Student-led Mentoring Program Fostering Retention of Female Undergraduate Students in STEM Fields

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ABSTRACT: This paper describes the mentoring program for female students in STEM fields developed by the collegiate section of the Society of Women Engineers at the New Jersey Institute of Technology (SWE-NJIT). The uniqueness of this mentoring program stems from the fact that it has been led by students since its inception, integrates peer and professional mentors, and is rooted to the geographical area surrounding our university. We believe other universities may find this model of mentoring useful for partnering with as well as for empowering female students in the development of retention and professional growth programs geared towards them.

In the second decade of the 21st century, the national average percentage of female enrollments in STEM undergraduate and graduate programs remains well below those for men[1], especially in fields unrelated to biological, medical, or chemical topics.[2] Concerned by our own experience of seeing female students migrating out of some engineering majors and into less math-intensive programs, the students and faculty advisor of the collegiate section of the Society of Women Engineers at the New Jersey Institute of Technology (NJIT-SWE) decided to take steps to address the key issue of retention of women in STEM fields, with a special emphasis in engineering careers in our institute.

The very broad literature on the gender gap affecting women in STEM fields shows that one of the primary reasons for the appalling statistics[1,2] is the lack of a positive support system for women in STEM—references 3 through 7 in this paper are excellent reviews of the current literature relevant to our work described here.[3-7] As a result, the NJIT-SWE team rapidly agreed to develop a retention program for our institute that was based on the creation of a *locally rooted* positive support system for female students at the New Jersey Institute of Technology (NJIT).

In the definition of the optimal characteristics and format of our program, we focused on four major aspects:

- **Student-led program**. Numerous support programs have been developed[3-7] by professionals for female STEM students but programs led by the students themselves are lacking. The wholehearted support given by the collegiate members of NJIT-SWE to this approach is backed up by previous studies showing that "*women prefer learning experiences that they help to design, that are learner-centered, and that involve them in a community*" as discussed by Reha *et al*. for the root cause titled 'Instructional Strategies'.[3]

- **Local community formation**. This aspect of our program builds on the notions that (i) women lean towards programs that make them feel as part of a community, (ii) the student body at NJIT comprises a number of commuters much larger than those of colleges in rural, less populated areas, and (iii) our campus is located in one of the most industrialized and densely populated areas in the US. These characteristics of our local environment result in a high percentage of our students staying in the area after graduation. We decided in favor of a support program rooted in the geographical area of NJIT because this approach would help students before graduation and also afterwards, when having a professional network is crucial to secure a job.

- **Professional and peer mentoring**. The interaction with role models and more experienced colleagues and professionals has been pointed out as a significant factor in the career achievements of women in the STEM fields.[8,9] Among the multiple types of mentoring described in the literature (and summarized by Amelink[9]), the style of mentoring that identifies our program is a combination of the Apprenticeship[10] and Peer[11] models under a Relational model[12] of interaction between the members in a mentoring group—or community. Through the apprenticeship approach, mentees in our program receive input from positive professional role models, learn about work/life balancing, and acquire knowledge about details of possible jobs in their field of study such as wage ranges and skills required. Mentorship by peers—typically older students in the same department—complements the extra-curricular information delivered by professional mentors with everyday, campus-life, useful insights that take a couple of years to amass—for example, details about course expectations or the amount of extra-classroom time required for completing a given course. The multiple members of a mentoring community interact among themselves in a personal, amicable, one-on-one way, as it could be described by the Relational model and supported by findings that females benefit of mentoring approaches that comprise both psychosocial and career-development needs.[12]

- **Long-term sustainability**. During the design phase of our program we kept going back to a question posed by the American Association of University Women (AAUW): "How can we move beyond the model of isolated one-time efforts and create a network of strategic approaches to achieving gender equity in STEM? [7]" We believe that our program is stronger than previous ones because (i) it is created from the bottom up—that is, by students for students—instead of depending on a staff member or an office in campus, and (ii) it is not dependent on a time-limited grant. We understand that the program will remain strong for as long as the female students in campus keep feeling they benefit from the mentoring.

