Institutional Practices to Close the Equity Gap

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Institutional Practices to Close the Equity Gap

Abstract

The S-STEM supported program "Achieving Change in our Communities for Equity and Student Success" (ACCESS) in STEM started at the University of Washington Tacoma in 2018 and has supported 108 students over 6 cohorts. University of Washington Tacoma has been designated an Asian American and Native American Pacific Islander-serving institution (AANAPISI) due to our high proportion of racial minority and first generation college students. The program is multidisciplinary across STEM majors including Mathematics, Environmental Science, Biomedical Sciences, Information Technology, Computer Science and Systems, Computer Engineering and Systems, Electrical Engineering, Mechanical Engineering, and Civil Engineering, with Computer Science, IT and Engineering representing 65% of ACCESS scholars to date. Program scholars receive full scholarships for their first two years, and partial scholarships for their third and fourth years. We provide a summer bridge precalculus or research experience course, and project-based Introduction to Engineering or Introduction to Research courses in students' first year. Individual faculty mentoring, an on-campus STEM living learning community,and quarterly Success in STEM seminar courses help scholars form a cohesive community through group mentoring, to promote a sense of belonging, identity, and empowerment in the STEM community. Our S-STEM program is distinctive in focusing on pre-STEM majors in their first and second years on campus to facilitate the entry into STEM majors, and we provide mentor training for ~30-40 faculty in teaching and mentoring diverse student populations, thus impacting all students in our majors.

Our goal was to evaluate how retention and academic success of our program scholars was impacted by the program, and whether this program helps to close equity gaps for students who identify as low socioeconomic status, underrepresented minorities, women or non-binary, or first generation in college. We also evaluated the impact of the program for students before, during, and after the Covid-19 pandemic. We compared our program scholars to a comparison group of students who met eligibility requirements but did not participate in the program. Overall, program scholars had higher first year retention, and higher GPAs, particularly for individuals belonging to groups that are historically underrepresented in STEM. Retention was markedly higher for program scholars during the pandemic, suggesting that the program may have been particularly impactful for students as they endured the emotional and financial stresses of the pandemic.

Introduction

The National Science Foundation (NSF) scholarship program for students in Science, Technology, Engineering and Mathematics (S-STEM) has been operating for many years. The goal of the program is to support low-income students in pathways to STEM degrees. Beyond scholarships, the program supports activities that focus on retention and recruitment of STEM students [1].

This NSF program has been important for students with lower socioeconomic backgrounds (SES) due to persistent equity gaps [2]. SES students may be reluctant to pursue STEM degrees for many reasons, including social capital [3]. Students encounter systemic barriers inside institutions, including a deficient mindset from some STEM instructors [4], [5]. Prior studies have explored the benefits of an asset-based mindset for supporting all STEM students [6].

Students with intersectional identities (women, LGBTQ+, racial minorities) may experience additional challenges. Prior studies have shown that these students are much less likely to graduate with STEM degrees than students from dominant groups [7]. The equity gap for underrepresented students in STEM fields had been established clearly in the literature [8], [9].

The S-STEM supported program "Achieving Change in our Communities for Equity and Student Success" (ACCESS) in STEM has supported 108 students over 6 cohorts since it was launched at the University of Washington Tacoma in 2018. The program has been designed to support students in the local region with scholarships, dedicated courses, peer mentoring and faculty mentoring. Past assessment of the program has indicated that students have higher retention rates (8-10% higher) than the comparison group and higher GPAs [10], [11].

In this paper, we explore how the program has tackled the equity gap institutionally for SES students in the ACCESS program.

Research Questions

- Does the program promote retention and academic success of all participants?
- To what extent does the program address equity gaps in retention, GPA, entry to STEM majors, and graduation rates?
- As the program has evolved and program elements have been added, to what extent has the program changed student experiences and outcomes?
- How did the pandemic impact student experiences in the program?

