Graduate Research Experience and Transitioning to Grad School (GREaT GradS): A New Approach to Graduate-School Onboarding for Marginalized Groups

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Abstract:

After undergraduate research programming was thoroughly disrupted due to the COVID-19 pandemic, it became evident that incoming graduate students may not have had the opportunity to fully prepare for the changes experienced in the first semester of graduate school. To ease this transition, the *Center for Nanoscale Science*, a National Science Foundation Materials Research Science and Engineering Center (NSF-MRSEC) at Penn State University, developed the Graduate Research Experience and Transitioning to Grad School (GREaT GradS) program initially for the summer of 2021 as a 6-week, graduate school summer foundational program for incoming students in disciplines spanning engineering, materials science, chemistry, and physics. After a successful pilot in 2021, the program was conducted with a larger group of students in the summer of 2022. Thus far, our results indicate that this program will be beneficial to students well after regular programming resumes at full capacity. GREaT GradS was designed to serve groups of graduate students who are typically marginalized within science with an eye toward retention through support and mentorship. The overall goals were to provide (1) Resource Recognition by introducing students to the various academic and personal resources available on campus, (2) Personal Preparation through programming on subjects such as personal finance and mental health, (3) Career Preparation through writing workshops and curriculum vitae editing, and (4) Network Building by connecting students with current graduate students. Students were also matched with faculty to conduct summer research in their field of interest. Here, we describe the program content in greater detail as well as the quantitative outcomes of the program. This program of a dedicated transition period can serve as a model for other researchers, educators, and coordinators to develop new and similar programs.

Introduction:

The first and second years of graduate school are crucial for the success of students [1] - [4]. Nearly one-third of all doctoral student attrition occurs within the first year of graduate school [5], [6]. The importance of these first interactions is not new information either. A study from 1980 showed that increased frequency in social interactions with peers and faculty within the first 10 weeks (about 2 and a half months) of graduate school reduced the impact of stress, both physically and psychologically, for the next 6 months [7]. Overall, we know that at least 40% of all doctoral students do not complete their programs, and much of this attrition could be prevented and is not reflective of student capability [8].

Simultaneously, doctoral degrees awarded in science, technology, engineering, and mathematics (STEM) continue to be disproportionately awarded to white students. In the 2019-20 academic year, 71.3% of all STEM doctoral degrees awarded to U.S. citizens and permanent residents were awarded to white students, even though the U.S. population is approximately 59.3% white. Only 4.3% of doctoral degrees were awarded to Black students, despite Black people representing 13.6% of the U.S. population. Only 7.6% of doctoral degrees went to

Hispanic/Latino/a students, which is much lower than the corresponding 18.9% of the U.S. population. Pacific Islanders, though only 0.3% of the U.S. population, are also underrepresented in doctoral degrees at 0.1%. American Indians and Alaska Natives are similarly underrepresented at 0.2% of doctoral degrees despite forming 1.3% of the U.S. population. The only group that has a higher percentage of doctoral degrees awarded than their U.S. population are Asian students, who account for 12.8% of degrees and 6.1% of the U.S. population, though this disparity is not as large as that observed in white students [9], [10]. For the purposes of this work, Black people, Hispanic/Latino/a people, and Indigenous people/American Indians/Alaska Natives/Pacific Islanders will all be considered "underrepresented" students in STEM.

In addition to underrepresented racial and ethnic minorities previously mentioned, students who are members of the LGBTQ+ (lesbian, gay, bisexual, transgender, queer, and more) community and first-generation students are also marginalized within the STEM fields. In this work, we will refer to underrepresented racial and ethnic minorities, LGBTQ+ people, and first-generation students as marginalized groups. Neither LGBTQ+ nor first-generation graduate students are well studied in comparison to racial and ethnic minorities, but data from undergraduate student and workforce populations can provide some insights into these two groups. In 2018, a study of undergraduate students found that students in the sexual minority were 7% less likely to stay in STEM as compared to switching to a non-STEM major [11]. Additionally, a 2013 survey of people who work in STEM and identify as part of the LGBTQ+ community found that 43% of respondents were part of a workplace where at least half of their colleagues did not know that they identified as part of the LGBTQ+ community [12]. The limited studies of first-generation graduate students suggest that finances are a major concern for students. First-generation students are much more likely to have student loan debt than their continuing-generation peers. Additionally, first-generation students said that job security, salary, and benefits were of more importance to them as compared to their continuing-generation peers. Racial minorities were also much more likely to be considered first-generation students, which leads to a compounding of barriers faced by both minority groups [13].

This underrepresentation is problematic in the U.S. and has been noted as a hindrance to the global competitiveness of the country [14], [15]. Suggestions have been made in past studies to counteract this. Hybrid holistic reviews have been suggested as an alternative to using graduate record examination (GRE) scores to prevent qualified applicants from being rejected solely based on their scores. Financial considerations that reduce or eliminate the financial barriers faced by marginalized students, such as the cost of applying for or moving to graduate school, have also been suggested. Additionally, bridge programs that provide support during the transition have been shown to increase enrollment and productivity by underrepresented students [16].

Bridge programs are not a new concept, though most literature about them is in reference to programs that assist in the transition into an undergraduate program. These undergraduate programs typically include content instruction, tutoring, research opportunities, campus orientation, and faculty and peer mentoring [17]. In STEM, these bridge programs often aim to help students build their identities as scientists [18]. Some graduate-level bridge programs do exist, but they are often built to support singular marginalized groups or fields [19] - [21] or may

only be available to students who previously were involved with a particular program or university [2], [20].

In recent years, the same barriers that have been present in the past for marginalized students were exacerbated by the COVID-19 pandemic. Marginalized students experienced increased difficulty in accessing resources due to closures, an array of adjustments to their home and family life and work/life balance, aggravated nonfinancial issues, and heightened fears and anxieties about the future [22]. As such, interventions are more pertinent now than ever before to ensure that marginalized groups continue to pursue graduate education.

In Golde's work on socialization in graduate school, the first year of doctoral education is broken into four tasks of transition. The first is intellectual mastery, in which a student completes coursework in their field. The second task is learning how graduate school operates and what they should expect from their life in graduate school as a student. Similarly, the third task is described as learning how their projected profession works and determining how they feel about moving in this direction post-graduation. Finally, the fourth task is integrating themselves into the department and their cohort [1]. The program described in this work is designed to primarily assist students with this fourth and final task while also following suggestions made previously regarding the easing of financial burdens [16].

The Graduate Research Experience and Transitioning to Grad School (GREaT GradS) program was developed to borrow from undergraduate bridge programs and interventions while maintaining that one does not need to approach graduate students who have already been admitted under the premise of a deficit model, such as the Meyerhoff Scholars Program [23] - [25] or Alliances for Graduate Education and the Professoriate (AGEP) program [26], [27]. GREaT GradS is a 6-week, graduate foundational program for incoming students in STEM disciplines, including engineering, materials science, chemistry, and physics. GREaT GradS was designed to serve groups of graduate students who are typically marginalized within science with an eye toward retention through support and mentorship.

