

Engineering Diversity at Queensborough Community College

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Abstract

The Engineering Technology [ET] Department at Queensborough Community College [QCC] presents several strategies used to attract and retain a diverse student population. Our recruitment and retention efforts support our goal of having a diverse student body that includes students from a wide cross section of underrepresented groups in our academic programs. This paper will examine the details of the efforts and programs utilized by the QCC ET Department. These efforts include our high school recruitment activities aimed at recruiting students from our local high school communities. The department conducts a Summer Robotics program, which introduces theories and applications of different Science, Technology, Engineering and Mathematics [STEM] disciplines including Mechanical Engineering, Electronic Engineering, Computer Programming and Mathematics concepts to a select group of the local high school students. This effort is intended to encourage students to consider a career in STEM and hopefully choose one of the many STEM programs at QCC. The Coding and 3D printing Technology workshops were conceived to encourage more female participation in Engineering. The department realized that although female students represent 50% of our population, their representation in the STEM programs were significantly below 50% of our enrollment. This program was designed to address some of these concerns. This paper will also examine the goals and efforts taken to reorganize our curriculum to help our department with student retention once they enroll in one of our Engineering Technology programs.

Keywords

STEM, Diversity, Robotics, 3D Printing, Women in Technology.

Introduction

Underutilized Science and Engineering [S&E] human resources can have a negative impact on a society's ability to innovate and find creative solutions to challenges. The stories of Katherine Goble, Mary Johnson, Dorothy Vaughan, and JoAnn Morgan who all worked in the STEM fields at NASA in the 1960's serve to illustrate this point. A society is more successful when it finds a way to harness the contribution of a diverse workplace.

Queensborough Community College [QCC] of the City University of New York [CUNY] has a multifarious student population. QCC is located in one of New York City's most diverse boroughs of Queens County. Using the fall 2018 semester fulltime enrollment data [1], our student body consists of 50.5 % female and 49.5% male. The racial make up of the student body is comprised of students from 127 nationalities and over 78 different languages. The ethnicity of the college population comprises 26% of African American, 1 % of Native American Indian,

30% of Asian or Pacific Islander, 15 % of Caucasian and 29 % of Hispanic / Latino [1]. However, the retention gap between non-underrepresented students [Asian or Pacific Islander and Caucasian] and underrepresented students [African American and Hispanic/Latino] has 7-10% difference. The ET department makes a determined effort to effectively recruit and retain students across wide cross section of the population. While the diverse population of five boroughs of New York City provides a large pool of potential candidates, QCC attracts students from all five boroughs with a majority of student originating from Queens County. The college also attracts students from Nassau and Suffolk counties as well. This paper will present our efforts to maintain and improve the diversity of our student body. The efforts are focused on our high school recruitment effort, the Summer Robotics program, the Women in Technology Summer Workshop, and the changes we initiated in our curriculum in an effort to maintain and have our student achieve a successful academic outcome. Research shows that a first-generation college student needs support to succeed in the STEM disciplines [2]. The trends at QCC also indicate that the grade distribution remain even across the college population. There were 33% of student who receive an A, 33 % of the student were in the B to C range and 33% of the population were below a C. However in the S&E programs, a greater number of the incoming students demonstrated an increase necessity for remedial Mathematics [5]. . Conversely, not all freshmen who enrolled received a C or better in these required Mathematics courses. Difficulties in Mathematics directly translate to difficulties in the S&E and STEM programs. An effort had to be made to improve on this outcome. The areas of emphasis are presented below.

Recruitment

In order to attract a wide cross section S&E students, the QCC ET department takes advantage of a variety of high school recruitment events offered in NYC. However to make the best use of our resources, the recruitment efforts are focused on high schools campuses that within a fifteen to twenty mile radius of our campus. This equates to approximately forty [40] high schools in our target area of interest. The recruitments efforts include ensuring that the college counselor in the target schools have an understanding of degree programs offered by the department. To supplement this effort, ET department faculty member actively participate in as many high school college fairs possible. An effort is also made to establish and maintain a close relationship with the high school counselors. Our recruitment efforts include representation at high school career day as well. The QCC administration also organizes an Open House Event usually in the spring and fall semesters. The ET department makes every effort to be represented at these event in the best positive light.

