Implementing a Successful S-STEM Project on SETS in an Urban Large Public University

Dr. Xiaojing Yuan, University of Houston, College of Technology (CoE & CoT)

Dr. Xiaojing Yuan is Associate Professor in the Computer Engineering Technology program of Engineering Technology Department. She is the founder and director of the Intelligent Sensor Grid and Informatics (ISGRIN)research lab and actively involving undergraduate researcher in her research on networked smart data acquisition systems, wireless sensor networks, and data analytics of the data collected. Her research interest also includes quality-of-service enhanced networking protocols, pattern recognition, data mining, and their application in cyber security.

Dr. Heidar Malki, University of Houston, College of Technology (CoE & CoT)

Heidar A. Malki is currently a Professor and chair of Engineering Technology Department at the College of Technology. He also has a joint appointment with Electrical and Computer Engineering Department at UH. He holds a PhD. degree in Electrical Engineering from the University of Wisconsin-Milwaukee. He is a senior member of IEEE and was associate editor for the IEEE Transactions on Fuzzy Systems. Dr. Malki was the general chair for the 1997 ASEE/GSW Conference and one of co-chairs of 1997 ICNN-IEEE International Conference on Neural Networks. His research interests are: applications of neural networks, fuzzy logic controllers, and design of fuzzy logic controllers for industrial applications

Dr. Mequanint A. Moges, University of Houston, College of Technology (CoE & CoT)

Mequanint Moges earned his Ph.D. from the Department of Electrical and Computer Engineering at the State University of New York at Stony Brook. He received his B.Sc. degree in Electrical Engineering from the University of Addis Ababa in Ethiopia and M.Sc. degree in Communication Systems from the University of New South Wales in Australia. His research interests are in the areas of wireless sensor networking, load scheduling in parallel and distributed systems and grid computing. Currently, he is working as an instructional associate professor at the Department of Engineering Technology. He has been teaching courses including Electrical Circuits, Telecommunications, Data Communications, Computer Networks and Advanced Wireless Networks. He is actively involved in curriculum development and revision. He has worked on a successful project funded by FDIP to enhance instructional excellence of part time faculty and teaching assistants using hybrid orientation programs. He has also been involved in two recently funded instructional research grants from NSF-CCLI (Co-PI) and NSF-REU (senior personnel). Prior to his current position, he was involved in the design of electrical systems of different nature viz. industrial, public as well as low voltage communication systems.

In 2008 and 2013 he received the College of Technology's Fluor Daniel Award for teaching excellence. In 2014 he received the UH teaching excellence award. He is also a recipient of Stony Brook Presidential Fellowship for the academic year 2001-02 and an AUSAID scholarship from the University of New South Wales, Sydney, Australia for the academic year 1996-1997.

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Xiaojing Yuan, Heidar Malki, Mequanint Moges, Wajiha Shireen
University of Houston, xyuan@uh.edu

Abstract
In this paper, the authors detail their journey writing and implementing a successful S-STEM project proposal, and sharing the lessons they learned in the process. In addition to providing scholarship for twenty promising students, 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 programs in an urban large public university with a diverse student population. The goal of the program is to enrich and enhance students experience during their higher-education tenure and ensure their success after they graduate and join the professional workforce by preparing them to be technically competent and professionally ready. The paper details the impact of the project has on students, faculty, programs, and the department. These include strategies and co-curriculum activities that engage scholars and their fellow students, enhance their learning experience on campus, and increase their retention and timely graduation rate. In addition, reflecting on what we did, what we achieved, and the lessons we learned, we share our categorization of the decisions and choices we have to make while preparing and writing a successful project proposal. We also detail our experience adapting established best practices in STEM higher education community to an urban public large university with a diversified population of students, faculty, and staff while implementing the program.

