SETS: Lessons Learned and Best Practices of Implementing S-STEM project in the Engineering Technology Department of a Large Urban Minority Serving Public Research Intensive University

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Abstracts

In this paper, the authors detail their journey implementing a S-STEM project in the Engineering Technology Department of a large urban minority serving public research intensive university. Since receiving the award on their "Succeed in Engineering Technology Scholars (SETS)" project in 2015, they gathered support from university and college as well as various student support and service divisions, and achieved great success. In this paper the authors will share the best practices to engaging students as well as student support and service division on campus and across colleges, many of them from well-acknowledged best practices in Technology and Engineering Education community, as well as lessons they learned through the process. Exceeding the project's objective of awarding up to $5,000 scholarship to twenty promising low-income students every year, we awarded 68 students the scholarship for the first four years of the SETS program. We are able to do this partially because of the success of the leadership development component that all scholars and local industry involved appreciated. Through activities and events around the leadership development, many of the scholars were able to find internship opportunities that utilize the knowledge and skills they learned, thus enhance their learning experience and marketability. Some of the scholars secured additional scholarship opportunities from professional societies. Many of them were able to graduate within three years after they were inducted into the program because they can spend more time studying, starting and building up their professional networks, instead of working in non-STEM related position part- or full- time. Three of the scholars are pursing graduate degree in their chosen STEM program and more indicated their intention to pursue graduate degree in the near future. This phenomenon is due to the success of introducing research experience early on to our scholars so that they have a taste of research project and experience the steps involved through the trial and error process. In addition to providing scholarship for per year, the S-STEM grant allowed a team of faculty from multiple disciplines to develop and test new student support mechanisms and programs at the engineering technology (ET) programs, where such supporting and services are traditionally lacking due to its teaching oriented history and students composition – majority of the students enrolled in ET programs are non-traditional and under-represented and minority (URM) students. In addition to typical challenges facing S-STEM project implementation, including scheduling activities and opportunities for all scholars to participate, choosing mandatory activities to hold them accountable, our SETS program has to overcome several institutional and college level hurdles due to institutional-wide digital transformation and college and departmental level leadership change. In the paper, we will details the impact of the project has on students, faculty, programs, ET department, and College of Technology. In addition, we share our categorization of the decisions and choices we have to make while implementing the project, including promoting it among students, faculty, and administrators, as well as seeking out opportunities for our students to take the lead and reach out to their local communities. We hope the findings will provide evidence based disciplinary practices within Technology and Engineering Education community.

1. Introduction

The Scholarship in Science, Technology Engineering, and Mathematics (S-STEM) program [1] is one of the most successful programs of the NSF (National Science Foundation) [2] that have benefited thousands of low-income students who are academically talented to pursue and finish their college education in their chosen STEM programs. Most of them become competent STEM professionals and contributed to the sustaining of the competitiveness of the United States in the global economy. Many of the S-STEM projects also demonstrated their broader impact in transforming STEM programs in two-year and four-year institutions of higher education (IHE) around the United States, impacting students, faculty, and supporting staff. In fact, there are more than 700 active S-STEM projects at over 500 IHE in the United States.

Since the SETS project was awarded, the S-STEM program also evolved. To encourage project leadership team record the instance (i.e., content), identify pattern, and continuously contribute to the knowledge base of STEM higher education, S-STEM program added the "Knowledge Generation" piece in 2016, allocating up to 40% of project resources to support such educational research and critical administrative tasks such as setting up targeted students recruitment mechanism and supporting structure. Such funding allocation emboldens STEM educational researchers to systematically create, adapt, implement, and study the effects of high-quality and evidence-based curricular and co-curricular activities to help students navigating unique challenges they face to obtain a STEM degree. From 2017, S-STEM program also explicitly included in their proposal solicitation the description of the three types of projects it supports with corresponding project focus, scope, size, and levels of supporting resources:

> "*Track 1 (Institutional Capacity Building) projects* seek to increase the participation of institutions that have limited experience with designing and conducting activities, as described in the description of the S-STEM Design and Development projects.
> "*Track 2 (Design and Development: Single Institution) and Track 3 (Design and Development: Multi-Institutional Consortia)* projects seek to leverage S-STEM funds with institutional efforts and infrastructure to increase and understand recruitment, retention, student success, transfer, if appropriate, academic/career pathways, and degree attainment in STEM, with emphasis on low- income academically talented students with demonstrated financial need."

Given that our SETS project was funded based on previous solicitation, with up to 15% of project resources allocated for administrative tasks of distributing, managing, and reporting scholarship, we will share our experience in the paper focusing on what we did to build the capacity within our programs and department. Within the local context, even though two of the three colleges offering traditional STEM programs and degrees on our university campus have had experience with NSF S-STEM and STEP program, our college did not. In addition, besides the STEM programs hosted in the Engineering Technology (ET) Department, our college (College of Technology) also hosts non-STEM programs (scattered in three departments ranging from management, logistics, and human recourses). As detailed in (Yuan 2018), departments within our college, including the ET department, were considered teaching units in the University before 2000. Since then, aligning with the mission to become research-intensive university, ET department went through both incremental programmatic improvement and paradigm shift. It has transformed itself into a research and innovation oriented academic unit and aims to boost student success by providing 360-degree support and opportunities. The SETS project started in the middle of such transformation. Several of student service and support practices implemented and tested during the SETS project have since been institutionalized.

