



Engineering Counterspaces to Address Inequities in Preparation for Undergraduate Academics

EMPIRICAL
RESEARCH

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ABSTRACT

Background: The Washington State Academic RedShirt program (STARS) aims to broaden access to engineering education through intensive educational and professional development support for high-achieving, lower-income, first-generation students whose academic backgrounds have underprepared them for engineering.

Purpose: This research asks how STARS creates counterspaces to enable its students to pursue an engineering degree. The guiding research questions are: 1) What counterspaces have emerged from STARS? 2) In the counterspaces enabled by STARS, do some marginalized groups express greater or broader positive outcomes than other groups? 3) Is STARS providing sufficient counterspaces for students?

Method: We hosted virtual focus groups that explored STARS students' experiences. Students added comments to Jamboards, which could be anonymous and helped guide some of the discussion. We asked about community, belonging, and academic and professional outcomes. We considered that counterspaces may operate at multiple levels: meta (the program and program staff), meso (students from other cohorts), and micro (cohort-mates). We completed collaborative and iterative coding and analysis.

Results: We find that STARS facilitates counterspaces at meta, meso, and micro levels to facilitate students going beyond stereotypes, adopting counterstories, and developing adaptive strategies to thrive in their programs. We did not find strong differences in overall experience across marginalized groups, though only students of color highlighted the importance of connecting based on shared identities. Some of these students found these connections outside of STARS, suggesting that the program's counterspaces are not sufficient for all students.

Conclusions: This study highlights the power of program counterspaces to provide structural support. STARS counterspaces help address inequities in preparation, so that its students excel in their undergraduate engineering program. Supporting students to access non-program counterspaces may further meet their needs. Other universities can use similar approaches to help expand equity in this field, though more systemic change is needed.

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The Washington State Academic RedShirt program (STARS) at the University of Washington (UW) is an initiative that supports engineering and computer science college students from underserved backgrounds. The program design arose from the redshirt concept in college athletics, where athletes delay their four-year eligibility in order to better prepare themselves to compete in college sports. In the world of college sports, better preparation may mean taking time to recover from an injury, participating in additional training, building strength and athletic skill, working on academics or a combination of these. Regardless of how the time is spent, a redshirt year extends the athlete's undergraduate experience from four years to five. Similarly, in STARS, students redshirt into a five-year academic program in engineering (one year longer than the suggested time to degree). During the first two years of the program, an intensive, cohort-based experience provides students with prerequisite technical (math and science) skills as well as professional development and life skills which prepare them to succeed in and graduate from their chosen discipline (major) in engineering. Students accepted into STARS are predominantly high-achieving, lower-income, and first-generation undergraduate students whose education underprepared them for engineering. STARS defines *underprepared students* as those 1) coming from a school at which at least 30% of students receive free or reduced-price lunch (FRPL) and 2) who were either not directly admitted to a UW College of Engineering major or decided they needed additional academic support to thrive in their major.

Underpreparation can prevent many capable but marginalized students from gaining the skills necessary to advance to higher stages of education and thus to financially secure occupations like those accessible with an engineering degree. For STARS students, the underpreparation typically stems from unequal access to educational resources. STARS students come from mid-low poverty K–12 schools (25–50% FRPL), mid-high poverty schools (50–75% FRPL), or high poverty schools (75–100% FRPL) (National Center for Education Statistics, 2023; Snyder & Musu-Gillette, 2015). Because of limited resources due to lower tax revenues in poorer areas, these students' schools generally offer less college preparation than schools in higher income neighborhoods (Nowicki, 2018). Insufficient access to college preparatory courses such as calculus, physics, and advanced placement (AP) courses in many of these schools is especially consequential for students interested in pursuing majors in engineering and physical sciences, creating a barrier to access that extends well beyond the quality of teaching and learning at any particular school (Nowicki, 2018). Therefore, STARS students often face a double bind in underpreparedness because they have less college preparation overall and may lack critical math (calculus), science (physics), and AP courses to set them on a level playing field with higher-income peers in engineering majors.

To address underpreparation both in math and science as well as other critical aspects of college life, STARS at the UW is a holistic model for wraparound support for marginalized students. The model includes four main programmatic components (described in detail in Knaphus-Soran et al., 2024) aimed at improving the engagement, retention, and graduation rates of engineering and computer science students: 1) intrusive advising and academic support services; 2) intensive study-skills, and personal and professional development; 3) intensive math and science academic curriculum; and 4) community-building (including pre-matriculation summer programs). Through five cycles of annual program evaluation, STARS has demonstrated consistently positive and significant academic and psychosocial outcomes. STARS students demonstrate higher GPAs in their second compared to the first year in the program, particularly for math and science courses. As importantly, STARS students outperform non-STARS students in overall GPA. In addition to these academic outcomes, STARS students report that the smaller class sizes enabled by the program alongside other program elements help them find supportive study groups and greater camaraderie, greater self-confidence in math and science skills, stronger sense of belonging, and higher graduation rates in engineering, all of which may not have been possible had they entered directly into their mainstream undergraduate programs (Knaphus-Soran, Hiramori & Litzler, 2021).

While program evaluation for STARS has explored the academic and psychosocial benefits of the program to participating students, much less is known about how students go about attaining

these benefits. A promising and fertile pathway to examine is how the program's pillars facilitate the emergence of one or more counterspaces within the STARS community. A counterspace is essentially an academic or social space that allows students from marginalized groups to belong and to be affirmed; to be neither hypervisible nor invisible, but comfortably visible in identity conscious and identity affirming surroundings. Counterspaces are necessary given oppression within a broader organization, institution, or society writ large. Members of the communities within these spaces typically create, cultivate, and sustain them. In this paper, we explore what it looks like when an educational support program provides the structure and support for counterspaces and the students actively participate in building the community.

To explore the counterspaces within STARS, we first explore in more depth how our understanding of these critically important spaces evolved, what they look like, and what we know about them based on the existing literature. We also draw on the work of Solórzano, Ceja, and Yosso (2000) and Keels (2020) to develop a conceptual framework for analyzing the experiences of STARS students based on focus group data collected from three cohorts of students in STARS.

BACKGROUND

The concept of counterspaces (Solórzano & Villalpando, 1998) developed alongside community cultural wealth as a response to calls from scholars of mestiza studies, Black liberation, and critical race theory (CRT) to better honor the assets of people who operate on the margins of society. Critical race theory developed out of critical legal studies (Bell, 1992/2018; Crenshaw, 1988) as a tool for understanding racialized inequities in education (e.g., Ladson-Billings & Tate, 1995) and emphasizes the lived experiences of people of color as a means to understand how racism oppresses and affects racially (and ethnically) minoritized communities (Bryson, 2018; Delgado & Stefancic, 2001; Dixon & Rousseau Anderson, 2018). These lived experiences often do not align with the narratives that mainstream society paints for minoritized people and finding a space (whether physical or virtual) to counter these mainstream narratives can be important for them to thrive. In this spirit, Solórzano, Ceja, and Yosso (2000) defined such counterspaces as "...sites where deficit notions of people of color can be challenged and where a positive collegiate racial climate can be established and maintained" (p. 70). Since these early explorations of counterspaces, scholarly discussion of and research on counterspaces have expanded to include groups of individuals who are marginalized based on a variety of social statuses (sexualities, migration status, etc.).

In education, students are often marginalized by race via what Gloria Ladson-Billings called an "education debt" (2006) that has accrued through centuries of providing fewer educational resources to Black and Latine students. Because US public school funding is largely dependent on the cost of housing within a school's district and the socioeconomic resources of students' parents, residential sorting of people based on social inequality means the ongoing unequal distribution of educational resources at the community level, with entire districts receiving larger or smaller infusions of resources depending on the socioeconomic characteristics of the area (Jargowsky, 2014; Lareau & Goyette, 2014). As a result, schools in lower-income neighborhoods typically have less funding for instructional and social resources than schools in higher-income areas (Owens & Candipan, 2019). Such resource disparities have a significant impact on Black and Latine populations who are disproportionately represented in lower-income communities (e.g., Reardon, Fox & Townsend, 2015), and students of other races and ethnicities are also impacted. Regardless of race or ethnicity, students from socioeconomically disadvantaged schools often face higher barriers to success in college and engineering (Orr et al., 2015).

Counterspaces have emerged as an effective strategy to assist students in overcoming these socioeconomic challenges and thriving during their college years. Counterspaces provide students with the opportunity to build community and share emotional and instrumental support with each other within a broader setting of oppression.

