



Evaluation of Suffolk University's Electrical Engineering S-STEM Program at Year 4

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Suffolk University's Electrical Engineering (EE) S-STEM Scholars program aims to give full scholarships to study electrical engineering at Suffolk University to academically worthy Boston public high school students that exhibit financial need. The program started in January 2014 and is currently in its fourth year. Out of the nineteen students that have been admitted into the program, four have graduated, two have left the program, and the remaining are active students. The four graduates are all employed in the field of electrical engineering, with three working in the electric power industry, which partnered with Suffolk for this S-STEM program.

This program was challenged by unstable university leadership and a sudden decision to terminate the EE program at Suffolk University in 2015. Despite these challenges, the S-STEM students have thrived, with all of the remaining students on target to graduate on time. Moreover, the EE program has found a new home at the Benjamin Franklin Institute of Technology (BFIT), a school well-suited for future S-STEM programs because of its commitment to keeping tuition low and to targeting graduates of Boston public high schools, most of whom come from low-income backgrounds.

This paper describes the unique features of the program such as a pre-matriculation five-day trip to a field station in northern Maine; outreach activities by the scholars such as annual participation in the Latino-STEM Alliance Robotics Competition and Science Fair, annual science and engineering experiments with Boston Public High Schools, and the annual Power Engineering Day which brings together engineers and leaders from the electric power industry, Suffolk EE students, and Boston high school students to learn about electric power and its career opportunities; career building activities; study groups; and weekly pizza events.

Introduction

The overarching objectives of S-STEM Electrical Engineering (EE) Scholars Program at Suffolk University were to attract academically qualified students with financial need from Boston Public High Schools (BPHS) to study EE at Suffolk University and to provide them with a community and support so that they would successfully graduate and obtain employment in the field or continue on to graduate school. Special emphasis was placed on electric power given the collaboration between the electric power industry and the EE program, as well as the electric power engineers' and managers' enthusiasm for hiring students from this program.

The goals of the S-STEM EE Scholars Program at Suffolk University were to:

1. Provide a pathway to a future in EE, particularly power engineering, for talented students with limited financial means. Special emphasis was placed on recruiting underrepresented minorities from BPHS.
2. Build on the EE program's sense of community with specific activities for S-STEM Scholars.

3. Improve the awareness of S-STEM Scholars' career interests and values, particularly as they relate to career decision-making and workplace satisfaction.

The objectives of the program were to:

1. Increase the number of EE majors from BPHS.
2. Have higher program retention rates for S-STEM Scholars than they would have had without the S-STEM program. Specifically, to have a 95% second-year retention rate and an 80% five-year graduation rate.
3. Improve the career-related knowledge of S-STEM Scholars through participation in career-development activities, including career counseling and formal reflection on internship experiences in relation to their assessed interests and values.
4. Have at least half of the S-STEM Scholars intern in the electric power industry and work in the industry upon graduation.

Student Selection Process and Criteria

The S-STEM program worked with the three partner high schools to recruit students from each high school and relied on Suffolk's undergraduate admissions department to recruit from the other Boston schools. Admissions and Financial Services used a similar procedure for this program as the existing Nathan Miller Scholarship program at Suffolk University which gives full scholarships to graduates of Boston public high schools. The following factors from students' applications are used in determining a scholarship award: overall high school GPA (2.7 or higher), SAT math scores (470 or higher), level of financial need, NSF citizenship eligibility, and a short essay to assess student interest and motivation.

The criteria for overall high school GPA (2.7 or higher) and SAT math score (470 or higher) derived from studying the high school GPAs and SAT math scores of past Boston students from the EE program and correlating them with academic success. We found that students who did not meet these criteria usually did not graduate, although a low score in one measure could counterbalance a high score in the other.

The student scholarship awards, which cover tuition and books, were funded through a combination of sources including federal grants (Pell, SEOG, etc.), state grants (MassGrant, Herter, Matching Grant, etc.), outside grants (Rotary, etc), institutional grants, and the NSF grant. In order to fully cover tuition and books each S-STEM scholar was awarded \$9500.

Program Execution

The notification of the S-STEM award was made in August of 2013, and the start date of the award was January 1st, 2014. The first four scholars were current Suffolk students in the EE program who were graduates of Boston schools and had expressed financial need. The award aimed to help students balance their need to work with their need to concentrate on their studies. There was also a fifth Boston student who had a Nathan Miller scholarship from Suffolk, who was not awarded the scholarship but participated in many of the program activities. The original plan had been to award six scholarships in year 1, six in year 2, and three in year 3 all to freshmen students from Boston schools. Since four awards had been made to sophomores and

juniors from Boston schools, the plan changed to award three in year 1, six in year 2, and three in year 3.

Some changes to that plan were made for the following reasons:

1. Of the three students who had been admitted in September of year 1, one was dismissed for weak academic performance.
2. Of the six students who had been admitted as freshmen in September of year 2, one left Suffolk for a community college and changed his course of study.
3. Two existing EE students replaced the two who left.
4. Suffolk eliminated the EE program after year two¹, and therefore was no longer accepting any new EE students, and so the scholarship was awarded to three Biology students and one Computer Science transfer student.