Students were selected for the GREaT GradS program by coordinating with member departments on incoming graduate students. Member departments like Physics and Chemistry were asked to identify students who were marginalized in their home department and could benefit from this program. After the department identified the students, a joint letter of intent/acceptance was offered to the incoming graduate student to join GREaT GradS for the summer. This offer letter included the financial incentives of this program (1) reimbursement for one way travel to Penn State (up to $500) and (2) $6000 summer stipend, where $3000 was given on day 1 of the program.

The overall goals were to provide (1) Resource Recognition by introducing students to the various academic and personal resources available on campus, (2) Personal Preparation through programming on subjects such as personal finance and mental health, (3) Career Preparation through writing workshops and curriculum vitae editing, and (4) Network Building by connecting students with current graduate students. Students were also matched with faculty to conduct summer research in their field of interest. After a successful pilot in 2021, the program was conducted with a larger group of students in the summer of 2022.

Program Structure:

GREaT GradS Timeline –

GREaT GradS runs on an accelerated timeline because it is offered to incoming graduate students once they have formally accepted Penn State's graduate school offer. Incoming graduate students in Chemistry and Physics must accept or decline the University's offer by April 15th. Thus, we wanted to highlight this skewed timeline (Table 1) as it requires putting together a program in condensed period (about 8-10 weeks). An interesting feature of this program is that two of the departments that we coordinate with handle summer research opportunities differently. In the Chemistry department a student can participate in one or two optional summer research rotations that are available to all new graduate students. Students had the option to begin rotating through research groups in June, July, or August with financial support starting upon arrival. In the Physics department, more behind-the-scenes work that needs to be done to place an incoming graduate student into a lab. The Physics department faculty liaison coordinates with potential GREaT GradS participants and faculty to place students.

One way to alleviate the stress of the condensed timeline would be to use GREaT GradS as a recruiting incentive, where this program would be part of the initial graduate school offer letter. Thus, the students participating in this program would be known on or before April 15th versus making GREaT GradS program offers after their acceptance to graduate school.

Table 1. GREaT GradS Timeline

Spring Semester	
March	Coordinate with departments on participating & identifying students once they accept offer to graduate school
April 15	Graduate School Decision Day; Graduate school coordinators in Physics and Chemistry identify students from accepted cohort
April 15 – June 1	GREaT GradS offer letters are emailed
May - June	Planning of summer activities
July 1	GREaT GradS Program starts
August 15	GREaT GradS Program ends

GREaT GradS Programming –

GREaT GradS primary goal is to offer students a six-week immersive research experiences with programming in resources recognition, personal preparation, career preparation, and network building (Table 2, organized by the primary goal). The programming goal is to introduce students to a wide range of services and resources that are freely available through the university such as mental health services and financial literacy. A secondary goal is to develop the incoming graduate student's network at the university and beyond their departmental resources. With such a short period of time with the students (about 6 weeks), the program aims for a balanced approach towards goals in resource recognition and career preparation and networking.

As can be seen in Table 2, there are numerous activities, resources, seminars/workshops that can be introduced to incoming graduate students. This is to highlight that this programming can be easily tailored depending on what the graduate programs would like to highlight for their incoming graduate students. It should be noted that because this is **not** a deficit model program there is no classwork (remedial or foundational) associated with this program. As a note with respect to programming, the first year (2021) was during more stringent COVID-19 guidelines, which meant there was more of a mix of hybrid and in-person opportunities, while in year 2 in-person cohort events were the preferred method.

Table 2. Events Conducted during GREaT GradS

Event	Year	Related Goal
Learning about the Ombuds Program	2021	Resource Recognition
Time Management Panel	2021	Resource Recognition
Graduate Writing Center: Intro to Center and Using Message Boxes	2022	Resource Recognition
Penn State Libraries: Media Center	2022	Resource Recognition
Dean Finch: Welcome to the Eberly College of Science	Both	Resource Recognition
PSU Financial Literacy	Both	Resource Recognition / Personal Preparation
CAPS: Introduction & Mindful Mood Management	Both	Resource Recognition / Personal Preparation
A2i: Interdisciplinary Teamwork presented by Brendan Abolins, Ph.D., Eastman Chemical	2021	Personal Preparation
Lego Robotics & Team Building	2022	Personal Preparation
Review of REU Talks & Posters	2022	Personal Preparation
Center for Sexual & Gender Diversity	2022	Personal Preparation / Resource Recognition
Careers in Intellectual Property	2021	Career Preparation
Science Communication with Michael Alley	2021	Career Preparation
NSF Career & Personal Statements	2021	Career Preparation
Career Opportunities in Community Science Center with Ismaiel Szink, Discovery Space	2021	Career Preparation
Career Panel: "*Oh the places you'll go with a STEM degree*"	2021	Career Preparation
LinkedIn, Resumes, and CVs, Oh my!	Both	Career Preparation
Industry opportunities as a graduate student: Co-ops & Internships	2021	Network Building / Career Preparation
Dinner & Intro: Meeting current graduate students	2022	Network Building
Research Talk from Post-doc	2022	Network Building / Career Preparation
Recent Grads: Their stories	2022	Network Building / Personal Preparation
Grad Panel: Ask me Anything (Dinner & Networking)	2022	Network Building
Ice Cream Social	Both	Network Building

Briefly, we want to highlight two lessons learned with the programming aspect of GREaT GradS. In-person socializing and networking opportunities were limited in year 1 (summer 2021) because of changing COVID-19 conditions in the community. Only two planned social events occurred, an ice cream social and a closing dinner, where both were planned outside. In year 2 (summer 2022), many of the COVID-19 limits imposed by the University or the community were dropped, and it gave the program the opportunity to do a few more team building activities. We continued with the ice cream social and a closing dinner, but now with an "*Ask Me Anything about Grad School*" panel. In addition, we added a welcome dinner with both cohorts of GREaT GradS participants that provided an opportunity for folks to mingle, meet and then after dinner provide an overview of the program to the new participants. Finally, we did a team building exercise through our university, where the students worked in teams of 2 – 3 students to build a Lego™ drawing machine. The catch with this team building exercise was that the instructions were intentionally designed not have the drawing machine work correctly. The students only learned after the machine was built and tested that they had to revisit, refine, and revise their prototype. It allowed the GREaT GradS participants to work as a team, while getting to know one another.

In year 1 (summer 2021) there was concurrent Research Experience for Undergrads (REU) programming that GREaT GradS could choose to participate in. This optional programming included a Science Communication Workshop, STEM career panel, and Grad School 101. Attendance from the GREaT GradS participants were low in these events, or if they attended the event, they felt it was more geared towards undergraduate students. Thus, the decision was made to remove these activities from the schedule. Instead, in year 2 (summer 2022), the GREaT GradS participants were asked to lend their experience to the REU program by reviewing posters and oral presentations as well as inviting them to the REU symposium to hear about the various types of research that was happening in science and engineering across campus. Integrating opportunities for the incoming graduate students that leverage their experience and expertise appeared to be viewed more favorably by the GREaT GradS participants. Furthermore, the GREaT GradS students viewed it as an opportunity for professional growth/development where they had the chance to learn by being the "expert" on what made for a good or poor poster/science talk.