Closely coupled with our recruitment is our retention efforts. Simultaneous to the retention effort that occurs at the administration college level, at the ET departmental level we also make every effort to retain our students as well. If a student decides to transition away from one of our programs, we make an effort to understand why that separation occurred. Our telephone outreach effort will include a phone call and a short conversation in hopes of understanding the reason the student decided to leave. The reasons will vary from financial, incarceration, the birth of a child or a change in employment situation. If there are on campus resources available to

help the student transition back to one of our programs we make an effort to do so. The department also makes a focused effort to actively encourage our active students to register for the upcoming semester.

Summer Robotics Program

To attract high school students interested in a STEM discipline, NYC public high school juniors and seniors are given the opportunity to enroll in our ET department Summer Robotics Program. This program offers a theoretical and application driven approach to introduce students to robotics and computer programming. The program is coordinated by the QCC College Now program and is taught by the ET department faculty. The Engineering Technology Department also uses the program to improve a student's college readiness and an entry pathway to our STEM programs. The participating students have a strong preference for STEM disciplines and they already have developed a fundamental level of STEM related knowledge at a high school.

The Summer Robotics Program utilizes students' regent's mathematics scores and other STEM related metrics as a selection criteria for the program. Each summer approximately twenty five students are selected from the pool of applicants. The program runs for four weeks in June and starts one week after the last day of classes of the New York City School students. The student meet four days a week Monday through Friday. The program starts at 09:00 AM and runs until 04:00 PM with an hour break for lunch. Students are expected to attend all classes and receive four college credit at successful completion of the course. The program is funded by a grant from the NYC Department of Education. The funding is used to provide a summer stipend for two ET department faculty members, as well as course material, a NYC MetroCard and lunch for all the participants.

The summer course content presented to the students is usually at an equivalent level to an entry level Engineering Technology classes at QCC. These topics include concepts in three primary areas; Electrical Engineering Technology, Mechanical Engineering Technology, and Software Technology. The Electrical Engineering Technology topics include Introduction to Microcontroller Hardware, Understanding the Microcontroller Board, Microcontroller and Components, Memory, Pushbutton Circuits, and LEDs, and Sensors. The Mechanical Engineering Technology discussion includes gear, gear ratio steering, differential steering, two wheel drive, and four-wheel drive. The software technology topics include variable blocks, looping, decision statements, and I/O. Mathematical theory and applications including trigonometry and related topics are also included. The class is usually divided between a morning lecture presentation of relevant theoretical concepts and an afternoon hands-on laboratory session with experiments in computer programming and construction of the robotic subassemblies. The main objective of this program is to extend STEM academic opportunity for the participated high school students by opening an entry path to the QCC for their successful STEM career.

Curriculum Rearrangement

After a review of the new students' enrollments and retention data, the ET department sighted that the retention rate of the first year engineering technology students who registered for three of our STEM program was trending downward significantly. The course sequence for these affected programs were front loaded with the necessary prerequisite classes of Mathematics, Science and Physics courses that follows the structure of a traditional engineering curriculum. However, at the community college level, the incoming freshmen are often in need of remediation. Data shows that thirty-three percent [33%] of freshmen needed remedial mathematics, twenty percent [20%] needed remedial writing, and eleven percent [11%] needed remedial reading in fall 2018 [1].

