed this realization as “a wake-up call” and “humbling experience.” The participants were also enthusiastic about the new cultures they encountered during international experiences, as one participant commented, “It is really nice to learn about other cultures and see kind of what's out there in the different ways that people think, and the different ways that people go about their scientific research.” While sharing their international experiences, some participants commented on the differences between the U.S. and other countries. They compared several aspects including public-private partnerships, public involvement in environmental issues, and the structure of Ph.D. programs in other countries. One participant, while sharing insights gained from an international experience, talked about being encouraged to see the public in other countries becoming involved in environmental assessments. One participant commented on how Ph.D. programs outside the U.S. were different (e.g., opportunities in industry) and how that served as inspiration to apply for a post-doc outside of the U.S.

Finally, trainees asserted that the NRT created a community where they could find support and a sense of belonging. Students provided examples of organized events like pizza at a local restaurant and NRT field trips as well as impromptu gatherings both on and off campus. One trainee expressed that they had no affinity group other than the NRT and felt that without this connection they would have withdrawn from the university. In a focus group discussion, faculty members shared their observations, as well as direct feedback from students, regarding the NRT community, which reinforced student belonging. A sense of belonging was not specifically measured – particularly its relationship to recruitment and retention of diverse students – but could be in future work.

4. Conclusion

This NRT's achievement in recruiting diverse graduate students into STEM fields is notable across numerous demographics including underrepresented minorities and women. The diversity of NRT students exceeds the diversity of the larger comparison population in the same STEM departments at the university, particularly for non-white students and women. These recruitment results, in both head count ($n = 48$) and diversity (particularly Black and African American) trainees, compare favorably to the findings of Shamir *et al.* in terms of head count ($n = 18$) and diversity (limited to Asian or Hispanic) [5].

Some findings from this investigation are similar to those of Shamir *et al.*, which include trainees' positive perception of inclusivity and belonging, trainee satisfaction with diversity of the NRT (diverse trainees, diverse faculty, cognitive diversity), and trainee satisfaction with the multi-, inter-, and trans-disciplinary approach to STEM research. Additionally, this investigation complements the findings of Shamir *et al.* by further understanding the reasons for diverse students enrolling in the NRT program and how the NRT creates community. Indeed, trainees identified specific recruitment efforts that attracted them to the NRT program, including the diversity of trainees and faculty as well as the diversity of disciplines represented by the faculty.

In focus group discussions, trainees reported that the multi-, inter-, and trans-disciplinary approach to STEM research and training impacted their process for solving problems and for conducting research. Trainees also found international experiences to be impactful as they encountered new cultures as well as new perspectives on public engagement with research and the role of research within industry.

Recommendations for further investigation include refining the measurement of multi-, inter-, and trans-disciplinarity to better understand its impact on trainees personally and professionally. Additionally, a quantitative measurement of sense of belonging would add to the qualitative data collected from this NRT.

Acknowledgement

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