Board 184: A Layered Mentoring Approach for Engineering Excellence

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Abstract:

The Alternative Pathways to Excellence (APEX) Program at the University of St. Thomas, funded by NSF as an S-STEM Track 2 project, aims to solidify transfer pathways, and assist Engineering students by providing financial, academic, and practical support. The successful integration of transfer students into engineering programs presents a unique set of challenges and opportunities for higher education institutions. The APEX program provides a comprehensive support system, including structured and informal mentoring, guidance for both academics and extracurricular activities, and collaborative teamwork experiences. The program is designed to forge accessible pathways into engineering careers for students with high academic potential, who are facing financial constraints by granting annual S-STEM scholarships to a select group of students [1]. This paper describes a layered mentoring approach adopted by our team that encompasses both pre-application and post-application phases. We explore the pivotal roles played by peers, faculty members, and industry advisors in mentoring aspiring engineers through their educational journey.

The paper describes the support structures and strategies implemented before students apply to engineering programs, shedding light on how early mentoring can influence students' preparedness and motivation to pursue engineering degrees. This paper also reports on the ongoing mentoring and support mechanisms vital for transfer students during their engineering studies. Peer mentoring, faculty mentoring, and industry advisor mentorship are all integral components of this stage. Furthermore, the paper outlines the training routines and strategies employed to prepare faculty, industry advisors, and peer mentors for their roles in supporting engineering students. This training ensures that mentors are equipped with the necessary skills and knowledge to guide students effectively, foster their academic growth, and nurture their professional aspirations.

Introduction:

Research shows that providing mentoring support to low-income STEM students boosts their retention rates. This effect is particularly pronounced for students transferring from community colleges into four-year STEM programs [2]. Effective mentoring helps students in understanding the academic norms as well as help deciphering the unwritten rules, values and norms – often referred to as the "hidden curriculum" [3]. For low-income, first-generation, and transfer students, the hidden curriculum can be particularly harmful as it may perpetuate inequalities and create barriers to their success. The hidden curriculum may include implicit knowledge about navigating the academic environment, understanding expectations, and accessing resources, which can disadvantage students who do not have prior familiarity with higher education systems. Additionally, the hidden curriculum may reinforce dominant norms and behaviors that marginalize underrepresented students, further exacerbating their sense of exclusion and alienation [4]. Engineering's "hidden curriculum" covers things like professional norms,

confidence-building, and ethics, taught indirectly in early foundational courses, making adaptation difficult for transfer students [5].

Mentoring has been identified as a valuable strategy for decoding the hidden curriculum and supporting students in navigating the implicit messages and norms present in educational settings [3], [4], [6]. Mentors can provide guidance, share their own experiences, and offer insights into the hidden curriculum, thereby helping students to understand and navigate the unspoken rules and expectations of the academic environment. By engaging in mentoring relationships, students can gain access to the tacit knowledge embedded in the hidden curriculum, develop a better understanding of professional behaviors and practices, and receive support in overcoming the barriers posed by the hidden curriculum. This support helps establish trust, build relationships, and develop connections with faculty and peers leading to better academic outcomes for transfer students [7].

Mentoring in the APEX program happens in two stages – a faculty led pre-matriculation mentoring and a faculty, industry and peer post-matriculation mentoring stage.

Pre-Matriculation Mentoring

The program aims to proactively foster a supportive relationship with prospective transfer students. Early academic and career mentoring is the key to setting students up for a smooth transfer experience. The APEX faculty in the School of Engineering have implemented a proactive faculty mentoring initiative aimed at supporting students who may transfer from a number of our local 2-year colleges. APEX Faculty members visit classes at nearby community colleges to connect directly with students. Over the past two years - these visits have taken the form of both on-campus as well as virtual visits via Zoom/Teams. The APEX faculty mentors provide an overview of the undergraduate engineering programs, the various student focused support structures, the transfer process, financial aid and scholarships. More importantly, faculty highlight the benefits of expressing an interest early on in the process and setting up a one-on-one pre-matriculation/pre-application mentoring session.