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] with the goal of developing much needed competent STEM workforce and sustaining the competitiveness of the United States in the global economy. In particular, NSF S-STEM program [3] "addresses the need for a high quality STEM workforce in STEM disciplines supported by the program and for the increased success of *low-income academically talented* students with demonstrated financial need who are pursuing associate, baccalaureate, or graduate degrees in science, technology, engineering, and mathematics (STEM)." There are 834 active S-STEM programs at over 500 2-year and 4-year institutions of higher education (IHE) around the United States.

As one of the largest Urban Public University and flag-ship institution of the UH system, the UH main campus offers 110 Bachelor degree (BS) programs, 120 Master degree (MS) programs, and 47 professional and doctoral degree programs [4]. Various STEM programs in three colleges have been awarded multiple S-STEM projects, assisting working-class students achieving their career aspiration of becoming a scientist and engineer.

The Engineering Technology (ET) department was considered a teaching unit on the UH main campus before 2000. Since then, it went through the transformation and has been established as a research and innovation oriented academic unit with focus on supporting student success by providing 360 degree opportunities, including research and service-learning experience for both undergraduate and graduate students.

In this paper, the authors detail their journey on preparing the proposal and implementing a successful SETS project supported by the NSF S-STEM grant and share the lessons learned along the way. After describing the strategies and programs implemented to attract and engage a diverse group of students, we provide examples of activities and events organized to enhance their learning experience in the last three years. At the end, we report the positive impact the SETS project has made on the three targeted ET programs based on qualitative study, including enhancing students learning (GPA), timely graduation of scholarship recipients, improved self-efficacy, and the retention and graduation rate for scholarship recipients as well as students enrolled in the three ET programs in general.

2. Transformation of the ET Department Coincide with the Timeline of Seeking NSF S-STEM Funding

University of Houston was established as institution of high education (IHE) for working class kids in early twentieth century [5]. Almost a century later, the UH system [6] has grown to include four IHEs serving one of the largest metropolitan area in the United States. The flag-ship campus – University of Houston (UH) – where the ET department locates, identified student success as one of the four pillars in its mission [7]. In Fall 2017, a new record of 45,000 student enrolled at UH, with about 9,000 residential students, shifting away from a commuter-school to college campus with its own culture and eco-system. Because of its continuous success in the last decade, including becoming a research intensive university [16], graduating students with least debt [17], and serving most transfer students [18], UH is attracting more students from both outside Texas and around the world.

There are four NSF S-STEM programs currently being funded on UH campus. However, the College of Technology and the Department of Engineering Technology (ET), to which the authors belong, never had the opportunity to lead in frontier research of STEM education at IHE level mainly because of its academic mission before 2000 focused on training and teaching. After going through the transformation process and became a research and innovation oriented academic unit in the first decade of the 21st century, the ET department started seeking NSF S-STEM grant in 2009 before being awarded one titled "Succeed in Engineering Technology Scholars (SETS)" in 2015. The grant not only allows them to continue their transformation and further enhances their students' learning experience by focusing on "identifying and developing future technology leaders" but also acknowledges their continuous effort in scholarship of teaching and learning (SoTL) in STEM education at IHE level.

After hiring a group of diverse and research oriented tenure track and instructional faculty from 2002, student enrollment in various programs of the ET department started to grow. In 2009, based on data recorded at the university level [8], ET served about 900 students with four programs (mechanical ET, computer ET, Electrical Power ET, and construction management). In Fall 2017 (most recent data point), ET department serves 2,324 (1,440 full time) students with four programs (MET, CET, EPET, and BioTech). Construction management became an independent department in 2014 with student enrollment reached 1,659 (1,040 full time) in Fall 2017. We also see a significant FTIC student enrollment growth in the three targeted programs since 2016, reaching to more than 28% in Fall 2017.

In 2012, a group of ET faculty formulated the SETS (Succeed in Engineering Technology Scholars) program, after reflecting the failure the program experienced in securing support from NSF S-STEM program in 2009. In 2013, we submitted a project proposal taking into consideration of the lessons learned from our previous experience. The proposal was not funded but received good review and constructive feedback. Taking into account of the comments and suggestions by the NSF S-STEM review panel, we improved the proposal and submitted the refined version in 2014. The project was awarded in early 2015.

