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Aura Ganz
University of Massachusetts Amherst

Susannah Howe
University of Massachusetts Amherst, showe@smith.edu

Vanessa Rivera
University of Massachusetts Amherst

Yuechun Chu
University of Massachusetts Amherst

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BREAKING THE SILICON CEILING: WOMEN IN ENGINEERING FRESHMEN SEMINAR

Aura Ganz¹, Susannah Howe², Vanessa Rivera³ and Yuechun Chu⁴

Abstract ³⁴ In this paper we describe a pilot study for freshmen women engineering students we launched at the College of Engineering at UMass Amherst in the fall of 2002. This pilot study, which targeted increased retention of women in engineering, was comprised of the following three main elements: a weekly seminar, use of Pocket PCs and a web-based information and exchange center.

The students' feedback to our seminar was very positive. The students noted that the seminar allayed their fears and concerns about pursuing engineering, provided a (classroom and online) forum for networking with their peers and other women engineers.

This pilot study is the first step in a longitudinal study that will include a series of such seminars as well as follow up assessment provided by the seminar participants throughout the engineering program. We hope that this seminar can serve as a model for women in engineering retention programs and can be deployed at other universities.

Index terms-women in engineering, women retention, freshmen seminar

1. BACKGROUND

One of the biggest issues facing faculty in large public universities, such as the University of Massachusetts at Amherst (UMass), is the number of students enrolled in the freshmen 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 alienated from the material and eventually change majors.

This observation is not just limited to UMass, but has been identified in institutions across the country. Many researchers have identified the 'competitive, isolating, or alienating' computing environment as a barrier that contributes to women's under-representation in computing [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' [6]. 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 into 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.

2. SEMINAR GOALS AND OVERVIEW

We decided to help with the national crisis by launching a pilot seminar which is the first in a longitudinal study aimed at increasing the interest and retention of freshman women in engineering. The pilot seminar had the following specific goals in mind:

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

² Susannah Howe, College of Engineering, University of Massachusetts Amherst, Amherst, MA 01003, howe@ecs.umass.edu

³ Vanessa Rivera, College of Engineering, University of Massachusetts Amherst, Amherst, MA 01003, vriviera@ecs.umass.edu

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

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

To achieve these goals our pilot study was comprised of the following three main elements:

- A Weekly Seminar: The goal of the seminar was to discuss technology, build community, and provide support. In the seminar, we had discussions and presentations related to technology as well as topics of interest to women engineering students. 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: The Pocket PCs (provided to the students) allowed the female students to view computers as a more purposeful entity, useful 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. We encouraged students to 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.

We engaged an all-women team that worked with the freshmen women: two professors from the college of engineering, an assistant dean (also the director of the women in engineering program), one graduate assistant and three sophomore students. The weekly meetings provided

an opportunity for personal interaction between the students and the teaching team, facilitating the professors' mentorship role and building community between the freshman women themselves and their peer mentors. These meetings were also used to discuss the role of computer technology and its uses, and articles on the latest technology developments. The students worked in groups, made presentations, and were introduced to research issues.

3. SEMINAR CONTENT

In this section we provide a detailed description of the seminar activities.

3.1 Workshops and Sections

In-class sessions consisted of a combination of workshops and sections. The workshops were attended by female engineering students, minority engineering students, and transfer engineering students. Examples of joint workshop topics included resume writing, time management, and job fair success skills.

The sections were only for the female engineering students, providing the women with the opportunity to interact with each other and the team of women teachers/mentors. The majority of the sections were spent with discussions and presentations about technology. In addition, the women students shared their experiences on working with the PDA and college life in general. The atmosphere during sections was friendly and informal, and often accompanied by refreshments. Figure 1 shows a typical scene from the section.



FIGURE 1
PROFESSORS, MENTORS, and STUDENTS IN THE SECTION

3.2 Assignments

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.

Examples of the assignments are shown below:

Assignment (Women in engineering/technology issues):

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.

[In Their Nature: Compelling Reasons to Engage Girls in Science](#) [16]

[Geek Mythology](#) [17]

[Diversity In Engineering](#) [18]

Assignment (PDA applications): *Read all 7 of the short articles about Pocket PC applications linked below. For the specific article assigned to you, prepare a short (5-10 minute), informal presentation to relay the main points of the article to your classmates. 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 technology is/does, how the technology works, who the target audience is, and why the PocketPC platform is appropriate. Feel free to relay any questions or comments you have about the article or the technology described therein, to encourage discussion.*

[An Architect's Tool](#) [19]

[Use in a German High School](#) [20]

[Medical Information](#) [21]

[Navigation Aid](#) [22]

[Personal Shopping Assistant](#) [23]

[Hotel Reservation Tool](#) [24]

[Social Services Patient Information](#) [25]

Assignment (PDA software): *Download the PocketPC application assigned to you. 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 one of the TAs for help.*

[Engin calculator](#) [26]

[Pocket Blinds](#) [27]

[Math calculator](#) [28]

[Chemistry assistant](#) [29]

[Tip & split](#) [30]

[Pocket Links](#) [31]

[BioBody 2.05](#) [32]

Assignment (Technology related student presentations):

Select a topic related to technology or women's issues in engineering/technology that you would like to research. Find several resources (for example, articles similar to the ones we read in class) to use in your research. Then, prepare a 15 minute presentation about this topic to present in class. Unlike your previous presentations, you should prepare visual aids to accompany this presentation - you may use whatever format you prefer.