Students who express interest in continuing on from their associate degree are paired with one of the APEX Faculty mentors. The faculty mentor schedules regular check-in meetings with the student over the course of a year or more. In these mentoring sessions, the faculty member provides guidance on selecting courses at the community college that will properly transfer academic credits. They advise the student on potential engineering degree paths, requirements, and timelines based on the student's interests. Additionally, faculty mentors connect students to campus resources related to financial aid, scholarships, and other support services. This helps students understand the true cost and aid options early on. Mentors also discuss internships, research opportunities, and networking to help students build their resumes and professional skills before transferring. This level of hands-on, personalized mentoring establishes valuable rapport between students and the faculty members. Students receive the insight and confidence needed to successfully transfer, transition, and stay on track for on-time graduation.

Post-Matriculation Mentoring: Faculty Mentor

To provide consistent guidance throughout students' academic journeys, the APEX program matches each scholar with a dedicated faculty mentor. Mentors are professors or instructors within the student's specific engineering discipline, which provides a discipline-specific support

for the scholars. These faculty mentors serve as advocates who help students navigate the ins and outs of university systems. Coming from community colleges or other four-year institutions, scholars often find the transition overwhelming without a knowledgeable guide. Faculty mentors offer a sounding board as students determine everything from course selection to accessing campus resources.

Importantly, mentoring extends beyond academics to address professional growth holistically. Faculty mentors also provide coaching on time management, leadership, research, internship seeking, handling ambiguity, and other skills critical for success through a series of workshops appropriately titled the APEX Success Series. These workshops facilitated by faculty mentors and supported by other dedicated professionals give our APEX scholars a roadmap to thrive in their engineering programs and careers.

We have found that the frequency of meetings is important to develop comfort and trust. Mentors and students meet consistently, at minimum twice per semester, but often more frequently as needs arise. Through regular check-ins, faculty mentors offer the wisdom and human connection vital for scaffolding students on their journeys. They empower scholars to find their voices and forge their own paths in engineering.

In 2018, St Thomas was awarded a Howard Hughes Medical Institute (HHMI) STEM USE Inclusive Excellence Grant. The HHMI initiative recognizes that institutional change is needed to effectively advance DEI practices and retain under-represented students. As a part of this initiative, most faculty mentors have previously undergone training on "inclusive excellence" through Inclusive Classroom Institute faculty workshops on evidence-based culturally responsive teaching practices. The faculty have also undergone a high-impact mentor training for STEM faculty to learn to provide culturally responsive, strengths-based mentoring. The Inclusive Classroom Institute and the Inclusive Mentor Training have equipped faculty mentors with the tools necessary to develop trusting relationships across diverse backgrounds. When combined with their academic expertise, these trained faculty mentors are able to offer our APEX scholars invaluable guidance both in and outside the classroom.

Post-Matriculation Mentoring: Industry Mentor

Mentorship programs that match students with industry mentors have become increasingly popular in higher education, especially in STEM fields. These partnerships aim to provide meaningful career guidance and connections that complement students' academic learning. Research shows professional mentorship enables crucial real-world perspective and experiential learning opportunities for mentees [8-11].

The goal of our industry mentoring program is to offer invaluable real-world perspective and connections for engineering students as they prepare to transition into professional careers. The program pairs students with experienced engineering professionals, aiming to expose them to the daily realities and responsibilities of potential career paths upon graduation.

The industry mentors were chosen from professionals from External Advisory Board members for each department. Mentors currently hold the following positions: President, Regional Vice President, Principal Civil Engineer, Engineering Manager, Senior Project Engineer, Senior Staff Systems Engineer, Senior Embedded Systems Engineer, Mechanical Design and Integration Engineer, Transportation Design Engineer, Software Engineering Group Manager.

The APEX scholars are a diverse group with different lived experiences than most of our traditional students. The program recognized the importance of training that would support our mentors as they work with various student populations. some of our mentors already had formalized training from their workplaces. All mentors were invited to a training that supported the mentors' intercultural competence. To facilitate that, we utilized the Intercultural Development Inventory (IDI) Instrument [12]. The goal of incorporating the Intercultural Development Inventory (IDI) training was to equip mentors to successfully connect with and empower increasingly diverse mentees [13]. The IDI assesses mentors' intercultural competence across a continuum from monocultural to intercultural mindsets. By first understanding their own capabilities for cultural bridging, mentors can then develop the adaptability and skills needed to engage inclusively. With the help of a trained IDI facilitator, the training supported mentors in building key competencies like self-awareness, perspective-taking, and managing stereotypes. With these intercultural tools, mentors gained the ability to have constructive dialogues that navigate differences. Our program believes when mentors expand their knowledge and adaptability, they can establish positive mentoring relationships with mentees of all cultural backgrounds. This training aims to provide mentors with the intercultural capacity to create more inclusive and impactful mentoring.

