FemProf

ADVANCING FEMALES TO PROFESSORIATE IN COMPUTING

Technical Report
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1. Introduction

Considering both the percentage of science and engineering PhDs awarded to women in the twenty year period 1974-2004 and the data from the National Science 2006 Survey of Earned Doctorates 1974-2004, the U.S. National Academies noted that women in 2004 have attained equality with men in their representation in the Social Sciences and Life Sciences but are still lagging in Physical and Computing Sciences and Engineering. In the top 50 engineering departments in the U.S., women earn one-fourth of the PhD's granted in Chemical Engineering and 15% in engineering overall (Handelsman et al, 2005). Although women constitute about half of the total workforce in the U.S. and receive half of the degrees in certain scientific fields, they number only one-fifth of the nation's scientific and technical workers (US-NA, 2007). The University of Puerto Rico at Mayaguez and the Center for Computational Science at the University of Houston Downtown have embarked on a major effort to change these statistics. This report summarizes the results of the NSF BPC-DP Demonstration project "*Paving the Road to Professorship for Female Students*" (CNS 0739213) (now known as FemProf) during the period of February, 2008 to June, 2010. This program between the two institutions stems from collaborative efforts with the NSF BPC *Computing Alliance for Hispanic Serving Institutions* (CAHSI) (CNS 0540592, CNS- 0837556). *FemProf is a comprehensive program engaging female undergraduates in a mentoring program that involves a focus on: research experiences, cultural, gender and workplace biases/issues workshops and seminars combined with summer internships- all focused on preparing for success in graduate school and directed to future participation in the professoriate*. The following sections summarize the main results of the project.

2. Student Progress towards Graduate School

According to FemProf students, faculty mentors, and FemProf coordinators, FemProf students are making progress in several areas known to promote student development in learning communities. The evaluation data is coming from the following sources: (1) Surveys of student participants, research mentors, and FemProf coordinators; (2) Interviews with student participants and FemProf coordinators; and (3) Focus groups with student participants. Using the community based model, Table 1 illustrates how the FemProf program provides students the opportunity to succeed in the science professoriate.

Table 1 FemProf's Community Based Model for Promoting Equity in the Science Professoriate

Fem Prof's Highlighted Results 2008-2010				
	Offer basic psychological needs	Highlight and make visible the structure of computing research	Provide access to more expert practice	Give timely, flexible feedback
Activities of FemProf ***FemProf Students…***	• Met regularly with one another, with mentors, and with FemProf staff	• Received assistance with application to graduate school • Attended GRE prep courses • Guided through the timeline of the graduate school application process • Received feedback for writing a statement of purpose	• Met colleagues as they attended conferences (e.g., Grace Hopper) • Received research mentors • Met frequently with peers and "near-peers"	• Were provided continuous feedback on statement of purpose • Presented research to research groups and advisors • Received feedback on interviewing skills • Received scores of practice GRE tests
Results to Date: (reported results are based on 2008-2009 survey and interview data from FemProf participants, mentors, and directors, participant observation, and document analysis)				

Students' Perceptions	• Interviews suggest Grace Hopper conference participants received an opportunity to "get to know one another" • 9 of 12 feel they are part of their campus computing community	• Majority of students claimed that FemProf has prepared them for graduate school by: o Revealing timeline of graduate school application process (10 of 10) o Providing practice in writing a statement of purpose (8 of 10)	• 10 of 10 students said they were informed about graduate programs in computing • 7 of 10 students said they learned how to critically analyze papers • 7 of 9 students gained the skill of communicating their research findings to their advisor and peers	• 8 of 10 students reported that they received feedback on their statement of purpose • 7 of 9 students reported that they presented research to their research groups and advisors
Faculty Mentors' and Coordinators' Perceptions	• Coordinators revealed that the majority of students developed professional relationships with: o Faculty (7 of 8) • Undergraduate research peers (6 of 8)	• Majority of mentors said their student gained research skills, in particular: o Math skills needed in computing (8 of 9) o Application of skills and knowledge through hands-on experience (8 of 9) o Framing of research questions (8 of 9)	• Mentors reported that students demonstrated gains in: o Demonstrating knowledge of what real scientists do (8 of 10) o Developing professional relationships with faculty (7 of 8) o Envisioning their professional lives (5 of 8)	• When asked how they could improve their relationships with their FemProf students, 2 of 4 mentors expressed an interest in spending more time meeting with their students

