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Board 207: ACCESS in STEM: An S-STEM Project Supporting Economically Disadvantaged STEM-Interested Students in Their First Two Years

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ACCESS in STEM: An S-STEM Project at University of Washington Tacoma Supporting Economically Disadvantaged STEM-Interested Students in their First Two Years

Abstract

Achieving Change in our Communities for Equity and Student Success (ACCESS) in STEM at the University of Washington Tacoma started as a Track 1 S-STEM program in 2018 and has supported 69 students to date. This year we received Track 2 funding and welcomed our fifth cohort to campus, with funding to support ~32 additional students through 2026. University of Washington Tacoma is an Asian American and Native American Pacific Islander-serving institution (AANAPISI), and we serve a high proportion of racial minority and first generation college students. Our ACCESS scholars are pursuing bachelor's degrees in 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 and Engineering representing over 60% of ACCESS scholars to date. First-time college students and first-year transfer students receive full scholarships for their first two years, and partial scholarships for their third and fourth years. The project includes an optional Early Fall Math course to enhance entry into STEM majors, and participants are able to engage in a Research Experience or project-based Introduction to Engineering course in their first year. Coupled with individual faculty mentoring and an on-campus STEM living learning community, the quarterly Success in STEM seminar course helps scholars form a cohesive community through group mentoring, as well as develop a sense of belonging, identity, and empowerment to transform the culture of STEM. This program is distinguished by its focus on pre-STEM majors in their first and second years on campus, and includes 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 the effectiveness of a program that focuses on the first two years of college and provides financial support, courses to introduce students to research and project-based engineering, and intensive mentoring in increasing retention and academic success for Computer Science and Engineering (CS+E) students, and whether this program helps to close equity gaps for CS+E students who are low socioeconomic status (SES), underrepresented minorities (URMs), female, and/or first generation in college (First Gen) students. We compared our student scholars to a comparison group of students who met eligibility requirements but did not participate in the program. Program scholars had higher first and second year retention, and had significantly higher GPAs. The pandemic resulted in significant social, emotional, and economic stresses for our program scholars, which may have heightened the impact of the ACCESS in STEM program.

Introduction

For economically disadvantaged students, a computer science or engineering (CS+E) degree can be a ticket out of poverty. Nevertheless, equity gaps for students from lower socioeconomic backgrounds (SES) have received less attention than other groups that are underrepresented in STEM [1], [2], making it difficult to draw conclusions about the impact SES status has on CS+E students. Low SES students may be less likely to pursue an engineering degree, due in part to differences in social capital [3]. This contributes to an equity gap that is further accentuated as there is at least some evidence that disproportionately fewer of these students achieve an undergraduate degree compared to higher income peers [4].

At the University of Washington Tacoma (UWT), we serve a large proportion of students with lower socioeconomic status (SES, defined based on Pell Grant eligibility); 42% of our domestic, first-time college students who express interest in majoring in Computer Science or Engineering majors are low SES. Based on institutional data, these students are slightly less likely to request computer science and engineering (CS+E) majors at entry, compared to their higher SES peers, and only 16% of our low SES students graduate with a CS+E degree instead of a non-CS+E degree, compared to 19% of high SES students (Table 1). Our low SES CS+E students are less likely to graduate in four years but are equally likely to graduate in six years compared to their high SES peers, and first and second year retention rates are similar (Table 1). This highlights the importance of encouraging all students, but particularly our low SES students, to consider CS+E majors, and address the structural and psychological barriers that may cause these students to switch to non-CS+E majors before graduation.

Table 1. Retention and graduation rates for low vs. high SES, CS+E-interested students, and CS+E interest at entry and proportion of degrees. Data for UWT domestic, first-time college students from 2010 to present. Low SES is defined as Pell eligible.

	low SES	high SES
Request CS+E major at entry	19%	22%
Graduate with CS+E degree	16%	19%
First Year Retention	80%	78%
Second Year Retention	70%	71%
Graduated from UWT in four years	42%	48%
Graduated from UWT in six years	60%	61%

Barriers to achieving a CS+E degree may be particularly acute for students who hold more than one marginalized identity, for example for students who are low SES and are also female, LGBT, disabled, or racial or ethnic minorities (URMs)). Eagan et al. [5] found that while URM students are nearly as likely as their non-URM peers to request a STEM major at entry (35% vs. 37%, nationally, data from 2012), they are much less likely to graduate with a STEM degree; six year graduation rates were 43% for White and 52% for Asian students vs. 29% for Latino, 25% for Native American, and only 22% for Black students. One reason for these low rates is that URM students are more likely than their White peers to switch to non-STEM majors [6]. While they are also less likely to persist to a degree, this is true across both STEM and non-STEM majors [3].

While higher education institutions have tended to attribute achievement gaps for low SES or other minoritized students to lack of preparation (a deficit mindset) [7], [8], a mounting body of research demonstrates that many of the barriers to retention and graduation are systemic and intrinsic to the structure and culture of STEM higher education [6]. To address these barriers, institutions need to take a holistic approach and recognize the strengths that economically disadvantaged students bring–an asset-based mindset [9].

With these principles in mind, at UWT we have implemented a program that takes a holistic approach to supporting and honoring the potential that CS+E-interested entering undergraduate students bring to our campus and to the profession. The Achieving Change in our Communities for Equity and Student Success (ACCESS) in STEM program was developed at UWT to address equity gaps for low SES and underrepresented students, particularly in STEM majors. Despite rapid recent growth in our STEM programs, STEM degrees are requested by 31% of entering undergraduates, but only 26% of students graduate in a STEM major, with greater disparities for women; 22% of women request STEM but only 15% graduate with STEM degrees. The ACCESS in STEM program is intended to address these disparities.