Student Deliverables –

Unlike a typical REU or bridge program, GREaT GradS is set up to give students an opportunity to gain hands on experience without the typical graduate student requirements that take up a majority of time such as classes and teaching. GREaT GradS students are in the lab for ~ 35 – 40 hours per week for about 6 weeks. The goal is not to burden the GREaT GradS participants by having them present a poster or talk about their research at the end of 6-week program. The practitioner of the program felt that if a presentation had to be done it would take the GREaT GradS away from the lab. The GREaT GradS deliverables were designed to help students think big picture about why they were in graduate school and how graduate school could help them achieve their long-term professional goals. The students had three deliverables to complete, which were (1) set up a LinkedIn profile, (2) send their resumé or CV to the coordinator, and (3) conduct an informational interview. The objectives of completing these deliverables were to set the students up for professional and career success and not to be

overwhelmed during the summer. Deliverables were all due by the end of the program. Deliverables 1 and 2 were highlighted as students often wait until a grant, fellowship, or application is due to update their resumé or CV. The goal of the resumé/CV is to have students periodically (once a semester) update their CV so they can tailor it when needed. A LinkedIn profile was created so GREaT GradS participants could easily network and connect with one another as well as with seminar or workshop speakers. Finally, the informational interview was given to participants to allow them agency over what they wanted to learn in their career development opportunities. The criteria for the informational interviews were to limit conversations to 30 minutes, come prepared with questions, and ask someone that you want to learn more about their industry, career, and/or career path. Potential candidates for the informational interviews could be current graduate students, post-docs, faculty, or someone with an advanced STEM degree to learn more about their career. Near the end of the program, the students shared who they met with for the informational interview, why they choose that person, and the most important piece of advice that person gave them (in their view). If there were any lessons to be learned, it was instead of having the deliverables all due at the end of the program, space them out about every 2 weeks, so students have time to review and work on each deliverable in a focused environment.

It was surprising that the students of cohort 1 asked for the opportunity to present their research. As a result of this ask, we had GREaT GradS present in our weekly MRSEC seminar in the Spring semester. Presenting about 4 months after the GREaT GradS program ended allowed students time to reflect on their experiences as well as more time to acquire any research results that they wanted to present. Because of the timing of the MRSEC seminar, only two students were available to present their experience and research findings. In the future, if GREaT GradS are interested in presenting to a group or an organization, it is important to find an opportunity where they can get more research accomplished to have a fully formed research presentation. This removes the pressure that may be felt if presentations are required solely on the work completed during GREaT GradS.

Mentors: Departmental Peer Mentors –

When developing this program, the practitioner recognized that they could provide the overarching framework of GREaT GradS, but that they would be limited in their ability to answer specific questions about each department. An intentional design of this program was to have a non-research peer mentor from their respective departments to meet with the GREaT GradS participants weekly. The goal of these weekly peer-to-peer meetings was to discuss specifics such as department culture, lab environments, classes, teaching, general expectations in their home departments, and answer any questions the GREaT GradS had about their specific home department or about living and working in their new community. The criteria for selecting the peer mentors for cohort 1 was to find a 2nd or 3rd year graduate student who could relate to the students and also valued diversity, equity, inclusion, and belonging. The program practitioner worked with faculty in Chemistry and Physics to identify a peer mentor and directly asked the student if they were interested in serving as peer mentor. Peer mentors were compensated for their work with MRSEC support via 1 month summer salary for them. After year 1, an intentional design of the program was to recruit future peer mentors from the previous cohort. In year 2 of GREaT GradS, three of the incoming students asked if they could be peer mentors the

following summer. Because of this robust response, we hope that the foundation is laid for GREaT GradS participants to become mentors to future cohorts. To weave in community and networking into GREaT GradS programming, a long-term goal is to continue to invite and bring back previous participants either in a formal or informal mentor capacity to the program. Former GREaT GradS participants will be invited back to participate in social/networking activities and/or attend seminars/workshops that interest them. Similar to the Meyerhoff Scholars Program and McNair Scholars programs, the goal is to create a GREaT GradS community that will allow the students to network and develop their own informal peer mentors, not only at Penn State but beyond graduation.

Methodology:

Evaluation Plan and Procedure –

Table 3. Evaluation Plan for the GREaT GradS Program

Evaluation Questions	Metrics	Assessment Instruments
1. How was the students' experience?	Students experience	Modified Undergraduate Research Student Self-Assessment (URSSA)
2. How many students were from under-represented groups? Or from institutions with limited research opportunities?	Recruitment of diverse student population	Modified Lawrence Hall of Science (LHS) Activation Lab Survey
3. Did students find the program to stimulate their scientific identity, sense of belonging, and self-efficacy?	Student's scientific identity, sense of belonging, and self-efficacy	Modified Measure of Engineering Identity Survey (MEI) survey Modified Sense of Belonging Scale (SoBS) survey Modified General Self-Efficacy Scale (GSE) Measuring Undergraduate Students' Engineering Self-Efficacy Survey (MUSES) Modified Student Response to Instructional Practices Survey (STRIP)
4. Did the students feel that they gained from the program and what were their attitudes and behaviors?	Student's perceived gains	Modified Undergraduate Research Student Self-Assessment (URSSA)

A mixed-methods evaluation was facilitated by an external evaluator. The evaluation gauged the program's effectiveness to help the administrators identify the most beneficial aspects of this intervention. The evaluator evaluated the program through formative and summative assessments, yielding quantitative and qualitative data. The analysis of this data allowed for strategic decision-making and pursued the continuous improvement of the program. Furthermore, identifying the most beneficial aspects and areas of improvement of the program helped the administrators serve the students. The formative assessment aimed at collecting data during the implementation of the program. This evaluation isolated specific program components

that need modification. The summative assessment collected data at the end of the 2021 and 2022 years and evaluated project outcomes, accomplishments, and lessons learned. The evaluation plan outlined in Table 3 used student surveys for data collection for each evaluation question.