In the following sections, we will share our successes and "lessons learned" about (1) how we established student support structures and activities that affect students academic performance and graduation rate, (2) how we set up and sustain the student recruitment and scholar selection

process, scholarship distribution, faculty mentoring, and (3) how we developed curricula and co-curricular activities to enhance scholars' learning experience in a large public urban university environment.

2. Transformation of Technology and Engineering Programs – Creating Professionally Ready Technology and Engineering Workforce

Since 2002, our college started the process to transform from a teaching unit to a research-intensive college by hiring a group of diverse and research oriented tenure track and instructional faculty. With the nation-wide technology and economic development, various programs in our college has been leading the increase trend of student enrollment every year. All these contributed to more than 45,000 students enrolled in the University with about 9,000 students living on campus and more than 50% graduation rate of the whole university. With the goal of quality enhancement, the department restructured by spin off the Construction Management program as an independent department in 2014, while adding BioTech program earlier.

Figure 2.1 shows the student enrollment trend of the ET department in the decade from Fall 2007. It is clear the whole department experienced a big enrollment jump from Fall 2013 to Fall 2016. The enrollment level stayed at similar level since then. It is no surprising that from Fall 2016, the college and department have been catching up by actively hiring for both tenure-track faculty positions and student supporting staffs until now. Note that our freshmen and sophomore enrollment experienced the biggest jump, resulting in our FTIC (First Time in College) student enrollment rate in the three-targeted programs reaching more than 30% in Fall 2019. While the SETS project leadership team is happy to see the rising reputation of the targeted ET programs, and the ever-expanding pool of scholarship applicants, we are challenged by the shift of students population. With more than 30% FTIC students in the programs, student support and services are urgently needed to help them successfully transition from high-school prescribed learning to college-level independent study. On the other hand, the student population characteristics and demographics are continuously changing, sometimes due to external circumstances (good or bad) that you cannot control. For example, after 2008 recession, all technology and engineering programs witnessed a big jump in their students enrollment. Many of the IHE started expanding their education capacity faced challenges in dealing with higher proportion of adult learners. With economic improving and expanding in the last decade, we observed that the student population gets younger while the enrollment number stabilized.

Following the student success model shown in Figure 2.2, the SETS project team has developed a cohort of student leaders by creating the best possible supportive environment from all aspects along their academic and career pathways. The goal is to develop the future technology leaders who are willing to take ownership of their own education and professional career.

Figure 2.1 Student Enrollment Trend in ET department at each class level (Fall 2007 ~ Fall 2017)

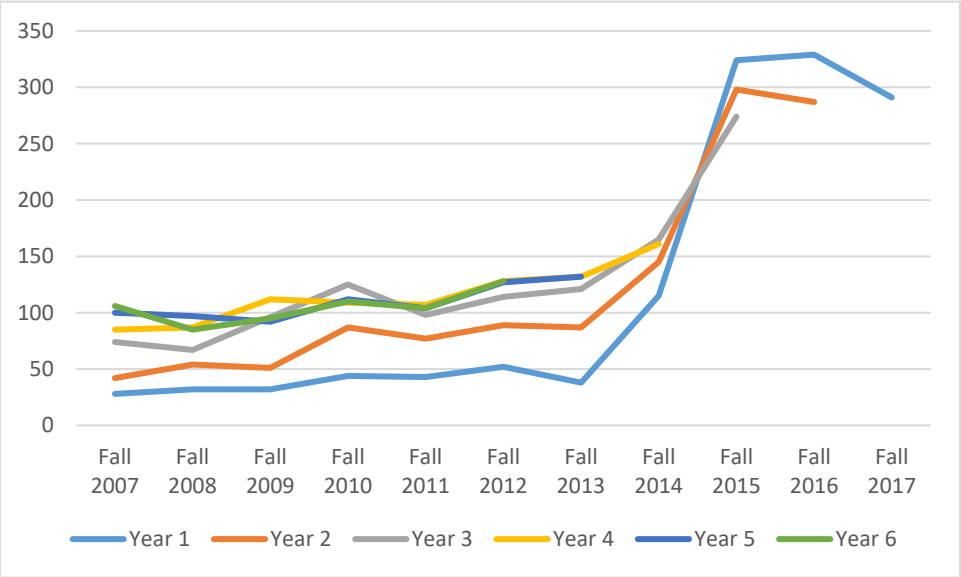
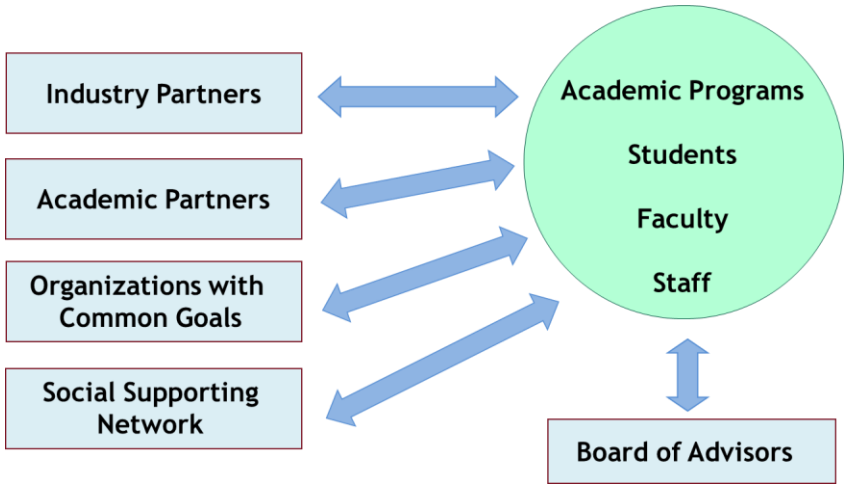