Some of the lessons we learned in the process of formulating the project and preparing a successful S-STEM project proposal include:

1) It is important to show that there is a large pool of qualified (academically) and eligible (financially) full-time students seeking the STEM degree by providing evidence such as quantitative data collected at the highest granularity. Depending on the institutional support and faculty effort, the data used as evidence can be collected at university, college, department, or program level. If there are multiple-year data points, it is important to show the trend that support the rational for the program to seek S-STEM funding.

2) The requirement for GPA should be at least 3.0 or higher to maintain the high quality of selected cohort. Due to a large percentage of non-traditional students enrolled in our ET programs (e.g., work full- or part- time job to support their education), many of our students have difficulty maintaining a high GPA. In the proposal we submitted in 2009, the GPA requirement was set below 3.0 because the project team at the time feel that many of our non-traditional students just do not have the luxury to spend enough time studying and succeeding in the rigorous STEM courses. The hope is that once they were selected into the program and provided financial support via scholarship, their GPA will improve because they will have more time learning and improving their technical competency. Many anecdotal stories shared by our ET students indicated that they are really committed to a STEM career partially because of their desire to improve their life situation. In spite of the many obstacles they may face, they are resolved to finish the degree and start a STEM career. Even though it may take them more time, they are determined to succeed because of all the professional skills they learned through real life: ethical hard work attitude, resourcefulness, perseverance, and grit.

   After discussion within the project team and with the program officer, the team put together a mechanism of renewing scholarship from year to year and a selection rubric. As a built-in accountability measure, all scholars need to apply for the scholarship and go through the same selection process each year. Once selected, the scholars receiving the scholarship are required to maintain their GPA at 3.0 or higher for the courses they are taking. When the scholar fails to maintain 3.0 GPA, they'll be allowed a "probation semester" to improve their grades if they actively involved in the enhancement activities and programs designed to help their learning, including regular interaction with their assigned faculty mentor. In the rare case that the scholarship recipient did not take advantage of any of these opportunities, the SETS project leadership team will meet and

initiate the scholarship termination procedure during Winter break. It is no surprise that such case has not happened yet.

3) It is important to demonstrate in the proposal how the project can attract a diversified group of scholars from all full time students enrolled in the program. Many research has shown that students from under-represented and minority (URM) group tend not to seek and apply for opportunities, mostly because they do not know such opportunity is available or how to apply for it. In either case, a little nudge and a lot of encouragement at the right time from faculty often makes a big difference. In the proposal we submitted in 2013, we rely heavily on the existing diverse student body at UH for recruiting and selecting a diverse group of scholars. According to US News & World Report rankings [9], UH is the second most-diverse public research university nationwide. From our interaction with our students and those involved with student organizations such as SHPE (Society of Hispanic Professional Engineers) [10], NSBE (National Society of Black Engineers) [11], SWE (Society of Women Engineers) [12], and SASE (Society of Asian Scientists and Engineers) [13], we gained deeper understanding and appreciation of the importance of actively attracting these students. The authors and project team continuously working with university's diversity office and disability office [14] to proactively reach such student population.

Through the proposal writing and refining process, we gained better understanding of our programs based on data collected, the mission and goal of the NSF S-STEM program, and developed a clearer vision of the programs and established action phases in the direction to get there.

3. SETS Program Goal, Objectives, and Key Achievements

The goal of our SETS project 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, we commit to improve the academic performance, time-to-graduation, and workforce-readiness of selected SETS scholars. By establishing collaboration with the UH scholarship and financial aid division [15], we are enhancing our programs to better serve our students to reach their full potential and make positive contribution to the creation and development of a more sustainable and resilient future.