Background

Institutional Context

The University of Washington Tacoma attracts a high proportion of non-traditional and/or minority students and is designated as an Asian American, Native American, Pacific Islander ([AANAPISI])-Serving Institution by the U.S. Department of Education. Our campus is primarily undergraduate (85%), and 50% enter as transfer students, drawing primarily from local community colleges. Over 58% of our undergraduates qualify for need-based financial aid and 35% are Pell grant eligible, 34% are people excluded due to ethnicity or race (PEERs, see Asai [12]: students who identify as Black, Hispanic, Indigenous, or Hawaiian/Pacific Islander, but not exclusively as Asian-American or Caucasian), 17% are military veterans or dependents, 48% are female, and 54% are the first in their family to earn a 4-year degree (First Gen). Our STEM programs have seen rapid growth and expansion, with over half of our 9 STEM majors added within the last 8 years– Mathematics, Biomedical Sciences, Electrical, Mechanical, and Civil Engineering, joining our existing Environmental Science, Computer Science, Computer

Engineering, and IT. As these programs have expanded, so has the need for support for our STEM majors and STEM-interested students.

Program Elements

The key objectives of our NSF S-STEM program are to recruit undergraduate students to STEM majors, support their success, and broaden participation in order to promote equity and inclusion in STEM majors. The program has evolved dramatically since its inception in 2018, expanding to accommodate all University of Washington Tacoma STEM majors except Psychology. The program focuses upon entering cohorts of STEM-interested students in their first two years, often before they declare a major, with supplemental support in years 3 and 4 after they are likely to have been welcomed into a STEM major with the community and mentoring that comes with it.

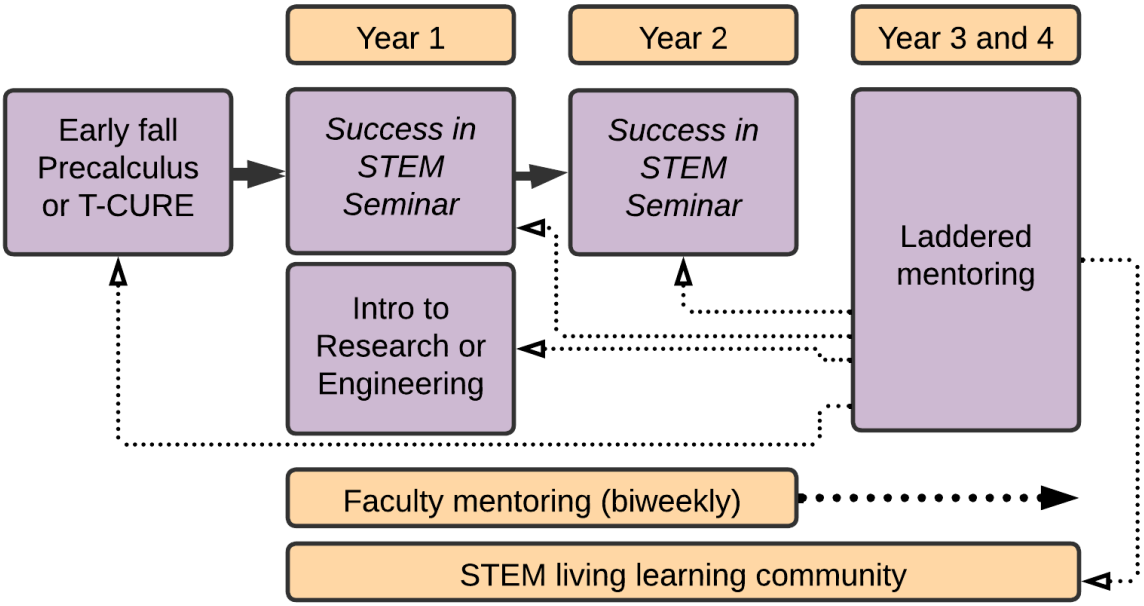

Figure 1. Program Elements

The key elements of our program have been described in previous publications [10], [11] and are summarized in Figure 1. Briefly, the centerpiece of the program is our quarterly *Success in STEM* seminar, which students take every quarter for their first two years at University of Washington Tacoma. Through these weekly sessions, students connect with each other and with their faculty cohort mentor, learning to support each other through challenging times, developing a growth mindset towards their academic journey, understanding barriers that lead to equity gaps in STEM such as stereotype threat and imposter syndrome, and building a sense of belonging and self-efficacy. The seminar allows participants to explore co-curricular opportunities (e.g., student clubs), campus resources such as disability services and financial aid

offices, and career preparation, while helping them to navigate complex university systems. More experienced participants are invited to serve on student or alumni panels as they share their insights into how to find a research experience, internship, or succeed in that first job after graduation, providing near-peer mentoring.