Suffolk's S-STEM program recruited from Boston because of the high concentration of students from underrepresented groups. In the second year, an insufficient number of candidates came from Boston, so the program recruited students from high schools from towns close to Boston, which also have a high concentration of underrepresented groups. Of the fifteen EE S-STEM students, twelve were from underrepresented groups (ten Latin Americans (all male), two African Americans (one male and one transgender), and three Asian students (all male)). Of the three Biology students, one is an African American female and two are Caucasian males (with one refugee from Iraq). The Computer Science student is a Caucasian male. This group of students shows that targeting recruitment from Boston and close suburbs did result in a high concentration of students from underrepresented groups.

Key Program Features

The EE program at Suffolk University has many of the features and support services that research indicates promote success in engineering students, such as faculty support [1] [2], project-based learning that promotes self-efficacy which is a belief in one's own abilities to succeed [3] [4], a sense of community [5] [6], and role models [7] [8].

Faculty support

Our current students and alumni consistently list faculty support as one of the chief qualities of the program. For instance, in the last alumni survey, 70% of alumni respondents gave the EE program a 5 (highest) and 30% gave it a 4 (second highest), in level of academic support. In student surveys in response to the question "What are the features of the EE program that you like?" 7 of 13 respondents referred to faculty support including professors that were approachable and available as well as having a small, close-knit community in the department.

Self-efficacy through project-based hands-on learning

¹ The EE faculty never found out the real reason for the shuttering of the EE program. The program had perhaps the highest growth rate of any program in the school. The stated reasons were that it's graduation rate was low and that ABET had concerns. The EE faculty pointed out to the administration that the EE graduation rate was no different from Suffolk's other majors and that an ABET concern merely meant the potential for noncompliance with a criteria or policy, and did not imply noncompliance. Our protestations were ignored.

In enhance a student's self-efficacy, Suffolk EE classes have laboratory components where students perform, either individually or as a team, hands-on exercises and projects that engage students in understanding the theoretical concepts learned in their lectures. As much as possible, "real-world" applications are used so that students get a sense that what they are learning is important and relevant. For instance, in the required *Introduction to Digital Electronics* course, teams of students develop a program using the Xilinx FPGA to implement a Hamming Encoder/Decoder. In the *Introduction to Engineering Design* course, teams of students build and program robots using the Parallax platform to perform stipulated tasks such as a line follower. These courses are extremely popular and the overall ratings for these courses are always between a 4 and 5 on a 5-point scale.

Sense of community

Suffolk's EE program promotes a strong sense of community in a number of ways. EE students share a pizza hour together each week that frequently includes EE faculty. At the beginning of each semester there is a welcome back pizza party attended by EE faculty and students. All EE students are members of the Suffolk's IEEE student chapter and the engineering department pays for student membership. Additionally, all students are encouraged to participate in the Northeast IEEE micro-mouse competition.

Another support service that fosters a sense of community is the study group program. The EE program strives to have study groups with every EE course. Study groups are attended by many students starting in their second semester or their freshman year. By junior year, students attend in high number and even request to form a study group if one is not formally offered.

Role models

Although the EE faculty does not consist of any ethnic/racial minorities, the Primary Investigator (PI) is a woman and the program has consistently attracted African Americans, Latino Americans, and women who are encouraged to become study group leaders who can serve as role models. Currently, of the four study group leaders, three are Latino Americans and one is African American.

Boston Public High School Students

Despite efforts to attract and graduate minority groups into engineering and other STEM disciplines, these groups are still underrepresented in the field [9]. The EE Scholars program at Suffolk University provided an important opportunity to attract talented Boston public high school students, who mainly come from minority groups, to attend an ABET-accredited student-focused program that will maximize their chance of successfully graduating with a BSE in EE.

Boston public high school students are primarily from low-income families (72%) and minority groups, with 35% African American and 41% Hispanic students [10]. Suffolk University is part of *Success Boston*, a citywide initiative to significantly increase the number of Boston public high school graduates who complete college degrees. As part of this initiative, Suffolk aimed to help Boston public high school graduates complete college by increasing student engagement and developing strategies for addressing on-campus and off-campus issues that affect student persistence. To support this initiative, Suffolk runs the Nathan Miller Scholarship Program, which provides full tuition scholarships to approximately 15 Boston public

high school students per year and includes a non-credit enrichment seminar. The EE Scholars at Suffolk program built on the Nathan Miller Scholarship program and shared some of its features to provide the highest chances of success for *S-STEM* Scholars.

In addition, the *EE Scholars at Suffolk* program partnered with three Boston public schools—the John D. O’Bryant School of Mathematics and Science (grades 7-12, approximately 1500 students), TechBoston Academy (grades 6-12, approximately 1000 students), and Dorchester Academy (grades 9-12, had approximately 400 students in 2014; now has 65 students and is set to close for underperformance), to encourage students while they are in middle school and high school to study engineering and recruit students.