Figure 2.2 Student Success Model



3. Did we successfully implemented our project?

The goal of our SETS project as laid out in our project proposal is to provide financial support, academic services, and leadership development opportunities to a cohort of engineering technology students in alignment with the mission of the NSF S-STEM program. Taking into consideration of the unique characteristics of our programs and student population, we commit to improve the academic performance, time-to-graduation, and workforce-readiness of selected SETS scholars. In particular, we identified four measurable objectives for the SETS project:

OB1: Award 20 scholarships per year to academically talented and financially needy students enrolled full time in targeted ET programs;
OB2: Ensure 90% of SETS recipients (18 out of 20) maintain a minimum grade point average (GPA) of 3.0 during the semesters for which they receive the scholarship;

OB3: Grant at least 30% of scholarships to students from underrepresented groups: Hispanics, Women, African-Americans, Native Americans, and individuals with disabilities; and
OB4: Require all SETS recipients to participate in at least 80% of project activities.

These measurable objectives align with what S-STEM program identified for Track 1 (*Institutional Capacity Building*) projects: "*(1) to provide scholarships (SETS-OB1), (2) to advance the adaptation, implementation and understanding of evidence-based academic and student support activities for NSF SSTEM Scholars and other academically talented low-income students pursuing STEM degrees (SETS-OB2, and OB4), (3) to increase retention, student success and graduation in STEM (SETS-OB2, and OB4), and (4) to test strategies for systematically exploring student academic and career pathways in STEM in ways that are congruent with the context of the institution (SETS-OB4).*" Note that we included objective 3 (SETS-OB3) in our project because most of the under-represented and minority students in our program and on our university campus are low-income students, same as the trend identified nationwide (National Research Council, 2011).

In our previous paper (Yuan, 2018) we detailed our journey shaping up our S-STEM project and formulating the project proposal to secure the funding from NSF S-STEM program. It was the first time College of Technology (COT) and the Engineering Technology Department secured such grant. There are two other STEM colleges on campus: the College of Natural Science and Mathematics and the College of Engineering. Both of them have successfully secured and implemented multiple S-STEM grants in previous years. The PIs of those projects not only shared their experience drafting successful S-STEM project proposals, but also provided guidance in implementing such project on campus.

However, the demographical and characteristics of the student body these colleges serve are very different from the students enrolled in the targeted Engineering Technology programs. In addition, the student support and service structure of our college (COT) were very limited at the time. Furthermore, in the last four years, there are some unforeseeable external hurdles at the institutional and college level we have to overcome. With the departmental and college commitment and support, the SETS leadership team worked hard to serve our students and kept our promise to enhance their learning experience on campus.

The overarching goal of our SETS project -- Succeed in Engineering Technology Scholars (SETS) – not only aligns with the mission of the NSF S-STEM program, but also with one of the six missions/goals – "Student Success" – identified by the University (UHMission, 2018). Because of this, the SETS leadership team was able to secure support and commitment from the department, the college, and the student support and service divisions in the University throughout the five years developing and implementing the SETS project.

The project team also proactively engage and work with faculty in the targeted ET programs (including five new faculty members hired after the project started) and student support staff (most of them were hired after the project started). By developing and providing opportunities for them to interact with our selected scholars, the project further enhances the learning experience of these students that ensures their success.

We measure the outcome of the project based on the students' success in three aspects: improved or sustained academic performance (SETS-OB2), timely graduation (SETS-OB1), and workforce readiness (SETS-OB3 and OB4). Below we briefly report the data we collected to assess the performance of the project before we detail the process and actions we took to set up and sustain the project in the last four years.

We were able to award scholarships to at least 20 qualified students every year during the last four years of the project (SETS-OB1). From the 2nd year, all of our selected SETS scholars receiving

scholarship were able to maintain their term GPA above 3.0 (SETS-OB2). For those with less than perfect academic record due to their financial difficulty, such xx make it possible for them to improve their cumulative GPA towards and goes beyond 3.0 (out of 4.0) when they graduate.