At the inception of the program in 2018, we developed a new Introduction to Research course that was provided as an option at the end of the students' first year. This project-based course allowed students to work in interdisciplinary teams to approach environmental questions relevant to their local communities. As the program developed and grew over the years, we have introduced three additional courses to better meet the diverse needs of our program participants. In Autumn 2022 we developed and offered for the first time an Introduction to Engineering course centered on coffee [13], modeled on the successful coffee-based class pioneered at UC Davis [14] and used at several other universities. Both the Introduction to Research and Introduction to Engineering courses were aimed at first time in college, first year students. As we began to welcome more students who had earned dual enrollment credit during high school (e.g., "Running Start"), it became clear that more advanced options were needed. This led to the development of an Engineering course-based undergraduate research course aimed at entering transfer students or Running Start students with junior standing, and offered in the interim period between summer and fall quarters, aka "early fall," to serve as a bridge to our institution, as described by Dillon et al. (in review). This course was offered for the first time in early fall 2023.

In addition to these courses that introduce students to the joys of project-based learning and/or research in their fields of interest, we added another early fall course in 2022 to provide a bridge to college-level mathematics. While many of our STEM-interested entering students have already taken college level math courses and are quickly able to move into advanced work, nearly half of our program participants are placed into Precalculus or lower-level classes at entry. This can lead to delays in STEM coursework due to the complex sequence of prerequisite courses needed to enter many of our STEM majors, and the tendency of many students to delay taking math classes well into their first or second year due to math anxiety. To give our program participants a head start while also introducing them to campus, we developed an early fall Precalculus I course (offered in a condensed format). By starting early and receiving intensive mentoring and academic support, students are set up for success in entering and finishing STEM degrees in a timely fashion.

To promote a sense of belonging to campus, we have worked with our campus housing to set up a STEM living learning community composed of program participants and other STEM-interested students living in the same wing. Similar programs have been found to be very effective in supporting students' integration into campus life and academic success [15], [16]. As we are a predominantly commuter campus (with only ~7% of undergraduates living on campus), many of our program participants would not have considered living on campus without the support of the S-STEM scholarship and the opportunity to room with fellow STEM-interested students. Our living learning community was interrupted by the pandemic from 2020 to 2022, and then reinstated.

One of the most important elements of the program is the one-on-one mentoring provided by faculty volunteers. By meeting with students over multiple years, our mentors build strong relationships and provide guidance to help with academic, emotional, and career needs, which has been shown to be essential in improving students' undergraduate experience and promoting academic and career success [17]. Annual training workshops and other professional development help faculty develop their mentoring skills and inspire reflection about positionality, power and privilege to better support our diverse students.

Adaptive Modifications of the Program and Lessons Learned

Over the last six years we have expanded the program by adding Information Technology, Computer Engineering, Electrical Engineering, Mechanical Engineering, and Civil Engineering to the original list of eligible degrees–Biomedical Sciences, Environmental Science, Mathematics, and Computer Science. This has helped to provide space for our STEM-interested pre-majors to remain in the program even if they change their minds about the specific STEM major they are seeking. We also expanded eligibility to ALL low-income students (not just Pell grant eligible students) and to transfer students with one year of college credits at entry, not just first-time-in-college students. Scholarship support was increased up to $10,000 per year for the first two years (from an original maximum of $5,500) and extended into students' 3rd and 4th years at up to $2,000/year. These changes in the students we accept and the level of scholarships we provide are coupled with new course choices to better accommodate students' various levels of preparation and interest. Here, we compare student experiences and outcomes from Phase 1 (2018-2022) supported by our NSF Track 1 funding, to the first year of Phase 2 (2022 to 2023) which corresponds to our Track 2 grant received in 2022.

Methods

To address whether the program promotes retention and academic success of all participants, we obtained institutional data including GPA and retention and compared program participants to students who met eligibility requirements (e.g., domestic, first time in college, low SES, STEM-interested). First year retention was measured as the proportion of students who return for the start of their second year or graduated during their first year. Entry into a STEM major by the start of year 2 was also assessed.