3. Empowering Women in Computing

From denying/discounting gender bias to becoming advocates, FemProf explicitly addresses issues of gender bias that may impede students' progress through BS and PhD programs as well as in their future faculty positions. In the beginning of the FemProf program, many women took the stance of discounting or denying that bias exists, treating the subject matter as "no longer a problem". *Two events seemed to change these perceptions, causing a shift for some women in how they view being female in a male-dominated discipline—attending the Grace Hopper conference as a FemProf cohort, and presenting a panel at the annual CAHSI meeting.*

The Grace Hopper conference was the first national event showing FemProf students the struggles faced by technical women and the possibilities for women in computing. In essence, the conference showed students that *gender matters in their field*. The experience at Grace Hopper paved the way for more active participation, for students taking on more empowered roles in activism. They attended workshops, and heard lectures and presentations about computing topics as well as social justice issues of gender in technical fields. Four FemProf students developed and presented a panel regarding women's underrepresentation in computing fields at the annual CAHSI meeting. Near the end of a presentation, a young woman raises her hand with a comment. "Isn't this whole thing counterproductive?" she asks. "Why are you bringing this up? I don't think being a woman is a problem in this field." Following this the evaluator heard messages of empowerment, of gender-related activism from the FemProf women themselves in a group setting. The experience of leading a panel on gender bias, *developing a case for women and technology and addressing dissenting opinions from their female peers* seemed to empower FemProf participants to discuss matters of gender bias in computing.

4. Summer Internships

One of the key components of the FemProf program is the participation of students in research internships during the summer. Early in the spring semester, students attend a workshop focused on summer internships. This workshop provides them an understanding of summer internships by hearing testimonies of students who have previously attended summer internships. The students also learn about the requirements for applying to internships and are provided information regarding available internship sites. After the workshop, FemProf mentors guide them in preparing the required application documents for internships the students are interested in attending. Last summer 13 out of 14 students were admitted to internships at institutions such as: Argonne National Laboratory, University of Maryland, and Texas

A&M[1]. This year 15 out of 16 have already been admitted to institutions such as: MIT, Carnegie Mellon, and Virginia Tech[2]

For a large majority of the students, summer internships have been an enriching experience, a sentiment they expressed to CAHSI coordinators and evaluators. Students spent from eight to ten weeks working on their research projects. In addition they engaged in activities aimed at improving their career development skills and preparing them for graduate school. Equally as important is the fact that in some cases, the summer internships served to confirm that doing research was not for them.

5. Research Presentations

A requirement of the FemProf project is that the students get involved in research projects during the fall and spring semesters. They conduct research by either registering for an undergraduate research course or working on a research project supported with an undergraduate assistantship. During the past two years, several FemProf students made poster presentations at the CAHSI Annual Meeting Poster Session. Some students have made extraordinary progress on their research. Such is the case of Marisel Villafañe who has the paper "*Entropy Measures Techniques to Characterize the Vocalizations of Synthetic and Natural Neotropical Anurans*" accepted for presentation at the 2010 International Conference on Artificial Intelligence and Pattern Recognition (AIPR-10).

6. Successful Admission to Graduate School

The FemProf program encourages students to broaden their career options by considering graduate school. The experience aims to support and guide students through their undergraduate studies with graduate school as a goal. FemProf activities led to more committed graduate school aspirations, graduate school applications, and acceptances to top computer science, computer engineering, and electrical engineering doctoral programs.

Five students graduated last spring semester and two will graduate this spring semester. Six of them applied to graduate school and one will apply next spring semester. All the students who applied to graduate school were admitted to Tier one institutions and all of them received a fellowship or an institutional assistantship (see Table 2). One of them earned the prestigious NSF fellowship this year.

Table 2 FemProf Alumna: Successful Admission to Graduate School

BS FemProf 2009 graduate	Graduate school acceptance	Honors, fellowships, scholarships
Hispanic woman	Purdue University	GEM fellowship
Hispanic woman	University of California at San Diego	GEM fellowship
Caucasian woman, non-traditional age student	University of Houston	Institutional Assistantship
Hispanic woman	University of Houston	NSF fellowship, AMP Bridge to the doctorate fellowship
Hispanic woman	Rensselaer Polytechnic Institute	GEM fellowship
Hispanic woman	University of Wisconsin at Madison	Institutional Assistantship

7. FemProf Narratives: Stories of Women Becoming Computing Researchers

In a small program, where numbers are few but impact is evident, case studies of participants provide an opportunity to illustrate program success. The following two cases describe in depth how FemProf apprentices women into professional computing research practice and paves the way toward the professoriate. The elements of equitable community practice are addressed in the cases, as are the ways FemProf provides pathways towards doctorates and faculty positions in computing.