Assessment Instrument –

To address these evaluation questions, the evaluator developed a survey with a range of questions to measure how the program fosters students' Research Experience, STEM Identity, Self-Efficacy, Sense of Belonging, and Engagement. These questions were collected by administering a pre-test survey in June 2021 and 2022 and post-test survey in August 2021 and 2022. To collect the students' demographic information, the evaluator used the Lawrence Hall of Science (LHS) Activation Lab surveys developed at the University of California, Berkeley by Moore *et al.* [28]. For the students' experience, the evaluator used the Modified Undergraduate Research Student Self-Assessment (URSSA) survey from Laursen and coworkers [29]. STEM Identity can be defined as how students and others see themselves as the type of person who can perform scientific or engineering activities. With this part of the assessment, the evaluator hoped to capture how GREaT GradS activities promote students' scientific and engineering identity. The questions are based on the survey developed by Godwin [30]. Self-efficacy can be generally defined as one's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their life. With this part of the assessment, the evaluator hoped to capture how GREaT GradS activities support the students in growing their confidence and self-image while performing tasks. The questions are based on the "General Self-Efficacy Scale" developed by Schwarzer and Jerusalem [31]. The questions are also based on the "Measuring undergraduate students' engineering self-efficacy: A validation study." developed by Mamaril *et al.* [32]. Sense of Belonging can be generally defined as the human emotional need to be an accepted member of a group. In this case, this would be the rest of the GREaT GradS group. With this part of the assessment, the evaluator hoped to capture how the GREaT GradS activities have supported the students in growing their sense of belonging inside the program and outside with the rest of the scientific community. The questions are based on the "Sense of Belonging Scale" developed by Anderson-Butcher and Conroy [33]. Active learning aims to draw the learner's attention away from passive listening and redirect it towards active engagement. With this part of the assessment, the evaluator hoped to capture how the GREaT GradS activities fostered students' active engagement. The questions are based on the "Student Response to Instructional Practices Survey" developed by Nguyen *et al.* [34].

Quantitative Results:

Evaluation Question 1 Analysis –
How many students were from under-represented groups? Or from institutions with limited research opportunities?

A total of 15 students completed the survey (5 in 2021 and 10 in 2022). The sample comprised a diverse group of self-identified genders and racial/ethnic backgrounds. The students' families also represented a wide range of educational backgrounds, with male or female adults that went to college but did not graduate or only graduated high school, graduated from college

and went to more school after college (master's degree, PhD, M.D., etc.). When looking at the data, five students had adult guardians who did not attend college or complete a college degree, making them the first in their family structure to complete a college degree. Demographic information about the participants is included in Table 4 and Figure 1.

Table 4. Demographic Information

What is your gender?				
Female	Male	Non-binary	Prefer not to say	
2	11	1	1	
How often is English spoken at your home?				
Always	Often	Never		
7	6	2		
What other languages are spoken at your home?				
None	Spanish	Portuguese	Amharic	Arabic
5	7	1	1	1
How much school has been completed by your mother (or adult female you live with)? (2022 survey)				
High School	Attended college, but did not graduate	College	More school after college (Master's, PhD)	I do not know
3	1	4	1	1
How much school has been completed by your father (or adult male you live with)? (2022 survey)				
High School	Attended college, but did not graduate	College	More school after college (Master's, PhD)	I do not know
1	1	5	2	1

The evaluator has assessed that the GREaT GradS program attracted students from under-represented groups based on the survey data. In particular, the students surveyed identified with Hispanic/Latino/a backgrounds and mixed backgrounds Latino/a or Asian backgrounds.

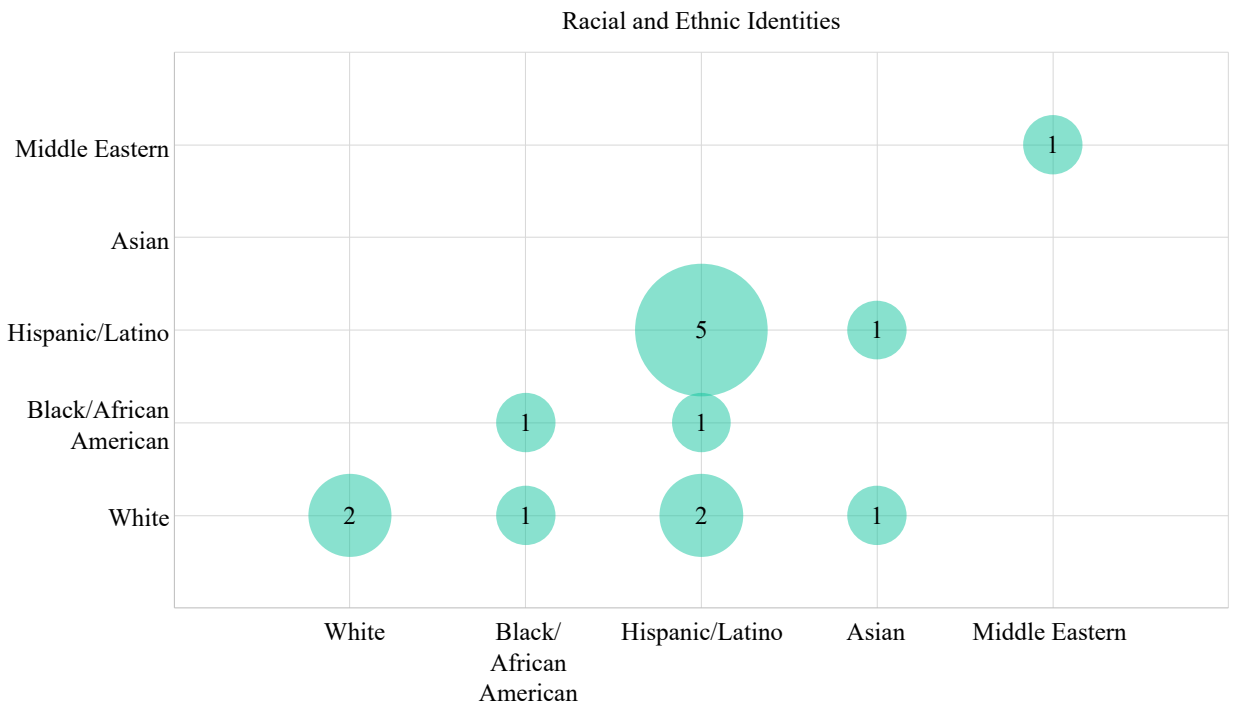

Figure 1. Racial and Ethnic data for participants across both 2021 and 2022. (Eval Q1)

Evaluation Question 2 Analysis –
How was the students' experience?

With this question, the evaluator was interested in evaluating the perceived students' experience in performing research. The survey was composed of several questions on a 5-point Likert scale. The questions used in this portion and the average participant response is included in Figure 2. The evaluator administered this survey in August 2021 and 2022 after the students participated in the GREaT GradS summer program prior to the start of their fall courses. By performing a descriptive analysis, the evaluator can see that the students have, on average, scored positively (or above a neutral score) for every question except only one. The students found that they did not get to interact with scientists outside their program/school.

Based on the collected evidence shown in Figure 3, the evaluator assessed that the GREaT GradS program met the goal of engaging in research related to chemistry, physics, and materials science. The evaluator found no significant issues that must be addressed in the program's research efforts. The program has also met its goal of recruiting students and engaging them in performing individual and original research projects.