To address the question whether the program addresses equity gaps for PEERs, low-income, female, and First Gen students, we compared the demographics of program participants to students who were eligible but not in the program, and examined GPA, retention rates, and entry into STEM majors by these identities.

To address our remaining research questions (i) how student experiences and outcomes have been impacted as the program has evolved and program elements have been added, and (ii) how the pandemic has impacted student experiences, we conducted focus group interviews at the end of year 1 and year 2 for each cohort and coded the responses into themes. All components were approved by the University of Washington Tacoma Institutional Review Board. We use "male/female" to refer to sex at birth, as reflected in academic data provided by the registrar, and

“man”, “woman”, or “non-binary” to describe individual program participants, collected via a survey that asks students to select their gender identity.

Program Outcomes

Demographics

Our program has succeeded in recruiting a diverse cohort of students, with a similar proportion of female students and First Gen students compared to the general eligible population, as summarized in Table 1.

Table 1. Demographics for students in Phase 1 of the program (cohorts starting Autumn 2018 to Autumn 2021) compared to Phase 2 of the program (cohort starting Autumn 2022), and compared to the general eligible population for the same period.

	Phase 1: 2018-2021 cohorts		**Phase 2: 2022 cohort**	
	Program	**Eligible non-program**	**Program**	**Eligible non-program**
Asian	30%	35%	26%	42%
Black or African American	22%	13%	22%	16%
Hispanic or Latino	7%	20%	4%	19%
Native Hawaiian or Other Pacific Islander	2%	1%	0%	1%
Not Indicated	2%	1%	4%	1%
Two or More Races	11%	7%	4%	4%
White	26%	23%	41%	16%
PEERs	40%	39%	27%	40%
1st Generation to College or 4 yr Degree	73%	75%	73%	75%
Female	56%	49%	37%	38%

Overall, the program attracted a higher proportion of Black or African American students and lower proportion of Hispanic or Latino students. Female students constituted over half of participants in Phase 1 but only 37% of participants in Phase 2, although this was similar to the general eligible population after including several Engineering degrees in the eligibility criteria.

While there were similar proportions of Asian and White students in Phase 1 of the program compared to the general eligible population, there was a higher proportion of White students and lower proportion of Asian students in Phase 2 compared to the general population.

Retention/Persistence

First year retention was consistently higher in the program compared to the general eligible population, and there was also a higher retention rate for Phase 2 compared to Phase 1 (Figure 2). In the general population, PEERs had the lowest first year retention rates, providing evidence for an equity gap. In contrast, PEERs in both phases of the program had higher retention rates than those not in the program, and this was sufficient to reverse the equity gap. Female and 1st Gen students in the program also had higher retention rates than in the general population. It is worth noting that there was no consistent equity gap for 1st Gen or female students in the general population.