Table 1 shows the demographic distribution of the SETS scholars awarded scholarship in the first four years of our project. We were able to achieve SETS-OB3, award scholarship to at least 30% URM (Under-represented and minority) students. Because of the diverse student population our programs serve, we eliminated diversity question from our scholar selection rubrics from the 2nd year of the project.

Table 1 Demographic Distribution of SETS Scholarship Awardees

Year	Awarded # /Semester	Hispanic (%)	American India/Alaska Native (%)	African America (%)	Pacific Islander (%)	Asian (%)	White (%)	Female (%)	Total (100%)	Graduated (%)
1	FA 2015	14(66.7)	1 (4.8)	1(4.8)	1 (4.8)	2 (9.5)	6 (9.5)	6 (28.6)	21	3 (14.3)
	SP2016	14 (60.9)	2 (8.7)	4 (17.4)	1 (4.4)	2 (8.7)	4 (17.4)	6 (26.1)	23	8 (34.8)
2	FA 2016	15 (57.7)	4 (15.4)	6 (23.1)	1 (3.85)	5 (19.2)	4 (15.4)	5 (19.2)	26	3 (11.5)
	SP 2017	14 (6.09)	4 (17.4)	4 (17.4)	1 (4.35)	5 (21.7)	4 (17.4)	5 (21.7)	23	10 (43.5)
3	FA 2017	7 (35)	1 (5)	1 (5)	1 (5)	9 (45)	8 (40)	3 (15)	20	7 (35)
	SP 2018									
4	FA 2018	9 (37.5)	0	2 (8.4)	1 (4.2)	8 (33.3)	4 (16.7)	5 (20.1)	24	15(62.5)
	SP 2019									

We were able to support three of our scholars one more year after they graduated with B.S. degree and continue pursuing their graduate degree in our university. Though most of scholars stated that they plan to do graduate study in the future during our interaction and discussion, we understand their decision to delay their dream and shoulder the financial responsibility towards their family.

The project team struggled with our last objective (SETS-OB4) that "*require all SETS recipients to participate in at least 80% of project activities.*" Because all our scholars take more courses than minimum required credit hour for full time students in order to graduate, their time becomes the most precious and limited resources they can dispose. Even though the project team eagerly developed and established many activities aimed at enhance their on campus experience from all three perspectives: academic, professional, and leadership, not many scholars can actively participate in more than 50% of them. From the 2nd year of the project, after discussion among the project team based on the feedback collected from scholars, faculty mentors, and supporting staff, the project team decided to reduce the amount of mandatory extra-curriculum activities for the scholars. Besides a couple of mandatory best practices, all other academic and professional development opportunities are optional, though highly encouraged.

In the first two years of the project, as detailed in the following section, most of the project effort were focused on developing the process and structure for student recruitment, scholar application and selection, scholarship distribution, and identifying and streamlining intervention activities that enhance students' experience and ensure their success on campus and after they graduate.

In the 2nd year of the project, SETS PI team secured supplemental funding from NSF and introduced summer research experience during Summer 2017. The leadership team also developed a multi-disciplinary and project-intensive new course on sustainable and resilient technology innovation to

introduce scholars and ET students the research and development cycle to create technical solution with big positive social impact. In addition, from the 3rd year of the project, SETS scholars started to take more leadership roles in the program, created their own student organization recognized by university, organized and hosted leadership and professional development activities, organically developed peer-tutoring during daily study hour in the designated room, and teamed up with various science and technology events oriented towards regional public school districts.

Eventually, data talks! Figure 3.1 shows from the S-STEM project reporting site shows the impact of the project. During the first four years of the project, we awarded a scholarship to 68 eligible and qualified students, with 55 of them graduated by Spring 2019. Among the 16 scholars in the program, six of them graduated in Dec. 2019 and the remaining will graduate in May 2020.

Figure 3.1 S-STEM Reporting Site Summary for Scholars SETS Project Served from Fall 2015 to Spring 2019

Count of Student Data Records, by Data-Entry Status					
		Not Started	In Progress	Completed	Total
Student Demographics		-	0	68	68
Semester/ Quarter Details	Fall 2015	0	0	21	21
	Spring 2016	0	0	23	23
	Fall 2016	0	0	27	27
	Spring 2017	0	0	24	24
	Fall 2017	0	0	29	29
	Spring 2018	0	0	29	29
	Fall 2018	0	0	25	25
	Spring 2019	0	0	25	25
Follow-up Questions		0	0	55	55

3. Lessons Learned for S-STEM Project Implementation

Turns out many of the lessons we turned from creating a successful project are still valid when implementing such a project. One of the biggest lessons we learned is that because this S-STEM project is the first one our department received, and during the transformation process the college is undertaking, we under-estimated the effort it requires to setup the project, recruit and support selected scholars, and rally the support for the project and scholars from faculty and student supporting staffs.