Counterspaces also function to raise consciousness of and affirm identity. In education, they provide a space "... where marginalized students challenge each other to push beyond stereotypical narratives, develop counterstories, and learn adaptive strategies from others

who are navigating similar struggles” (Keels, 2020, p.161). In this context, counterspaces have emerged in education systems in a wide range of forms with an equally varied range of goals. Appropriately, much of the relevant empirical research has focused on racially and ethnically homogenous groups of individuals who are marginalized, often in predominantly White settings. For example, Carter (2007) examined both informal counterspaces (the library steps) and formal spaces (the school’s Black Leadership Advisory Council) whereby Black high school students found ways to draw attention to and affirm their racial identities. In colleges and universities, such counterspaces can also be strategically catalyzed by members of marginalized groups. For example, the African American Student Network (AFAM) at a large, midwestern university is a faculty-facilitated networking group which meets weekly and provides space and flexibility for Black undergraduates, graduate students, faculty, and staff to interact socially and intellectually as “self-actualizing meaning-makers” (Grier-Reed, 2010, p. 183). The counterspace enabled by AFAM has been shown to provide students with safety, connectedness, resilience, empowerment, and other positive outcomes (Grier-Reed, Na’im & Buckley, 2008). Masta (2021) discusses a classroom counterspace for Black and Brown students in a graduate course about research methodologies at an institution in the United States, finding that this counterspace embraced the multifaceted nature of Black and Brown identity, centered Black and Brown identity, and supported Black and Brown students’ frank perspectives about academia. Student organizations can also provide social counterspaces. For instance, Anguiano and colleagues (2022) found that Latine students created student organizations that centered music to create ‘sonic counterspaces’ that supported them during their academic journey.

Importantly, counterspaces are not limited to permanent or long-standing groups, organizations, or networks. They can also emerge from informal or temporary activities. For instance, a book club focused on literature by African American authors was a catalyst for an identity affirming counterspace that helped African American women reshape their experience at their predominantly White institutions as one they could “confront on their own terms.” (Sutherland, 2005, p. 391).

Counterspaces may also provide a powerful community for people marginalized based on a variety of ascribed social statuses (e.g., socioeconomic status, sexualities, immigration status). Some counterspaces function at the intersection of race or ethnicity and another minority identity. For example, the Raza Womyn organization at UCLA provides a queer-friendly counterspace for Chicana/Latina students to feel safe and supported in their ethnic and LGBTQ identities while also gaining the skills needed to become politically active in fighting for social justice (Revilla, 2010). Other counterspaces are disproportionately populated by people of color but not exclusively so. For example, Chaney and Schwartz (2017) and Mackillop (2017) describe a support program that acts as a counterspace for formerly incarcerated individuals to reintegrate into society through a college education. A combination of academic support services, mentorship, networking, personal guidance, tutoring, and opportunities to share experiences in an authentic way functioned to enable these individuals to push past negative stereotypes and adopt strategies for succeeding in college. These examples are supplemented by many more in the literature that focus on counterspaces populated by members of marginalized groups who have a racial, ethnic, or similar characteristic in common. Whatever this unifying characteristic may be, it tends to provide a catalyst for bonding and affirmation in its corresponding counterspace.

The examination of counterspaces in the literature has suggested that they can benefit individuals who are marginalized across many axes of oppression. Some counterspaces include a more racially and ethnically heterogeneous group of individuals, although—given the bigotry that makes counterspaces necessary—it is reasonable to expect that trust may be easier to establish in more racially and ethnically homogenous groups. Much less is understood about these heterogeneous counterspaces both in terms of what they share in common with more homogeneous groups and what they do not. By examining a heterogeneous population of engineering students who are marginalized by socioeconomic status, underpreparation for engineering, and one or more additional characteristics (race, ethnicity, gender, etc.), this paper and case study seek to help bolster this area of the counterspace literature.

It is important to note that while counterspaces are helpful to marginalized groups in most contexts, they may be especially important in fields which are not only dominated by a particular racial or ethnic group but which also place a high value on the behavioral norms of the majority group. Engineering and many other STEM fields bear this twin burden where marginalized groups must not only directly contend with that marginalization, but they must also push back against the privileged behavioral norms of competitiveness and individualism that, not coincidentally, align with White male scientists and engineers (e.g., [Secules, 2019](#)). Complicating matters in engineering and related STEM fields, numerical White male dominance is so high that many marginalized students find it logistically difficult to find a homogenous community of those that look like them and study what they study to build an effective counterspace. Yet, Ong, Smith, and Ko ([2018](#)) found that marginalized students can and do find ways to create counterspaces within existing structures in STEM despite these barriers. In fact, the authors found five different counterspaces in which 39 women of color operated to validate their experiences, vent frustrations, challenge stereotypical notions about individuals of color, and establish a positive racial climate to support and affirm them in their studies. These five counterspaces emerged from peer-to-peer relationships, mentoring relationships, national STEM diversity conferences (e.g., the Grace Hopper Celebration of Women in Computing), both STEM and non-STEM campus groups, and importantly, their own STEM departments. One hundred percent of the women interviewed in this study reported experiencing at least one counterspace, which underscores their noticeable value for supporting marginalized students in STEM education. As importantly, however, the fact that counterspaces took on such a wide range of forms in fields which seem to inherently oppose them suggests a need to further study counterspaces in such fields.

In engineering specifically, multiple studies have looked at graduate students: Leeker and colleagues ([2019](#)) describe how Black women created a counterspace for themselves in an engineering doctoral program, while Thomas and colleagues ([2021](#)) identify more than a dozen counterspaces for Black graduate students that categorized providing identity, professional, familial, and/or wellbeing support. Brawner and colleagues ([2022](#)) study the importance of counterspaces for undergraduate students, particularly Black men engineering students who are veterans; the counterspaces may be religion, family, and/or Black-identity focused. Revelo ([2015](#)) looks at professional societies and shows that the Society for Hispanic Professional Engineers (SHPE) serves as an academic and social counterspace for Latina and Latino engineering students. King, Peña-Telfer, and Earls ([2023](#)) describe a counterspace within a summer STEM program for Black and Brown girls, including an aspiring engineer, which combined academics and community building, allowing the girls to develop trust in a STEM space and enhance their critical data literacy, deepening their learning. The present study adds to the literature on counterspaces by considering whether and how a holistic, complex set of program elements contribute to one or more engineering counterspaces, as well as how the racial and ethnic heterogeneity of the program shapes those counterspaces and possibly their outcomes.

This study seeks to add insight into understanding of counterspaces, particularly in fields which are highly male dominated like engineering. In 2022, women were awarded just 24% of bachelor's degrees in engineering, highlighting a stark gender disparity in engineering education ([American Society for Engineering Education, 2023](#)). This engineering-focused study offers the opportunity to understand the unique role that counterspaces can play in helping build spaces of support for minoritized communities within a relatively homogenous and privileged population in college and the workforce. This study also looks at the potential for heterogeneous groups of STARS students (who are all marginalized in a number of ways—some uniform and some different) to form and experience the benefits of counterspaces. We expect that STARS students, despite sharing the common foundation of being marginalized in engineering, are unlikely to experience the same benefits of groups which support students with a common racial and ethnic identity; we expect that the diversity of STARS will provide students some unique benefits. The processes, mechanisms, and the extent to which these benefits emerge is the focus of this engineering case study. To interpret the results in terms of counterspaces, however, we first turn to a conceptual framework that allows us to isolate the counterspace(s) from other forces at work within STARS.

In order to properly identify and analyze counterspaces that emerge from a multi-faceted program like STARS, which serves a heterogeneous group of students, the critical elements of a counterspace must be clearly defined. To do this, we base our analysis on the definition of counterspaces put forth by Keels (2020) which includes any marginalized or combination of marginalized groups in a particular context. Keels suggests three critical elements of a counterspace: going beyond narratives, developing counterstories, and adapting strategies from students facing similar struggles.

Going beyond stereotypes

Students from low-income backgrounds often attend low-resource public schools and arrive in college underprepared. This is especially true in fields like engineering which are math- and science-intensive and expect students to “hit the ground running.” One common limiting narrative for engineering students—and one that is somewhat pervasive in society—may be that only students for whom math and science are easily understood belong in this field (e.g., Rattan, Good & Dweck, 2012). This is a belief that can be dispelled through experience overcoming challenging material (Yeager & Dweck, 2012). This experience may be less accessible for underprepared students, who may carry a label that Secules and colleagues (2018) describe as culturally constructed: “not cut out for engineering.” Academic counterspaces can serve to encourage students to dispense with these limits by presenting underpreparation as a structural problem to be solved (through academic support) rather than as an inherent failing, fault, or weakness of the student.