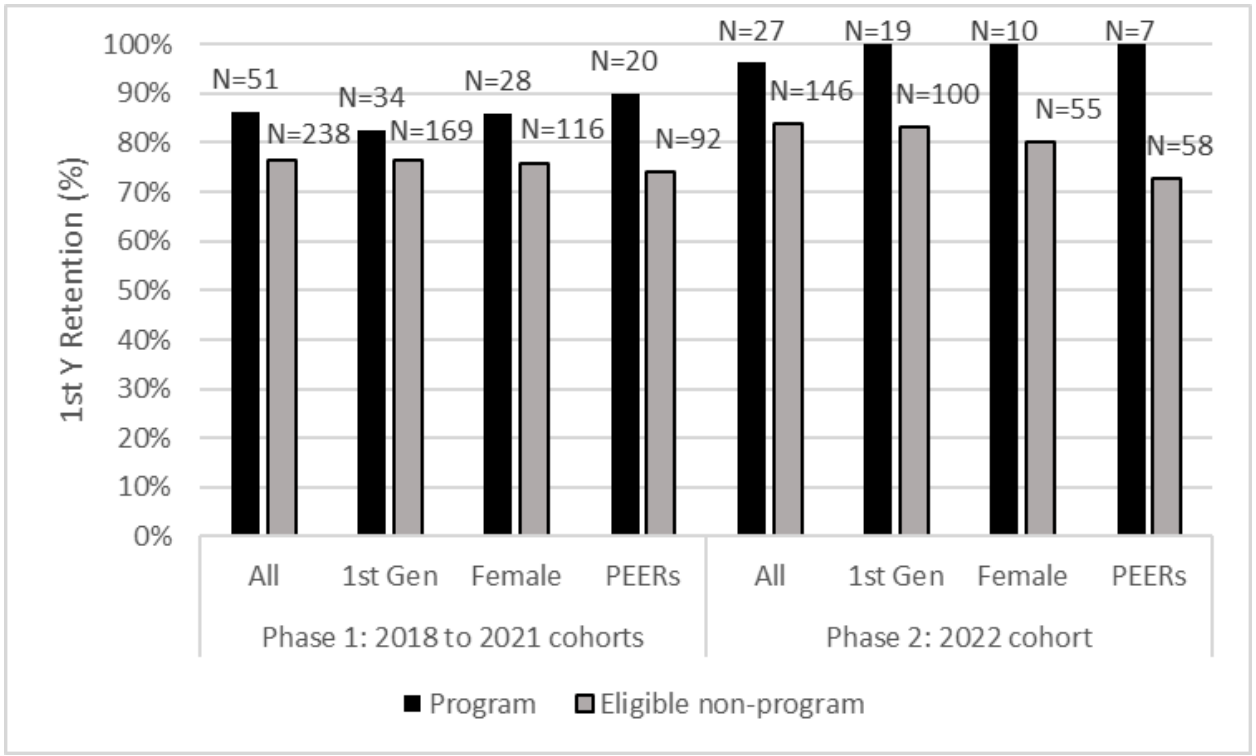

Figure 2. First year retention rate for students in Phase 1 of the program (cohorts starting Autumn 2018 to Autumn 2021) compared to Phase 2 of the program (cohort starting Autumn 2022), and compared to the general eligible population for the same period.

Academic Success

Students in the program had consistently higher cumulative GPAs at the end of their first year when compared to the general eligible population (Figure 3). GPAs were relatively similar across different groups and there was little to no evidence of equity gaps for 1st Gen, female or PEER students. GPAs were slightly higher for program students in Phase 2 compared to Phase 1.

