

RETENTION THROUGH CURRICULAR INNOVATION: WOMEN IN ENGINEERING FRESHMEN SEMINAR

Aura Ganz¹, Vanessa Rivera², Susan Lyon³ and Yuechun Chu⁴

Abstract — This seminar was designed to assist freshmen women engineering students in making a smooth and informed transition into the university. The primary goal of the course was to enable each student to adjust successfully to a new higher education environment while exploring and planning career opportunities in the broad field of engineering. In this report we summarize our experience of the fall 2003 semester. The seminar details are provided on the seminar web site <http://dvd1.ecs.umass.edu/ws>.

Index Terms — Women in engineering, women retention, freshmen seminar

MOTIVATION

One of the biggest issues facing engineering faculty in large public research universities, such as the University of Massachusetts at Amherst (UMass), is the large number of students enrolled in the freshmen introductory engineering classes. The large size of these classes reduces the amount of personal interaction that a student can have with members of the faculty. As evidence, we bring our observations from the freshmen course “Introduction to Electrical and Computer Engineering – II”, which deals with the basics of software design, and introduces computer programming in C++. Prof. Ganz has been teaching this course for the past three years and has observed that the women (who constitute 10-15% of the class) rarely ask questions or voice their opinions. They seem to be disengaged from the material and often-times change majors.

This observation is not unique to UMass, and has been observed in engineering programs. Many researchers have identified the ‘competitive, isolating, or alienating’ engineering environment as a barrier that contributes to women’s under-representation in computer engineering [1-4]. Traditionally, computing has been taught in a hierarchical setting in the form of lectures, with a single professor lecturing to large numbers of students in a lecture hall [5]. Where there are only small numbers of female students, they can suffer from ‘invisibility syndrome’ [3]. In such a hierarchical environment, it is difficult to give students feedback on their work, or to provide equal attention to less experienced students who are more likely to be female and who may be too intimidated to ask questions. Women are attracted to, and learn better in a co-operative

environment, but current teaching styles and computing environment do little to capitalize on women’s interest in communication, problem-solving or teamwork [7-10]. As a result, women either leave the field prematurely [11], or are not attracted in the first place.

One strategy often used to encourage the retention of women revolves around building community. Studies have shown that women are attracted to community building activities and are more likely to enter and remain in a program where they can develop such community with role models and peer groups [12-15]. Activities which promote community include mentor programs, collaborative projects, volunteer events, and social opportunities. In recent years, many schools have initiated and expanded programs for women in engineering to promote a culture that will invite and retain women to these fields. Within Computer Science (CS) itself, Carnegie Mellon University has made a successful effort to revamp their CS program and its culture in an effort to attract and retain more women; now about 40% of their CS students are women [1]. Some schools, such as University of California at Berkeley, University of Illinois at Urbana-Champaign, and Stevens Institute of Technology, have taken the community building concept one step farther; all three offer dormitories designated specifically for women in science and engineering. These dorms provide computer facilities, peer mentors, and academic resources so as to enhance the students’ combined academic and residential experience.

PROGRAM DESCRIPTION

The UMass First Year Female Seminar has following specific goals:

1. To build community and provide support to women students.
2. To provide students with access and education about new technology.
3. To empower women students to use and understand technology.
4. To facilitate working relationships between students, faculty, staff, and available services.
5. To provide interaction with engineering students and practitioners who can share effective strategies for coping successfully with the academic and professional life of an engineer.

¹ Aura Ganz, College of Engineering, University of Massachusetts Amherst, Amherst, MA 01003, ganz@ecs.umass.edu

² Vanessa Rivera, College of Engineering, University of Massachusetts Amherst, Amherst, MA 01003, vrivera@ecs.umass.edu

³ Susan Lyon, College of Engineering, University of Massachusetts Amherst, Amherst, MA 01003, lyon@ecs.umass.edu

⁴ Yuechun Chu, College of Engineering, University of Massachusetts Amherst, Amherst, MA 01003, ychu@ecs.umass.edu

6. To increase students' confidence and ability to succeed in engineering.

The weekly seminar provided an opportunity for personal interaction between the students and the teaching team, facilitating the professors' mentorship role and building community between faculty, the freshman women and peer mentors. The meetings were also used to discuss the role of computer technology and its uses, and articles on the latest technology developments.