Developing counterstories

Counterstories are a tool for minoritized or marginalized groups to tell stories that reflect their lived experiences and intimate knowledge of their situations and circumstances. They can serve to challenge and dispel myths; CRT scholars often use counterstories to contradict stories that mischaracterize or pigeon-hole the lives of people of color. In their broadest context, counterstories are a means for “telling the stories of those people whose experiences are not often told” (Solórzano & Yosso, 2002, p. 32), and they are especially important in education for scaffolding self-efficacy and self-confidence of marginalized groups. For example, developing counterstories in a counterspace allows students to bring their whole selves to schools and share parts of their lived experiences that they may not be comfortable sharing with others. This ability to “be real” and share the complexities of their lives and identities is foundational to supporting positive engineering identity development and self-confidence (Ross, Huff & Godwin, 2021).

Developing adaptive strategies

Counterspaces can help marginalized individuals develop adaptive strategies for navigating contexts that were not designed with them in mind. These strategies can include approaches to cope as marginalized individuals and the social, professional, and study skills to thrive within the broader environment. Developing these strategies can be particularly useful for students from socioeconomically disadvantaged backgrounds, whose schools often provide less training than do schools in wealthier areas regarding the cultural norms and pathways to success that are expected in many undergraduate institutions (i.e., the “hidden curriculum”) (e.g., Calarco, 2018).

To understand the presence and role of counterspaces in STARS we look for evidence of one or more of these three counterspace elements in our data as emerging from the four key pillars associated with STARS (intrusive advising, personal and professional development, an intensive math and science curriculum, and community building).

Intrusive advising

STARS provides a level of supervision and support that is generally absent in the broader university engineering community. A key component is intrusive advising, which implies a “deliberate structured student intervention at the first indication of academic difficulty in order to motivate

a student to seek help” (Earl, 1988, p. 28). Research shows that this proactive advising approach improves retention with students from academically underprepared backgrounds (Rodgers, Blunt & Trible, 2014). STARS advisors or mentors are a regular presence in students’ lives. There is one advisor officially working with about 60 students—all of the 30 students in each of the two STARS cohorts in their first and second years—in addition to some STARS alumni in their third or later year of college. Advisors maintain an open-door policy for student drop-ins. They meet with each student at least twice per quarter, usually more, and weekly if a student is struggling. Advisors also teach a weekly 90-minute seminar, which includes a substantial reflection component. This intensive level of interaction allows students and the advisor to get to know each other better and develop a strong base of support as the students move through a challenging academic program.

Personal and professional development

Professional development (focused on study skills) and personal development (focused on self-management) are critical components of STARS. Starting before their first year at the UW, STARS students participate in a summer bridge program which supports the transition into the university, navigating the differences between high school and college, and developing students’ time management and study skills. STARS staff and instructors regularly and vigorously highlight the importance of these noncognitive skills for success and several aspects of STARS programming support this. In addition to the bridge program, the first-year seminar supports students to develop their skills in self-reflection and studying, and otherwise focus on personal and professional development and STARS students take a one-quarter course on resilience. In the second year, students take another year-long seminar that focuses on professional skills, including resume writing, networking, interviewing, and developing interpersonal skills. By doing so, they complete a required career success certificate. STARS staff also introduce students to UW’s related services, encouraging their use, and focus on personal development when providing one-on-one support. Since STARS attends to students as full human beings and the students complete this work as a cohort, they can develop strong bonds with each other as well as with the STARS staff supporting them.

Intensive math and science curriculum

STARS students take a rigorous series of math and science courses that is spread out over two years and necessitates the five-year graduation plan. Before the first academic year starts, cohorts participate in pre-first-year summer homework that includes meeting for 90 minutes each week and completing assignments. The second half of the summer program focuses on math problem-solving, as well as some preparation for chemistry. Students subsequently take an intensive problem-solving course in math, chemistry, physics, and computer science prior to taking a first course in each of these disciplines. The program also provides supplemental workshops that run concurrently with courses to support students in these courses; group tutoring; and intensive four- to six-hour Saturday study sessions before each midterm and final (“Math-Til-You-Drop,” “Chemistry-Til-You-Drop,” etc.). STARS students and their instructors spend substantial time together grappling with challenging material. It is worth noting that while STARS students are taking courses that other students enter college with already under their belts, and some STARS students retake algebra, there is little basis for stigma against these students, who often academically score higher in relevant courses than the average student (e.g., Knaphus-Soran, Hiramori & Litzler, 2021).

Community-building

STARS intentionally supports community-building within the program. Students go through STARS as a cohort, which begins at a UW advising and orientation session during the summer before Year 1. Students then attend a summer bridge program, during which time they move into the engineering residential learning community. The students are required to live in this community within a single dormitory during their first two years at UW; research shows living-learning communities are helpful for building community, professional development that can increase confidence, and persistence among engineering students (Samuelson et al., 2014). They also do most first-year coursework together. STARS initially requires and later encourages students to

work together on homework and help each other learn good study-group habits. There are two formal community-building events: the two-week bridge program for incoming students and the annual community-wide event, Bowling with the STARS. This event happens in the fall quarter and all cohorts of STARS students and staff are invited. Finally, both the STARS office suite and a common classroom serve as gathering places/ spaces for students. Students take most, if not all, workshops and mentoring sessions in the STARS classroom. Within the cohort-centric STARS community, smaller groups may form, since the program splits each cohort in half for mentoring (tutoring) groups, workshops, and quiz sections for all regular UW courses.

The STARS pillars and counterspace elements are visually described in [Figure 1](#) below.

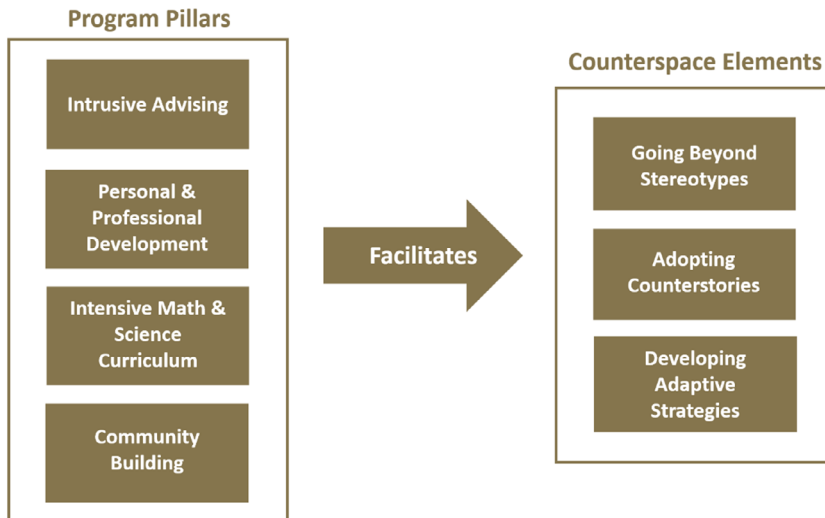


Figure 1 Guiding Framework for Data Analysis. This figure visualizes that four STARS pillars facilitate participants to create a counterspace and enact three foundational counterspace elements.

Looking for the three fundamental elements of a counterspace in the context of holistic program support leads to three research questions that guide the data analysis for this study:

Research Question #1: What counterspaces have emerged from STARS?

To analyze this research question, we look for references to one or more of the three fundamental counterspace elements in the focus group data collected for this study. The data are also analyzed to identify which of these elements (if any) are more dominant than others in the holistic structure of the program.

Research Question #2: In the counterspaces enabled by STARS, do some marginalized groups express greater or broader positive outcomes than other groups?

To answer this question, we consider whether and how themes that emerge in the findings differ based on race/ethnicity, gender, and the intersection of these two characteristics.

Research Question #3: Is STARS providing sufficient counterspaces for students?

The response to this question provides insight into strategic future improvement in STARS and similar holistic academic and social support programs. The program endeavors to support a tight-knit group of students bound together by similar struggles, but in so doing, is it unintentionally denying students access to other social counterspaces or communities that provide needed additional support?