In this paper, we explain the theoretical framework that guided our development of the program, describe the key program elements, and present work-in-progress outcomes from the first five years of the program, with a particular focus on our computer science and engineering-interested pre-majors and majors.

Research questions:

1. How effective is a program implemented in the first two years of college that provides financial support, early CUREs and hands-on design courses, and intensive mentoring, in increasing retention and academic success for CS+E students?

2. Does this program help to close equity gaps for CS+E students who are low SES, URMs, female, and/or First Gen students?

Background

To improve student retention, we must understand the typical student experience, exemplified by the "Persistence Framework" of Graham et al. [10]. This model emphasizes the importance of early research, active learning, and learning communities to help students first identify as scientists, thereby building confidence, increasing motivation, and enhancing learning to foster a positive feedback loop (Figure 1). For example, early research experiences, coupled with strong mentoring that builds a cohesive learning community (e.g. [11]), may provide an especially productive entry to college level coursework that helps students build confidence and motivation that translates into success in learning, perpetuating a positive reinforcement cycle. In contrast, an abrupt entry to collegiate coursework without adequate preparation can undermine the confidence required to succeed [2].

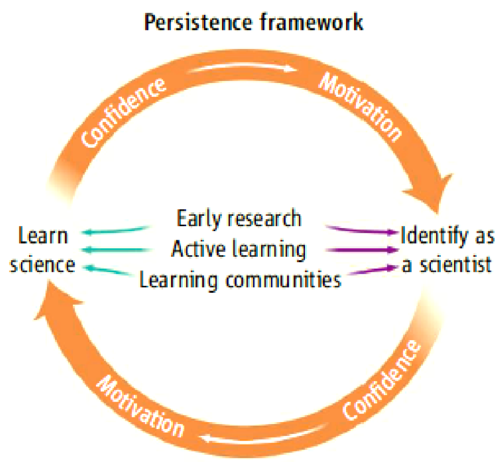

Figure 1. Persistence framework from Graham et al. [10] modeling the key factors that interact to predict persistence in STEM.

Lower SES students, who often identify as URMs and/or first generation (First Gen) in college students, face added challenges in STEM due to the explicit or implicit biases from faculty and peers, ranging from micro-aggressions that undermine identity to blatant discrimination. Discrimination may often seemingly appear as positive treatment. For example, faculty and peers favor those similar to themselves (a "nice" behavior for those who are favored), filtering representative social identities into STEM and underrepresented identities out of STEM and into other majors. This means majority students more commonly receive opportunities that, over time, undermine the participation of URM students in STEM and disrupt identity recognition as scientists or mathematicians [12]. Ultimately, these wider problems can only be solved by changing the overall culture of the STEM community. At the same time, URM students are negatively affected by stereotype threat and identity threat [13], which reduces their confidence, undermines their identity as scientists or mathematicians, and therefore reduces their learning of science or math. By helping students identify these barriers, we enable interventions that remove these barriers to their performance in STEM, thus breaking the negative feedback loop. A greater awareness of issues surrounding equity and inclusion in STEM could therefore have a substantial impact on student persistence and success in STEM.

Interventions for Stereotype and Identity Threat

Negative stereotype stress directly reduces student performance on high stakes tasks such as exams, an effect that has been named "stereotype threat" [14], [15]. College level performance of women and minorities in STEM fields is often strongly impacted [16]. Among several identified antecedents, the effect often occurs when students feel pressure to perform well in order to avoid reinforcing negative stereotypes about their group [14]. Identity threat is a closely related issue, referring to reduced performance as a result of a subconsciously perceived threat to an individual's sense of social identity [17], [18]. Both of these factors must be addressed to improve student retention.

Stereotype and identity threat can be reduced by psychological interventions such as an incidental explanation that women and men perform equally well on a particular test [16], and self-affirmation [19]. Values affirmations have reduced achievement gaps for women in college physics [20] and first-time college (FTIC) students in introductory biology [21]. Awareness of stereotype threat has reversed the achievement gap for women in math [22], as did exposing URM students to the theory that intelligence is malleable rather than fixed or innate [23], [24]. Most striking is that these interventions have long-lasting effects. Cohen et al. [19], working with 7th grade African-American students, found that a single 15-minute self-affirmation writing exercise reversed the achievement gap by 40%, and these benefits persisted over a span of at least two years, with the strongest effect on low-performing students. Overall, the lowered performance on high-stakes exams can set up a recursive negative feedback loop [19], leading to reduced confidence, motivation, and learning (see conceptual model, Fig 1). Enhanced awareness of stereotype threats, the malleability of intelligence, and self-affirmations should have a powerful impact in breaking this negative cycle when implemented systematically and as early as possible in a student's STEM education.

Course Based Undergraduate Research Experiences (CUREs)

Participation in undergraduate research promotes confidence, motivation, and ultimately, persistence in STEM. Undergraduate research is a "high-impact practice" [25] with positive effects on both student persistence and learning. Large studies show that students with research experiences have a stronger intention to pursue a STEM career than students who do not participate [26], [27]. Meta-analyses with large student populations also support the conclusion that student research increases persistence in STEM fields, particularly among URM students [28]–[30], and increases students' sense of self-efficacy [30]–[33], science identity [34], academic skills [32], and views of the nature of science [33], with distinct benefits for underrepresented populations [31], [35], [36].

These benefits are more substantial for research projects that last multiple years [37], which is facilitated when students can engage in ***early*** research experiences. CUREs are common vehicles for introducing early stage students to research [37]. Because they are often highly structured – incorporating journal clubs, lectures, and group work – CUREs provide more support for students who have less experience and improved opportunities to develop conceptual skills [37], with benefits similar to apprenticeship-based research programs [38], [39]. This is despite the fact that many apprentice-model undergraduate research programs are highly selective based on GPA or other criteria – introducing a potential selection effect – while CUREs are more likely to admit all interested students [40]. CUREs can also enhance engagement in STEM fields early in the educational experience, recruiting students who might otherwise avoid STEM majors (e.g. Hurtado et al. [41]).