Electric Power Industry

Due to concerns about a workforce shortage in the electric power industry [11], engineers and managers in that industry approached Suffolk’s EE program eight years ago to create pipelines of students for potential power engineers and collaborated with us in the *EE Scholars at Suffolk* program. Our partners include OMICRON Corp., Phoenix Electric Corp., ThreeC Electric Corp, Electroswitch Corp. and Eversource.

Programming

Five-Day Trip to Friedman Field Station in Northern Maine

To enhance the sense of community and self-efficacy in Suffolk’s S-STEM EE scholars, a pre-matriculation trip to Suffolk University’s Friedman Field Station in northern Maine was made part of the S-STEM scholarship program². The Friedman Field Station was an educational field station owned and operated by Suffolk for over forty years whose purpose was to expose students to science in a natural preservation area. For many years, the EE program brought students to this rustic and pristine environment to work on projects involving solar heating, photovoltaics, wind turbines, and geothermal heating, as well as to join the biology students in studying the diverse life located in a tidal basin. Students have found it to be a wonderful bonding experience as well as a great place to work on projects and to learn about a unique ecosystem.

In August of 2014 and 2015, incoming and existing Suffolk University S-STEM Scholars in EE from Boston public high schools spent four days at the Friedman Field Station in Maine prior to starting their freshman year. In 2014, all but one of new scholars attended along with a Nathan Miller Scholar. In 2015, five out of the six scholars attended the trip. There was not a trip in 2016 due to the closure of the Friedman Field Station.

Itinerary for both trips included a tour of the field station, a whale watch, a tour of Eastport, Maine including a model of FDR’s plan to generate electricity from tidal power and the 100+ years old Raye’s Mustard Factory, and a hike to learn about the ecology of Shackford State Park. Additional activities included measuring current velocities in Cobscook Bay in order to understand the energy content of the running water which could be harnessed to generate electricity, studying the 10 KW Aerostar wind turbine installed at the field station, and

² A presentation about this activity was given at the 2017 ASEE Northeastern Conference in Lowell, MA.

measuring wind velocities. The final days of the trip were spent studying the field station's photovoltaic array, performing experiments on photovoltaics, and performing solar thermal experiments involving light and dark cups as well as liquids of different heat capacities. Students hiked in West Quoddy Head State Park Bog and the spruce-moose/forest rocky coast of Maine. There was also a trip to Lubec to learn about the fisheries that once thrived there. Upon their return home, students completed surveys and wrote blogs detailing their experiences.

The Maine trip was assessed by the PI, co-PI, and the outside evaluator Dr. Russell Faux of Davis Square Research Associates who meets with the scholars each year to evaluate the program. Dr. Faux concluded that the foundations that were laid in Maine did a great deal to provide ongoing learning and moral support for the students, as well as create an information network helpful for dealing with coursework and internships. He writes:

“The impacts of this network on self-efficacy, and intentions found their origins in the Maine experience, and that the other side of this new network is that it helps the students to feel supported as they leave their old lives behind and begin to assume new roles in society. Prior to Suffolk, they had no engineering network at all. The contrast in the students' personal networks pre- and post-Maine was sharp. Although these students were provided with support during the year such as faculty availability, small class sizes, study groups, and weekly pizza parties, the Maine experience was both effective and essential for building, though not sufficient for maintaining, the peer and faculty network critical for student success.”

Project-Based Freshman Seminar: Sustainability, Energy, and Technology at Suffolk

To further enhance the sense of community and self-efficacy in Suffolk's S-STEM EE scholars, all freshmen S-STEM EE scholars took a freshman seminar taught by the PI exploring the topics of energy, sustainability and the role of technology in our society. The course explores these issues with reading and blogging assignments and teaches the science of sustainability issues through experiments using Lego Mindstorm with LABVIEW software. The final project of the course involved teams of students designing an experiment that teaches the science of sustainability to students in our partner middle and high schools.

In 2014 and 2015, all of the freshman scholars took this course, which met twice per week for a total of two and a half hours per week throughout the semester. Attendance was regularly taken and outreach was performed when a scholar missed class. At the end of the semester, the students performed their team's experiments with three Boston public high schools. The course was popular among students and students gave it an average score of 4.2/5.0 (with 5.0 being the best) in 2014 and 3.9/5.0 in 2015.

As shown in Figure 1, the course grade for the freshman seminar was positively correlated with later student academic success, as measured by GPA. The two students with the lowest grades (both “C=2.0”s) in the course achieved the lowest GPA's of all of the scholars who took the course and both left the program (one was dismissed and one left to study teaching at a community college).