METHOD

DATA

To study how STARS has engineered a counterspace, we conducted eight one-hour focus groups that explored the lived experiences of participating students. We chose a discussion-based data

collection approach for this study in order to hear firsthand about the perceptions of STARS students and to be able to ask follow-up questions in real-time as appropriate (de la Croix, Barret & Stenfors, 2018). We chose focus group discussions for multiple reasons. First, we were able to speak with more people in groups than we would have been able to if we had conducted one-on-one interviews. Second, the group structure also allowed participants to respond anonymously to some questions (refer to the discussion of Jamboards below), further boosting participant privacy and facilitating frank responses. Third, recall may have been an issue since we were asking participants to discuss a program that had begun 1–3 years prior to our session; focus group participants could remind each other of aspects of the program they might have forgotten about (Krueger, 2014). The data collection was reviewed by the UW's institutional review board, which determined it to be exempt from meeting the requirements of federal human subjects regulations per exempt categories 2 and 3 (STUDY00014144).

We recruited students for the study by email. This followed communication (an email and information session) from the executive director of STARS, who notified students about the study and encouraged students to participate. To maintain student choice in participating, we assured students that they were not required to attend a focus group, that they could skip any questions or the study entirely, and that we would not provide identifiable information about participation or specific responses with program staff (including co-authors).

We invited 80 students from the three most recent cohorts (at the time of this study) to participate in the study: 23 people from the 2019 cohort, 28 people from the 2020 cohort, and 29 people from the 2021 cohort. Roughly 73% participated, with varying participation rates that were much lower for the 2019 cohort (35%) than for the 2020 (93%) and 2021 cohorts (83%). Talking with individuals from multiple cohorts allowed us to consider how experiences may vary across years, including regarding how pandemic-related policies and practices may have shaped experiences. Speaking to those from the most recent cohorts helps provide data about the program in its most recent form and may allow participants to better remember the program (refer to research about the recency effect and remembering details, e.g., Baddeley, 1968). We held separate focus groups with women and men (the data did not include any individuals who identified themselves as nonbinary to the program), talking with 28 women (80% of those we invited) and 30 men (68% of invitees). We did so to observe potential gender differences in our results, which is important given stark gender disparities in engineering—for example, women constitute 14% of the engineering workforce (Rincon, 2023). To assess possible differences in responses based on racial and ethnic status, we also fielded a two-question web survey at the end of each focus group to collect relevant data. We summarize the racial and ethnic composition of the participants in Table 1 below. Roughly four of every five participants reported being students of color: about a third reported being Asian American/Asian only, another fifth reported Latine status, and a quarter total reported being Multiracial (12%), Black only (9%), or Middle Eastern/ North African only (3%). One-seventh reported being White alone and 7% did not provide information about racial or ethnic identity.

	COUNT	PORTION OF PARTICIPANTS
Asian American/ Asian Only	19	33%
Black Only	5	9%
Latino/a/x/e Only	13	22%
Middle Eastern/North African Only	2	3%
White Only	8	14%
Multiracial	7	12%
No Response	4	7%

Table 1 Participant Race/ Ethnicity. This table outlines the race/ ethnicity of students who took part in a focus group.

During focus groups, in order to assess the possible benefit of counterspaces for STARS students, we asked questions about community and belonging, relevant features of the program, and academic, professional, and other outcomes the program may produce. Given the uncertainty of

the Covid-19 pandemic and corresponding health concerns, we hosted the focus groups through Zoom video conference software.

The two primary researchers, who had not been directly affiliated with STARS, facilitated the focus groups, speaking with 58 students in eight one-hour focus groups during February 2022. Between two and ten students attended each session. The facilitators used a semi-structured protocol and the collaborative brainstorming software, Jamboard, to elicit input from students. We began with questions about feelings of community at the university, both within and outside the STARS program, and comfortable spaces on campus. After this, we asked students to contribute to a series of Jamboard slides, each labeled with a potential outcome of participating in STARS including academic performance, academic confidence, professional confidence, interest in working in the field, and additional outcomes. We prompted students to add a sticky note with an example for each way that the program influenced the students relative to the outcome and invited them to duplicate other students' sticky notes with which they agreed. We then invited students to share more information about their sticky notes. This process helped us guide the discussion in a targeted way to ensure we were hearing about our focal themes and enabled us to gather more information on each topic than we had time to discuss verbally. It also allowed students, who were logged in to Jamboard anonymously, to maintain greater privacy and decide to share something on the Jamboard without verbally revealing that they had done so. We recorded video and audio of each focus group and downloaded participants' work on the Jamboards as well as comments via chat. We submitted audio files to [Rev.com](https://www.rev.com) for transcription and added images of completed Jamboard slides and chat comments to the transcripts in the most relevant locations.

ANALYTIC APPROACH

We analyzed the focus group transcripts using Dedoose qualitative data analysis software. We iteratively created a detailed codebook, using both concept-driven and data-driven approaches. Our iterative approach to developing the codebook allowed us to leverage the benefits of existing theory and knowledge about the program and student participants while also allowing codes for emergent themes that did not fit familiar literature or expectations (Bingham & Witkowsky, 2021).

In order to speak to our expectations about the possible benefits of STARS counterspaces, we created codes for various environments, both physical (dorms, program and non-program classrooms, etc.) and virtual, as well as codes for community and belonging (whether or not the community is within the context of STARS, whether the community is strong, etc.). We also included codes about the potential benefits, including outcomes that are academic (academic performance, preparation for non-program courses, etc.), professional development (awareness about the field, preparation for the job market, etc.), psychosocial (confidence, reduced stress, etc.), and/or do not fall into these categories (collaboration skills, help with transition through college). In addition, we included codes about various aspects of STARS and how participants seemed to assess the program component, counterspace, outcome, and so on (positive, neutral, negative). We examined the level at which a counterspace may be operating through codes for program components (meta) and dynamics across (meso) and within (micro) cohorts of students. To consider how much discussions varied by race/ethnicity, we also included codes for self-reports of this information.

The two primary researchers pair-coded one full transcript and a portion of another and agreed on codes based on consensus (Paul, Bezerra Rodrigues & Cicek, 2021). Following that, we maintained coding consistency with one author individually coding all remaining transcripts and another reviewing this work. We reviewed transcripts a second time for codes we added or edited (by expanding definitions) during the first round of coding. The codebook is available for review in Appendix A. We used memo-writing and regular meetings to identify and develop themes, discuss decision-making around coding, and otherwise document our process (Birks, Chapman & Francis, 2008). A third author provided feedback on the analysis process during meetings and the rest of the team provided written feedback on the analysis.

As authors, we have various identities and backgrounds that shape our approach to all aspects of the research process on individual and collective levels. We are all cis-gendered, able-bodied women who have benefitted from access to higher education and privileged professional spaces. Yet, we hold differing race/ethnic identities, economic and family backgrounds, and span four generations (ranging from Baby Boomer to Generation Z). We are all committed to working towards the diversity, equity, and inclusion of marginalized peoples, despite in some cases not having experienced the same marginalizations. As Cunningham put it, the dream is that someday, preferably sooner rather than later, programs like STARS will not be necessary because access, equity, and inclusion will have been achieved.

As a group, and sometimes individually, our perspectives have been shaped by experiences with both privilege and disadvantage along racial, ethnic, and economic lines. Rajouria is South Asian and grew up in the United States and Nepal, Cunningham is African American, Riskin is White and Jewish, and Carll, Wilson, and Litzler.

While we are all now middle-class, we experienced different socioeconomic contexts growing up. Wilson and Cunningham are from a poverty-stricken and first-generation college student background. Growing up in underestimated communities in Harlem and the South Bronx, Cunningham's life changed drastically when, unexpectedly, she was whisked away by the lure of a full scholarship to a small predominantly White and wealthy college in rural New York State, and graduated four years later, despite two of her favorite high school teachers, both White, telling her not to go because she would not make it. The life of Wilson was similarly transformed by a full scholarship to an elite and wealthy institute in the Northeast where she arrived highly underprepared with a public high school education from a state which ranked 48th in K-12 at the time. At the age of nine, Carll moved from a working-class neighborhood to one populated with middle-class families, which showed her the correspondence between economic and racial/ethnic segregation in neighborhoods and schools. Rajouria, Riskin, and Litzler grew up in relatively educated and/or middle-class families, which facilitated access and integration into well-resourced educational institutions, as did Carll's context during adolescence. Rajouria finds that her global experiences and perspectives also helped her navigate higher education. Riskin identifies heavily with being a parent and is the mother of one college student and one college graduate.