The connections between undergraduate research, motivation, and science identity may relate research participation to persistence [35], [38]. Self-efficacy, an aspect of motivation defined as the expectation that one will succeed at a task, is a predictor of student success [42]. Self-identification as a scientist may also mediate the effect of self-efficacy on persistence [35]. In addition,research participation increases student's comfort with new ideas [32], [43]. For example, students may come to view setbacks in completing a task as challenges to overcome [44]. Science identity is positively related to persistence in STEM [45]. Undergraduate research improves students' sense of self-efficacy as they master new techniques, overcome difficulties in the laboratory, interact with others who overcome similar difficulties, and develop a support network [31], [44]. As students interact academically and socially with faculty and peers in research projects, they develop an identity as scientists [35], [46], a critical step that improves retention [10].

Effectiveness of Mentoring

For URMs and First Gen students, mentoring provides pivotal emotional and academic support, engages the university and local community, and acts as a core support system as these diverse student-scholars acclimate to novel cultures, traditions and values [47]–[50]. Importantly, undergraduates who participate in faculty-student mentoring achieve higher grade point averages, retention rates, and graduation rates versus their un-mentored peers [51]. Moreover, these benefits are particularly salient for URMs, increasing the graduation rates of these students to over 90%, a tremendous lift over the national average of 59% for all degree seeking students at 4-year institutions [52]–[54].

Institutional Context

University of Washington Tacoma (UWT) is a public, urban-serving, primarily (86%) undergraduate campus (5,380 students). As an access-focused institution with over 66% entering as transfer students, UWT serves a large community of non-traditional and/or minority students. Across all undergraduates, 62% are low-income based on our campus definition and 45% are Pell grant eligible, 33% are underrepresented minorities (URMs: students who identify as Black, Hispanic, Indigenous, or Hawaiian/Pacific Islander, but not exclusively as Asian-American or Caucasian), 18% are military veterans or dependents, 53% are female, and 55% are the first in their family to earn a 4-year degree (First Gen). Our campus is classified as Asian American, Native American, Pacific Islander ([AANAPISI])-Serving by the U.S. Department of Education. Relatively little research has been done to examine the unique context of AANAPISI institutions [55], and in particular there is very little information specifically about CS+E students.

As a predominantly undergraduate institution serving a diverse urban population, UWT provides access to STEM pathways for students who too frequently lack such opportunities. A recent drive to expand degree offerings in STEM resulted in the introduction of two new Engineering degrees in the past few years (Electrical and Mechanical Engineering), with a new degree in Civil Engineering slated to begin in the next year. As a result, our campus is well situated to examine the experiences of low SES, CS+E-interested students in a diverse and student-focused setting.

ACCESS in STEM Program Design

The key objectives of the ACCESS program are to recruit students to STEM majors, support their success, and broaden participation in order to promote equity and inclusion in STEM majors. While the program is multidisciplinary, encompassing all UWT STEM majors except

Psychology, more than half of our ACCESS scholars are computer science or engineering majors or pre-majors, despite having only added Information Technology and engineering to the eligibility requirements for the program within the last year.

We focus our scholarship support on the critical first two years at UWT, with supplemental support in years 3 and 4. ACCESS scholars participate in a quarterly *Success in STEM* seminar, an on-campus living learning community, and have the option to take innovative, project-based first year *Introduction to Research* or *Introduction to Engineering* courses. ACCESS scholars meet biweekly with faculty mentors throughout their first two years, with continued check-ins in years 3 and 4. To address the barrier to entry posed by gateway math courses, we offer incoming students the opportunity to engage in the *Early ACCESS Math Prep* program in early Fall, allowing them to receive credit for Precalculus I before the start of the academic year. Our *Success in STEM* seminar has a strong focus on STEM equity through including seminars on stereotype and identity threat. We promote campus-wide events and speakers to showcase diverse and intersecting identities in STEM and meaningfully-engage with transforming STEM culture towards inclusion at UWT and beyond. Retention of URMs is specifically enhanced by the ACCESS program's focus on promoting equity and inclusion in STEM, including hosting inspirational speakers in the *Success in STEM* seminar, and through campus-wide workshops for faculty, staff, and students aimed at transforming UWT's institutional culture towards STEM inclusivity.

Program Elements

The key elements of the ACCESS program are early engagement through the *Early ACCESS Math Prep* program and the *Introduction to Research* and *Introduction to Engineering* courses, coupled with ongoing faculty mentoring and engagement with issues of equity and inclusion through the quarterly *Success in STEM* seminars. The *Introduction to Research* and *Introduction to Engineering* courses, coupled with intensive group mentoring via the *Success in STEM* seminar develop cohort cohesion, which is strengthened by the opportunity to live on campus in a STEM living learning community (**Figure 2**).

Element 1: Introduction to Research and Introduction to Engineering.

ACCESS scholars choose between our *Introduction to Research* or our *Introduction to Engineering* courses in their first year. Both provide an early immersive hands-on experience to ignite students' passion, enthusiasm, and motivation for STEM fields, and were designed specifically for the ACCESS program. These courses allow first-year ACCESS scholars to be active practitioners, building their self-efficacy, STEM identity, and sense of belonging and enabling them to overcome the expected challenges of their early coursework, informed by the Persistence Framework model shown in Figure 1 [10].

i. *Introduction to Research*.