To achieve such ambitious goal, we identified four measurable objectives for our project after intensive discussion within the project team and with our assessment expert. The four quantifiable project objectives are:

1) Award 20 scholarships per year to academically talented and financially needy students enrolled full time in targeted ET programs;
2) 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;
3) Grant at least 30% of scholarships to students from underrepresented groups: Hispanics, Women, African-Americans, Native Americans, and individuals with disabilities; and
4) Require all SETS recipients to participate in at least 80% of project activities.

In the first year of our SETS project (Academic Year 2016), we awarded SETS scholarship to 26 students due to several reasons. First, the application cycle was cut short because we received the grant in April, when the semester is approaching the end and we had little time to setup the application website, promote the program, and attract the applications before semester ends and students leave for summer. Secondly, since the scholarship was awarded based on students' financial aid need, many of our scholars, being resourceful, were already taking out student loans, which affected their ability to receive full-amount of scholarship ($5,000). In addition, since this is our first S-STEM project, SETS project team is new in scholarship award and distribution process. Adding to the confusion, the University was upgrading its financial software platform at the time. Lastly, three scholars graduated in Dec. 2015. They applied for and was awarded the scholarship because of the good relationship they established with their faculty mentor through their course work. They were made aware of the scholarship opportunity from their faculty mentor and were highly recommended and advocated by their faculty mentor during the selection process. In fact, one scholar was able to graduate in Dec. 2015 because he was able to take 16 credit hours courses instead of taking less course load and work full time to support his education and family. Among the selected 26 SETS scholars, 21 are from student population typically considered as underrepresented and minority (URM) in STEM (81%), among which six were women (23%) (Objective 3). More than 76% of 26 SETS scholars maintained their term GPA above 3.0, while the remaining improved their GPA towards 3.0 (Objective 2).

In the first year, the SETS program provided four types of professional and leadership opportunities including two events designed for scholars: the annual orientation in September 2015 and the leadership development retreat in January 2016. We conducted the end-of-semester survey with scholars in Dec. 2015 and June 2016 in order to identify the activities and opportunities they enjoy and found the most beneficial in addition to the scholarship. The results show that SETS scholars found the following activities and opportunities most beneficial: Professional Networking and/or Volunteering (66.7%), Professional Training (like the LabVIEW boot-camp) (50%), Entrepreneurship Opportunities and/or Resources and Research scholarship and/or Internship Opportunities (both at 33.3%). Eight SETS scholars graduated in Spring 2016. All of our SETS alumni were able to start their career in their chosen STEM fields within six months of their graduation.

In the second year of our SETS project, we awarded SETS scholarship to 25 students. With enough time to promote the program via formal channels listed in our proposal and the word-of-mouth of scholars, we received more than 60 applications. In an effort to broaden the impact of SETS program and ensure the success of more of our ET students, SETS project team decided to select 30 SETS scholars to join the SETS program, with 25 awarded scholarships. The remaining five students were granted the privilege to participate in all activities and programs developed for SETS scholars including assigned faculty mentor. These SETS ambassadors will be awarded scholarship when existing SETS scholar graduate or drop out of the program. Their contribution will also be taken into consideration during the SETS application and selection period in the following year. Among these 30 selected scholars, we have 12 Hispanic or Latinos, 7 African American, 4 American India or Alaska Native, 2 Native Hawaiian or other Pacific Islanders, and 5 Asian, achieving 83.3% URM rate. Four out of our 25 scholarship recipients are women (16%). (Objective 3). Among the 25 students receiving the SETS scholarship, 88% maintained or

improved their GPA above 3.0 (22 out of 25 scholars), one of the scholars improved his GPA towards 3.0, and the remaining two scholars did not participate in any of the activities organized for them nor seeking help from their faculty mentors. However, both of them graduated from the program and found job in their chosen STEM field. Their faculty mentors suggested that they may have spent too much time networking and finding jobs than improving their academic standing during the time. (Objective 2).