All authors have direct or indirect connections to STARS. Cunningham and Riskin were longstanding leaders of the program: Cunningham was the executive director and Riskin was a co-founder and faculty director. Wilson has taught STARS students from all three cohorts in her courses in electrical engineering. Authors Carll, Rajouria, and Litzler work at a center that once co-resided with STARS in the UW College of Engineering and evaluated the program for many years. None of these individuals, however, have directly served as evaluators of the program, so the students who participated in this research should not know these authors in this capacity. Given our positionalities, the authors had open conversations about how to minimize the influence of our biases on the results. We agreed to intentionally allow the data to dictate the main findings and to keep an eye out for evidence that might disconfirm our expectations. After formulating our main findings, we leveraged our knowledge of the program and the particular expertise of Cunningham and Riskin to understand and contextualize the results.

LIMITATIONS

While the primary researchers who conducted the data collection and analysis assured the students their input would remain confidential and would not be shared with program staff or affect their standing in STARS or at the UW, current STARS students may be particularly vulnerable to desirability bias, or the tendency to respond as they anticipate the researchers may want them to. Incorporating earlier cohorts of STARS students may help address this limitation since these students are no longer directly affiliated with the program. At the same time, talking with current students is important because these individuals have the most up-to-date experiences and memories to draw on during discussions about the program.

Desirability bias may have been a particular issue in some focus group meetings. While some groups of students shared critical feedback, others did so minimally or not at all. At the end of one focus group, a student asked why the researchers did not inquire about the program's flaws. While we explained that we were asking about impressions of the program whether good, bad, or neutral, this was unclear to at least this one student. While this may have precluded some students sharing more critical details about the program, we do not anticipate a reason why this would substantially change the praise that we heard. However, future research that more carefully attends to this may reveal nuances that we missed in this study.

RESULTS

RQ1: WHAT COUNTERSPACES HAVE EMERGED FROM STARS?

In this section, we explore the focus group data and this first research question through the lens of three foundational elements of counterspaces: going beyond stereotypes, adopting counterstories, and developing adaptive strategies. We present evidence that these elements of counterspaces operate in STARS at three levels of aggregation: the program as a whole, including program pillars and staff (the meta level); current STARS students, from other cohorts (meso); and cohort-mates (micro). This conceptual model can be summarized as in Figure 2, an extension of Figure 1.

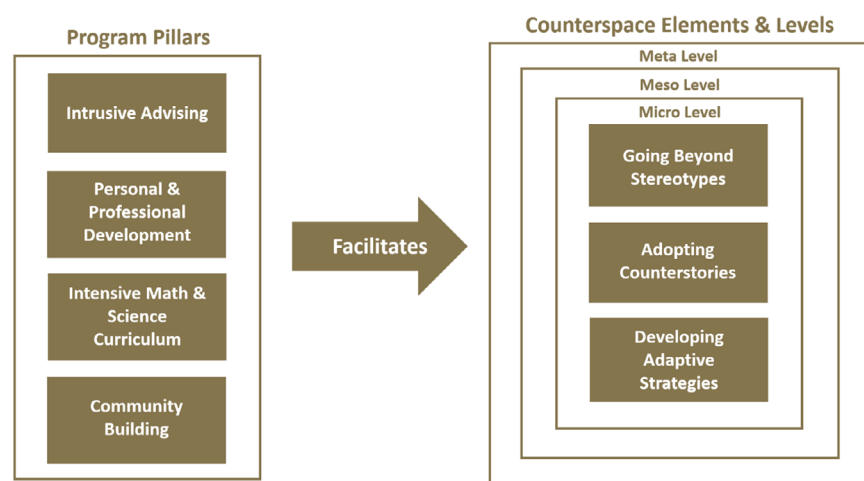


Figure 2 Guiding Framework for Understanding STARS Counterspaces. This figure visualizes how four program pillars facilitate participants to create counterspaces at multiple levels of nested aggregation and enact three foundational counterspace elements.

Going beyond stereotypes

Underpreparation for an undergraduate engineering program, by its very name, conveys a negative, deficits-oriented message to lower income students and sets them up to be vulnerable to negative stereotypes that impede their success. STARS seeks to support participating students in going beyond these negative stereotypes through programming. The focus groups (and Jamboards) did not ask students directly about how they have been influenced or limited by negative stereotypes, which helped avoid stereotype threat (e.g., [Spencer, Logel & Davies, 2016](#)) and the biased responses that might emerge in response to such threat. Instead, the focus group protocols ask about self-confidence and use this as a proxy for going beyond negative stereotypes. Diminished academic confidence of underprepared students is well documented in the literature ([Richardson & Sullivan, 1994](#); [Wilmer, 2008](#)) and the emergence of strong self-confidence can reflect how STARS enables students to move past predisposed beliefs about their success in college.

Many students in the focus groups concurred that the overall program (meta level) and their peers (meso and micro level) played a significant role in improving their academic and career self-confidence. Students felt that the program “gave me the confidence to go into every class with the feeling that I am going to do well” and that “the abundance of academic support makes classes less intimidating and makes us more confident in our ability to succeed.” These student quotes

suggest that the program supported students to go beyond existing stereotypes and be confident regarding their potential for academic success.

Students who previously thought that an engineering or STEM career was out of their reach came to believe that this was not at all true. One student shared that “STARS really emphasized grit and perseverance and was always supportive and always made me believe I can be an engineer.” Another student suggested the following:

Before I was not very supported to pursue a STEM major, especially engineering. So, when I got to UW and when I got into STARS, things just changed. Everyone was so supportive of it. And then there was always saying that “Reach out to us,” whenever I need to, or for anything. That doesn’t have to be a career-related need. [...] So, STARS really helped us to see how good our future can be, if we keep pursuing what we want to pursue right now.

Both quotes indicate that the program provided substantial instrumental support (e.g., “Reach out to us... for anything”) and emotional support from program staff at a broader level (meta level). These quotes underscore the program’s encouragement for students to pursue engineering as a major and provide insights into the methods for achieving that goal, such as perseverance. The second quote provides evidence that this kind of confidence-boosting support was not always available to the student prior to college. Further, students pointed out ways that proactive advising can be encouraging. One said,

There’s really no set space where I guess we [...] encourage each other. It’s everywhere [...] Maybe we’ll get an email from [staff], with some new opportunities, new research positions, new internship applications. And even the program director [...] they’ll reach out to us once in a blue moon and just let us know that they see the work that we’re doing and they’re proud.

This student’s quote shows how outreach from staff advisors is part of the general milieu of encouragement in the program (“It’s everywhere”).

Students also described how they boosted each other’s confidence. One individual shared the following about their peers:

It doesn’t feel like peer pressure. It feels like all these people around me are doing something for themselves. They’re going out here and getting these internships. They’re making all these moves that are good for them and their future. I could be doing that as well. It’s always, people are encouraging you, you can do this.

This student suggests that the student community—which is developed by the students (meso and micro levels) within the structure the program provides for community building at the meta level). In so doing, it provides members with models for success and the implication that they too can succeed. Further, as we discuss further in the section on counterstories, mutual support is more emphasized than is competitiveness among the students we spoke with (“it doesn’t feel like peer pressure”).

While the above quote is about other students generally without specifying whether they are cohort-mates, there are several examples of student input suggesting that they receive boosts from both cohort-mates and active STARS students from other cohorts. One individual from the 2021 cohort shared that they have benefitted from both their cohort and other cohorts:

I just want to add that it’s not only [the 2021 cohort] that I’ve gotten support from. I’m sorry if I out you, [name redacted,] but I love the pep talks you give me. I’ve had a lot of people from even different cohorts come up to me like, “I know it’s hard right now, but it’ll get better.”

This quote demonstrates how students from earlier cohorts validate STARS students’ struggles and encourage them to stick with it (“it will get better”). This underscores the fact that the student community within the program operates at both the meso and micro levels.

Clearly, students' peers were instrumental in supporting the students to go beyond the stereotype that underprepared students cannot succeed in engineering. Instead, through STARS, students looked beyond this stereotype and saw a future career that was theirs to choose and define.

Adopting counterstories

In addition to building confidence among students, STARS also encouraged and enabled counterstories regarding a wide range of college experiences, just a few of which are described here. Lower-socioeconomic status students are more often socialized to take on what Dweck (2012) terms a fixed mindset—we are either smart or we are not, we know the answer or we do not—rather than a growth mindset which suggests that we can fail and learn from our mistakes (Destin et al., 2019). The tendency for marginalized students to be both more often culturally construed as “not cut out for engineering” (e.g., Secules et al., 2018) and to be socialized to work with a fixed mindset can create a more challenging environment for these students to persist in engineering. However, STARS counters that idea with a growth mentality by supporting students to learn from their mistakes and focus on why things worked the way they do. A student described this shift this way:

Typically, in my high school environment, I was told, “Did you get it right or not?” [...] “You got the wrong answer, why’d you get the wrong answer?” And that’s just all we talked about. But in STARS, the workshops, our professors would ask us, “Okay, so what do you think the next step would be?” And then they help us walk through the problem. And then they explain, this can be applied to something else. [...] And something that my professor in the workshops has always asked me is, “Have you seen this problem before?”