Following the main points discussed above, the collegiate section of the Society of Women Engineers at NJIT (NJIT-SWE), with the financial support of the dean of the college of engineering (Newark College of Engineering, NCE), created a mentoring program aimed at providing female students in campus with a multilevel (professional and peer) support network.

TEAM STRUCTURE IN THE MENTORING PROGRAM. The core concept of this program is to connect female students with multiple mentors or role models (from diverse career stages) to whom they can relate and interact personally. We formed multiple small groups with low student-to-mentor ratios that functioned as independent, close-knit environments that enabled students to share their thoughts and seek guidance without inhibitions.

Typical mentoring programs consist of one or more students and a mentor. However, the structure of our program was quite distinctive. Each group consisted of members at different career levels. Specifically, in the 2012-13 mentoring program, teams consisted of 3-4 students and a faculty or industry mentor. Formative assessment of the program, via quantification of the attendance of students and mentors to each one of the meetings in the program, demonstrated that larger number of members in a team yielded more frequent meetings, as the most numerous teams would meet even if one or two of the members had to cancel due to last-minute

complications. In the current 2013-14 mentoring program, teams consist of 5-8 members and typically comprise two undergraduate students (preferably one first-/second-year student and one junior/senior), one or two graduate students (masters and/or PhD), a faculty mentor or an industry mentor. Preferably, all the members of a team would study or work in related fields.

As launched in the academic year 2012-13, the mentoring program had 30 different groups and 108 participants, including students (~80) and professionals (~30). Currently, in 2013-14, the program consists of 14 teams and 110 participants, with ~80 students and ~30 professionals.
The benefits of this multi-level structure of the teams—i.e., teams comprising members at multiple career stages—are multiple and include:

- Juniors, seniors, and graduate students benefit from being mentored as well as gaining leadership skills by acting as mentors for the younger students.
- Students receive personalized academic support from peers such as help in choice of classes, homework and exams, as well as locating research and job opportunities in campus.
- Students get valuable professional guidance through their interaction with the faculty and industry professionals who can provide support in interview preparation, communication skills, internship and job search, etc.

The faculty mentors in the program are both tenure-track/tenured professors and university lecturers (about 50% of each group), which provides a broad perspective on the career opportunities available in academia, from teaching to researching and advising. Faculty mentors were all from NJIT although associated to multiple departments in the STEM fields: biomedical, chemical, electrical, civil, and mechanical engineering, as well as chemistry and industrial engineering.

The industry mentors are alumnae (~75%) and friends (25%) of NJIT. Our formative assessment (through surveys and personal interactions) showed that students in the mentoring program related more easily to alumni because they could see the clear path between the concepts they were learning in their courses and the application of such concepts in industry. Having an alumna as the mentor also facilitates the interpersonal connection between mentors and mentees since they oftentimes have taken similar courses and/or have had a few of the same professors. Most of the alumnae serving as industry mentors are within the first 5 years of industrial experience, which helps illustrating the challenges that students will face during their first years after college. We also recruited more seasoned mentors for our program: about 25% of the industry mentors in the program had 10 or more years of experience in industry. Alumnae were approached thanks to personal connections of the current and past NJIT-SWE members as well as of faculty members. The more experienced industry mentors were found after recommendations from the upper administration of NJIT—a number of these mentors are also members of department and college boards at NJIT. We acknowledge the invaluable help we received from NJIT towards finding committed and experienced industry mentors who are able to show students paths for women towards leadership in industry.

The agenda of the mentoring program was developed keeping in mind that students as well as mentors have a busy schedule during the academic year. Hence, each group was given the freedom to choose when and how they wanted to interact with each other. To help keep the teams engaged with the program a monthly newsletter was sent to all the participants comprising informational items on professional development and mentoring such as career-building articles and workshops and talks on campus. The Society of Women Engineers, both in campus and nationally through webinars, provided a solid and diverse agenda of professional development tools that supported the participants in the mentoring program during the whole year.