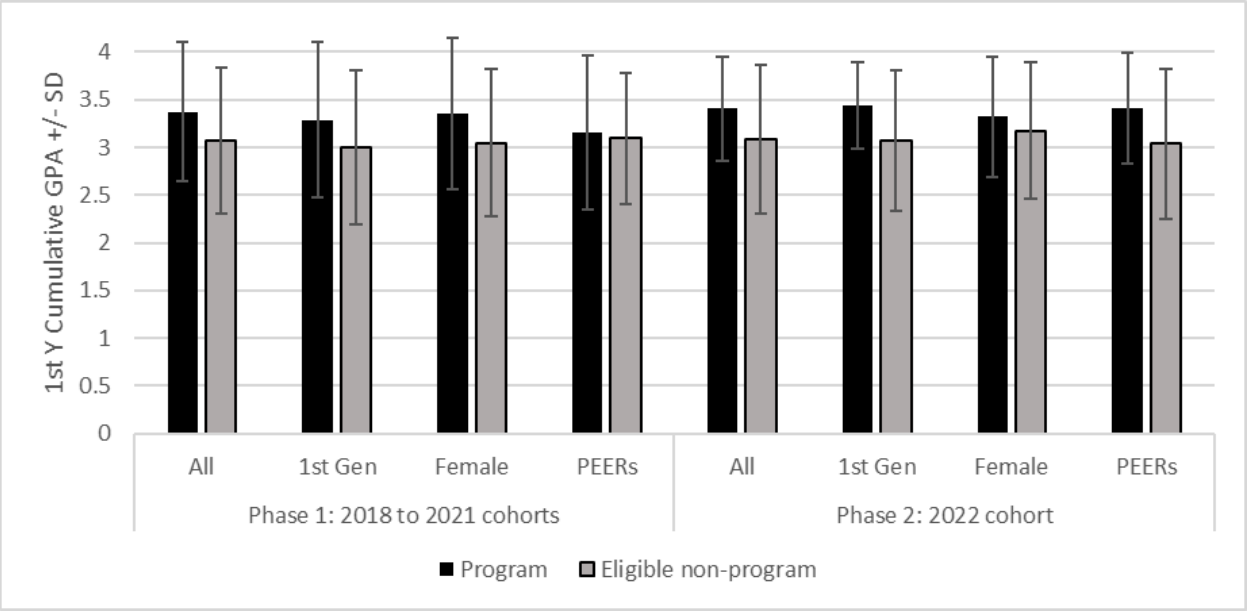

Figure 3. Cumulative GPA at the end of their first year for students in Phase 1 of the program (cohorts starting Autumn 2018 to Autumn 2021) compared to Phase 2 of the program (cohort starting Autumn 2022), and compared to the general eligible population for the same period. Values are means +/- standard deviation.

During phase 1, program students were slightly more likely to have entered a STEM major by the beginning of their second year compared to the general eligible population (Figure 4). There was a striking difference in Phase 2, with nearly 70% of program students entering a STEM major by the start of year two, vs. 20% for the general population. This may reflect both the support of the program itself, as well as an increase in students entering with dual enrollment ("Running Start") credits earned while in high school. There was evidence of a consistent equity gap for PEERs in the general eligible population; while Phase 1 program participants experienced an equity gap similar to the general population, the equity gap was more than reversed for Phase 2 program students.