In this course based undergraduate research experience (CURE), ACCESS scholars conduct air pollution sampling in locations of their choosing throughout the Tacoma region and tie their data collection to questions of environmental and social justice. Students engage in guided data analysis and inquiry culminating in a public poster presentation attended by staff, faculty, family, and community members. This experience provides students with a structured introduction to the scientific method, and allows them to engage with experimental design, data collection and analysis, and results dissemination. Early entry into undergraduate research benefits students by providing the opportunity to engage in multiple years of research, experiences which support continued growth and development in higher-order scientific thinking skills, intellectual independence, and their identity as a scientist. This scaffolding facilitates development along the trajectory from "novice researchers" to "skilled technicians," as described by Feldman et al. [56], a progression that Thiry et al. [37] found to occur as early as the first 1-2 years of college. As a result of this early research experience, ACCESS scholars are prepared for success in later, more independent (traditional 'apprentice model') research capstone experiences.

ii. *Introduction to Engineering*.

Offered for the first time this year, this course leverages evidence-based practices from engineering education to engage students in hands-on experiences and learning, modeled on the successful coffee-based class pioneered at UC Davis [57] and used at several other universities (Tufts University, 2020; Virginia Commonwealth University, 2020). It is intended to enhance student retention, as seen in other well-designed first year engineering courses [58], [59]. In addition to providing students a glimpse into the various concepts in engineering, the course was developed to create a sense of community and also provide a support structure for students wanting to pursue engineering. Students are exposed to various aspects of coffee brewing, production, tasting, roasting, and distribution and how the different fields of engineering are intricate parts of the entire process. They are also tasked to perform a disassembly analysis of a coffee machine, whereby they suggest possible design improvements to increase the efficiency of the disassembly and recycling process.

Element 2: Mentoring.

The ACCESS program provides a structured longitudinal mentoring experience that: (1) promotes group cohesion as a means of increasing scholars' sense of belonging and engagement, (2) increases awareness and empowerment around issues of diversity and equity in STEM fields and education, (3) provides academic skill-learning and academic 'best practices' workshops, and (4) promotes understanding of and engagement with campus services and resources. Our mentoring program consists of three main components: the *Success in STEM* Seminar, individual one-on-one faculty mentoring sessions, and scholar-to-scholar laddered mentoring (**Figure 2**).

i. *Success in STEM* Seminar.

The centerpiece of the ACCESS program is the required quarterly *Success in STEM* seminar, which works to acclimate, educate, and empower our STEM students across their first two years at UWT. These weekly cohort meetings strengthen academic skills and resilience as our students transition to a demanding STEM curriculum and a novel collegiate environment. In the first year, the *Success in STEM* seminar builds group cohesion and a sense of community within cohorts, strengthens academic skills (e.g., academic language acquisition, critical thinking, time management), and supports students as they navigate the rigors of STEM coursework and college life. In their second year, students participate in academic 'best-practices' workshops and reflect on their visions for equity within the campus and broader STEM community and form an understanding of the steps needed to realize those aspirations through action.

ii. *Faculty – Student Mentoring.*

ACCESS scholars participate in bimonthly individual mentoring sessions with a designated faculty mentor during their first two years (**Figure 2**). Faculty mentors engage in annual training workshops and other professional development to hone their skills in mentoring students to promote academic success, particularly for URMs, low-income, female, and First Gen students. By working with a single student across their undergraduate years, our faculty mentors establish the types of stable positive relationships that have been demonstrated to increase retention and graduation rates, positively influence mentees' evaluations of their undergraduate experience, and prepare students for the rigors of future careers [53], [60]. By establishing the crucial connections that students often rely upon in times of acute stress, students can overcome many of the difficult challenges that otherwise might negatively affect retention in STEM.

iii. *Scholar – Scholar Laddered Mentoring.*

Experienced 3rd and 4th year ACCESS scholars contribute to the *Success in STEM* seminar as presenters and panelists. Individual scholars are also recruited to serve as paid peer-mentors for the *Early ACCESS Math Prep* program and the campus STEM living learning community.

Element 3. Early ACCESS Math Prep program.

Many of our students enter college unprepared for college-level math, often causing a significant delay or barrier to entry into STEM majors. Due to anxiety, many students delay taking math classes well into their first or second year at UW Tacoma, despite intensive advising to start math early. To address this issue, we introduced the *Early ACCESS Math Prep* program this year. Students who require *Precalculus* (~one-third of our incoming ACCESS scholars) are offered a dedicated early Autumn Precalculus I course coupled with mentoring and academic support. By incentivizing students to start early and providing intensive mentoring and academic support, the goal of the *Early ACCESS Math Prep* program is to set students up for success in entering and finishing STEM degrees in a timely fashion.

Element 4. STEM living learning community.

The first four years of the ACCESS in STEM program included a pilot STEM living learning community at our campus housing building, but full implementation was hindered due to the pandemic. This year we launched a formal living learning community program. While many of our low-income students struggle to afford the costs of on-campus housing, ACCESS scholarships have allowed over half of our scholars to live on campus (pre-pandemic), far exceeding the typical rate for UWT students (~7%). We anticipate that, with the bolstered living learning community, more scholars will be able to benefit from the opportunity to connect to other STEM students, and build deep support structures for each other, as has been demonstrated for living learning communities [61], [62].