In an effort to retain these students, and help to keep them interested while their Mathematics skills continue to develop the course sequencing for these programs were rearranged. The program adjustment included moving two of the third semester courses into the first semester. These courses required less Mathematics and Physics. Rearranging our course sequence allowed students to matriculate into the ET curriculum and develop an affinity for the ET curriculum while simultaneously developing a mathematically higher degree of competence and skill. The hope is that as their confidence improves it will serve as motivation for these students to succeed. Some of these courses include

- **TECH-100: Introduction to Engineering Technology:** An introduction to the history, philosophy and methodology of engineering and technology related professions. The disciplines of computer, electrical and mechanical engineering and technology are introduced. Basic mathematical, graphical and analytic skills are developed as well as experimentation and data analysis techniques. The analysis and presentation of engineering data and designs, as well as ethical and professional considerations, are considered.
- **ET-540: Digital Computer Theory:** Provide an understanding number systems; Boolean algebra; logic elements; multivibrators; clock circuits; decoders; counters; data registers. Laboratory hours complement class work

The course contents for these two classes were modified so that a prerequisite is not required. Also, it benefits students by allowing them to take these courses and remedial mathematics in the same semester.

Women in Technology Summer Workshop

The goal of any diverse program is to have a group that represents the makeup of the larger society. Therefore an effort had to be made to increase the female representation in the Engineering Curriculum. Women represented 50% of the population, and over 50% of our total QCC student enrollment. However, they remained an underrepresented group in the QCC ET student population. The enrollment of women in Engineering Technology program in QCC was as low as 3 % in fall 2013 and fall 2016. Computer engineering was composed of 7% of women and computer information was composed of 14% of women for the same period [3]. Degrees

granted in STEM disciplines in City University New York [CUNY] from 2016-2017 represents only 20% and 23% of women in Technology, including Computer Science and Engineering majors respectively compared to 62% of women in Science disciplines. While the number of women enrollments in technology fields remains low, the rate of job demands in technology fields is drastically increasing [4]. The U.S. is graduating only 52% of the trained workforce in the technology related job areas. Addressing these issue and concerns, spurred the genesis of the 3D Printing and Coding summer workshop. An innovative curriculum is vital to get more young women started in the areas of STEM education and STEM related careers. The emphasis of this program was to engage female students with technology in a supportive and friendly environment. The program is organized as a workshop that applies a project-based learning approach and focuses on two components, 3D printing and computer programming code development.

The summer program invited QCC female freshmen students in all majors to participate. In this program, we develop the interest in technology for the students who lack exposure in a technical discipline. Community College is the place where students can safely explore their interest, potential and capacity that they may not have discovered from their high school studies. Community College offers a great opportunity for these students to develop new academic and career goals through their experiences. Most of the community college students transfer to a senior college to continue in their desired areas of study. Therefore, early positive technology experiences in community college through the proposed practical project are expected to increase the interest in technology disciplines for young female students.

The workshop was organized in two groups and developed over the mid-summer months. The QCC Advanced Manufacturing Laboratory was utilized because of its ease of access and availability. The main objective of our program was to expose female, fulltime students to the most current technology. The recruited participants of the program were newly enrolled QCC female students in all majors for the 2018 fall semester. During the 2018 fall admissions, the QCC Admission Office assisted by providing invitations to all of the newly admitted women who started in the 2018 fall semester. Since the objective of the program is only promoting interest in technology, there were no specific criteria developed with regards to the recruiting of the incoming students. The program was offered on a first-come, first-served basis. Each session was fully registered and interest was so strong that the program had long waiting lists of students. The team invited 20 first applied students per session, a total of 40 students were invited to the workshop, and 36 students completed full programs in the workshop.

Conclusions

In this paper we highlighted the need for diversity in STEM disciplines at QCC, and discussed methods utilized at QCC to increase the enrollment by the underrepresented groups. Among other topics robotics, computer programming and 3D printing were presented as valuable tool to attract and retain students. Attracting, and maintaining a more varied group of students will result in a more diverse group of S&E professionals. In the long term the society at large will bear the benefits from an increase in STEM knowledge and participation.

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