Three of the biggest lessons we wish to know before we started project implementation: 1) Always prepare for unforeseeable circumstances – both organizationally and naturally; 2) Always keep a keen eye on the student population change and have an open mind in order to adjust the program as needed; 3) Invest in an independent assessment expert for the project.

1) For example, the project leadership team understood the support the project needs from divisions of student service and support at both university and college level, and established potential collaboration when preparing and submitting the project proposal. However, they did not anticipate the structural changes in those divisions throughout the 5-year project duration. In addition, with the advances in data analytics within the education, including higher education community, the project leadership team has to learn multiple versions of software platform the scholarship and financial aid office adopted in order to distribute the scholarship, as well as students academic performance tracking software. Because of the nature of the scholarship selection and award process, all the academic progress and records of the scholars needs to be manually tracked. This is especially challenging between Fall and Spring semester because of the short time period.
2) During the 5-year duration of our project, our department and programs are also going through transformation to orient our curriculum more towards producing technically competent graduates with marketable knowledge and skills to ensure their professional success, we are streamlining

the courses required for degree plan of all the programs, including the three targeted programs covered in our project. With the scholarship support, many of our scholars were able to take on more courses per semester – by reducing their working hours outside of campus. With the university wide UH-in-4 effort (started one year into our project) and expansion of our programs (hiring new faculty), we are expanding our curriculum by giving scholars flexibility to count these new courses as their senior elective hours. The project leadership team also worked together and developed a research-driven project intensive course to give students (mostly scholars) opportunity to learn and practice research skills, and getting exposure to graduate study.

4. Main Activities Critical to the Success of the Project and Individual Scholars

In order to achieve the goal and objectives of the project, the project leadership team identified two categories of major activities that are critical to the success of the project and its sustainability after the project duration. These include:

Category 1: The process and structure to build capacity that supports and services scholars; and

Category 2: Adapting, testing, and adopting disciplinary based activities that enhance scholars' learning and ensure their individual success during their education tenure and starting their professional life.

Note that the project leadership team focused on developing the process and structure for student recruitment, scholar application and selection, as well as scholarship distribution in the first year of the project. In the subsequent years, the team fine-tuned process to work with ever-changing personnel and digital platform. However, they focused their main effort on adapting and adopting identified best practices that contribute to the success of the individual scholars and the project.

Table 4.1 shows the process-oriented activities that contributed the most to the success of the project (Category 1 Activities). After putting in major time and effort in the first year of the project, the leadership team followed up on these and made changes when necessary. The reasons for such changes include either conforming to university-wide policy or improving the efficiency and effectiveness of the process based results from formative assessment.

Table 4.1 Process Oriented Activities to Setup and Sustain the Project

Sub-category		Activities	Notes
Set up the project supporting process and infrastructure	1	Established project leadership team, selected project external advisory board members, and identified annual orientation as mandatory activity.	
	2	Create promotional material and artifact: Banners, Flyers, Brochures, Newsletters	
	3	Promote the SETS program to target students in class	
	4	Send out emails to targeted students	
	5	Create scholarship application & selection process: Apply → Review → Ranking → Selection → Award → Distribution	
	6	Work with University Scholarship and Financial Aid office and create Scholarship Distribution process	*i
	7	Create formative assessment rubrics and data collection instruments	
	8	Reached out to local industry and professional organization to build two-way networking events	
	9	Collected resources to help scholars in their pursuit of sustained academic and professional success	
	10	Developed annual Orientation Day for scholars embedded with social cohort building activities	
	11	Worked with institution research (IR) division to gather basic demographic data of applicants and selected scholars	*ii

	12	Worked with Faculty to increase their interaction time with scholars outside of the classroom.	*iii
	13	Worked with staff from our ever expanding student service center to inform, collaborate, and organize	*iv
Set up the project digital presence	1	Project website: www.uh.edu/et-sets for SETS basic information	*v
	2	Secure scholarship application and ranking portal for students and project team	
	3	Assessment portal for scholars and faculty mentors to provide feedback	
	4	Academic, Professional, and Entrepreneur Opportunities and Resources (https://uh.edu/technology/sets/opportunities/)	

NOTE:

*i. Turns out as a urban large public tier one university, our FA office need to process a lot of scholarship and loan distribution from all 15 colleges, 108 majors & minors, and around 150 graduate degree programs. The FA office helped us screening applicants to make sure all demonstrated financial neediness based on university criteria. Project leadership and faculty then review the applicants based on academic performance and potential.

*ii. In 2017, our University started the process of migrating student academic data to a new data analytics platform, EAB's Navigate [https://eab.com/products/navigate-for-four-year-institutions/]. This effort aligns with the then newly articulated mission/goal of 'student success.' The project team went through a series of training before gaining access to the program. Annual paperwork needs to be submitted to keep the status.

*iii. Because of the expanding of the program and increasing in student enrollment, among the three targeted programs, we have ten new faculty (tenure track and instructional) hired after the project started. After getting to know more about the SETS program, all of them are committed to serve as faculty mentor for the selected scholars, thus giving our scholars more opportunities to research in a broader range of technical areas.