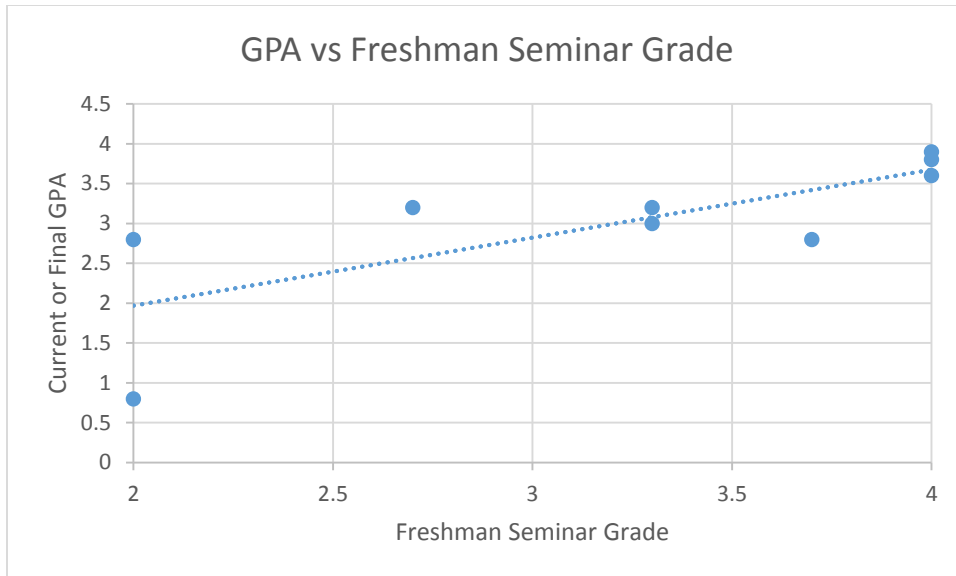


Figure 1 Current or final GPA vs freshman seminar grade.

Non-credit enrichment seminar

In the non-credit enrichment seminar, scholars discussed academic and non-academic challenges and received support to overcome them. Students also met with a learning center counselor individually twice each semester for additional support. The counselor proved to be very important to at least one scholar who was in danger of failing Physics I. The counselor arranged tutoring for this scholar in Physics I, in which he ultimately earned a C in the lecture and an A- in the lab component. This scholar has now completed all of his requirements and is currently working on completing his senior design project.

Pre-matriculation math course

In the summer before matriculating, scholars who did not place into pre-Calculus were strongly encouraged to take a non-credit online math course which had been developed by the Suffolk Math Department. This course ran for six weeks and covered basic algebra, functions and graphs, and trigonometric functions. Students who passed this course were then able to register for pre-Calculus in the fall of their freshman year.

Four scholars were asked to take the summer pre-matriculation remedial math course after a weak performance on their pre-matriculation math placement exam. One scholar was asked to take the course with additional Calculus material added after he received a D grade in Calculus I (students must receive at least a C grade in a prerequisite course to continue to the next course.) All of the students had sufficiently low SAT math scores that would indicate that they would be at risk of failing their freshman engineering courses [12]. As evidenced by their grades in Calculus II³ (all above a C-), this class was helpful for scholars. All students who either completed or partially took the course are expected to graduate within the next two years.

³ We chose Calculus II to look at because one scholar took the remedial course after he had taken Calculus I.

Study Groups

Suffolk's EE program strives to have study groups for each engineering course. Although attendance of study groups is optional, scholars were strongly encouraged to attend. Study group leaders are trained by the professionals at Suffolk's learning center which also administers the study groups. Scholars who achieved at least a B in their engineering courses were encouraged to become study group leaders after their freshman year.

An indication of how useful Scholars viewed the study groups is shown in Figure 2, which indicates the frequency at which Scholars attended study groups⁴. Of the thirteen scholars who continued in the EE program after their freshman year, eleven responded that they attended study groups for 1-2 courses, and seven indicated that they attended study groups for more than two courses. A deeper understanding of the effects of study groups on student performance may be obtained from Figure 3, which correlates the Scholar's SAT math score, current or final GPA, and frequency of study group attendance. The two scholars who did not attend any study groups had strong math skills, with high current GPA's and high SAT math scores (average GPA and SAT math scores: 3.6, 675, respectively) indicating that they succeeded without the need to attend study groups. These two scholars also had outside jobs which likely prevented them from attending.

The four scholars who used study groups for 1-2 courses had average GPA and SAT math scores of 3.1 and 580 respectively; and the seven scholars who used study groups for more than 2 courses had average GPA and SAT math scores of 3.3 and 527 respectively. That the students with lower SAT math scores who attended more study groups had higher GPAs than those with higher SAT math scores who attended fewer study groups may be an indication of the effectiveness of study groups.