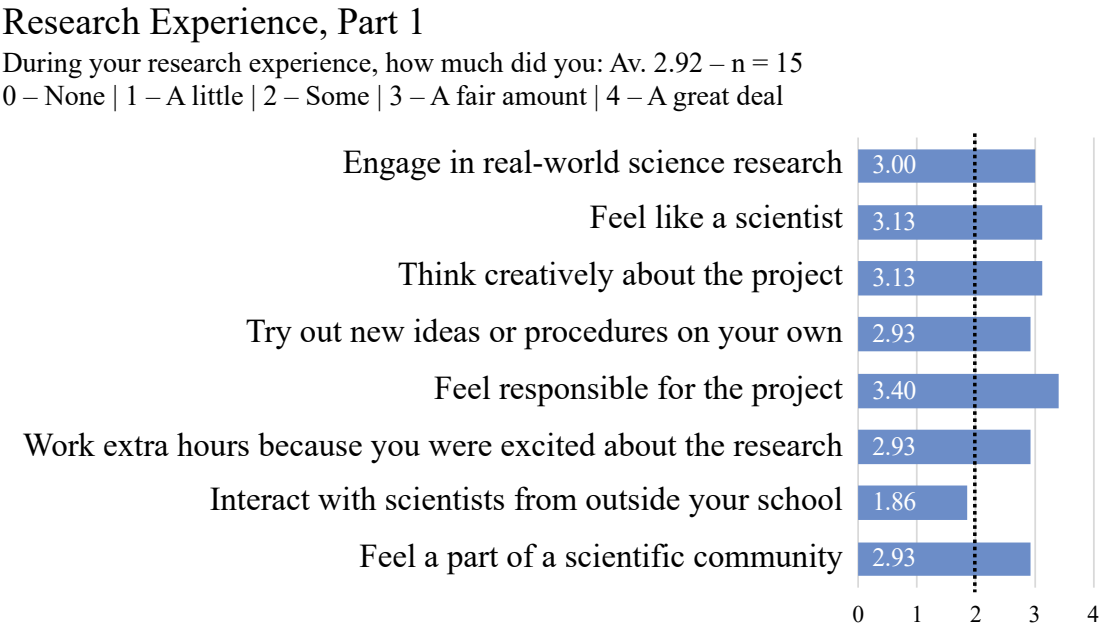

Figure 2. Assessment of research experience based on activities during program. (Eval Q2)

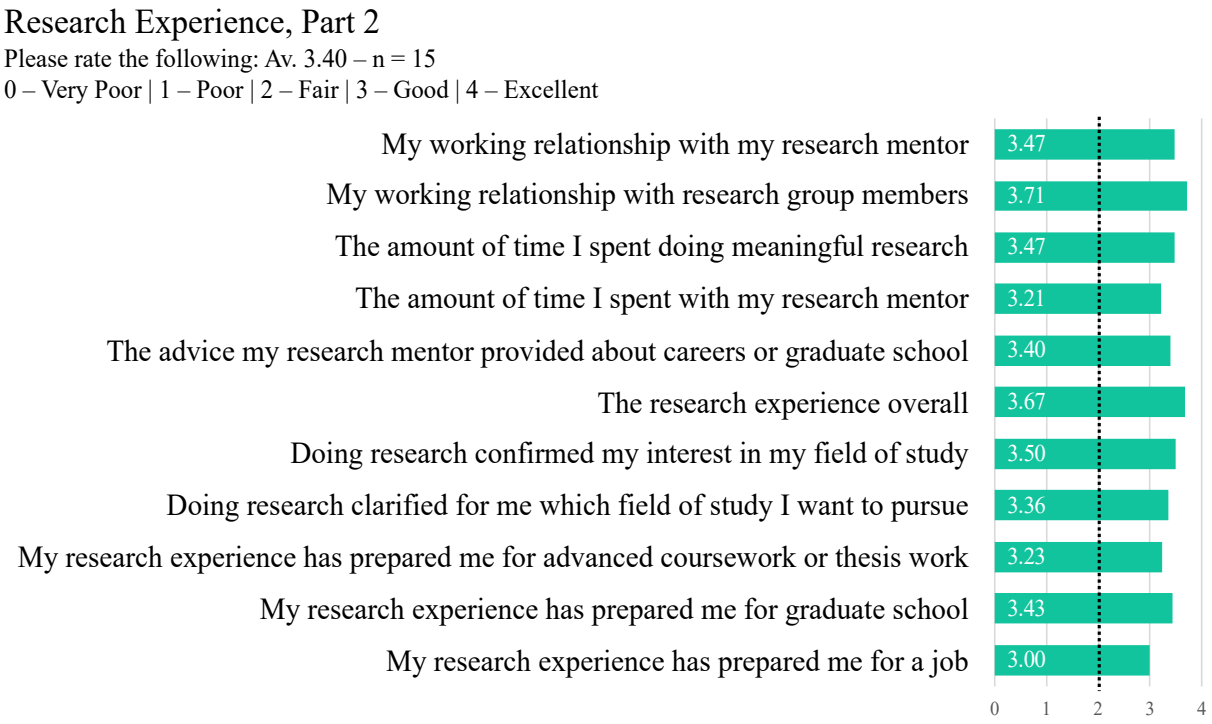

Figure 3. Rating of components of research experience. (Eval Q2)

Evaluation Question 3 Analysis –
Did students find the program to stimulate their engagement, scientific identity, sense of belonging, and self-efficacy?

The program has met its goal of generating an environment that stimulates students' engagement, scientific identity, sense of belonging, self-efficacy, and engagement (Figures 4, 5, and 6). The collected survey data illustrates the students are currently reporting high levels of STEM identity, self-efficacy, sense of belonging, and engagement. Through visual inspection, most of the dimensions of the survey scored higher than a neutral point of 2.5, and all scored higher than a 3 point. Due to the small sample size, the evaluator could not run a Student's T-Test and assess if the scores were significantly higher than a neutral score. However, while the sample size was small, through visual inspection, the evaluator can determine that the program is excelling in meeting the goal of generating an engaging, inclusive, and stimulating environment. In particular, the students found themselves increasing or maintaining the same levels of STEM identity. The only questions where students did score a lower level of self-efficacy after the program was: “deal efficiently with unexpected events”, “solve real problems”, and “handle unforeseen situations”. This could be explained by the Dunning-Kruger effect [35], where overconfident students self-assessed themselves lower after participating in the program. Another potential explanation is that the content presented during the program lowered the overall confidence of students in these areas. The lower score could be a positive for the students with overconfidence as they continue to pursue their studies.

