Building a Critical Mass of Female Engineering Technology Students

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Abstract

In effort to address low enrollment of female students in the Engineering Technology programs at the Rochester Institute of Technology (RIT), a scholarship program that combines financial support with academic support, professional development and social support has been implemented. The name of this project is: Critical Mass of Engineering Technology Scholars or COMETS. The goal of the COMETS project is to build a critical mass at RIT of female scholars in Engineering Technology by recruiting, retaining, and graduating female students in the Engineering Technology BS programs. The focus of this paper is on the assessment of the COMETS project: the assessment plan, methodologies and preliminary findings.

Introduction

The Engineering Technology (ET) programs at RIT attract academically talented women; however, the number of women in these programs is lower than national averages. Research demonstrates the importance of a strong, vibrant community of women in engineering programs in recruitment and retention of female students. In an effort to build this community of women, a project has been funded by National Science Foundation Scholarships in Science, Technology, Engineering and Math (NSF S-STEM) at RIT. This project provides academic, monetary and social support to academically talented and financially needy students enrolled in the Engineering Technology programs at the RIT. The name of this project is: Critical Mass of Engineering Technology Scholars or COMETS. The goal of the COMETS project is to build a critical mass at RIT of female scholars in Engineering Technology by recruiting, retaining, and graduating female students in the Engineering Technology BS programs.

The objectives of the COMETS program are:

- Engage scholars in the Women in Technology community through participation in professional development workshops, socials, mentoring, and outreach events.
- Effectively prepare the scholars for the workforce or graduate school.
- Reinforce the students’ decision to major in Engineering Technology.
- Perform regular and thorough assessment of the COMETS program.
- Identify scholars struggling academically and provide proactive academic support.
- Strengthen relationships with regional community colleges and high schools as a means of recruiting scholars.
The COMETS project strategies to achieve the objectives:

- Academic, social support and professional skills development provided by the Women in Technology program in our college.
- A required one credit course covering topics ranging from academic success skills, career and graduate school preparation, and how women have and can make an impact on society and the world through a career in engineering. This course will also serve as a means for community building amongst the scholars.
- The existing RIT support network: a well-established, substantial network of support services encompassing areas ranging from academic support centers to the Women’s Center to health and wellness programming.

The focus of this paper is the assessment plan, methodologies and preliminary findings.

Background

The COMETS project goals are aligned with the goals of the NSF S-STEM program to encourage and enable academically talented but financially needy students to enter the workforce following completion of a degree by improving educational opportunities, increasing retention of students, improving student support programs and increasing the number of well-educated and skilled employees in technical areas of national need.

Unless the U.S. can attract more students to science and technical fields, there will be a shortage of qualified workers for our increasingly technology-oriented society. The next generation of scientists and engineers will have to be innovative to quickly adapt to emerging technologies. Participation in the development of innovative technologies requires diverse perspectives. Increasing the number of female engineering and engineering technology graduates is one way to increase the number of qualified workers for the future. In 2007, women accounted for 46 percent of the workforce yet only represented 11 per cent of engineers. While the number of female graduates of Engineering Science programs in the U.S. is close to 20 percent, women graduates of Engineering Technology programs remains stable at 11.7 percent of the workforce.

While RIT has made a successful effort to attract more female students, the percentage of female students in the Engineering Technology programs languishes at just below 10 percent. Recent improvements have contributed to an increase in the percentage of women in ET from 7.7 in 2004 to 9.2 percent in 2012 (See Figure 1). The number of women students increased from 73 to 166, an increase of 59%. Part of this growth is due to the size of the College of Applied Science & Technology at RIT growing by 29% over the same time period. The recent establishment of a Women in Technology support program has made the ET programs a more attractive option to female students. Research has shown that the lack of a critical mass or support systems is a main factor in why women leave engineering programs. The COMETS program aims to produce a critical mass of female scholars in the Engineering Technology programs at RIT and provide the support needed for these scholars to successfully complete our programs.
Research suggests that women who stay in engineering programs tend to be confident in their abilities, involved in student societies, and enjoy strong relationships with mentors. The COMETS program includes activities to build self-confidence and relationships with mentors and encourage involvement in professional societies and utilization of support services available at RIT. Studies also indicate that support activities play a critical role in the retention of women in engineering majors. The COMETS program will provide this support through support of the Women in Technology (WIT) organization, a one credit course specifically designed for COMETS scholars and the well-established RIT support network.