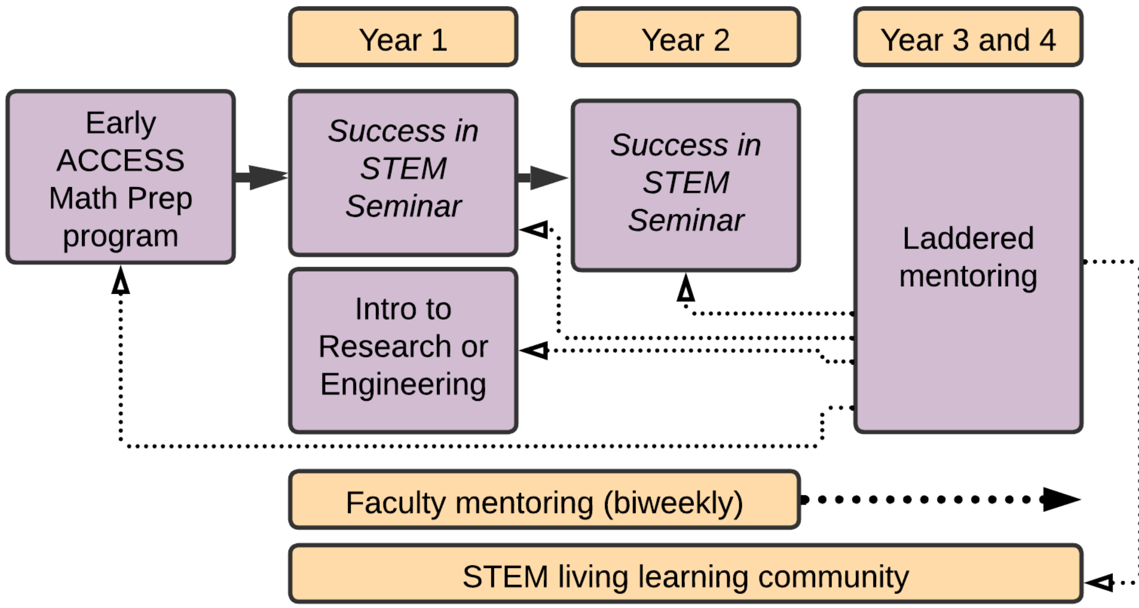

Figure 2. ACCESS in STEM Program Elements

Adaptive Modifications of the Program and Lessons Learned

Over the last five years the ACCESS in STEM program has evolved to meet the changing needs of our students. ACCESS Phase 1 included only students intending to major in Computer Science, Mathematics, Biomedical Sciences and Environmental Science, but we soon learned that many of our ACCESS scholars shifted their intended paths and ended up in other STEM majors. Also, as our campus introduced additional engineering degrees and our existing engineering degrees expanded their enrollments, it became imperative to accommodate this wider array of choices for our STEM-interested students. When ACCESS Phase 2 launched in Autumn Quarter of 2022, we added Information Technology, Computer Engineering, Electrical Engineering, Mechanical Engineering, and Civil Engineering to the list of eligible degrees. At the same time, we added the *Early ACCESS Math Prep* program to incentivize students to take math earlier and with greater support, introduced the *Introduction to Engineering* course to complement the existing *Introduction to Research* course, and increased scholarships from $5500/year to the S-STEM maximum of $10,000 (up to the student's level of need). We also extended limited scholarship support to students in their 3rd and 4th years. We expanded eligibility to ALL low-income students and to transfer students with one year of college credits at entry. Here, we focus on student outcomes for CS+E students from Phase 1 of the ACCESS in STEM program, while demographic data include our new cohort admitted under Phase 2 of the program.

Methods

To address the question whether CS+E students in the ACCESS program demonstrated increases in academic success and retention, we obtained institutional data for UWT CS+E, domestic, first-time college students, including GPA, retention, and graduation rates and compared (i) ACCESS scholars, (ii) students who were also low SES (i.e., Pell eligible) but were not ACCESS scholars, and (iii) high SES students. We obtained registrar data to identify domestic, first-time college students at UWT who requested one of our CS+E majors at entry, including Computer Science, Information Technology, Computer, Electrical, Mechanical, or Civil Engineering. Academic success was assessed by examining first year and second year cumulative GPA. Differences in means between ACCESS and the comparison group were tested with two sample t-tests without assuming equal variance (IBM SPSS Statistics for Windows, Version 29.0). 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, and second year retention as the proportion of students who returned for the start of their third year or graduated during their second year. Proportional differences between ACCESS scholars and the comparison group were tested using Chi-Square tests (IBM SPSS Statistics for Windows, Version 29.0).

To address the question whether the ACCESS program helps to close equity gaps for CS+E students who are URM, low-income, female, and First Gen students, we assessed domestic, first-time CS+E college students at UWT, comparing the demographics of (i) ACCESS scholars in the program, (ii) students who were also low SES (i.e., Pell eligible) but were not ACCESS scholars, and (iii) high SES students, and disaggregated GPA and retention rates by these identities.

To assess student experiences and attain a more nuanced understanding of the underlying factors driving student retention and graduation, we are utilizing a mixed-methods approach combining quantitative data from quarterly self-report surveys and institutional data with qualitative results from focus group interviews. Surveys are administered quarterly in year 1, twice in year 2, and once in years 3 and 4 for each student cohort. Scores on quantitative measures are compared to a matched ACCESS-eligible comparison cohort. The comparison cohort consists of students entering UWT at the same time as each ACCESS scholar cohort with comparable academic characteristics, including high school GPA, as well as demographics. All components were approved by the UW Institutional Review Board.

Here we focus on institutional data and student outcomes from the first four years of the program for computer science and engineering students or pre-majors. A more in-depth analysis of survey and interview responses and outcomes for students who are pursuing all STEM majors in the program will be published elsewhere.

Program Outcomes

Students in the ACCESS in STEM program generally reflect the diverse composition of the student body at UWT, with 74% First Gen, 31% URMs, and 11% veterans or military dependents (Table 2). Although female and non-binary students are still underrepresented compared to the overall campus population, at 27% they show much greater representation than the comparison group (19%) or the high SES group (20%). There is a slightly lower proportion of URMs in the ACCESS program (31%) than the comparison group (36%), but both groups have a higher proportion of URMs than the high SES group (18%). The ACCESS program has a much higher proportion of Black students than the comparison group (18% vs 14%), and a lower proportion of Hispanic or Latino students (4% vs. 18%) (Figure 3).