This student suggested that, in contrast to the message they received in high school, where answers were categorized as either right or wrong, the STARS staff (meta level) viewed a wrong answer as a starting point. They would guide students through the process of finding the solution (“What do you think the next step would be?”) and enhance learning by eliciting and linking students' prior knowledge (“Have you encountered a similar problem before?”).

Another story that might emerge in environments that tend toward a fixed mindset is that education is not about exploration and the joy of learning, but it is rather a means to an end—getting a grade, earning a degree, or getting a good-paying job. However, STARS demonstrates that learning can be more than that, even fun. One individual suggested that, through the program overall (meta level), they “have found learning more fun and have been introduced to the possibilities engineering has to offer.” Along with this, multiple students shared how the program had supported them to discover or pursue their “passion.” Another student suggested that their studying and living with their cohort-mates (meso level) have helped them perceive learning as enjoyable:

I think it’s pretty fun to just see my friends studying in [the study rooms in the dormitory]. And then I just go in and say “Hi,” or be like, “Hey, are you guys doing this problem? How did you guys approach this one?”

This student’s comment suggests that the combination of social connection with cohort-mates (micro level), residential proximity, and academics (meta level) help demonstrate how learning can be collegial and fun.

Finally, the quote above that begins with “It doesn’t feel like peer pressure” helps to demonstrate how the program—by building strong, mutually supportive community—helps create a counterstory about what the experience of engineering looks like, including by subverting the idea that its classrooms need be competitive (e.g., Secules, 2019). As one pre-engineering student described the program environment,

So, I feel like the competitive nature of the rest of UW compared to the cooperative nature of STARS, there’s a really big contrast there. In STARS, everybody wants to help each other out. We do stuff together. If we need help, we ask.

Further, by supporting the thriving of students who have been marginalized based on socioeconomic status and in many cases race/ethnicity, gender, and/or other statuses, we argue that STARS is helping to change the face of engineering, helping to shift from a field that includes “predominantly and stereotypically [...] White, heterosexual, and middle-class men” (Secules, 2019, p. 198).

Developing adaptive strategies

STARS students discussed several ways the program community supported their developing and/or using adaptive strategies for flourishing in their academic programs. For example, they talked at length about how challenging the intensive academics of the program are, and that the program counterspace helped them develop the skills to adapt. As one individual described this dynamic:

We have the times where it's like we're trying to learn new stuff and I'm here for it, right? But once you're in it for long enough, there's going to be those days where you're just not into it. You just have a hell of a lot to do, just so much on your plate to handle. And something else that STARS does is teach you how to handle those moments because they know that those moments are going to come through. And they're always just teaching you the time management skills [...] and just showing you campus resources.

This student demonstrates how the combination of the intensive math and science curriculum (“you have a hell of a lot to do”) and personal and professional development (“STARS [...] teach[es] you how to handle those moments”) elements of the program (meta level) have helped them recognize that there are going to be challenges and provided skills for how to navigate those difficulties.

Students also discussed how the program helped them adapt to college in general, for example with concrete study and notetaking skills, as well as in terms of building a community and getting adjusted to the rigors of the university. One student shared the following:

If it wasn't for [Program ...] I wouldn't have had an academic community, or I wouldn't have learned how to learn or learn how hard college classes were. School is all right, but the gap between high school and college was vast. We had that summer quarter to bridge the gap, catch up, so that really fueled our success. And yeah, it was through all the preparation. Without STARS, I'm not sure where I would be, to be honest.

This quote demonstrates that the program—especially the intensive math and science curriculum (“how hard college classes were”) and personal and professional development (the summer bridge program) elements—has provided support for students to transition into college and to thrive overall, which can facilitate their developing strategies to adapt to their overall academic program.

We also note numerous examples of students providing each other with instrumental support (micro level) that helps them adapt to academic and life challenges in a variety of ways. This helps them stay up to speed and can lower their stress. For example, several focus group participants talked about the relief of knowing that if they have a question about their homework or miss a class session, other people will quickly help them work through problems and fill them in about things they may have missed. One student shared, “I remember missing one lecture, but we have a group chat, and I was easily able to contact the group chat and just say, ‘Does anyone have the notes from lecture?’ And then they're able to provide [them], or if I'm stuck on a homework problem, I could hit someone up and they'd be happy to explain it.” In this quote, the student speaking outlined ways that the students in the same cohort (micro level) are adapting to setbacks (in this case, not making it to a given lecture), which may stem from life challenges.

RQ2: IN THE COUNTERSPACES ENABLED BY STARS, DO SOME MARGINALIZED GROUPS EXPRESS GREATER OR BROADER POSITIVE OUTCOMES THAN OTHER GROUPS?

The second research question investigates how STARS counterspaces may provide differential outcomes across marginalized groups. While we do not observe strong distinctions in outcomes,

we do notice varied findings along some axes of disadvantage. For example, we notice that some students of color reported prioritizing developing communities at the UW, whether within or outside of STARS, with which they can identify based on an important aspect of their personal backgrounds, including a religious group and another that focuses on men of color. White students did not bring this up.

For several students, especially Latina women, the program provided a community with which they could identify, since the students all shared marginalization from the perspective of the socioeconomic conditions in which they grew up. For example, a Latina woman shared that the program builds a tighter community because the students share a similar, “low-income, underrepresented” background.

Some other students of color, however, remarked that they sought affinity group connections outside of the program that were based on race, ethnicity, or another salient social marker like religion. For example, one student shared:

Outside of STARS I’ve spent the second most [time] with the Instructional Center [IC] at UW, because that center is for OMA&D [Office of Minority Affairs & Diversity] students. I guess, for me, I don’t really regularly see a lot of people who look like me in my other STEM classes. So, finding somewhere to be able to kind of work towards my education, the IC is really comfortable for me because, I guess I just feel I have others that are going through the same experience as a student like me.

That students of color exclusively brought up a need for affinity group connections underscores the importance of this kind of community for individuals who face racial and/or ethnic marginalization. It also suggests that some students have different needs and challenges that are not relevant to other students.

Aside from the particular appreciation among some Latina women for the STARS community they can identify with, we do not find evidence of substantial gender differences in how students discussed their experiences in the program. This does not definitively demonstrate that there are no such differences, just that they did not arise in the conversations we had with STARS students.

RQ3: IS STARS PROVIDING SUFFICIENT COUNTERSPACES FOR STUDENTS?

Most students cited STARS as their strongest community, however, there is some evidence to suggest that the counterspaces the program helps facilitate could be improved. First, STARS facilitates students’ somewhat singular reliance on one another: the program has historically discouraged students from participating in extracurricular activities during their first year at the university and more recently, the program prohibited them from doing so. These policies are designed to support students staying focused on their demanding STARS program. However, not allowing access to outside groups can inadvertently limit the ability of these racially and/or ethnically marginalized students to access all the support and participate in the other counterspaces they need to flourish. As mentioned above, some students—particularly students of color—looked forward to formally connecting with students outside of the program and lamented this limit on their ability to do so: “I was really excited to meet a bunch of people and see a lot of diversity. So, this is really bad, but despite STARS telling us not to do clubs, I did go to a lot of club meets.”

Research suggests that supporting students’ decision-making control may support student achievement (e.g., [Chan et al., 2014](#)), and could possibly even endear the students to the STARS community even further. Since the program is so demanding that students have little time to connect with others anyway, a firm policy about participating in extracurricular activities may not be necessary for many students:

I would say [...] because we had already STARS, we didn’t really look at other communities. We weren’t really given the options since all of our classes for the first quarter, [it] was just the 30 of us. There was no other students. And so now we’re on the second quarter, and sure, we got to see some new students, but at the same time we’ve

already kind of formed our friend groups, et cetera, to the point where [...] we've grown to think, oh, okay. If we meet a new person, cool, but otherwise it's not really needed.

Second, it is noteworthy that we were only able to recruit a few individuals from the 2019 cohort to participate in focus groups. They were enthusiastic about the program and agreed that the STARS community was their strongest on campus. At the same time, the limited number of students we spoke to from this cohort may speak to the program's waning prominence for students over time, once they move beyond the formal program to integrate into their engineering departments more fully (Knaphus-Soran, Hiramori & Litzler, 2021). It is arguably not surprising that many more students in the thick of the program participated in this research, though this is worth exploring further to understand the extent to which programs like this do or can help build counterspaces that maintain some strength as participants complete their degrees and move into their careers.