Figure 1 SETS Learning Community

Figure 1 shows the pathway created to enhance scholars' experience. Figure 2 and 3 shows some of the scholars in cohort of 2016 and 2017 participating in the annual leadership development retreat at the Innovation Center of the University of Houston.

Figure 2 Annual Leadership Development Retreat: SETS Cohort 2016

Figure 3 Annual Leadership Development Retreat: SETS Cohort 2017

One focus of the SETS program is to give opportunity for scholars to learn and develop their professional and leadership skills in preparation to become next generation leaders in technology. The industry members of our project advisory board initiated and hosted the first whole day "leadership development retreat" for our scholars in January 2016. Since then, our scholars established the SETS student organization that has been recognized by the University since Fall 2016. They elected officers and hosted regular meetings that not only give them opportunity to practice their professional and leadership skills but also start their own professional network. Their weekly meeting in Fall 2016 hosted most of the faculty mentor research talk. Their bi-weekly meeting in Spring 2017, focuses on developing skills to secure desired position in current job market and identifying inter-disciplinary research projects that all can contribute. These meetings are typically scheduled on Fridays, with the average attendance rate of 72.0% for Fall 2016 and 54.6% during Spring 2017. Given the large number of scholars selected from three programs and from sophomore to junior to senior, it is not easy to achieve

higher participation rate on a weekly or even bi-weekly basis, even though many scholars expressed their desire to participate. Typically course and lab schedule conflict with the meeting time for sophomore and junior students, while internship and/or job fair and interview conflict with the meeting time for junior and senior students. This demonstrated in the lower participation rate during Spring 2017, with ten scholars graduating and more junior scholars trying to find internship opportunities. Fridays are the time they attend career fairs and/or conduct phone or on-site interview.

Despite all these, the success of the SETS student organization has been felt throughout both the ET department, College of Technology, and the whole university. We found that it is critical to keep scholars engaged and provide them opportunities to lead: organize and host professional networking and service learning. Many of our scholars demonstrated their leadership attitude and skills during the weeks last Fall when Hurricane Harvey hit and many of the students, staff, and faculty need immediate help.

4. Conclusion and Future Direction

The S-STEM scholarship and SETS program have been beneficial to many full time low-income students enrolled in our ET programs. It not only enhanced their learning experience, improved their self-efficacy and the retention and graduation rate of these selected scholars, but also changed the mindsets of many of these non-traditional students' population, resulting in better retention and graduation rate in all ET programs. Based on our experience in the last two years, our SETS program found success through targeted recruiting, intentional faculty mentor matching and regular meeting, peer mentoring, annual leadership development retreat, and research and service experience, among other approaches.

In summary, we believe that to successfully secure S-STEM award and implement the project on campus, a flexible but comprehensive plan is not only necessary but also crucial in the success of the project. Such a multi-facet project needs to be monitored and evaluated from each and every perspective: project management, student support activities and programs, scholars, faculty, and supporting staff. On the other hand, the project plan needs to be flexible enough so that certain aspects of the project implementation can be adjusted to best serve our students. A flexible mindset is necessary to incorporate new resources and tools that can streamline project effort, help students persevere through rigorous heavy STEM course load and graduate on time. For example, with technological advances, many divisions of the University of Houston went through software upgrading phase, from human resources management, to tracking students' academic performance, to managing and distributing financial aid and scholarship. Even though project team has to learn two systems since the project started, the new system is much easier to use and making it less labor intensive for tracking and reporting students financial need and academic performance. The time saved can be reallocated to other effort such as mentoring students and creating more learning experience enhancing activities.

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. As the size of the SETS group grow, faculty mentors involved must allocate more time to mentor their scholars and ensure their success. It is also necessary to keep scholars

engaged by providing them opportunities to lead: organize and host professional networking and service learning. Many of our scholars demonstrated their leadership attitude and skills during the weeks in Fall 2017 when Hurricane Harvey hit and many of the students, staff, and faculty need immediate help.

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