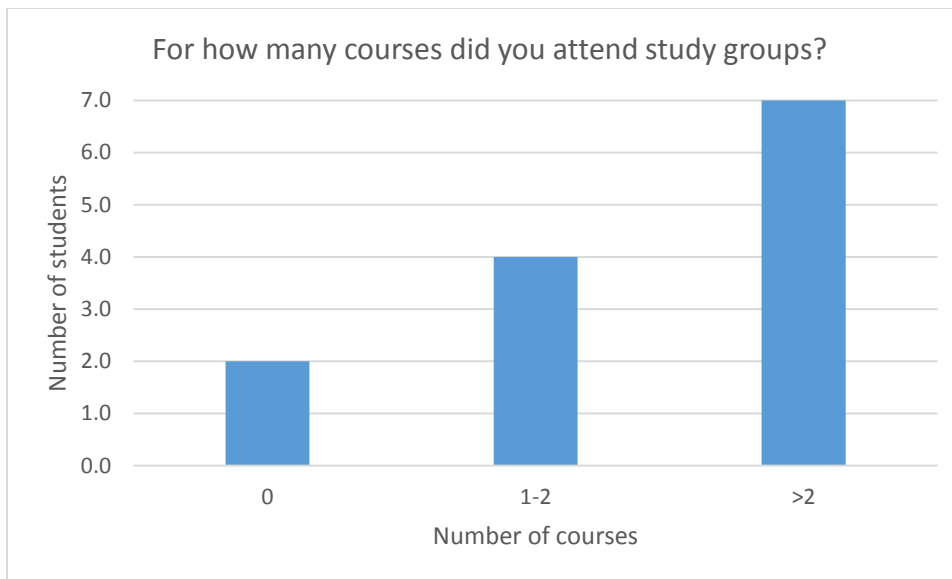


Figure 2 Responses of Scholars to the question about how many courses for which they attended study groups.

⁴ Only students who continued after freshman year are included.

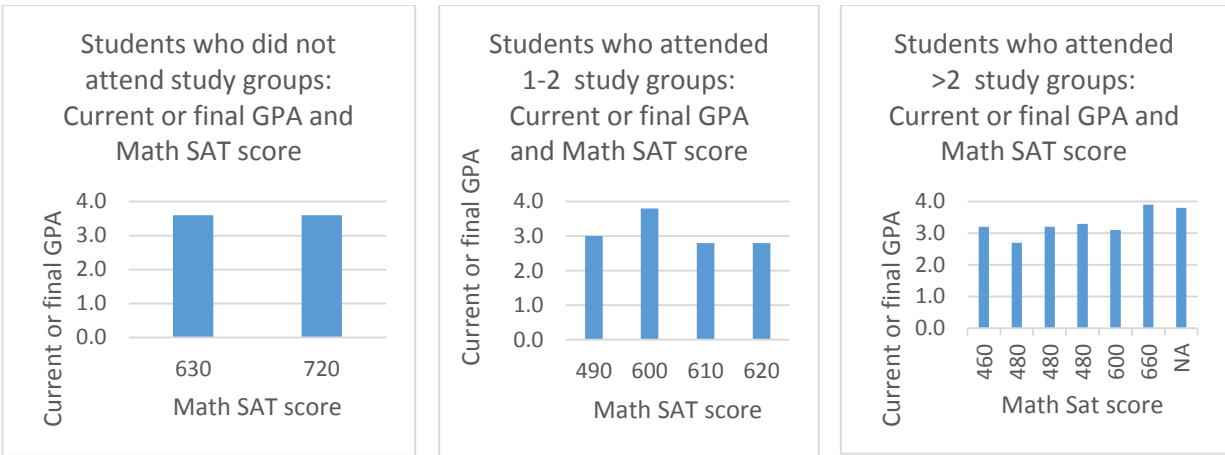


Figure 3 Analysis of study group attendance. Two scholars with strong academic backgrounds did not attend any study groups. Scholars with weaker math scores were more likely to attend study groups with greater frequency.

Career Development

Two to three times each semester during their freshman year, scholars met with the co-PI to engage in a variety of career development activities, such as interest and values assessment and interpretation, career decision making, and use their assessment results to plan for future education and fulfilling work. Out of the 19 scholars, 17 attended and completed the career development activities. Each scholar completed the following questionnaires: Career Thoughts Inventory (CTI) [13], Career Decision Making System-Revised (CDM) [14], and the Strong Interest Explorer [15]

The CTI is an assessment geared toward college students to help identify dysfunctional thinking and decision-making in relation to careers. This is a 48-item self-report measure aimed to improve the quality of students' career making decisions [13]. After completing and scoring the CTI, the co-PI helped students interpret their results and identify and decision-making difficulties, such as pressure from family members to choose a particular career, related to career decisions. Answers on the CTI fell into one of three categories: decision-making confusion, commitment anxiety, or external conflict. The cut-off score that indicated additional career counseling was the 84th percentile. Out of 17 students, none of the students had decision-making confusion scores at or above the 84th percentile. For commitment anxiety, one out of 17 students experienced an elevated score (above the 84th percentile) in this category. Two out of 17 students experienced elevated scores (above 84th percentile) for external conflict and an additional 6 students scored above the 50th percentile; however, this is not as surprising given that many students feel pressure from their family members and other external forces to engage in certain careers. Overall, the scholars did not exhibit much dysfunction in the career decision-making thoughts.

The CDM and Strong Interest Explorer questionnaires are self-report questionnaires aimed to assess student interest in different career fields. Students complete a number of questions related to activities they may or may not enjoy, and then they see what types of careers best match their interests. Overall, scholars who completed these questionnaires found that their interests and careers were mostly consistent with their majors, including interests in science,

math, and computers. Students discussed their results with the co-PI and took home a copy of potential careers based on their interests.