Assessment Plan and Methodologies

Project success and student progress is being determined utilizing formative and summative assessment techniques. Formative assessment is comprehensive and utilizes both quantitative and qualitative techniques: participant retention, GPA, focus groups, individual interviews, etc. A system of tracking of retention statistics, GPAs and student satisfaction surveys is a well-developed function of the Women in Technology program. Results will be compiled at the end of each quarter. Data analysis and interviews will utilize well established content analytical methods. Data is reviewed by the program team and a professional evaluation consultant is assessing program effectiveness and progress. The evaluator is assisting with design and implementation of all assessment tools, assisting with data compilation, analyzing data and providing the project team an annual evaluation report.
The Academic Pathways of People Learning Engineering Survey (APPLES) developed by the Center for the Advancement of Engineering Education (NSF Grant ESI-0227558) is being used as a guide to assess the scholar’s intentions to pursue an engineering degree over their undergraduate career and to pursue a career in engineering upon graduation. This survey captures:

- Motivation for pursuing an engineering degree
- Confidence in math and science skills, ability to solve open-ended problems and professional and interpersonal skills and perceived importance of these skills
- Extracurricular fulfillment
- Satisfaction and interaction with instructors
- External and intrinsic motivation factors

This survey is given each quarter and results are tracked. The data provides insight into areas where individual students need support and allows the program to determine which factors correlate to academic success and degree completion at our institution.

### CoMETS Program Assessment and Evaluation Plan

**Goal:** To build a critical mass at RIT of female scholars in Engineering Technology by recruiting, retaining, and graduating 44 additional female students in the Engineering Technology BS programs.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Evaluation/Assessment</th>
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<tbody>
<tr>
<td>Engage scholars in the Women in Technology programming</td>
<td>Track scholar participation in WIT events&lt;br&gt;Analyze program satisfaction surveys</td>
</tr>
<tr>
<td>Effectively prepare the scholars for the workforce or graduate school.</td>
<td>Track career placement for graduates&lt;br&gt;Track graduate school intentions and applications&lt;br&gt;Measure student perspective in confidence and coverage of intended learning outcomes in CoMETS course</td>
</tr>
<tr>
<td>Reinforce the students’ decision to major in Engineering Technology</td>
<td>Analyze Academic Pathways of People Learning Engineering Survey (APPLES) to be completed by scholars at the beginning of each quarter.&lt;br&gt;Evaluate interviews with scholars (given at the beginning of each academic year and exit interview)&lt;br&gt;Interpret focus group findings annually</td>
</tr>
<tr>
<td>Identify scholars struggling academically and provide proactive academic support.</td>
<td>Track GPA, academic performance in core technical courses&lt;br&gt;Measure utilization of academic support services</td>
</tr>
<tr>
<td>Strengthen relationships with regional community colleges and high schools as a means of recruiting scholars.</td>
<td>Record interactions with community colleges&lt;br&gt;Compare number of scholarship applications from community college partners versus other schools</td>
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**Figure 2: COMETS Assessment and Evaluation Plan**

A focus group will be held with a sample of students (N = 4-6) during the third year of the grant. The focus group protocol will be developed specifically for this project. It will follow-up on questions raised by the survey results and will explore students’ perceptions and experiences of the project as well as factors that facilitate or inhibit their participation and that influence their attitudes, behavioral intents and actual behaviors vis-à-vis pursuit of Engineering Technology.
education and engineering careers. Focus group results will be analyzed qualitatively using conventional content analysis\textsuperscript{13} and analytic induction\textsuperscript{14}. The results of the focus group will provide important contextual information to the project staff so that they tailor the project to the complex lived experiences of the students.

Summative program assessment information is compiled annually and reported to the NSF following NSF reporting guidelines. The summative evaluation includes the impact the CoMETS program has made on the scholars; systematic impact on the recruitment and retention of female students; and impact on the participating departments, the Women in Technology program and other participating student support services.