Post-Matriculation Mentoring: Peer Mentor

In addition to formal faculty and industry mentors, a group of students are selected as APEX Ambassadors and Tutors. The APEX Ambassadors support scholars during all APEX recruitment and co-curricular activities. APEX ambassadors support recruitment by joining visits to partner schools and hosting prospective APEX scholars at on-campus events and tours. The APEX Tutors support the scholars in their academic courses. Each of the departments uses student peer tutors to support the learning of students in a variety of classes. These tutors often run sessions multiple times a week in student collaboration spaces and support our scholars.

To support scholars' retention, these ambassadors and tutors also assist with cohort-building activities and serve as informal peer mentors to scholars. These ambassadors ensure that prospective transfer students and enrolled APEX scholars can readily connect to visible, accessible engineering peers for informal mentorship. Current upper class engineering students, including APEX scholars and other engineering transfer students who have completed at least one year at St Thomas are invited to apply to become ambassadors and tutors.

Methods:

An anonymous mixed-methods survey was developed to assess student perspectives on the faculty and industry mentoring components of the program. It did not include any questions related to peer mentoring. Due to the small number of peer tutors and APEX ambassadors, collecting data on this group would pose risks to anonymity even with aggregation. Therefore, the questionnaire's scope focused solely on student perspectives on the faculty and industry mentoring relationships.

The questionnaire contained both quantitative Likert scale questions and open-ended qualitative questions. The survey was administered to two cohorts of students in the program, totaling thirteen students. Out of the thirteen students surveyed, ten completed the questionnaire, yielding a high response rate of 77%.

Students were first presented with nine Likert scale questions asking them to rate their level of agreement (5 = strongly agree to 1 = strongly disagree) on various aspects of their faculty mentor relationship. Topics included mentor understanding of goals, provision of guidance, satisfaction with mentoring, and frequency of contact. The same questionnaire format was repeated for the industry mentoring component, with 7 Likert scale questions and three open-ended questions about communication frequency, preferences, and relationship value. The use of parallel question sets allowed comparison of student perspectives on the two different mentoring relationships. Descriptive statistics were calculated for Likert scale question responses.

In addition, open-ended qualitative responses provided details on communication frequency, channel preferences, and overall relationship value. Questions included:

- *How often do you have contact with your [faculty/industry] mentor (online, email, in-person)?*
- *What do you think about the frequency of your contact with the [faculty/industry] mentor?*
- *What is/are your preferred methods of contact with your [faculty/industry] mentor?*
- *What do you find most valuable about your mentoring relationship with your [faculty/industry] mentor?*

Qualitative data was reviewed using thematic analysis to identify and summarize recurring themes regarding beneficial aspects of each mentoring relationship.

In addition to mentoring-specific questions, the survey included Likert scale items to gather data on the overall program's influence on students' sense of belonging. These questions asked students to rate their level of agreement on whether through participating in the program they felt:

- a stronger sense of belonging
- welcomed by faculty, industry mentors, and peers.
- that they were valued
- confident in their potential for success

These measures were included to determine if the program's various mentoring components combined had a positive effect on students' wellbeing, inclusivity, support, and empowerment. This data provided additional insights beyond the specific mentorship relationships into how the program influenced students holistically.

Results:

Figure 1 shows a Horizontal Stacked chart depicting Likert scale responses from ten student participants about their experience with faculty mentoring. Responses are shown for questions Q1 to Q9 on a scale ranging from 5 (Strongly Agree) to 1 (Strongly Disagree).