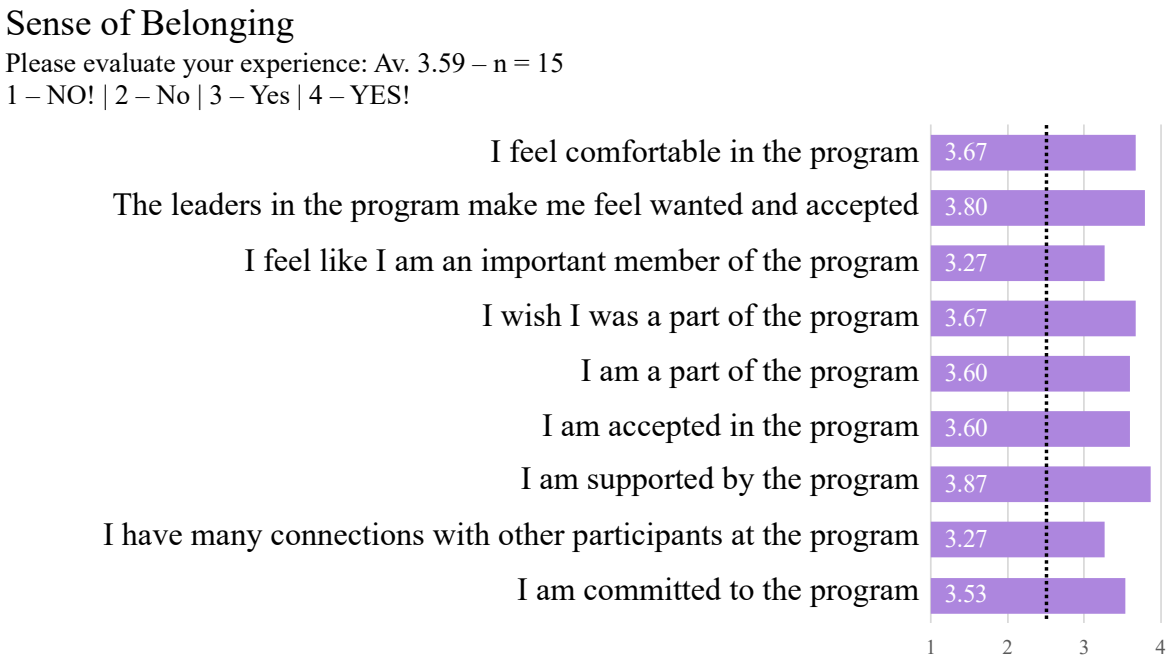

Figure 4. Assessment of sense of belonging felt by participants. (Eval Q3)

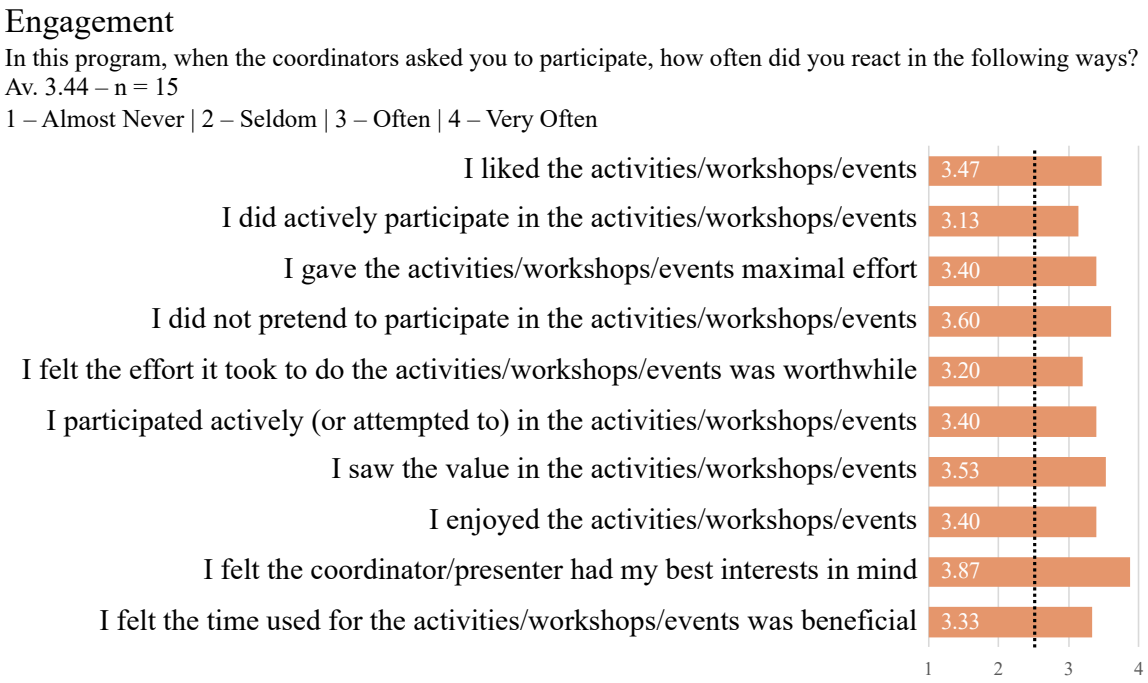

Figure 5. Assessment of student engagement in the program. (Eval Q3)

Evaluation Question 4 Analysis –
Did the students feel that they gained from the program and what were their attitudes and behaviors?

The evaluator modified the URSSA survey to answer the last assessment question as shown in Figures 7 and 8. In particular, the evaluator was interested in evaluating the perceived students' sense of personal gains and attitudes and behaviors. The survey comprised several questions on a 4 and 5-point Likert scale. The evaluator administered this survey in August 2021 and 2022 after the students participated in the summer program.

The evaluator assessed that the students found positive gains from attending the summer program based on the survey results. In every question, the students reported a positive and above neutral response. The evaluator found that the students reported at least "Moderate Gains" for each question through visual inspection. Based on these results program supported the students' attitudes and behaviors. In every question, the students reported a positive and/or above-neutral response.