Pizza Events

The EE program offers a weekly pizza event for students to socialize with each other and with faculty. Scholars were encouraged to attend. Interestingly, based on high school GPA data, SAT math score data, and college GPA data, there was a stronger correlation between attending pizza events and college GPA than correlation between high school GPA and college GPA or SAT math score and college GPA (see Table 1). From Table 1, we see that pizza attendees and non-pizza attendees had a similar range of HS GPAs and SAT math scores yet the average college GPA of attendees was 3.4 and that of non-attendees was 2.7. The correlation between pizza event attendance and academic success provides additional support that a sense of community is important for academic success for our scholars.

Table 1

Attended Pizza Events	Yes	No
HS GPA	3.3	3.4
Mean SAT Math Score	542	568
Mean College GPA	3.4	2.7

Mentoring Activities

Experiments with students from Boston schools

Each year at the end of the fall semester scholars and other students visited our partner high schools to do experiments with high school students. The goal of these visits was to teach students about EE, energy, and sustainability. This activity was part of the scholars' freshman seminar course. Scholars also shared their college experiences and answered the HS students' questions about college, as many of whom would be first-generation college students. Several of the scholars had attended these same high schools, which gave the visit special meaning to both the scholars and the high school students for whom the scholars served as role models. Also, in addition to the freshman seminar students, upperclassmen scholars came along as well to give demonstrations of projects that they had worked on and to speak with the high school students. All but three EE scholars participated in this event more than once, which was more than what was required⁵.

At the end of the visit, high school students were given a survey about the visit and their interest in engineering and STEM fields. In 2014 most students agreed or strongly agreed that the experiments helped them learn about STEM careers (3.6 out of 5, 5 = strongly agree), the experiments were fun (3.8 out of 5), they learned a lot from the experience (3.6 out of 5), and that the experiments increased their interest in STEM careers (3.2 out of 5). In 2015, most students agreed or strongly agreed that the experiments helped them learn about STEM careers (3.8 out of 5, 5 = strongly agree), the experiments were fun (3.8 out of 5), they learned a lot from

⁵ Not including the EE Scholar who started after his junior year.

the experience (3.8 out of 5), and the experiments increased their interest in STEM careers (3.4 out of 5).

Power Engineering Day

Power Engineering Day is an event in which students from our three partner high schools come together to learn about engineering from professionals in the power engineering industry. High school students divide into small groups, and each group is led by one of the EE S-STEM scholars to the demo booths set up by the power engineering companies. Representatives from each company describe their work and instruct the students with hands-on activities that the companies bring to teach the students about electric power, in order for them to consider it as a career. Suffolk EE students also have tables where they demonstrate their senior design projects and other projects that teach about sustainable electric power. In addition, the engineering lab coordinator, who is a member of the Tesla Society, demos a Tesla coil and other electrical engineering devices. The EE S-STEM scholars, along with other Suffolk EE students, also spend time with the students, discussing college life and being an engineering student.

The motivation for the annual Power Engineering Day came from our partners in the electric power industry who are in need of recent graduates to replace their aging workforce, understand that new and renewable sources of electric power are becoming more important, and that the current aging system of power generation and delivery needs to be overhauled. The event is held annually, the day after spring semester final examinations, allowing students the time to mentor and to lead high school students as well as help run the event. Most of the scholars welcomed the chance to play leadership and mentoring roles in this event. The 2014 event was described in detail at the 2015 ASEE conference [16].

So far, four Power Engineering Day events have been held: two at Suffolk and two at the Benjamin Franklin Institute of Technology (BFIT), the school to which the Suffolk EE program is in the process of moving. All of the EE Scholars who remained in the program but one participated in at least one event, and all but three participated at every available opportunity. Figure 4 illustrates the College GPA vs. HS GPA and College GPA vs. SAT math score for those who attended Power Engineering Day on all available days and those who did not. As with the pizza events, college GPA is positively correlated with attendance at this event.