**Preliminary Assessment Findings**

**Data Corpus**

Data from this program were gathered from the following sources:

- 3 Scholars interview responses from Fall 2012, conducted by faculty mentors
- 2 Scholars interview responses from Spring 2013, conducted by faculty mentors
- Scholars survey from Fall 2012
- Scholars survey (including 23 other female engineering students) from Spring 2013
- COMETS Single Gender Discovery Class End of Course Survey 2012 from 14 female students
- Winter 2012 GPA and overall GPA for Scholars
- Focus group transcripts with Scholars’ mentors in August 2013

**Methodology**

**Qualitative Methodology**

Interview data from both fall and spring were initially coded to look for overarching patterns using ground theory techniques described from Charmaz (2006). Once these initial codes were developed, interview responses were consolidated into a single document, and then re-coded line-by-line underneath emergent categories derived from the initial codes. During this time, reflective memos described initial themes and impressions before an overall codebook was created that pulled specific examples from each individual interview into a much more descriptive set of categories.

These categories were developed even further through the open-ended responses found in the COMETS Single Gender Discovery Class End of Course Survey 2012.

**Quantitative Methodology**

Scholars surveys from Fall 2012 and Spring 2013 were reformatted and imported into SPSS statistical software. From there, qualitative categories derived from the interview data were used
to direct the analysis. Because data comes from a small sample size (five scholars), descriptive
statistics were used.

Findings

The initial findings reveal overarching themes in terms of connectedness, or social needs,
competence, and communication.

Connectedness
From the interview data, there was a strong social need to connect with others at RIT. Two
scholars mentioned how easy it was to meet new people and make friends. One scholar talked
about how she started doing homework with people, “even if they aren’t in the same class as
me.” Another spoke about how the liked the female Discovery because it was nice to be “with
the girls.” All Scholars had found ways to socially connect through either WIT events, or other
groups, such as martial arts and Imagine RIT. In particular, one scholar talked about enjoying
GS outreach, and meeting other ET females. Another scholar, although she mentioned that she
had very little time to join groups, but admitted that she wanted to, found connectedness through
skyping with her mother and sister on a regular basis, or going to dancing clubs. In her initial
interview, she mentioned being very depressed when she first arrived at RIT, because she
believed her accent made it hard for people to understand what she was saying.

In addition to connectedness with friends, family and peers, the Scholars mentioned how they
also connected with faculty, with one scholar even saying that the professors “genuinely care if
we succeed and are willing to answer any questions we have,” and that the professors were
relatable. Another felt she was connected to both faculty and students at RIT. Two Scholars
mentioned how they have enjoyed networking through their groups – one through National
Society of Black Engineers (NSBE), and another through WIT events.

There was also a negative aspect to connectedness in the findings. For example, two women
found that group work in classes “is discouraging” because other members either did not
contribute, or people (including her professor) assumed that she wasn’t capable of doing some
things in lab. Another Scholar felt that she was treated differently, and that the “guys in her
group give her the calculations to do.”

Additionally, the lack of being able to connect was mentioned in a negative light. One Scholar
reported that it was difficult being away from family, and finding the time to keep in touch with
new people. Another mentioned how the most difficult thing for her to handle so far was her
soccer injury, because it prevented her from participating in intermural sports for the winter.

Competence
Competence, as described by Reeve, Deci & Ryan (2004)15 “is the need to be effective in
interactions with the environment, and it reflects the inherent desire to exercise one’s capacities
and, in doing so, seek out and master optimal challenges” (p. 34). For many of the Scholars,
competence was in the form of academic success, and Scholars mentioned both academic
achievements and struggles that they have had throughout the year.

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The feeling of being overwhelmed or struggling with the balance between time, work, and school was common for three of the Scholars. In their interviews, they mentioned improvements in time management, or study skills that they have had to work on throughout the year – two feeling that high school did not prepare her “for the rigors of college.”

One Scholar in particular spoke about how her “Insights for Success” taught her good study habits that she now puts into action. Another mentioned that WIT helped her get better grades because she had people to talk to who understood the situation.