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

3.3 PDA Activities

In order to prompt students' interests in new technologies, we provided each student in this seminar with a PDA (see Figure 2) and encouraged students to use these devices outside the classroom, for everyday activities, both academic and personal.

<p>PDA model: Compaq iPaq PC H3870 Price: \$600 OS: windows CE Processor: 206M Intel strongARM 32-bit RAM: 64MB Display: TFT LCD 64K Colors</p>
--



FIGURE 2
PDA

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 tutorials:

Besides the several PDA tutorial sessions that were given in the first half of the semester, the TAs were responsible for helping students with installation and download software outside classes. A forum was offered on the course website (<http://dvd1.ecs.umass.edu/ws>) to address

the PDA problems and share experiences. Figure 3 shows an example page of the forum.



FIGURE 3
FORUM

PDA Assignments:

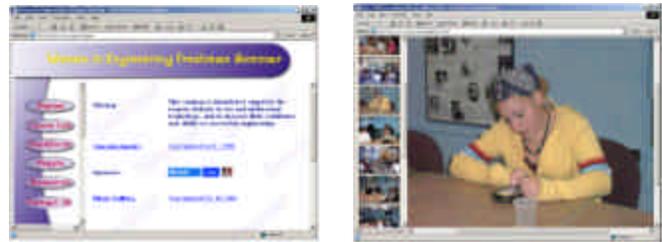
Some of assignments were PDA related. Students were assigned articles about PDA applications to read and discuss in the section. Figure 4 shows students involved in the PDA related presentations and discussions.



FIGURE 4
STUDENTS IN PRESENTATION AND DISCUSSION ABOUT PDAS

3.4 Website

An interactive website (<http://dvd1.ecs.umass.edu/ws>) was set up for this course. In addition to the ordinary course information, such as course description, syllabus, and assignments, it also contained a forum, a photo gallery, and resources specific to freshmen female engineering students. The forum was used to build community and offer technical support. Figure 5 shows some pages from the website.



(A) HOME
(B) PHOTO GALLERY

FIGURE 5
WEBSITE

4. EVALUATION

4.1 Observations

During the semester, we observed that the topics presented at the seminar really drew the students' attention. 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 seemed to enjoy using and learning about the PDA technology (see Figure 6). Moreover, the students were particularly receptive to the informal 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 support network from which they could draw support and inspiration.



FIGURE 4
STUDENTS ARE SHARING THEIR PDA TRICKS

4.2 Feedback

Two types of evaluations were distributed to the freshman women students in the seminar. One was the course evaluation for the seminar; the other one was a self-assessment for their first semester in engineering. In

addition, four months after the seminar we conducted a follow-up meeting with the seminar participants. The summarized results of all three sets of feedback are shown below.

Course evaluation

- 1) The seminar received very high ratings.
- 2) When asked about their impression of the seminar, most students described the section as “a big support group”. All the students felt that the seminar was informative and were glad to be there.
- 3) When asked about their favorite part of the seminar, students listed both the PDA and sharing experiences with each other.
- 4) When asked about other topics they wished to have been included in the seminar, most students mentioned “new technologies”. In addition, some students wished to take more advantage of the PDAs.

Self-assessment

- 1) More than half of the students still worried about some engineering courses. Other students felt confident in their own abilities but remained concerned about the high competition in the engineering field.
- 2) Some students had difficulty adjusting to the amount of work, and were unhappy that they had had to stay up many late nights to complete assignments.
- 3) Many students felt it was important to know “help was available whenever needed”.
- 4) Most students looked forward to making new friends and working in groups in the upcoming years.

Follow-up meeting

At the end of the following semester (approximately four months after the completion of the pilot study) we organized a follow-up meeting (pizza lunch) with the women that participated in the freshmen seminar.

Overall, the seminar was viewed as extremely beneficial to the women who participated. As one woman commented, “It gave me a sense of connectedness that I wouldn’t have experienced without it”. Several women commented that they are not sure they would have made it through the first semester if they did not have this course and network to rely on.

The women also mentioned that the seminar also allowed them to meet faculty and administrators that they would not have met otherwise. The women said they felt “more confident” as a result of this course. They were more comfortable dealing with administrative matters such as

registering for classes, and had a better idea of whom to approach with questions.

The majority of the participants thought the use of technology was “awesome” and “great”. They enjoyed learning to use the Pocket PC and “came to rely on it”. They were sad when they had to return them! One participant recommended to include more PDA/software assignments at the beginning of the semester. Another participant (a transfer student) said that she was not comfortable with technology and computers and did not plan to use a PDA device after the course.

The women also enjoyed completing the assignments during the seminar. These assignments gave them a chance to be involved with projects not necessarily in their major. In particular, they enjoyed the final projects in which they had the freedom to pursue a topic of their choosing. For future seminars, they suggested that “competitions”, such as building a robot, would be great.

One of the participants recommended to include additional discussions on related topics, such as ethics in engineering.

All of the participants mentioned that they would recommend this seminar to future students.

5. SUMMARY

First year female students need guidance and support to adapt to college life. As such, the students appreciated the pilot seminar because it provided an extended support group, a place where they could articulate their concerns, seek help, and make new friends. The PDA was one of the most exciting parts of the seminar, exciting their passion for new technologies.

Based on this semester’s experience, we are pleased to see that this seminar format was successful. The pilot students found it helpful and recommended offering the seminar in future years for incoming women engineering students. This pilot study is the first step in a longitudinal study; we will follow up the seminar participants throughout their engineering program. In addition, we plan to run the seminar each year. Follow-up assessments will be presented in future FIE conferences.

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