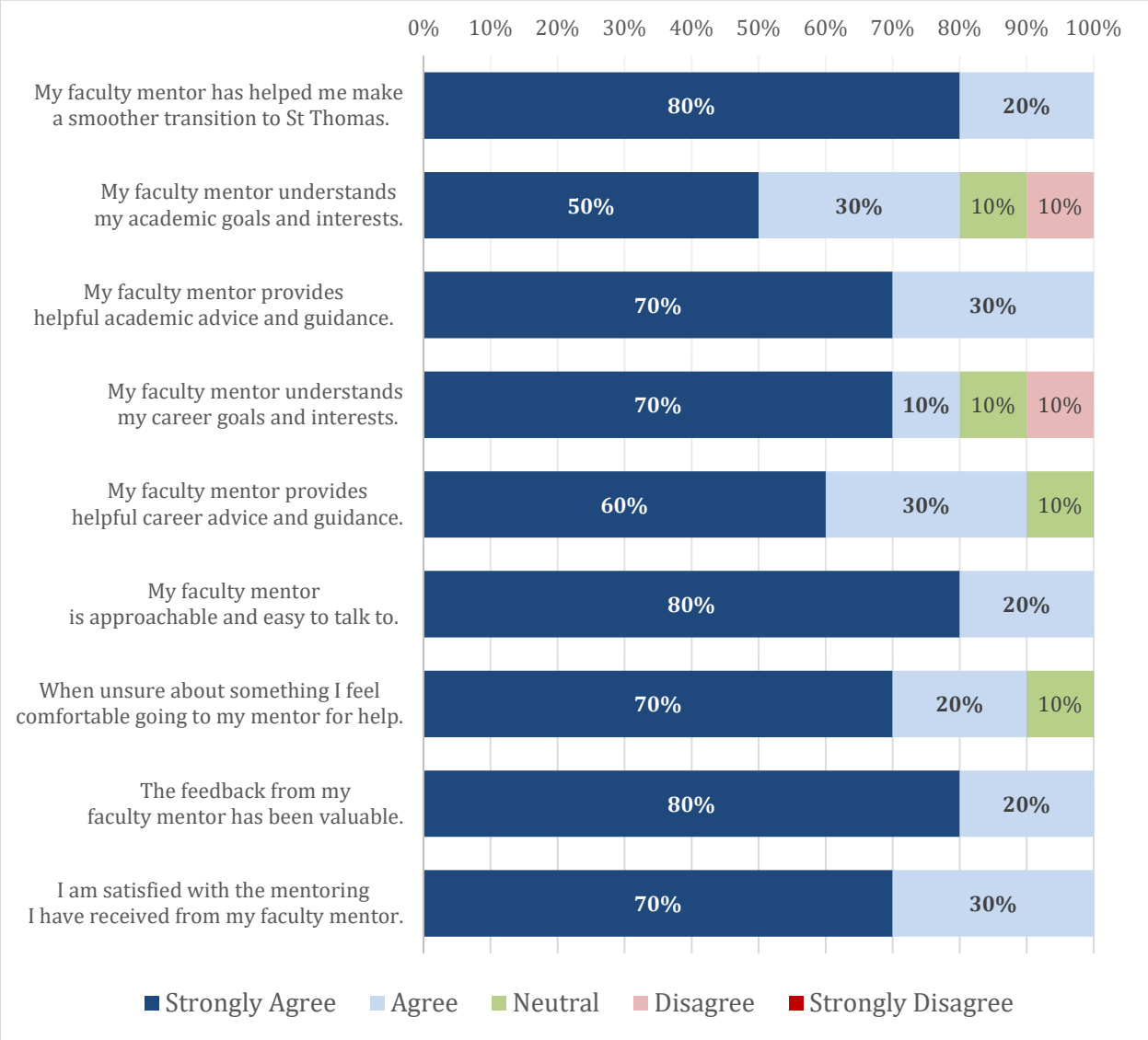

Figure 1 Distribution of Likert scale responses from survey participants about their experience with faculty mentoring.

As seen in Figure 1, participants exhibited strong agreement with statements related to faculty mentoring. The survey results unveiled a strong sense of approval, with most questions averaging above 4.5 in agreement. Topics in Q1 (*smoother transition*), Q6 (*approachable*) and Q8 (*valuable feedback*), received near-unanimous positive responses (average 4.8, standard deviation of 0.4), suggesting a clear alignment with those areas. However, some nuances emerged in Q2 and Q4 related to faculty advisors understanding academic goals and career goals. While the average score for Q2 (*My faculty mentor understands my academic goals and interests*) landed at 4.2, indicating a general agreement, the wider standard deviation (1.03) hinted at diverse opinions on the specific statement – with 20% of the respondents either neutral or disagreeing with the statement. Similarly, Q4 *(My faculty mentor understands my career goals and interests)*, despite an average of 4.4, displayed a higher standard deviation (1.07), suggesting

a wider range of viewpoints compared to other questions – with 10% of the respondents disagreeing with the statement. These variations, while small and while not undermining the overall positive sentiment, highlight potential areas for further exploration for the APEX team.