Table 2. Demographics of CS+E-interested students from UWT who are domestic, first-time college students with GPA > 3, comparing ACCESS scholars vs. comparison group of students who meet eligibility requirements but are not in ACCESS (e.g., low SES) compared with high SES students. Cohorts from 2018 to 2022.

	ACCESS	Comparison group	High SES
Number of students	45	146	413
Female/non-binary	12 (27%)	19%	20%
First Gen to college or 4 yr degree	32 (74%)	75%	57%
Vet/military dependent	5 (11%)	8%	14%
Disability	1 (2%)	2%	3%
URM	14 (31%)	36%	18%
High school GPA	3.7	3.5	3.5
College credit at entry	36	24	36

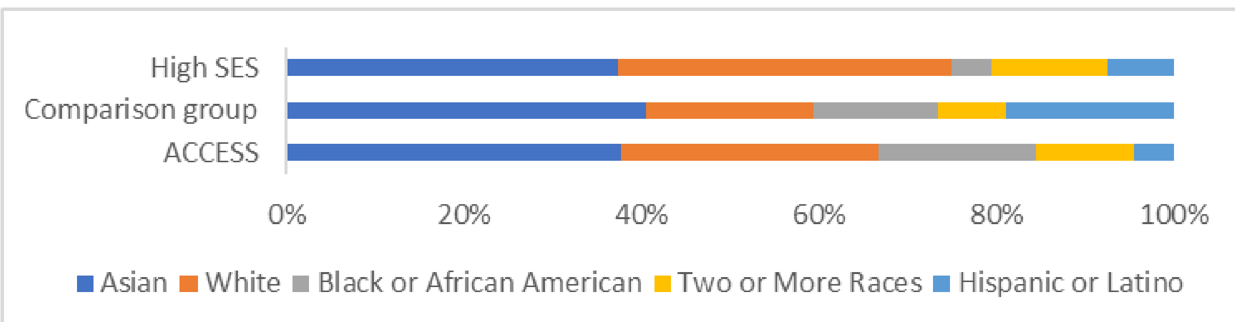

Figure 3. Racial and ethnic demographics for CS+E-interested students from UWT who are domestic, first-time college students with GPA > 3, comparing ACCESS scholars vs. comparison group of students who meet eligibility requirements but are not in ACCESS (e.g., low SES) compared with high SES students. Cohorts from 2018 to 2022.

There were no significant differences in retention rates between the ACCESS and the comparison group based on Chi-Square tests, overall and when disaggregated by URM, First Gen, and Gender, but this may have been due to the small sample size in the program. Nevertheless, there were some notable patterns. Students in the ACCESS program were more likely to persist through their first and second years than the comparison group; for the group as a whole, first year retention rates were 8% higher than the comparison group and second year retention rates were 10% higher (Figure 4). High SES and low SES students had similar first year retention rates (78% vs 79%), while low SES students had lower second year retention (71%). ACCESS scholars had retention rates similar to high SES students (81% vs. 79%). Retention rates were highest for our 2nd, 3rd, and 4th cohorts who experienced remote instruction during the pandemic (data not shown), suggesting that the program may have been particularly effective for students who otherwise were not given the opportunity to develop a similar sense of belonging.

The program was particularly protective in the first year for URMs (18% higher) and First Gen students (9% higher), while the benefit was similar between female and male students (Figure 4A). The benefit was similar for URM and non-URM students in their second year (13% higher for URMs and 9% higher for non-URMs), but the program appeared to have a greater effect for women and non-binary students in their second year (16% higher than the comparison group) (Figure 4B). The program may have had a greater benefit for First Gen students than for non-First Gen students, for whom retention rates were lower than the comparison group (8% lower in their first year and 19% lower in their second year). The results for the ACCESS group should be interpreted with caution due to the small sample size, particularly for 2nd year retention which includes only the first three cohorts.

First year cumulative GPAs (Figure 5A) were significantly higher for ACCESS scholars than for the comparison group overall ($t=3.9$, $p<0.001$), and also for First Gen students ($t=5.508$, $p<0.001$), non-URM students ($t=3.645$, $p<0.001$), women and non-binary students ($t=3.992$, $p<0.001$), and men ($t=2.464$, $p=0.019$), while the difference was marginally significant for URM students ($t=1.882$, $p=0.077$). There was no significant difference in first year GPA for non-First Gen students.

There was a consistent trend of higher second year cumulative GPAs for ACCESS scholars (Figure 5B) but the difference was not statistically significant ($t=1.66$, $p=0.106$), possibly due to the lower sample size as only three cohorts could be included in the analysis. When considering only First Gen students, however, the second year GPA was significantly higher for ACCESS scholars than for the comparison group ($t=2.145$, $p=0.040$), while there was no significant difference for non-First Gen students, or when disaggregating by URM or gender status. Overall, GPAs of high SES students were similar to those of low SES students who were not in the ACCESS program, while students in the ACCESS program had higher GPAs in their first and second years (Figure 5).

By focusing on CS+E students in the ACCESS program, we addressed the question whether this multidisciplinary STEM program that provides financial support, mentoring, and courses to introduce students to research and project-based engineering during their first two years provides effective support for computer science and engineering pre-majors and majors. These outcomes are similar to those observed for all STEM-interested students over the first three years of the program; when considering this broader group, the ACCESS scholars also had significantly higher first and second year cumulative GPAs than the comparison group [63]. Our retention rates were similar to those from the University of Maryland Baltimore County Mechanical Engineering S-STEM Scholarship Program [64], which is similar to our program in its emphasis on faculty and peer mentoring, and providing research experiences to participants in the program [64]. As the ACCESS program continues and our cohorts have time to graduate, in future work we hope to compare our graduation rates to those from successful S-STEM programs, such as the NSF/CSEM & S-STEM Programs at Louisiana State University [1].