CONTENT

The weekly seminar is comprised of the following elements:

- **Workshops and Class Sections:** Class sessions consisted of a combination of workshops and sections. The workshops were attended by women in engineering students, minority engineering students, and transfer engineering students, whereas the sections were only for the women in engineering students. The workshops include topics such as curricular information, self-management and career skills.
- **Lecture/Discussion:** Discussions and presentations related to technology as well as topics of interest to women engineering students were addressed. As the women shared their experiences and fears with each other, they increased their own self-confidence and became more active participants in their classes. Moreover, the discussions of technology in the seminar highlighted the role of technology in today's world and boosted the women's interest in their engineering majors.
- **Use of Pocket PCs:** Pocket PCs were provided to the students which allowed them to understand computers as a more purposeful entity, both inside and outside the classroom. The women learned that computers are not just tools for the stereotypical "cyber-geeks", but an everyday necessity in today's world. Students were encouraged to experiment and use these devices outside the classroom, for everyday activities such as course scheduling, maintaining personal schedules, contacts, and other private uses, in addition to course related activities.
- **A Web-Based Information and Exchange Center:** This component enabled students to share experiences and questions via a bulletin board and chat room, in addition to accessing a list of references and activities helpful to freshmen women engineers. The web-based center served as both a repository for information and links that guided them during their introduction to college and engineering, as well as a venue to exchange ideas, and ask and answer questions, in a safe and comfortable setting.



Figure. 1: Typical scenes from the seminar

Assignments

Assignments are related to technology and women in engineering issues. In the first part of the semester, the students were given articles about a wide range of engineering issues. Students were assigned to present and lead the discussion on different articles at subsequent section meetings. In the second part of the semester, students were given the opportunity to select articles on their own, about a topic of their choosing, and present them in class.

Example assignment: *Read each of the three articles linked below about women in engineering/technology. For each article, write one question to be used for a discussion in class. (Note, be sure to remember which question goes with which article, since we will be discussing the articles one at a time.) In addition, think about your own experiences so far with technology and engineering, and be prepared to share them in class.*

- 1) *In Their Nature: Compelling Reasons to Engage Girls in Science* [16]
- 2) *Geek Mythology* [17]
- 3) *Diversity In Engineering* [6]

Several examples of the students' final presentations are posted at <http://dvd1.ecs.umass.edu/ws>

PDA Activities

In order to prompt students' interests in technologies, we provided each student in this seminar a PDA (Compaq iPaq PC H3870, Toshiba Pocket PC e750 or Dell Axim) and encouraged students to use these devices outside the classroom, for everyday activities such as course scheduling, maintaining personal schedules, contacts, and other private uses, besides course related activities.

PDA software: Address book, Calendar, memo pad, mail, calculator, ActiveSync, file explorer; Microsoft Pocket Excel, Word, Slideshow, Outlook, Reader 2.0, eBook, Adobe Acrobat Reader for Pocket PCs, Microsoft Media Player, Microsoft Transcriber, Voice-Recorder.

PDA Assignments: Students were assigned to read, present and discuss PDA applications.

Example PDA assignment: *Download the PocketPC application assigned to you (see below). Install the program on your PocketPC and learn to use it. Then, prepare a short (5-10 minute) presentation about the application. You do not need to prepare any overheads or slides, but instead should simply state your points orally. Items to address in your presentation include the following: what the application is/does, how the application works, why/where/when you might use the application, and what difficulties (if any) you had with using the application. Keep in mind that your audience will not have had any experience with the application, so you will need to be clear in your explanations. If you have any difficulty downloading the application, contact the TA for help.*

- 1) Engin calculator
- 2) Pocket blinds
- 3) BMP calculator
- 4) Chemistry assistant
- 5) Tip & split
- 6) ClassMate
- 7) BioBody

Website

An interactive website (<http://dvd1.ecs.umass.edu/ws>) was created for use in this course. In addition general course information, such as course description, syllabus, and assignments, it housed a forum, a photo gallery, and resources targeted to inspire freshmen women in engineering. The forum was used as a tool to build community and offer technical support.