*iv. One of the results of our effort to build capacity to support and service our students is that we have hired a lot of competent people who are passionate helping our students in the college and for the programs: from degree plan advisors, to career guidance and service, to program director. Once they are familiar with the SETS program and scholars, they provided much needed help for many of our scholars to progress academically on time and find the best professional opportunity when they approach graduation.

*v. Throughout the last four years of the SETS project, our web technology team in the college has changed three times. The first team helped us put together the project website once our project was funded in Spring 2015. In Fall 2016, the web team helped us converted all pages on the site to Web 2.0 conforming to university-wide policy. The website included useful pages about basic information about NSF S-STEM program, eligibility for SETS scholarship, and the responsibilities of selected scholars. It also included pages for faculty mentors with their research interest and link to their own webpage (when available), opportunities, events, and news. We decided not to update the site because (1) the time of the events/opportunities are similar year by year and we will promote it to our scholars and students directly; and (2) the consistent transition of the Web Technology team. The only page that needs to be updated every year is the page for Scholarship application (students access) and ranking (faculty access). From 2017, after transitioning to Web 2.0, the web team enable the scholarship application process to export summary excel file that make it much more easier and efficient for faculty to review and compare quality of applicants objectively.

Table 4.2 shows a relatively comprehensive list of student support and services available to our scholars, including those available to all students on campus and in our college. The project team

decided at the beginning of the project that given the limited resources, we will remind our scholars about these existing support and services and encourage them to utilize such services in an preemptive manner. Any new support activities we will develop for scholars need to be disciplinary based best practices that are well-acknowledged in the STEM education community that suit for a diverse student population and enhance their academic performance and marketability after graduation. Among the mandatory program we setup for the scholars, students like the annual leadership retreat the best. However, the weekday study hour we mandated from the 3rd year of the project, turns out to be most effective in improving and sustaining their academic performance. We mandated the practice right after Hurricane Harvey, when many of our students, including these scholars, spent too much time and effort helping others and forgot to take care of themselves first. This preemptive measures and the resilient humanity they experienced effectively turned them into leaders!

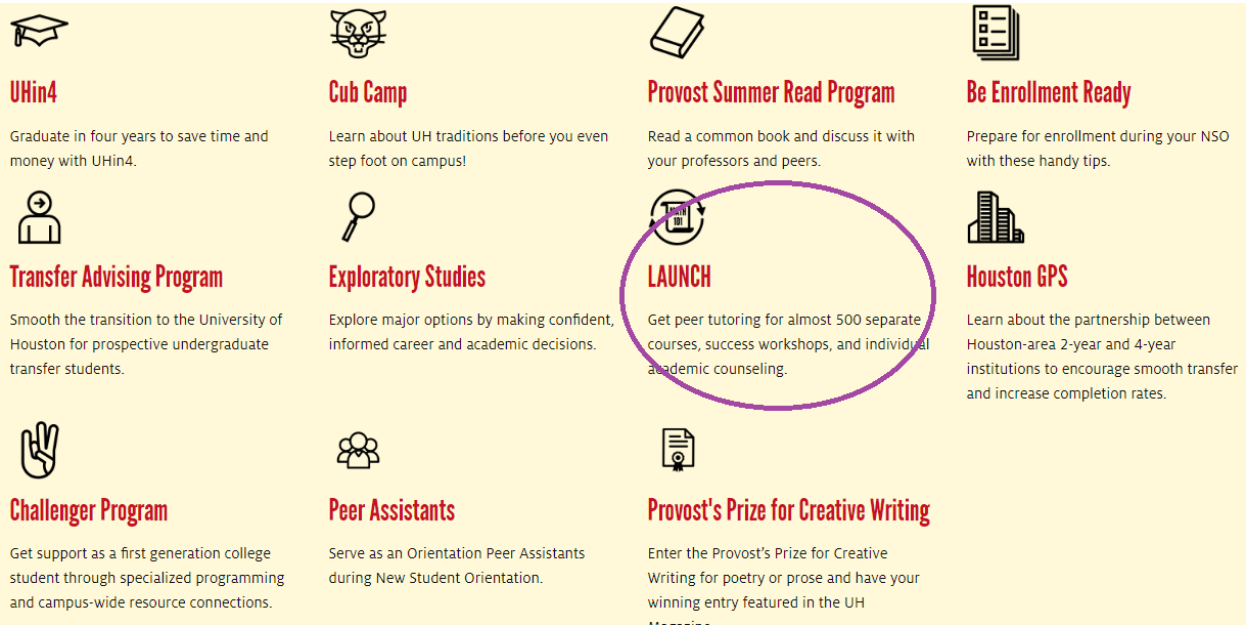
Table 4.2 Student Support Activities Adapted and Adopted