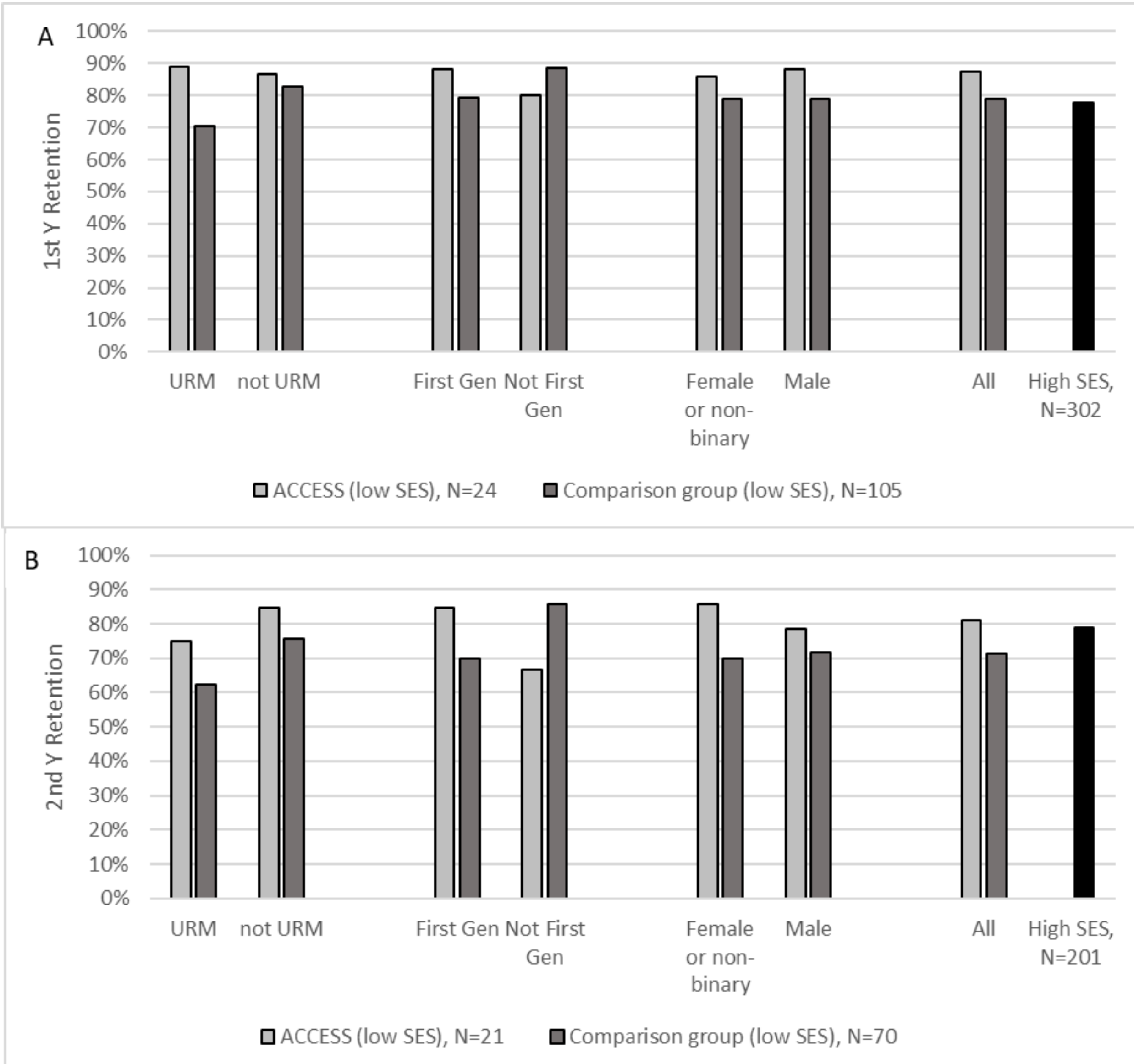

Figure 4. First (A) and second (B) year retention for CS+E-interested, domestic, first-time college students at UWT with GPA > 3, for ACCESS scholars vs. the comparison group (low SES but not in ACCESS program), disaggregated by URM, First Gen, and gender status, and compared to high SES students. Data are from students entering UWT between (A) 2018-2021 and (B) 2018-2020. There were no significant differences between ACCESS and comparison group based on Chi-Square tests with alpha=0.05.