At the end of the program a survey was distributed among the participants in request for their opinions about the usefulness of as well as possible improvements to the program. Students were asked to provide the reasons why they joined the mentoring program and their responses included interest in finding a mentor (*"I believe that having a mentor in life is really important. You always need to have someone to look up to and that's what attracted me towards this program. I'm glad I signed up for it."*), networking and mentoring younger students ("*[I joined the program to] network with others in [the] medical device industry, to utilize my knowledge and experience to mentor juniors in the same field*" or "*to share my experiences with my other fellow students as well as taking advantage of getting experienced by professional individuals, in addition to [benefiting from a] great networking opportunity*.") Some were excited that their interaction with mentors from industry would improve their options to land an internship ("*I wanted to try to find a job or internship through this program. I was hoping to get help on how to find a job or internship.*") The survey showed that the program had been able to attract students in *high-risk* groups such as returning-to-school and international female students, whom find it typically more difficult to integrate themselves in a mostly-male campus: "*as a non-traditional student, re-entering college, and not an Engineering major, I hoped to form a bond and socialize with other women. (…) I'm returning to school after a 30-year leave. I am studying Business Information Systems. I enjoy the campus but since it is a male-dominated school I wanted the 'sisterhood' and hoped that I would learn/teach my younger ladies*" or "*as an international student, and a woman in engineering, the first couple of years in campus and in the United States were challenging for me both personally and professionally. As a fourth-year Ph.D. candidate, I felt I was now in the position of helping other students with the different concerns, and everyday troubles they could face, and of sharing with other women engineers our experiences in this field.*"

Feedback from participants also showed that the lack of a rigid meeting schedule and location imposed to all the participants helped each team find their favorite times to meet. We recorded that certain groups met on campus while others preferred virtual meetings—e.g., Skype, Gtalk—or a combination of both. Additionally, in some teams the multilayered structure of the groups (with participants at diverse career stages) translated into global and partial meetings in which all or just some of the participants (respectively) would meet. For example, only the undergrads in some teams would meet in order to discuss the best routes to study for the exams of a common course whereas all the members of the team would meet to share approaches for securing an internship, a job, a fellowship, or a research opportunity or for writing a resume. We also requested participants if they found the monthly newsletter useful for their meetings and received a positive response from about half of the participants with about 25% of all the participants giving the newsletter the maximum rating (5/5).

The mentoring program proved useful towards creating stable, personal connections between female students and professionals. The program was a success also with the few male students (less than 10) who enrolled and experienced a (relatively) unusual distribution of roles in STEM fields: that is, with women holding the most experienced position in the STEM group. The whole community of mentors and mentees also interacted through an *ad-hoc* group created on LinkedIn, which has also allowed keeping the contacts alive even after the end of the academic year and after some of the participants graduated and moved far from campus.

Overall, the mentoring program presented here has been able to bring together participants from different stages in their careers. The program was successful in attracting industry mentors who want to give back to their communities but find that universities are oftentimes too focused in providing students with in-campus support (faculty and university personnel) and forget that professionals outside of the academic world are the main constituents of our programs and the employers of our graduating students. The program was also successful in attracting students because the program itself was designed and run by students.

The program received the support of all institutions at NJIT, which was key to reach out to all the students in campus. Remarkably, the mentoring program received the support of the dean of engineering, who funded the program while giving freedom to the student association NJIT-SWE to make the executive decisions. We believe this model of mentoring may be of great use for other universities that want to partner with female students in developing retention and professional growth programs. After the extremely positive responses we receive from the participants in our mentoring program, we plan to keep running it for years to come, increasing the number of mentees and mentors as well as deepening our surveys and assessment analysis.

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