Sub-category		Activities	Notes
University Level	1	Figure 5.1 shows the support and services provided for all under-graduate students in the university [www.uh.edu/students].	*i
	2	Library (M.D. Anderson) and the subject guideline created for Technology [MET, CET & EPET]	
	3	Writing Center	
	4	University Career Service	
	5	University Wellness Center (Figure 5.2)	*ii
College Level	1	Added two new degree-plan advisors to the targeted programs	
	2	Hired two new staff to handle college level career service	
	3	Established TechConnect to connect students with their potential employers	
	4	Host bi-Annual College Career Fair	
	5	Host Graduate Study event to inform students graduate programs we offer	
Project Level	1	Annual SETS Orientation (Half Day)	
	2	Annual Leadership Development Retreat (Full Day), Figure 5.3, 5.4	*iii
	3	Annual Undergraduate Research Symposium (Full Day)	*iv
	4	Established new student organization	
	5	Week Day Study Hour	
	6	Summer Research Experience	*v
	7	Process Control & Safety Symposium → Process Industry Conference (ISA)	
	8	Project Intensive Multi-Disciplinary Course	*vi
	9		

Note:

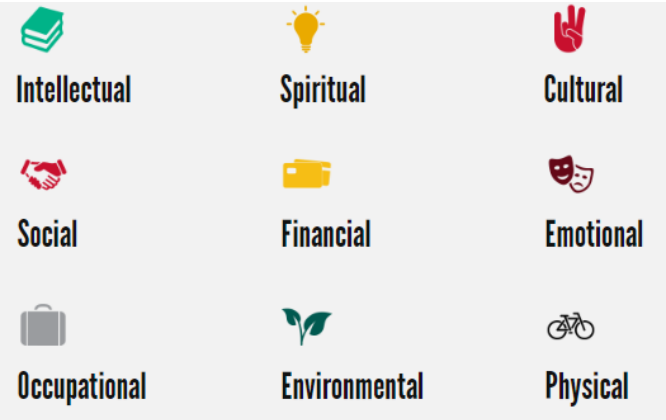
*i. At the University level, since the establishment of the Undergraduate Student Success Division, most of the existing student support and services were consolidated with many new programs created, as shown in Figure 4.1. The Launch program (circled in purple) includes student support services such as STEM course tutoring (especially fundamental courses in math, physics, and chemistry), study habit workshops, and academic counseling. It expands on previous student support services such as CASA (Center for Academic Support and Assessment) and CAPS (Counseling And Psychological Services).

Figure 4.1 University-wide Student Support Initiatives from Undergraduate Student Success Program



*ii The University Wellness Center, shown in Figure 4.2, provides various services (ranging from workshop, one-on-on counseling, and group meditation) to help students understand the nine dimension wellness model and how to improve their lives in each dimension.

Figure 4.2 Nine Dimension Wellness Model



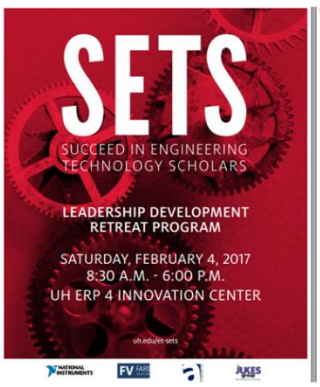
*iii Annual Leadership Development Retreat (Full Day) has become the flagship event of SETS program since our industry partners suggested in our first external advisory board meeting back in 2015. They also took the leadership in developing the proper material and sponsored the event. Figure 4.3 shows the pictures taken after the retreat in 2016, 2017, and 2018 of scholars and industry partners. We held our full day annual leadership development retreat on a Saturday in early spring. The program details of the retreat was adjusted from 2016 to 2017 based on feedback from students (Figure 4.4) in collaboration with our industry partners. Because of the Hurricane Harvey, our annual advisory board meeting (typically held before the beginning of the Fall semester) got postponed. After the whole thing finally settled down, and with considerable leadership initiatives demonstrated by our SETS scholars, we held our annual leadership retreat in Fall 2018 successfully (as shown in Figure 4.3), using the same program as we used in 2017 retreat.

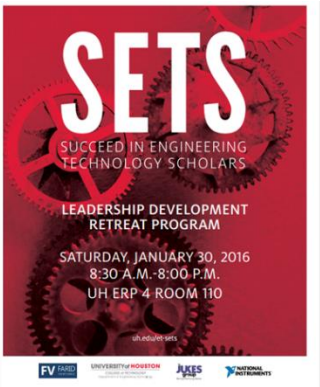
Because of the success of the annual leadership development retreat in 2016 and 2017, the SETS scholars took the initiative and established their own student organization (SETS) that gained

university recognition. With the newly hired student support staff, the student leadership team has been helping with the outreach to students, co-organizing and co-hosting student oriented events in the college.

Figure 4.3 Annual Leadership Development Retreat: SETS Cohort 2016, 2017, and 2018

Figure 4.4 SETS Annual Leadership Development Retreat Programs 2016 and 2017





*iv The Annual Undergraduate Research Symposium (URS) has been a long-established tradition for the last decade in the Computer ET and Electrical Power ET programs to allow their senior project classes present and demonstrate their capstone projects to local professionals, faculty, and their fellow students. With the SETS project targeting students from three programs, the URS expanded its program first to include senior project class of Mechanical ET program, and then to the BioTech program. With the positive feedback from students and local industry, SETS project team worked closely with all program coordinators in ET Department and extended the opportunity to participate the URS to students from all four programs in ET department. The best project team from all courses with final project component can demonstrate their working prototype during the Symposium.