DISCUSSION AND CONCLUSIONS

Our study provides evidence that STARS helps engineer program counterspaces at the program (meta), cross-cohort (meso), and cohort (micro) levels (Research Question #1) for high-achieving and underprepared students who face marginalization along socioeconomic and often racial, ethnic, and/or gender lines. By operating largely distinctly from the broader UW College of Engineering and placing considerable emphasis on cultivating a strong community of holistic support, the program creates an encouraging environment that prepares students to academically excel in the highly competitive engineering programs at one of the highest-ranked public universities in the United States. As an academic, professional, and personal support program that combines several of Ong, Smith, and Ko's (2018) types of STEM counterspaces (peer-to-peer relationships, mentoring relationships, the events component of STEM student groups, and the institutional support of STEM departments), STARS helps show how multiple counterspace dynamics can work together to support students. The program also holistically combines the counterspace categories Thomas and colleagues (2021) outlined—supporting their engineering identity, professional development, close (“familial”) peer relationships, and general wellbeing. This research shows that counterspaces can operate at multiple levels of aggregation and adds to the literature that the combination of intensive academics and strong community bonds can create a successful engineering pathway for students who enter college with limited prior preparation for the program (e.g., Litzler & Samuelson, 2013; refer to Xu et al., 2018 for work related to biology students). Past research has shown that efforts at multiple structural levels (classroom, department, and institution) are necessary for creating an inclusive engineering space (Davis et al., 2018), and the present study helps articulate the usefulness of multiple levels of counterspaces for making change. Large research universities can develop similar programs to expand equity in their engineering programs and the entire field, which has long lagged others in diversifying. While diversity is only one step toward equity and justice, it is crucial for this work.

Our focus group data suggest that the STARS counterspaces operate at all three levels of aggregation (meta, meso, and micro) to facilitate students going beyond stereotypes, adopting counterstories, and developing adaptive strategies to thrive in their programs. This is an important finding for considering how the overall program as well as various actors can each contribute to building counterspaces, despite forging different relationships with current students. For example, while the program and its staff provide the necessary structure for the counterspaces and near-peers show models for the future, cohort-mates comprise the core counterspace and go through uniquely intensive bonding that likely allows them to bring their fuller selves into the program and benefit substantially from the additional layers of program counterspaces.

Program structure, staff, and students from concurrent and previous cohorts share confidence-boosting encouragement and peers show each other models for different ways to pursue success. STARS students maintain a culture of mutual academic and life support. They validate each other's struggles and promote sticking with the program. All of this reinforces students' capacity to succeed (going beyond stereotypes) and indeed students reported that the counterspace contributes to students' academic and professional performance, and thus their prospects in engineering.

Further, the program pedagogy and staff (meta level) promote counterstories by emphasizing a growth mindset—which can be less common for students from lower-socioeconomic status backgrounds (Destin et al., 2019)—building the structure for students to have fun and find their passion amidst a demanding academic program, and by countering dominant stories about the field—that it is inherently competitive and that engineers need be middle-class, White men. Students co-create and participate in this culture, so we find these counterspaces in action at the meso and micro levels as well.

Students develop their adaptive strategies through personal and professional development, the intensive math and science curriculum, and through academic and life support students provide each other, and we find evidence that this also operates at multiple levels of aggregation. The program structure and staff (meta level) demonstrate how to adapt to both challenging academics and college in general to succeed. Students are also providing each other mutual support and therefore adapting collaboratively when issues arise, such as getting sick and missing a lecture.

While we did not find substantial differences in program outcomes based on different forms of marginalization (race, gender, etc.; Research Question #2), we did find some evidence that a counterspace based on shared marginalization may be particularly important for students of color, some of whom found this community within the program and others who sought this community elsewhere. For some students of color, the racially and ethnically heterogeneous STARS counterspaces were not sufficient for meeting their needs (Research Question #3). This underscores the usefulness of counterspaces that are specifically designed for students facing racial and/or ethnic marginalization, for whom scholars developed the theoretical framework, and may connect to the strong emphasis that some groups of color place on community (e.g., Fernández, Rincón & Hinojosa, 2023; Yosso, 2005). Further, White privilege allows lower-income White students to “pass” within wealthier White crowds and racial and/or ethnic marginalization tends to remain salient in historically predominantly White spaces. Given the possibly greater importance for students of color to connect with communities they identify with, the ability to join affinity groups outside of the program may be particularly salient and consequential for them. Staff administering programs like STARS can support equity in their programs by ensuring their students of color have access to the counterspaces they need, regardless of whether they are program specific.

It is important to emphasize the usefulness of the holistic set of STARS components for facilitating the building of counterspaces. A small body of research shows that several components of the program—support from peers and faculty, co-curricular development, and residential requirements—improve engineering students’ sense of community and belonging (Litzler & Samuelson, 2013). The present study builds on this work by expanding the components under consideration and exploring how these pillars contribute specifically to counterspaces and related outcomes. The four program pillars—intrusive advising, personal and professional development, intensive math and science curriculum, and community building—are intricately interwoven, each playing a pivotal role in creating a community that helps minoritized students succeed by partially facilitating students going beyond stereotypes, adopting counterstories, and developing adaptive strategies.

While the institutional structure of STARS facilitates a robust set of supports for students, this structure also means that the program’s counterspaces may develop differently than those that arise from programs with a narrower focus (e.g., community building for emotional and navigational support without a focus on academics) or with fewer demands on participants’ time. As a result, and while students play a very large role in developing their own counterspaces, there are limits to how much ownership they have over the counterspaces. For example, the program dictates to some extent how much interaction students have with each other and other aspects of the program. This may inhibit the sustainability of the counterspace over time, which starts with participants essentially living the program and follows with a substantial drop-off in organized interaction after the first two years.

This is certainly not the first study about program-initiated counterspaces (e.g., Grier-Reed, Na'im & Buckley, 2008; Grier-Reed, 2010; Margherio et al., 2020; Masta, 2021). However, STARS has some unique features including the length, intensity, and holistic nature of the program that can shed light on how sustainable programs are after they end. Future research would benefit from a deeper dive into how well counterspaces like those structurally supported by STARS survive once the program ends. On one hand, conversations with students who were in their third year of college (i.e., they were done with the formal STARS programming) suggested that the STARS counterspace lived on beyond the first two years of formal program activities. Some of these students shared that their connections to their cohorts remained particularly strong and reflected positively on the training they gained through the program. At the same time, we only spoke with a small number of students who had completed the formal program, who may have been particularly enthusiastic about the program. Speaking with a broader set of students and drilling into this question may help to highlight how programs like this can provide participants with long-term counterspace support.

This research suggests potential practical implications for other institutions that are interested in applying the STARS model within their engineering program. Firstly, providing such opportunities will likely lead to an increase of engineering applicants from marginalized communities. Secondly, given that the program's model creates a culture of equity in an engineering program, STARS helps to lower some of the barriers participating minoritized students face as they work to succeed in the field at large (Knaphus-Soran et al., 2024). However, it is important to note that while STARS provides students supports necessary to succeed, thereby broadening participation in the field in the long run, the program does not directly address existing structural issues of diversity and equity within the UW College of Engineering or the field more broadly. Until these inequitable structures are dismantled and replaced with equitable systems, programs like STARS will remain necessary (Knaphus-Soran, Foster & Scher, 2021). They may, however, provide a promising step towards transforming the engineering field and, ultimately, contribute to their own gradual obsolescence.

APPENDIX: CODEBOOK

ID	PARENT ID	DEPTH	TITLE	DESCRIPTION
1		0	Academic Outcomes	Any mention of academic outcomes associated with the STARS program/UW Experience.
2	1	1	Academic Performance	Any mention of GPA increasing or decreasing.
3	1	1	Coding Skills	Any mention of STARS students learning to code.
4	1	1	Help With Work	Any mention of support providing help with work.
5	1	1	Preparation for Courses	Any mention of preparing or becoming well prepared for current/ future courses.
6	1	1	Problem Solving/ Learning	Any mention of increased problem- solving skill and any emphasis on learning.
7	1	1	Study Skills	Any mention of increased study skills.
8	1	1	Time Management Skills	Any mention of improved time management skills.
9		0	Additional Agreement	Includes agreement for things that are not otherwise coded, verbal or non-verbal in nature.
10		0	Additional Outcomes	Any mention of additional benefits/ drawbacks.
11	10	1	Collaboration Skills	Any discussion about learning to collaborate.
12	10	1	Emotional Support	Any mention of receiving emotional support from STARS community.