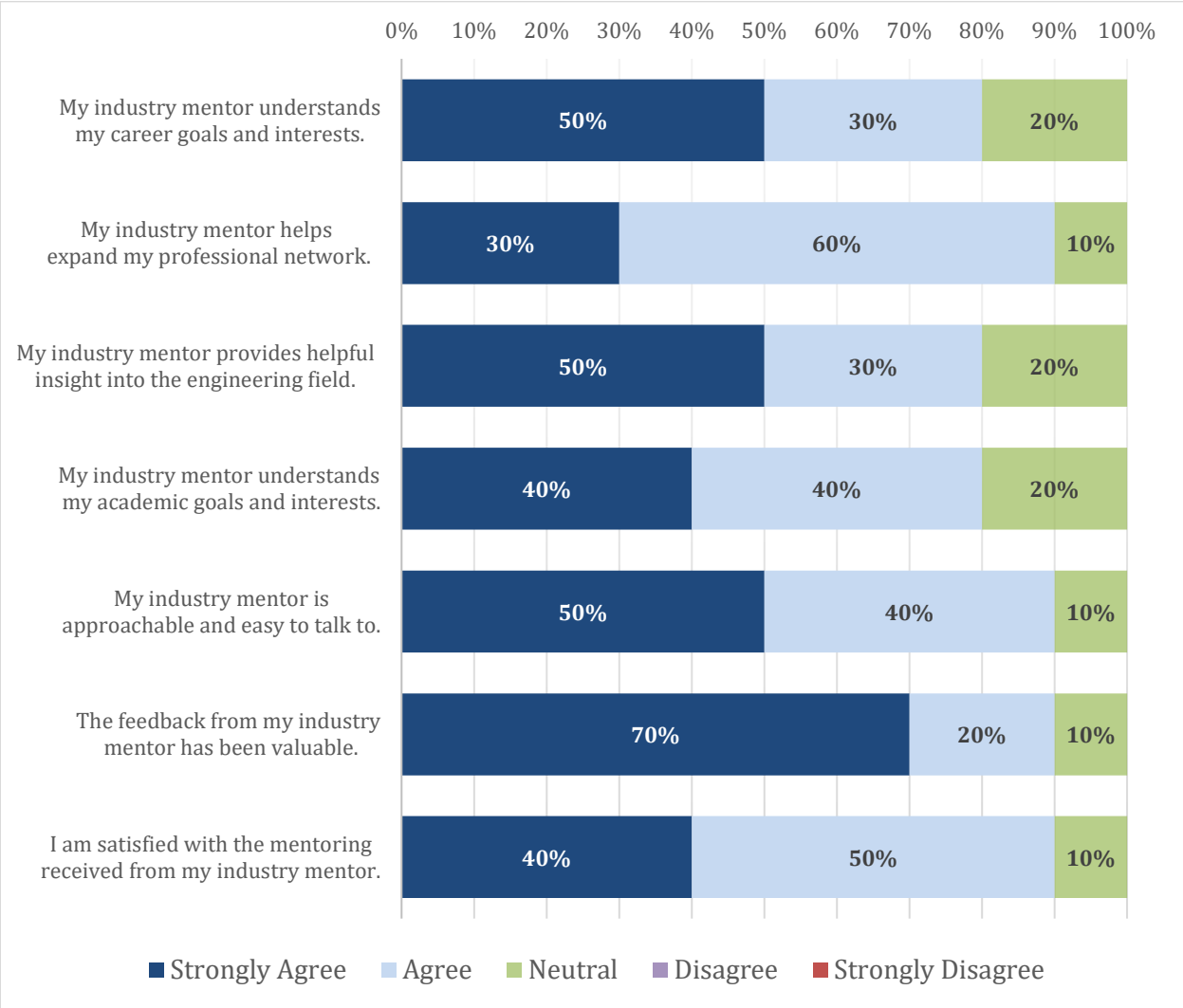

Figure 2 Distribution of Likert scale responses from survey participants about their experience with industry mentoring.