FINDINGS

Observations

The number of students that participated in the seminar reached 13 (increased 85.7% comparing last year's seminar). The intended majors of the students included mechanical engineering, chemical engineering, civil engineering, computer engineering and electrical engineering, covering all the engineering disciplines. Throughout the semesters, the women became increasingly more engaged with the topics of discussion. Students participated actively in group discussions, sharing ideas and experiences. They quickly became friends and appreciated interacting with their peers

in a small group setting. Students enjoyed using and learning about the PDA technology. Many students tried to use PDA in their classes and labs. Moreover, the students were particularly receptive to the informal and friendly environment in which they could share experiences and concerns with a supportive community. They entered the seminar as single students not sure what to expect of engineering, they left the seminar with a better understanding of their academic field, and a network on which they could rely on.

Feedback

Two types of evaluations were distributed to the freshman women students in seminar: a course evaluation for the seminar and a self-assessment for their first semester in engineering. The results of both evaluations are shown below.

Course evaluation

- 1) The workshop and women's section received high ratings. Some students claimed that they hated to return their PDAs at the end of the semester.
- 2) When asked about their satisfaction of the seminar, all the students felt satisfied with the seminar and were glad to have attended. Most students found it informative and helpful. Typical comments included: "Great program, making women feel included"; "It (the seminar) gave me opportunities that I would not usually have"; "It let me interact with other female engineers in a fun environment"; "Good benefits to the classes"; "Fun activities".
- 3) When asked about favorite part of the seminar, students listed PDAs, and getting to know other women engineers.
- 4) When asked about activities that were helpful in adjusting to college life, most students mentioned curricular information, career skills and available facilities/services.
- 5) Many students commented that it was important for them to have a non-academic focused class in which they were free to ask any type of question. The chance to meet and interact with female faculty, administrators and staff members was noted as beneficial to the participants.
- 6) When asked about future topics for inclusion in the seminar they noted: major-related information and technologies, more interactive tours, as well as more female guest speakers to talk about real-life engineering experiences.

Self-assessment

- 1) More than half of the participants were still worried about keeping up the grades in some of their engineering courses. Some students claimed that the engineering major is harder than they imagined. Some students felt unable to handle many courses at the same

time. Many students are concerned about the high competition in the engineering field.

- 2) Most students felt confident in their own abilities and really enjoyed their classes and college life.
- 3) Some students had difficulty making social adjustments and felt uncomfortable in the social scenes.
- 4) Some students worried about the work loads and stress level in the engineering field.
- 5) Many students felt it was important to know "help was available whenever needed".
- 6) Most students looked forward to their engineering classes, making new friends and working in groups in the upcoming years.

CONCLUSIONS AND FUTURE WORK

First year female students need guidance and support to transition into college life. The benefits of the UMass First Year Seminar afforded the female participants the opportunity to create a support network they can build upon throughout their academic career. The inclusion of technology enabled students to tie their coursework to outside experiences, which excited their passion for new technologies and strengthened their commitment to engineering.

The early success of the UMass First-Year Seminar has been well documented [18]. It has surpassed its goals and created an informal and unique environment where female students are able to connect socially and academically. Past participants "highly recommended" offering the seminar in future years for incoming women in engineering students. Our hope is that in future years, the seminar will become a requirement for all female engineering students who enter UMass.

In addition to offering the First Year Seminar, efforts are underway to continue the study of women in engineering programs in a concerted effort to increase the recruitment and retention of women in engineering programs at UMass.

ACKNOWLEDGMENT

This project was funded by contributions from Microsoft and Intel Corporations, NSF-0087945, NSF-0080119, NSF-ANI-0230812 and the University of Massachusetts Amherst, College of Engineering.