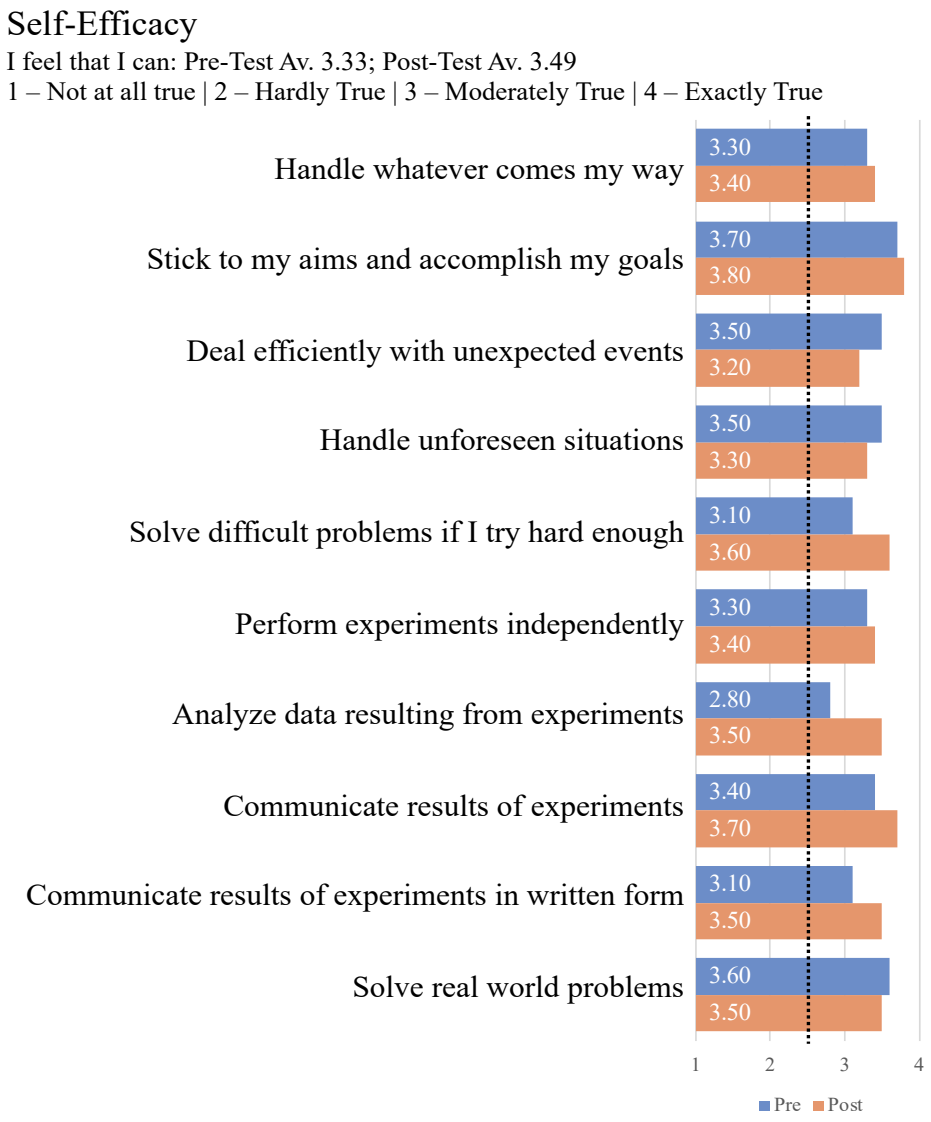

Figure 6. Assessment of self-efficacy felt by participants. (Eval Q3)

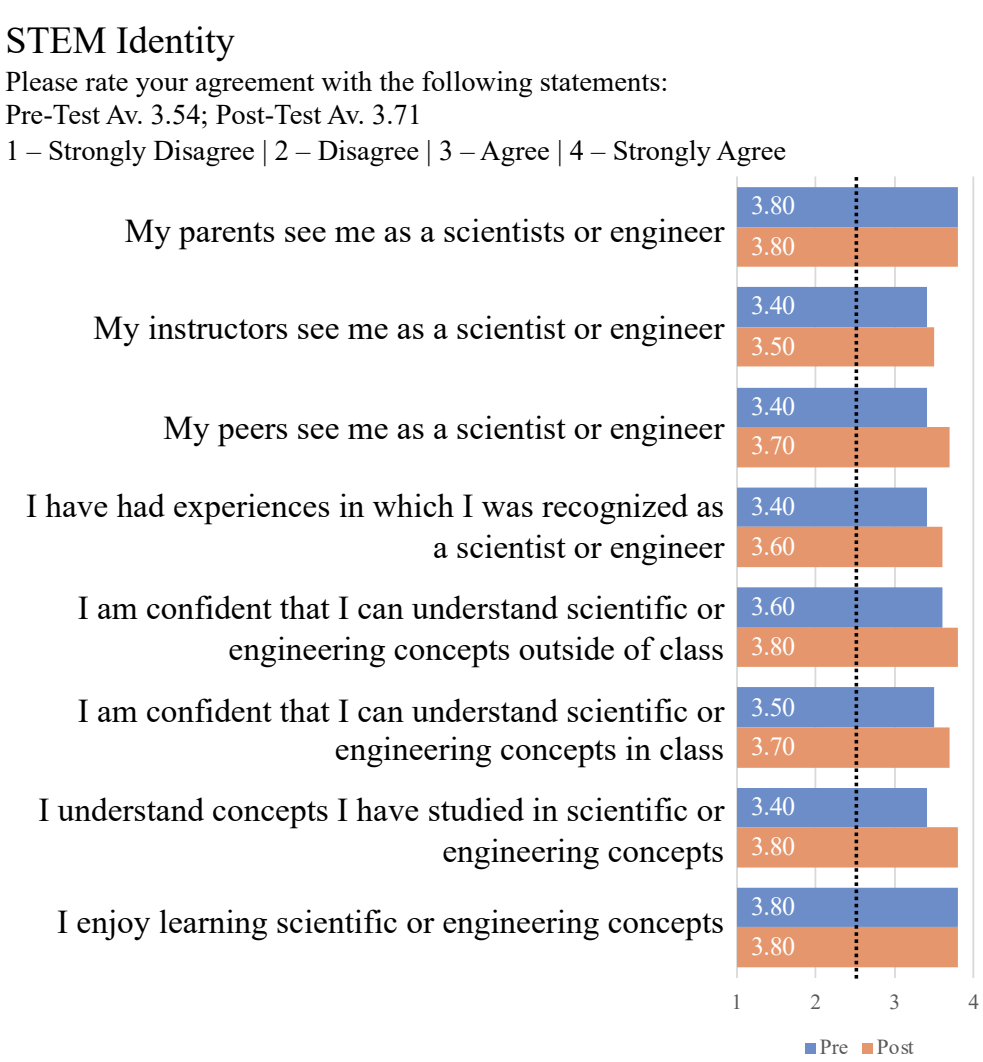

Figure 7. STEM Identity data for participants across both 2021 and 2022. (Eval Q4)

Figure 8. Assessment of gains felt by participants. (Eval Q4)

Qualitative Results:

In addition to quantitative data, qualitative data was also obtained through exit interviews conducted on the final day of the program and about two months after completion. This delay was to ensure that students could give feedback on the usefulness of the program contents once they had some experience in their various graduate programs. A selection of the qualitative results is presented in Table 5 along with an assessment of whether this was a positive or negative piece of feedback, when this feedback was received (August or November), and which of the four program goals is most reflected in the excerpt.