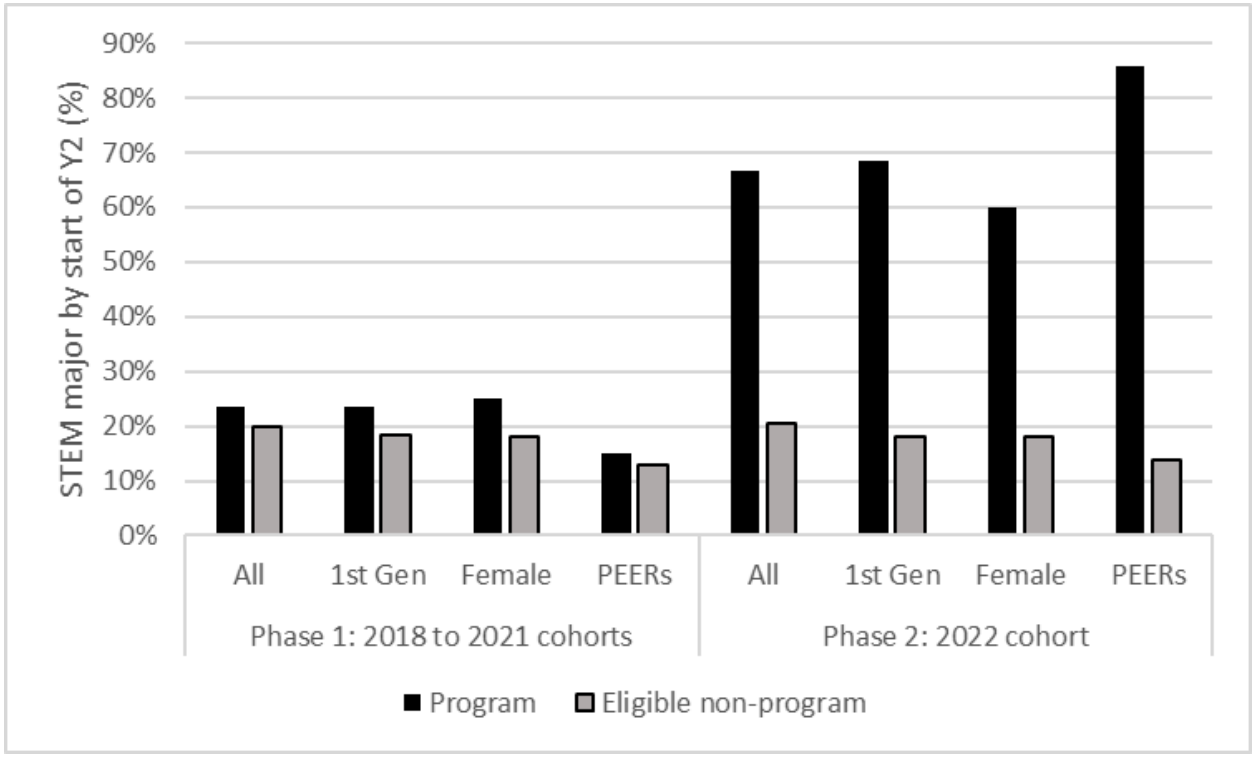

Figure 4. Rates of entry into a STEM major by the start of their second year, for students in Phase 1 of the program (cohorts starting Autumn 2018 to Autumn 2021) compared to Phase 2 of the program (cohort starting Autumn 2022), and compared to the general eligible population for the same period. Values are mean percentages +/- standard deviation.

Student Experiences in Phase 1 and Phase 2

Students in both Phase 1 and Phase 2 reported that their involvement in the program allowed them access to resources and opportunities they wouldn't have otherwise known about. Many students received advising and course advice from their faculty mentors and felt that was important in learning to navigate university systems.

> *When I started talking to my mentor I told her that I wanted to major in Computer Science and she said to take one [of] the coding classes and make sure that it's what I want to do. When I took the course I learned that I didn't really like it and then she asked me questions that helped me shape the ideal career I want. That's how I ended up switching my major to Mechanical Engineering* (Black woman, Cohort 2).

Program participants also reported the benefit of career preparation and guidance:

> *[O]ne of the main things that it does is that it kind of sets up your life after UW Tacoma and after ACCESS in STEM because we'll work on like resumes or work on like other career building like exercises. And so I think it just like getting into the real world, getting more experience, like in the research and like just broadening like your knowledge about everything* (Asian man, Cohort 2).

Other students spoke about becoming involved in research opportunities or internships they found out about from their mentor.

> *[P]ersonally my mentor helped me find some opportunities … I got ahead like with internships* (Hispanic male, Cohort 3).

> *I would say that [the program] actually helped me to like feel more confident and feel like I can take initiative and explore more opportunities. Through [the program] I got like a research opportunity through my faculty mentor* (Asian man, Cohort 2).

In Phase 2, students mentioned the impact of the student and alumni panels, reflecting the program's increased emphasis on laddered mentoring by participants from previous years.

> *I just think I enjoyed the panels a little more - the panels, and then, like, certain things that we did like the resume workshop, felt more useful for, like, hearing what was going on inside of, like, different jobs or stuff, and, like, hearing what's happening and, like, tech in general, and seeing how other people prepared for it, or their different struggles. Them talking about it made me feel less like an outsider, or, like, imposter syndrome. They always talked about it at least once every 2 or 3 of the panels, and it helped me feel like where I was right, and how I was feeling wasn't just myself alone* (Asian man, Cohort 5).

While participants from both Phase 1 and Phase 2 spoke of the importance of the scholarships, students in Phase 2 emphasized how critical the financial support was for their ability to persist in college, an effect that may have been exacerbated by the financial stresses of the pandemic:

> *My car had broken down. It was totaled. And I get financial aid disbursements because of this scholarship among others, but this is the biggest one. And without that disbursement I was—I was literally waiting on it for the winter quarter to start. So I got—I was like carless for like a month. Which, it's kind of—it's a first world problem, but it was a major deal. Like I had to get groceries to live in the dorm. I have to go to work. I lost my job—like I was a delivery driver for Pizza Hut. Like I lost my job. And I got it, I looked at this disbursement, and I was able to get a used car and like, get my job back* (White man, Cohort 5).

As mentioned above, one major difference between the Phase 1 and 2 programs was the addition of the opportunity for students to take the early fall precalculus course. Since the fall of 2022, 12 program scholars have participated in the Precalculus program, 4 in fall 2022 and 8 in fall 2023. Of these, one student did not pass the early fall Precalculus I class but repeated for a passing grade. For the remaining 11 students who passed Precalculus I in early fall, all took Precalculus II in fall, and of these, four did not receive the required 2.0 to advance, while the remaining students received >2.0 and were able to advance to calculus courses. At 36%, this is slightly higher than the typical ~20% rate of grades below 2.0 for Precalculus 2. We will continue to adjust the early fall course to ensure that students are prepared for Precalculus 2 when they complete it.