**Communication**

The topic of communication came up several times in the interviews from three of the Scholars. For one Scholar, she mentioned how she felt her accent made it hard for people to understand her. She also talked about how she had a professor that “did not really explain what was going on,” and that one professor seemed to make everything too complicated. Another scholar mentioned about how she learned to “speak up” in class. In contrast, the third Scholar mentioned how the guys (in her class) seemed to have trouble talking to girls.

**Analysis**

The findings parallel the theoretical foundation for the goal of the COMETS program – to build a strong women’s community within the ET program through social, academic and monetary support. In terms of social support, the data show that connectedness is an important aspect for the Scholars. They reach out in different ways through RIT groups, family, university and community to find ways to socially connect with others. From the interview data, some of these connections were facilitated through WIT participation in the form of networking, and through the female Discovery class by connecting with other ET girls.

Academically, Scholars had to acquire or improve on time management and/or study skills for success. From the interview data, there seems no indication that either the WIT or Discovery class helped with competence. In the case of one Scholar, she mentioned that she used strategies from her Insights for Success class to help her, and suggested that the Discovery class should be more like the Insights to Success class. She also told the interviewer that the Discovery class “was more to do with your degree and that seems so far off that it wasn’t relevant.” However, in the Discovery Class End of Course Survey, students mentioned coaching, having a peer mentor, and reading the 4.0 Book among the most helpful components within the class.

The End of Course Survey open responses seemed to facilitate communication among the students, with comments such as “everyone’s opinion was heard” and that it “helps me be a team player,” or that “we were able to hear other people’s viewpoints.” This class could possibly facilitate some of the miscommunications found within the statements Scholars made in their interviews – such as learning to “speak up.”

**Implications and Suggestions**

Both connectedness and competence were issues of importance for the Scholars. In one case, a Scholar used her connections with friends as way to study and improve her competence in her
classes. As such, the COMETS program may be able to improve and draw upon the social network at RIT through the Discovery course, WIT, as well as the COMETS faculty mentorship program, can create a professional network that supports the academic endeavors of the Scholars.

Currently, the Discovery course syllabus focuses on study skills through self-reflection for the first half of the class, then on career readiness for the second half. One common format found within the syllabus the use of small and whole group discussions, which seems a key aspect of the course’s success. It is possible that within a mixed gender course, issues of communication between individuals could be a topic that is addressed in order to improve overall communication between students outside of class and in other classes. Additionally, and based upon the interview data, perhaps more emphasis could be placed upon study skills (drawing upon the model of the Insights to Success course), and less upon career readiness. Additionally, career readiness, networking and “real world work” were topics that the Scholars found beneficial.

Mentorship is a key component in developing a strong, supportive community of women in Engineering Technology. Because there seems to already be a social network at RIT from which the Scholars draw from, mentors could also help to build a professional and academic network for the Scholars. Some of the suggestions to help draw upon the mentorship aspect would be:

- Literature on mentoring – ways in which both mentors and mentees can communicate with each other to help both strengthen and draw upon this professional bond
- More frequent interactions with mentor and mentees in informal settings outside of the office
- Encouragement to increase participation in WIT activities
- A brief workshop webinar through WIT on finding and working with both faculty and peer mentors.

**Conclusion**

Preliminary assessment of the COMETS scholarship program indicates that connectedness and competence are factors of concern for the scholars. By developing targeted programming and interventions related to connecting the students with other students, their department and the university and providing academic support; the COMETS program will address the strongest concerns of the scholars. The evaluation and assessment of the scholars’ progress and perspectives will enable the COMETS to meet its goal of building and growing a critical mass of Engineering Technology scholars at RIT.

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Bibliography


3. Cordova-Wentling RM, Camacho C. Women engineers: Factors and obstacles related to the pursuit of a degree in engineering. ASEE Annual Conference and Exposition, Conference Proceedings; 2006; Chicago, IL, United states. American Society for Engineering Education. p Dassault Systemes; HP; Lockheed Martin; IBM; Microsoft; et al. (ASEE Annual Conference and Exposition, Conference Proceedings).


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