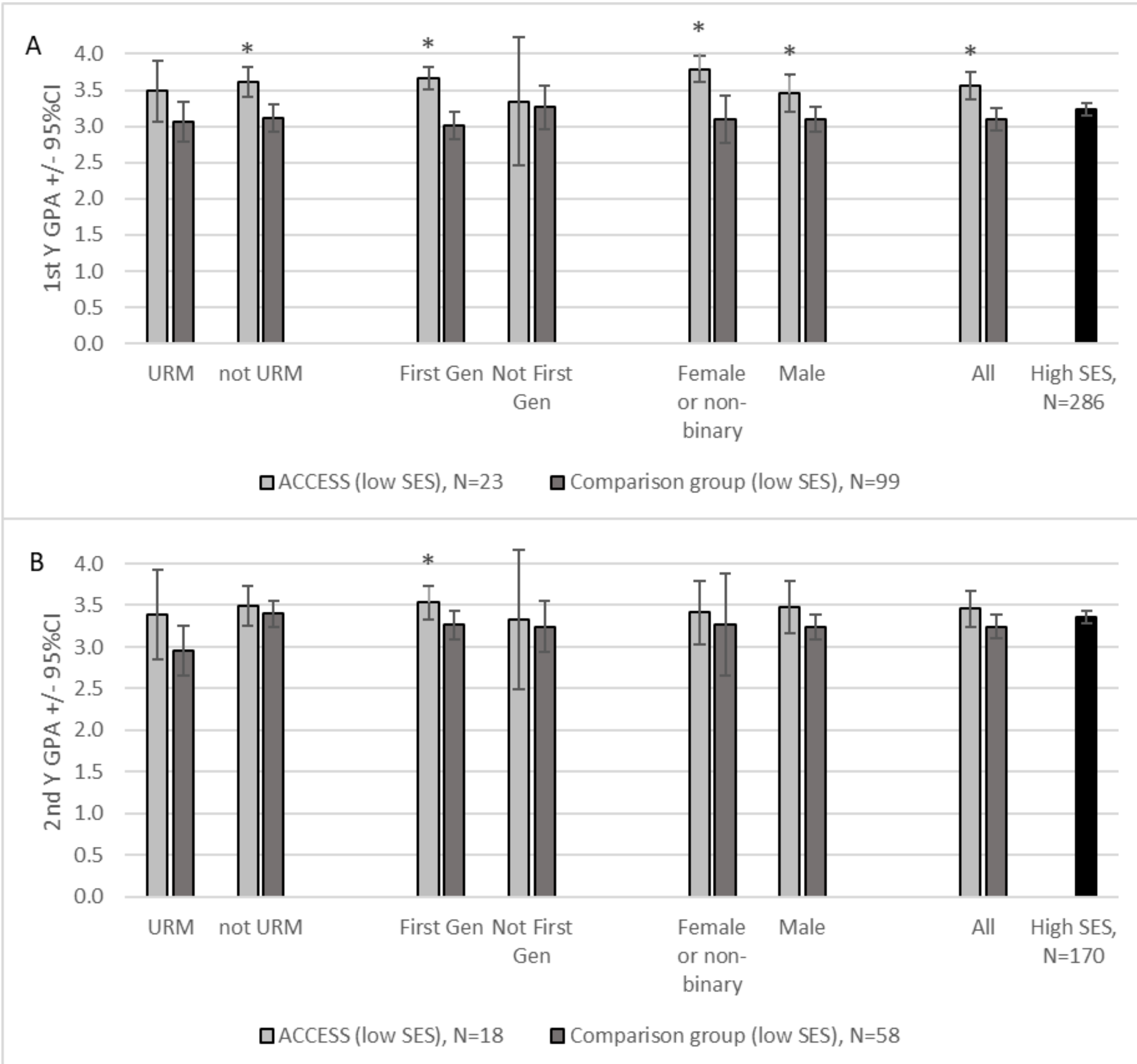

Figure 5. Cumulative GPAs at the end of (A) year 1 and (B) year 2 of attendance, for CS+E-interested, domestic, first-time college students at UWT with GPA >3 for ACCESS scholars vs. the comparison group (low SES but not in ACCESS program), disaggregated by URM, First Gen, and gender status, and compared to high SES students. Data are from students entering UWT between (A) 2018-2021 and (B) 2018-2020. Values are means +/- 95% confidence intervals. An * marks significant differences based on t-tests with alpha=0.05.

Conclusions

Research Question 1: How effective is a program implemented in the first two years of college that provides financial support, early CUREs and hands-on design courses, and intensive mentoring, in increasing retention and academic success for CS+E students?

We found that the ACCESS in STEM program was effective in increasing retention for CS+E students. First year retention rates were 8% higher and second year retention was 10% higher than the comparison group. It was striking that these results were obtained while many of our students were severely impacted by the global pandemic. It is indeed possible that the program's impact was heightened due to the isolation and disengagement that some students experienced during remote instruction. In interviews, students described the ACCESS program as their primary connection to campus, and especially for students who completed their first year of college during remote instruction, this connection was described as being particularly significant. In our future work, we intend to explore the impacts of the pandemic more thoroughly through analysis of longitudinal surveys and thematic analysis of annual focus group interview responses.

The ACCESS in STEM program was also effective in supporting student academic achievement as demonstrated by the significantly higher first year GPAs for program participants when compared to the comparison group, and the trend towards higher second year GPAs. We will continue to track GPAs as the program continues. It will be particularly interesting in future work to evaluate the impact of the newly introduced Introduction to Engineering and Early ACCESS Math Prep courses on CS+E students' academic performance.

Research Question 2: Does this program help to close equity gaps for CS+E students who are low SES, URMs, female, and/or First Gen students?

We found the ACCESS in STEM program served a protective role in reducing equity gaps for some underrepresented groups when considering retention rates and academic performance. Positive differences between first year retention rates for the ACCESS students compared to the comparison group were more pronounced for URMs and First Gen students than for non-URMs and non-First Gen students; likewise, positive differences in second year retention rates were greater for URMs, First Gen, and female/non-binary students. Overall, URMs, First Gen, and female/non-binary students achieved similar or higher retention rates than their non-URM, non-First Gen, and male peers. Similarly, the ACCESS program appeared to reverse the equity gap for academic performance, with URMs and First Gen students achieving similar or higher GPAs than their non-URM and First Gen peers in the program, and higher GPAs than the comparison group.

In future work, we will continue to explore the mechanisms behind these positive impacts on students through a mixed-methods approach, utilizing institutional data and data from longitudinal surveys and qualitative results from focus group interviews. We will investigate the impact of the ACCESS program on scholars' academic motivation, STEM identity, self-efficacy, and interest, awareness of bias and barriers to STEM access, health and well-being. We will also explore the impacts of the ACCESS program on our faculty, as they engage in trainings and professional development opportunities to develop their own awareness of inclusive teaching and mentoring practices, and assess how this may contribute synergistically to ongoing institutional change initiatives on our campus to create more equitable and inclusive environments for our students.

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