REFERENCES

- [1] Margolis, J. and Fisher, A., "Unlocking the Clubhouse: Women in Computing", *MIT Press*, 2002.
- [2] Chan, W., "The Project Voyager Personal Shopping Assistant: Bringing Web Services Into the Supermarket", <http://www.media.mit.edu/pia/voyager/docs/Project-Voyager-Description.pdf>
- [3] Pearl, A., "Women in Computing", *Communications of the ACM*, Vol 38, No 1, 1995, pp26-27.
- [4] Henwood, F., "Establishing gender perspectives on information technology: problems issues and opportunities", in E. Green, J. Owen

- and D. Pain (eds.), *Gendered by Design*. London: Taylor and Francis, 1993.
- [5] Lewis, L., "Females and Computers", *Women, Work and Technology Transformations*, B. Wright (Ed.), Michigan Press: University of Michigan Press, 1987.
- [6] Wulf, W., "Diversity in Engineering", <http://www.nae.edu/nae/naehome.nsf/weblinks/NAEW-4NHMBG?opendocument>
- [7] Schinzel, B., "Why Has Female Participation in German Informatics Decreased?" *Women Work and Computerization: Proceedings of the 6th International IFIP Conference*, Bonn, Germany., A.F. Grundy, D. Kohler, V.Oechtering, U.Petersen (Eds). Germany: Springer, May 24-27, 1997.
- [8] Whitehouse, C., Lovegrove, G., and Williams, S., "IT Equity through the Web and Internet", *Women Work and Computerization: Proceedings of the 6th International IFIP Conference*, Bonn, Germany., A. Grundy, F., Kohler, D., Oechtering, V., Petersen, U. (Eds). Germany: Springer, May 24-27, 1997.
- [9] Cole, A., Conlon, T., Jackson, S. and Welch, D., "Information Technology and Gender: Problems and Proposals", *Gender and Education*, Vol 6, No 1, 1994, pp 77-85.
- [10] Martin, D., "In Search of Gender Free Paradigms for Computers Science Education", Eugene, OR: *International Society for Technology in Education*, 1992.
- [11] Seymour, E. and Hewitt, N., "Talking About Leaving: Why Undergraduates Leave the Sciences", *Westview Press*, 1997.
- [12] AAUW Educational Foundation on Technology, Gender, and Teacher Education, "Tech-Savvy: Educating Girls in the New Computer Age", AAUW Educational Foundation, 2000.
- [13] Hobbs, S., Millett, L., and Holland-Minkley, A., "A Case for Building Inclusive Research Communities as an Integral Part of Science and Engineering Graduate Education", *Proceedings of the 1999 International Symposium on Technology and Society*, IEEE, 1999.
- [14] Astin, H.S. and Sax, L.J., "Developing Scientific Talent in Undergraduate Women", *The Equity Equation: Fostering the Advancement of Women in the Sciences, Mathematics and Engineering*. Davis, C., Ginorio, A.B., Hollenshead, C.S., Lazarus, B.B. and Rayman, P.M., (Eds.), San Francisco, CA: Jossey-Bass Publishers, 1996.
- [15] Seymour, E. and Hewitt, N., "Talking About Leaving: Factors Contributing to High Attrition Rates Among Science, Mathematics, and Engineering Undergraduate Majors: Final Report to the Alfred P. Sloan Foundation on an Ethnographic Inquiry at Seven Institutions", University of Colorado, Ethnography and Assessment Research, Bureau of Sociological Research, 1994.
- [16] Advocates for Women in Science, Engineering and Mathematics (AWSEM), "In Their Nature: Compelling Reasons to Engage Girls in Science", <http://www.awsem.org/In%20Their%20Nature.pdf>
- [17] Margolis, J., Fisher, A., and Miller, F., "Geek Mythology", <http://www-2.cs.cmu.edu/~gendergap/geekmyth.html>
- [18] Ganz, A., Howe, S., Rivera, V., and Chu, Y., "Breaking the Silicon Ceiling: Women In Engineering Freshmen Seminar", *Proceedings of 33rd Frontiers in Education*, Vol. 2, 2003, pp. F1D_8 - F1D_13.