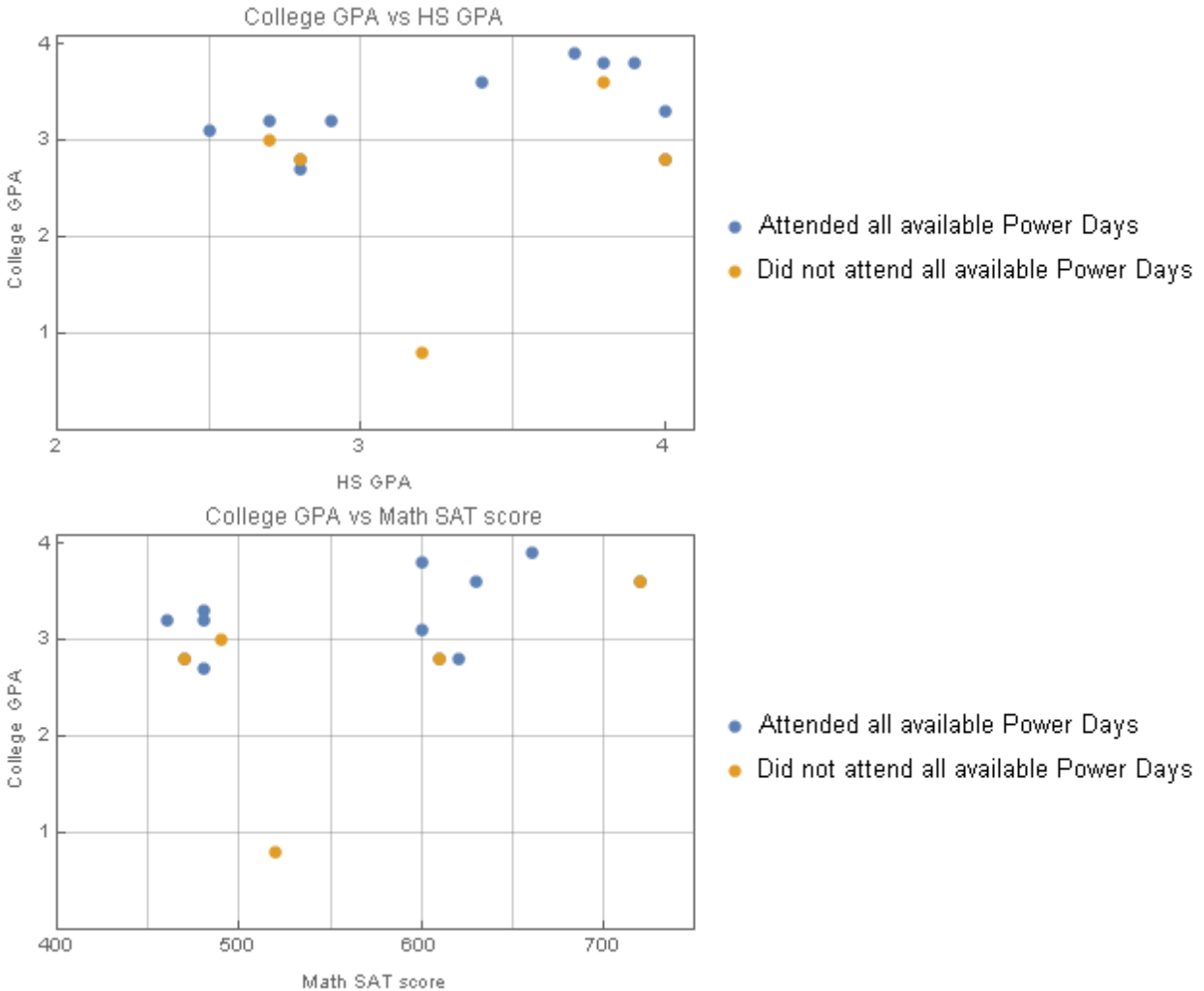


Figure 4 Correlating participation in Power Engineering Day with academic success. The same plots also apply to participation in the Latino-STEM Alliance events, and professional conferences and other events.

The Latino-STEM Alliance Robotics and Science Fair Competition

An annual robotics competition and family science fair is held in an inner city neighborhood in Boston sponsored by the Latino STEM Alliance (LSA), for students in grades 4-8 and their families, to promote engineering to students from underrepresented groups. The scholars, who mainly are graduates of Boston schools were encouraged to volunteer to engage the fair participants in hands-on experiments about energy and electricity and served as role models for the participants and their families. The 2015 event was described in detail at the 2016 ASEE conference [17]. The degree of participation in the LSA events for each scholar matched that of the participation in Power Engineering Day (Figure 4).

Career-Related Activities

Internships

Scholars were encouraged to apply for summer internships with our collaborating power companies, particularly after their junior year when our collaborators prefer to have summer interns. They are also encouraged to apply for the IEEE PES Scholarship, which is available to all EE majors who attend an ABET-accredited EE program. This scholarship awards a few thousand dollars in scholarship aid and provides leads on internship opportunities. To date, two Scholars have received the IEEE PES Scholarships.

Out of the seven scholars who could have had an internship after their junior year with an industry partner of the program, four have had internships: two with CE Power, one with Electroswitch, and one with OMICRON. Of the three who did not have internships with an industry partner, one had an internship with General Dynamics and the other two did not have internships.

Conference, Seminar, and Professional Society Attendance

Scholars were encouraged to attend and present at local conferences such as the regional NE-ASEE and IEEE student conferences, to attend the monthly seminars given by the Boston chapter of IEEE Power and Energy Society (PES), to attend the annual dinner of the Boston chapter of IEEE PES Society, and to attend the IEEE PES US-CA Student Congress that held at BFIT in August 2017. Participation in these activities for each scholar matched that of participation in Power Engineering Day and in the LSA events (Figure 4).