*v One of the well-researched and well-acknowledged best practices to engage and sustain STEM students through their education tenure is early involvement in research experience. In 2016, we secured supplemental funding to provide such opportunity for our SETS scholars in research experience. Instead of pairing each scholar with one faculty, we created flexible mechanism for our scholars getting involved in research. For those scholars who already developed relationship with their faculty mentor or want to work with their faculty mentor, we are willing to support. One of the scholar continued his research project with his faculty mentor, and one scholar went to the NSF REU program at UC Berkeley. For those returning scholars actively participated in the brainstorming session during Spring 2017, or those incoming scholars interested in the project, we provided both financial support and research training. During ten weeks of Summer 2017, we had our first cohort of ten SETS research scholars working as a team on a research project titled "BiCycle Sharing on UH Campus -- Enable Access to Transit by First/Last Mile Transportation." The project was divided into five sub-projects, each with focus ranging from customer discovery and data analytics, to bike share station (BSS) scouting and identification, to raspberry PI based smart padlocks, to alternative solar energy system, to mobile app and cloud computing. Each scholar can lead in one and serving as team member (contributors) for up to two sub-projects. For all of scholars involved, this is the **FIRST** time they are involved in a research project. We joined effort with the University Honor College and provided support for our SETS researchers to learn the basics of the research process and practice research methodology and skills, as well as prepare and present posters at the annual University-wide Undergraduate Research Day in Oct. 2017. We were also able to work with the Process Control and Safety (PCS) symposium organizer and International Society of Automation (ISA) for all our SETS scholars (including those involved in the summer research experience) to participate. These scholar researchers submitted and presented their summer research projects in Nov. 2017. Two teams were awarded best poster presentation in the symposium. They also presented their project in the ET URS (Undergraduate Research Symposium) and gathered a lot of interest from fellow students regarding their research internship experience. Their paper on "Beyond First/Last Mile Active Transportation – BikeShare@UH" was accepted and presented at ASEE GSW 2018 in Austin Texas. Figure 5.5 shows our first cohort of SETS research scholars after they presented their project at the annual University Undergraduate Research Day (Oct. 2017).

Figure 5.5. Summer Research Experience 2017. (L) Weekly Meeting; (R) UH Undergraduate Research Day

*vi Multi-disciplinary project-intensive course on sustainable and resilient technology development. During the summer 2017 undergraduate research experience, our scholars participated in the research workshop provided by the Honor College. They learned about the research cycle, from literature review, to problem statement formation, to come up with methods and alternatives, to implement the prototype, to testing the system functionality and performance, to analyze data and present the results. Working with students through their research project, the project team realize that most of our students is passionate about applying what they learned to solve real-world challenges, but need guidance to navigate the process. With the support from the supplemental

grant, the PIs collaborated with a Sustainable Urban Design professor from College of Architecture, and developed a multi-disciplinary project-intensive course on sustainable and resilient technology development. It has been successfully offered three times since Fall 2017 and is going through the process to become a permanent course in our program in Academic Year 2021.

Though we consider our project as successful, as those data demonstrated, any progress require proportional time and effort from the project team. Our team decided to reduce some mandatory activities for our students even when we believe they all have the potential to enhance the learning experience of our scholars and sustain their professional success in the future. Because of our scholars social-economic circumstances, most of them do not have the luxury and time to participate in extra-curriculum activities. From the 2nd year of the project, we are very conscious when adding any mandatory activities for our scholars. One exception is the 'week day study hour.' When many of the scholars study after class, they realized they can also help each other besides studying alone. Several study groups were formed because of the fact that they can be in the same room at the same time. However, for many academic and professional symposium/conference or networking opportunities, we give scholars options to participate based on their own schedule.

5. Conclusion

The S-STEM scholarship and SETS program have been beneficial to many full time low-income students enrolled in our ET programs in addition to more than 68 students who received the scholarship. In addition, many of the activities develop to enhance the learning experience of the scholars has been opened up to all ET students to participate. Such exposure and experience improved the self-efficacy of the selected scholars and their friends enrolled in the program. The retention and timely graduation rate of these selected scholars are phenomenal. Their leadership quality also influenced the mindsets of their friends, many of them are from non-traditional students' population, just like them. In summary, we feel our SETS project achieved its goal and positively enhanced scholars' learning experience on campus and transformed our targeted programs. In this paper, the project team shares the hurdles they have to handle when external unexpected circumstances happens.

In conclusion, the complex challenge any S-STEM project has to overcome requires a strong, diverse and committed project team consists of faculty and staff at departmental, college, and university levels. On the other hand, the joy is immeasurable journeying along and witnessing the growth of these scholars. With the basic student supporting infrastructure set in place and the capacity built, our next step is to work with educational researcher to systematically study the most effective model to championing more students along the career pathway of technology and engineering.

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