(Contd.)

ID	PARENT ID	DEPTH	TITLE	DESCRIPTION
13	10	1	Life Support/Connection	Any mention of life support from STARS community, this can include learning life skills like doing taxes, instrumental support (e.g., bringing food, sharing homework), and non-school community.
14	10	1	Smooth Transition to/through College	Any mention of the STARS program streamlining transition into/through college. This includes comments related to suggestions that the student would not have been at UW without the STARS program.
15		0	Assessment	Any assessment of an aspect of the STARS program or another feature of the students' experiences at UW.
16	15	1	Negative/ Unhelpful/ Uncomfortable	Any description of an aspect of the STARS/ UW experience as negative or unhelpful for the student(s).
17	15	1	Neutral	Any description of an aspect of the STARS/ UW experience as neutral.
18	15	1	Positive/ Helpful / Comfortable	Any description of an aspect of the STARS/ UW experience as positive or helpful for the student(s).
19		0	2019-2020 Cohort	Any comment by a person from the 2019-2020 cohort to identify comments from students further removed from the program.
20		0	Community & Belonging	Any discussion of students' sense of community/ belonging in STARS/ at UW.
21	20	1	Additional Friendship	Any mention of friendships at UW that are not related to STARS or another formal group.
22	21	2	Friendship Through STARS	Any mention of additional friendships through the STARS network.
23	20	1	Strong Outside Community	Any mention of communities/ organizations outside of STARS that cultivate a strong(er) sense of community.
24	20	1	Strong STARS Community	Any mention of a strong(er) sense of community within STARS. This can include discussions about things like trust.
25	24	2	Across Cohorts	Any mention of strong community across cohorts.
26	24	2	Cohort-Specific	Any discussion of a strong(er) cohort-specific community.
27	24	2	Strongest Community	Any mention of STARS as a space where students experience their STRONGEST sense of community.
28	20	1	UW Student Groups	Any mention of UW groups students are a part of outside of STARS, including race/ethnicity-based affinity groups, religious groups, academic groups, gym membership, etc.
29	20	1	Weak/ No Outside Community	Any mention of communities/organizations outside of STARS that are either present but represent weak(er) ties or not present.
30	20	1	Weak/er STARS Community	Any mention of a weak(er) sense of community within STARS. This can include discussions about things like trust.
31		0	Community Cultural Wealth	Any discussion that points to forms of community cultural wealth that students may have, develop, or access.

(Contd.)

ID	PARENT ID	DEPTH	TITLE	DESCRIPTION
32		0	Covid-19	Any mention of the influence of Covid-19 on student experience
33		0	Diversity	Any mention of how diversity (racial/ gender) in STARS has made students more comfortable working in a traditionally White/male dominated field.
34		0	Feature of STARS Program	Any mention of a specific aspect of the STARS program.
35	34	1	STARS Staff/ Faculty Intrusive Advising or Other Support	Any mention of support from an individual or group – including staff proactively contacting students (“intrusive advising”).
36	34	1	Personal & Professional Development	Any mention of the STARS programming focused on personal and/or professional development.
37	34	1	Academic Program/ Intensive Math & Science Curriculum	Any mention of the STARS academic program, including the intensive math and science curriculum.
38	34	1	Community Building	Any mention of community building as a part of the STARS program.
39	34	1	Strict Program	Any mention of STARS students mentioning the program being strict or inflexible, including rules against joining non-STARS clubs.
40	34	1	Model Speakers/ Contacts	Any mention of hearing/ learning from more senior students/ professionals about their pathways.
41	34	1	Shared residence	Any mention of STARS required shared living spaces on campus.
42	34	1	Skills & Reflection Sessions	Any mention of a course that focuses on professional, life skills (e.g., interviews, taxes), including reflection sessions.
43	34	1	Struggle/ Challenging Program	Any mention of struggling with the amount/ level of difficulty of STARS program.
44	34	1	Study Groups/Peer Support	Any mention of STARS study groups or any peer support.
44		0	STARS Providing Necessary Resources	Any mention of STARS scholarships, computers, etc.
45		0	Professional Development Outcomes	Any mention of professional development outcomes related to STARS/UW experience.
46	45	1	Awareness about Field	Any mention of gaining greater awareness of field.
47	45	1	Career Fairs	Any mention of career fairs.
48	45	1	Conferences	Any mention of conference participation.
49	45	1	Internships/ Research Opportunities	Any mention of STARS helping students pursue an internship or research opportunity.
50	45	1	Job Prep	Any mention of resume-building, interview preparation, LinkedIn support, etc. that supports pursuing and obtaining a job (outside networking).
51	45	1	Networking	Any mention of networking encouraged or facilitated by STARS.
52	45	1	Professionalization	Any mention of STARS supporting development of professional behavior (how to interact, write emails, etc.)

(Contd.)

ID	PARENT ID	DEPTH	TITLE	DESCRIPTION
53		0	Psychosocial Outcomes	Any mention of psychosocial outcomes of the students' STARS program/ UW experience.
54	53	1	Certainty about & Interest in Path	Any mention of STARS supporting greater certainty/interest in following (engineering) career path.
55	53	1	Confidence/Comfort in Skills	Any mention of STARS influencing self-confidence or greater comfort in own skills/ ability to do things.
56	53	1	Growth Mindset	Any mention of learning how to cultivate a growth mindset.
57	53	1	Humility	Demonstration or mention of gaining humility.
58	53	1	Motivation	Any mention of STARS shaping student motivation.
59	53	1	Persistence/grit	Any mention of developing a "never give up" attitude, or similar.
60	53	1	Reduced Stress	Any mention of reduced stress about future major (program nearly guarantees access to top choice) or profession.
61	53	1	Solidarity	All mentions of instances of feeling solidarity.
62		0	Quote	Any potential quote for the paper.
63		0	Race/Ethnicity	Noting the participant's race/ethnicity as they recorded in the Race/Ethnicity Survey.
64	63	1	African American/Black only	Noting participants that identify as African American/Black only.
65	63	1	Asian only	Identifies as Asian only in the race/ethnicity survey.
66	63	1	Latine only	Noting participants that identify as Latin only.
67	63	1	Middle Eastern/North African only	Noting participants that identify as Middle Eastern/North African only.
68	63	1	Multi-racial/ethnic	Noting participants that identify as Multi-racial/ethnic.
69	63	1	No racial/ethnic identity specified	Noting participants that do not code their racial/ethnic identity.
70	63	1	White only	Noting participants that identify as White only.
71		0	Spaces & Places	Any mention of spaces & places on campus.
72	71	1	Big Classes/Big Campus	Any mention of big lecture halls/big campus.
73	71	1	Gym	Any mention of the campus gym.
74	71	1	Instructional [Tutoring] Center	Any mention of the Instructional Center.
75	71	1	Library/Study Rooms	Any mention of libraries or study spaces (e.g., study rooms).
76	71	1	Building with STARS Offices	Any mention of the building with STARS or Faculty/Staff Offices.
77	71	1	Dorms	Any mention of the engineering dorm or "dorms" in general.
78	71	1	Non-STARS Classrooms/Classes	Any mention of classrooms or classes that are not specific to STARS.
79	71	1	STARS Classrooms/Classes	Any mention of STARS -specific classrooms or classes.

(Contd.)

ID	PARENT ID	DEPTH	TITLE	DESCRIPTION
80	71	1	The Ave (Local Street)/ Near the Ave	Any mention of the Ave or surrounding area.
81	71	1	The Hub (Student Meeting Place on Campus)	Any mention of the Hub.
82	71	1	Virtual Spaces	Any mention of virtual spaces.
83	71	1	Wherever Friends Are	Any mention of the specific space not mattering as much as the people the participant spends time with.

DATA ACCESSIBILITY STATEMENT

Because of the terms of the confidentiality agreement with participants, it is not possible to share the data beyond the research team.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

All authors approve the author list and this manuscript and for submission to *Studies in Engineering Education*. They also agree to be accountable for the study.

- Carll participated in all aspects of the research process and manuscript preparation and revision.
- Rajouria participated in all aspects of the research process and manuscript preparation process and revision.
- Wilson participated in substantially revising the paper.
- Cunningham contributed to the research design as well as revising the paper.
- Riskin contributed to the research design as well as revising the paper.
- Litzler contributed to the research design as well as drafting and revising the paper.

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