Table 5. Student Survey Excerpts of Free Responses

Student Excerpt	Positive/ Negative	Month	Related Goal
"I felt that the tax office was a really good resource as well. [There] were just little things that I feel would have gotten lost in the shuffle of orientation."	Positive	August	Resource Recognition
"The most important [part was] just getting familiar with all of the polic[ies] and all of the services that are being offered."	Positive	November	Resource Recognition
"Some of the challenges are sort of taking in all this information. Like, what should we do with this? Should I keep it sorted or should I keep it in a notebook?"	Negative	August	Resource Recognition
"I personally think that the professional development was the most valuable [feature], such as the personal finance [workshop]."	Positive	August	Resource Recognition / Personal Preparation
"Being new to all of this [and] the campus, we don't really know where mental health services are and stuff like that. [The coordinator] provided us with insights on where these programs are located and what they have to offer."	Positive	August	Resource Recognition / Personal Preparation
"It gave me a leg up [compared to] other students that will be coming in the fall, so I feel like I am already settled in."	Positive	August	Personal Preparation
"It was much better for me to come early because I feel like I struggled when it came to adjusting to Central Pennsylvania, just because it is so different from where I'm from. Where I was born is 60-70% Hispanic and then coming here, it's very different."	Positive	August	Personal Preparation
"I really liked the CV and resume workshops, as we all need it to find work. Telling us to update [our] CVs often [was] helpful."	Positive	August	Career Preparation
"It was hard sometimes to have workshops on career[s] as we are just beginning, and most things are 5 to 6 years down the line."	Negative	August	Career Preparation

"Maybe [there could be] a workshop about TA (teaching assistant) strategies or effective teaching strategies."	Negative	November	Career Preparation
"I would say that the thing that impacted me the most … [was] the networking. … I was able to reach out to [people in the department] and they [made] me feel very welcomed."	Positive	August	Network Building
"The best part was the community building aspect of the program. Getting to know a few people before the chaos of orientation was very helpful."	Positive	August	Network Building
"We get paired with a research mentor [and] a research advisor, and from that perspective, it has been very welcoming."	Positive	August	Network Building
"We got to network with the people, the program, [and] the cohort of this program, which is outside of all our departments."	Positive	August	Network Building
"I think that meeting a lot of people—a lot of graduate students in different departments—was a huge help."	Positive	November	Network Building
"They didn't have any engineers on their grad panel this year, and they should have a variety of departments there."	Negative	August	Network Building

One common theme in exit interview responses was a positive response to the program's financial incentives. The inclusion of financial support is an essential component of a graduate bridge program. Many students may not have attended GREaT GradS without a financial incentive given the prohibitive costs of moving away from home and renting near a college campus. A subset of excerpts from exit interview responses related to financial assistance are recorded in Table 6. No negative responses were given regarding the timing or amount of financial assistance provided.

Table 6. Student Survey Excerpts Regarding Financial Incentives

Student Excerpt	Positive/ Negative
"The greatest feature was I guess the money. A lot of us are traveling [to get here]. [The financial assistance helped us] settle here and be financially stable for the first month or two."	Positive
"[One of] the strongest features was the ability to come early and kind of help us settle in by providing us with a check."	Positive
"The financial incentive was one of the biggest factors of why I joined the program just because I moved from [far away], so it was extremely costly and being able to be paid upfront really did help some of the moving costs."	Positive
"The financial incentive definitely did help choosing between coming early to campus of just waiting [until] orientation."	Positive

Discussion:

Since the sample size is small, this early data should not be taken as definitive evidence for particularly small effects. It can provide insight into areas of interest for future programming of this type. Students uniformly had overall positive views of the program and the preparation it provided. Nearly every question posed in the post-survey yielded results that were above the neutral point of the scale used. The only area that did not score above neutral was interacting with scientists from outside of this university, which was not a key focus of the GREaT GradS program. Students reported particularly elevated levels of satisfaction with their mentor relationships, sense of belonging in the program, and support from the program. In terms of self-efficacy, students showed the largest improvement in areas related to their science communication and problem-solving skills, both of which contribute to multiple of the four core goals of the program: Resource Recognition, Personal Preparation, Career Preparation, and Network Building.

While the four goals are not explicitly covered in the quantitative data, their assessment can be derived from a mixture of different components from these quantitative and qualitative responses. Resource Recognition may be quantitatively most reflected in the engagement questions posed to students, who generally felt that the coordinator of the program had their best interests in mind and saw value in the activities conducted. Resources provided to students included both services and individuals throughout the university community. Students particularly highlighted the inclusion of information on mental health services and financial services.

Personal Preparation was primarily addressed in the qualitative responses. Notably, students felt that they were more prepared for entering graduate school compared to their peers who were not on campus until orientation began at the end of the summer. Students highlighted the importance of the financial assistance that was provided. In many graduate programs, a student's first paycheck is not distributed until the end of their first month of employment. Thus, they are dependent on savings or external assistance to afford moving to graduate school, paying their first month of rent, purchasing essential groceries, and other financially draining necessities. Students additionally noted that moving to the area early allowed them to become settled in their new living situation and cultural environment without the stress of orientation and the start of classes.

Career Preparation is notably an area that, while appreciated by multiple students, leaves room for improvement. This is especially true given the range of fields represented by the students. Students were most receptive to activities that were applicable to everyone, namely a workshop on CVs and resumes. Additional programming was unable to fully capture the range of fields or left students wondering what to do with the information they gained given that they are not currently near graduation. Future installments of a graduate bridge program of this type can reduce the number of activities that are most attractive to individual majors or can consider having a split-section event on careers.

Networking Building was arguably the strongest portion of the program. Students repeatedly commented in the qualitative results about the impact that current graduate students

had on their experience in GREaT GradS. Participants also noted the importance of meeting students outside of their own department. This was strongly encouraged since it allows for interactions with additional peers outside of their departmental cohort who understand the idiosyncratic struggles of graduate school. Quantitatively, this is evident across multiple areas, including elevated levels of feeling wanted and accepted and maintenance or improvement of their STEM identity. Research mentors and working relationships with group members were also rated very highly by participants.

Future iterations of this program are easy to scale up considering that housing and suggested programming are both not problematic for coordinators who have more students. The only limiting factor is funding for this program given that the financial incentive is crucial to the success of the students involved. Scale up will be essential to increasing the number of participants and allowing for better statistical analysis of the program's effects. The rate at which students accepted the invitation to join the program is also a metric that should be noted. Students received this offer after accepting their graduate program offers, so GREaT GradS was not a motivating factor for students considering whether they should attend Penn State for graduate school. As such, nearly every invited student accepted their invitation to the GREaT GradS program. Anecdotally, the only student that has rejected an offer in the last two years was due to a family emergency rather than a lack of interest in the program. Future iterations of this program could identify and invite students from the potential pool of incoming graduate students as part of their admission offer for the graduate program of their choosing. Thus, it can potentially be used as a recruiting tool.

Conclusions:

The GREaT GradS program, while in its infancy, shows potential as a new way to consider the onboarding and orientation process for graduate students, especially for those who are members of marginalized communities. The program provided concrete support in financial incentives, research opportunities, and personal and professional development activities. Students ranked the program as above neutral in nearly every category studied, including engagement, sense of belonging, and research experience. Qualitative data was overall positive as well while also yielding constructive suggestions for future iterations of the program. Though both quantitative and qualitative data suggest that the program is thus far a success, one should still note that this is a pilot program with a small sample size. Nonetheless, we find it essential to report the preliminary findings and suggestions for improvement so that other universities can follow a similar path. This program was founded after the COVID-19 pandemic when a need became evident, but we foresee programs of this type continuing to positively affect graduate student retention and support moving forward.

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