Open-ended responses on a post-term survey of Cohort 5 students indicate that participants had a positive experience. While some students indicated that the four-week class felt very fast, overall they recognized the financial and academic benefits of that participation:

> *It really helped me because I wasn't confident that I could go straight into Precalculus. …And if I didn't do that class I would have had to pay for college algebra which cost like $700 more. And because of the Precalculus class, I just went straight into what I should be doing* (Caucasian man, Cohort 5).

Student Experiences During Remote Instruction

During Phase 1, students in Cohort 2 transitioned to online instruction due to the pandemic during spring quarter of their first year. Students in Cohort 3 began the program with remote instruction and did not attend classes in person until their second year. While all cohorts of students were impacted by the pandemic, in these two cohorts it was felt most acutely.

Student focus group responses indicate that aspects of the program insulated students from the worst effects of the pandemic. Several students expressed difficulty with the isolation of the pandemic, but identified the program as an important point of connection to their peers and to campus. One student said that the weekly team mentoring meetings were one of the only times they felt like they were in college during a normal year:

> *[F]or me, the weekly meetings with everyone … gives me like at least part of the social feelings that I think would be a part of college and like just interacting with other students. Because it's again, it's not like interacting with class based material like in discussions during zoom, it's more of like, 'Well, I like this thing or I like this thing or I'm annoyed with this Professor' or like in that sort of stuff so like it gives some of that social aspect of college back to some extent* (Asian woman, Cohort 3).

Another student noted that the program was particularly helpful in transitioning to college under remote instruction:

> *Honestly it's really helped with the pandemic and not being able to be on campus. It gives me a space to connect with students and faculty so I don't feel as left behind in the introduction portion of transitioning to college* (Asian & White woman, Cohort 3).

Another student found that upon returning to campus after the end of online instruction, they knew people on campus due to their involvement in the program:

Definitely feels like a community. Like last year, when we were …doing our weekly meetings, even though we weren't on campus we still knew that there are people there. And next year coming back to campus when we didn't have anybody, but you know each other, we kind of knew that we had somebody we could reach out to, or at least know they're in a similar position (Asian woman, Cohort 3).

Conclusions

Does the program promote retention and academic success of all participants?

Both student responses and academic data support the impact the program has had for student retention and academic success. First year retention rates and cumulative GPAs were consistently higher for program participants in both Phase 1 and Phase 2. Retention rates were particularly high for program participants in Phase 2. These rates resembled those from the University of Maryland Baltimore County Mechanical Engineering S-STEM Scholarship Program [18], which is similar to our program in its emphasis on faculty and peer mentoring, and providing research experiences to participants in the program.

To what extent does the program address equity gaps with respect to retention, GPA, and entry to STEM majors?

Our campus has worked hard to address equity gaps in retention and academic performance, promoting inclusive teaching practices and support for our diverse students, and it is promising that we do not see strong evidence of equity gaps for female and 1st Gen students when compared to the general population, but lower retention rates and GPAs for PEERs provide evidence to suggest that equity gaps persist. Where equity gaps were present (e.g., 1st year retention and entry into STEM majors for PEERs), the program was highly successful at reversing those gaps, especially in Phase 2.

As the program has evolved and program elements have been added, to what extent has the program changed student experiences and outcomes?

Students have consistently attested to the importance of faculty mentoring and peer mentoring and support provided by the program. As the program has evolved, students have cited the impact of the early fall Precalculus program.

How did the pandemic impact student experiences in the program?

Under remote instruction, students spoke of a sense of alienation from campus and that their main sense of connection came through the program. They also emphasized the importance of the scholarship in addressing financial barriers.

In future work, we will continue to explore student experiences through a mixed-methods approach, utilizing institutional data and data from longitudinal surveys and qualitative results from focus group interviews. We are assessing scholars' academic motivation, STEM identity,

self-efficacy, and interest, awareness of bias and barriers to STEM access, health and well-being. We are also interested in how trainings and professional development opportunities associated with the ACCESS program impact faculty awareness of inclusive teaching and mentoring practices, and how this may contribute to our campus' efforts to promote equity and inclusive environments for our students.

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