Based on the qualitative response, seven of the students reported meeting with their faculty advisor more than four times a semester. Analysis of the responses show that the APEX scholars clearly value their faculty mentors, highlighting several key benefits in their responses. Accessibility and responsiveness were a major theme that came through in most responses, with students appreciating open-door policies, quick email replies and the ability to frequently ask questions. Students appreciated that besides availability, mentors provided valuable resources and guidance, including career advice, real-world insights, and knowledge about the school's programs and opportunities. This helped students with long-term decision-making and exploring career paths. Importantly, the caring and understanding nature of the mentors fostered a supportive environment, where students felt that *"their past experiences are valued, and future aspirations encouraged."* Based on the students' responses, the faculty mentors emerge as more

than just academic advisors, acting as trusted confidantes who guide students through academic and professional challenges.

Figure 2 shows a Horizontal Stack chart depicting Likert scale responses from ten student participants about their experience with faculty mentoring. Responses are shown for questions Q1 to Q7 on a scale ranging from 5 (Strongly Agree) to 1 (Strongly Disagree). The Likert scale data reveals a strong tendency towards agreement across all seven questions. The majority of respondents (8 out of 10) consistently chose "agree" or "strongly agree" (4 or 5), indicating overall positive sentiment. While some variation existed, a high average score (between 4.2 and 4.6 for the seven questions) and low standard deviations (between 0.6 to 0.8) point to consistent opinions within the group. Notably, only two respondents indicated a *neutral response* to some of the questions. While we acknowledge that the total population was small with just ten participants and these results certainly paint a picture of overall satisfaction or approval based on this limited sample.

Analysis of the qualitative questions show that the APEX mentees agree that through sharing their career journeys, industry mentors have been invaluable in offering motivation and advice on building the technical and other mindset skills required in various engineering roles. Despite varying levels of engagement, students value their industry mentor relationships for the practical information and insights they offer. From real-world work conditions to career guidance and job-hunting tips, mentors bridge the gap between academic learning and professional preparation. Even those with limited interaction acknowledge the potential benefits and desire deeper engagement, highlighting the importance of optimizing these programs to support diverse student needs and maximize their impact.

Table 1. Impact of mentoring and the success series on the APEX Scholars' sense of belonging

I feel…	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
… a stronger sense of belonging at St Thomas	60%	40%	0%	0%	0%
… welcomed by the faculty, industry mentors and my student fellows	70%	30%	0%	0%	0%
… like I am valued.	70%	30%	0%	0%	0%
… like I can be successful.	90%	10%	0%	0%	0%

The survey results shown in Table 1 indicate that the mentoring program and the associated success series have had an overwhelmingly positive impact on APEX scholars' sense of belonging, connection, and self-efficacy. 100% of students agreed or strongly agreed that they feel a stronger sense of belonging since joining the program. All students also agreed that they feel welcomed by program mentors and peers, with 70% strongly agreeing. Further, 100% of students reported feeling valued in the program, with 70% strongly agreeing. Most notably, 90% of students strongly agreed that they feel they can be successful since joining the APEX community. Not a single student responded negatively or neutrally, demonstrating the program's resounding effectiveness at fostering inclusivity, support, and empowerment for our student

scholars. Overall, the data highlights that comprehensive, consistent mentoring positively influences students' well-being and confidence in their potential.

Conclusions:

The APEX program has provided scholarship recipients with more than just financial support. The first two years saw a multi-pronged approach: scholarships, various mentoring formats, and community building through the success series workshops. This aimed to unveil the "hidden curriculum," the often-unspoken aspects of higher education, such as navigating academic systems, social norms, and accessing resources. Mixed-mode surveys revealed the program's impact on students, particularly regarding different types of mentoring. While the sample size was small, positive sentiment towards the program was overwhelmingly high. Notably, some students mentioned limited engagement with their mentors, highlighting an opportunity to strengthen program structure and encourage deeper connections.

Looking beyond individual responses, we see a broader picture. Mentoring, coupled with fostering connections among APEX scholars and participation in other success series programs, has had a profoundly positive impact. Students reported a stronger sense of belonging, connection, and self-efficacy. This comprehensive approach underscores the APEX program's success in empowering students to navigate their academic journey and thrive in higher education.

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