Student Success and Outcomes

Of the fifteen NSF EE Scholars at Suffolk, four have graduated and are working as electrical engineers with three in electric power, eight are still in the EE program, one switched to computer science after his second year, and two left both the program and Suffolk after their first year. This past summer, three current scholars had summer internships with two in our partners' electric power companies. We therefore have an 86% second year retention rate and all nine of these students who remain are highly likely to graduate. The 86% is less than the 95% we were hoping to obtain, yet still much greater than the national average of 60% [18]. Moreover, it is highly likely that the remaining students, who are all juniors and seniors, will graduate, yielding a graduation rate of 86%, higher than the 80% that we targeted. Success in the program is correlated with participation in the program's activities. It has been shown that greater participation in program activities resulted in a higher college GPA for a given HS GPA or SAT math score.

It may be instructive to focus on the students whose level of academic achievement may be somewhat surprising in order to better understand the contributing factors to a student's success or lack thereof. It should be noted that the PI taught the students in their first, third, fifth, sixth, and eighth semesters and so was able to monitor their progress and observe their interactions with other students.

In the first cohort (January 2014) of scholars, one student with a final GPA of 3.3 had a low SAT math score of 480 but was compensated by a high HS GPA of 4.0 from a regular, non-

exam Boston public high school. He had high participation in the program activities, regularly attended study groups, worked as a study group leader, and is currently working in the electric power industry. Another scholar with a final GPA of 3.1 in the same cohort had a low HS GPA of 2.5 but that was compensated by a relatively high SAT math score of 600. He came from the top Boston exam high school. He too had high participation in the program activities, regularly attended study groups, worked as a study group leader, and is currently working in the electric power industry. It should be noted that these two students often worked together and became good friends. They also continue to volunteer for the EE program, including participating in Power Engineering Day and being members of our Industrial Advisory Board. From the first cohort, three out of four scholars' currently work in the electrical engineering industry, and the fourth student has completed all of this requirements and will be graduated at the end of the spring 2018 semester.

Three scholars made up the second cohort, beginning in September of 2014. One student, with a HS GPA and SAT math score that were average for the scholars, was uninvolved in the program and was later dismissed from Suffolk⁶. Of the remaining two students, both are highly involved and have high college GPAs (3.2) despite having lower high school GPAs and SAT scores compared to other scholars. One of these scholars had a summer internship with the electric power partner company and already has accepted a job offer upon graduation in spring 2018 from the company in which he interned. This student had the highest level of participation in the program's activities, completed the pre-matriculation remedial math course, regularly attended study groups, and works as a study group leader. The other also had a high level of participation, regularly attended study groups, and worked as a study group leader. He has a high current GPA of 3.2 and interned this past summer in an electric power partner company.

The third and largest cohort started in September of 2015. Out of the six scholars, four of them are Latino male, one is an Asian male, and one is an African American transgendered male. Four of the scholars are EE majors and one switched into computer science. Another student from this cohort left the program after a year to pursue a degree in teaching. He reported that he was glad for his experience in engineering and felt that he could incorporate his engineering studies in his future career as an elementary or middle school teacher. Similar to the other cohorts, the students with the highest current GPAs are the ones who participate in the most activities and are most involved with the STEM scholarship program. Nonetheless, all remaining scholars are on track in the program and should graduate on time, in the spring of 2019.

The five most recent scholars from 2016 and 2017 consist of one EE major, three biology majors, and one computer science major. The EE student from the 2016 cohort was given the scholarship later in the program and has since graduated and works in the electronics industry. He was also involved in all of the program activities. The non-EE students have been involved in outreach activities such as visiting the BPHS and volunteering in the LSA events. Unfortunately, the other EE events are not applicable to the new scholars with different majors.

In summary, it seems the more engaged students were in the program and its activities, the higher the student's likelihood of success. Engagement with other students, along with academic pursuits such as attending study groups and taking remedial math courses, compensated for a weaker academic background. The scholarship, which allows students to attend college tuition free and mitigate the need for an outside job, was key in enabling students

⁶ He would be replaced the following year by an existing Latino male student who had joined the scholars in many activities, even before he knew he would become a scholar,

to engage in these activities. This aspect is particularly important for the academically weaker students because it allowed them to focus on school without having the burden of outside work.

These findings are consistent with the findings of the program's outside evaluator. In 2017, he reported that students seeking help had diverse sources of assistance all within relatively easy reach; that the students found the program both challenging and supportive; and the importance of faculty who were easily accessible. He also reported that the program has been effective at creating a supportive social and physical "space" in which the students can learn, which has helped them become more self-assured and determined to pursue engineering.

Conclusion

Although the EE program at Suffolk was shuttered in 2015, it has nonetheless been effective in offering an NSF S-STEM program in which students who may have had lower-than-average SAT math scores could succeed. Key features of the program include a five-day pre-matriculation trip to Maine to do science in the field, study groups, mentoring activities with middle and high school students, weekly pizza events, remedial math courses, career counseling activities, and a partnership with the electric power industry to encourage students to seek careers in electric power. Overall, we have found that greater participation in the program's activities is positively correlated with higher academic achievement. The EE program continues at BFIT, an institution that is dedicated to offering education in engineering/technology catering primarily to inner-city, minority, and economically disadvantaged populations. The PI plans to submit a new S-STEM proposal in 2018 that will be very similar to the proposal described in this paper, but more specifically tailored to the student population and resources of BFIT.

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