[1] Additional schools include: University of Rhode Island, University of North Carolina at Charlotte, Colorado State University, Notre Dame University, University of South Florida and Trinity University

[2] Additional schools include: University of Colorado, Jackson State University, Kentucky University, Lamar University, Baylor College of Medicine, University of Houston Downtown, and University of South Florida.

7.1 Laura – Fostering Individual Success: Fitting into the Computing Community

Laura was a junior at City University during the 2008-2009 school year. She is an African American computer science major in her early twenties, though she is a year behind in her major, as she recently transferred into computer science from the computer engineering department. In this section, we detail her development as a computer science researcher and aspiring graduate student through her participation in the FemProf community at City University. The enactment of FemProf at City University encouraged Laura to build her own trajectory into the academic computer science community, fitting into the pre-determined model of success in the discipline.

Laura has engaged with undergraduates, graduates, and faculty at multiple conferences throughout her participation in FemProf (spring 2008-present), including a "women in computing" conference, two national diversity in computing conferences, and two regional meetings of student leaders in computing. Laura is spending more time on campus since joining Fem Prof, as she completes research on-campus for pay. In previous semesters, she traveled to a job at a retail store off-campus. Through her interactions with FemProf leaders she has also become involved in other BPC Alliances. She travels alone or with one or two other FemProf students to conferences, and at two of the events met with FemProf students from the sister institution.

Receiving feedback regarding one's efforts in community practice is vital to gaining a feeling of belonging – without feedback, a novice who lacks an understanding of his or her performance may choose a trajectory peripheral to central practice, or may choose a path out of the target community altogether. Studies of women in STEM fields indicate that a lack of feedback, coupled with few opportunities to engage in more expert practice, often lead females to choose other fields where they might gain access to more central participation and receive positive feedback regarding their performance (Lord & Cohoon, 2006; Margolis & Fisher, 2001). Laura describes meeting weekly with her research mentor regarding her efforts on a project, and the feeling that she could email her research advisor for assistance when needed. Through presentations at national conferences, Laura receives some feedback regarding her work – for example, acceptance of her poster to the conference serves as positive feedback, and opportunities to describe her efforts to conference attendees may solidify this knowledge for her. Laura says she can go to FemProf directors when she needs assistance, and can solicit help from her research partner. *Laura describes a campus community that is responsive to her needs when she solicits advice or support*. Her participation in national communities of computer scientists offers venues for additional feedback.

Laura has encountered challenges in her male-dominated computer science classes, as she feels that her male peers do not listen to her ideas. There has been a shift over the last year in how Laura feels about and confronts these problems. Before entering the FemProf program, Laura wrote: "most males I have worked with on projects seem to not listen to the ideas of females." One year later, she indicated a change in her comfort level, responding that she feels free to express her ideas, and that she now confronts the males about how they dismiss her statements. She explained: "I will say something, and then a guy will come behind me and say the same thing and everyone will respond to him and not to me, and I will say, 'wait, I just said that, why did you just ignore me and listen to him?'" Furthermore, she was more optimistic later in the year, explaining that males do not dismiss her as often because they are more aware of this problem.

As an active student researcher, Laura interacts frequently with other undergraduates, graduates, and faculty members who are involved in academic computer science research. As a novice in this field, she reads up on the literature relevant to her research projects, communicates her research findings to her advisor and analyzes her results with publication in mind. Her direct contact with graduate students provides a model of more competent practice, and her near-peer research partner, a woman who is a few courses ahead of her in their studies, also serves as a model of competent practice. According to Laura, FemProf gives her "exposure to all of the opportunities out there" in computer science. On her own initiative, Laura attends technical talks, demonstrations, and workshops that highlight the discourse of the domain, and provide models of what competent computer science practice "looks like" within her field. She also attends graduate school workshops that deconstruct the application process and make visible the path to continued education in her field. Along with her research advisor and another FemProf student, she presented a technical poster at a national meeting of CAHSI, an experience that positioned her, the speaker, as a competent researcher, and required her to use the technical language of computer scientists.

7.2 Yolanda – Facilitating Individual-in-Community Success in Computing

Yolanda was an Hispanic fifth year student (equivalent to a senior in the U.S.) at Island University during the 2008-2009 school year. She graduated in 2009 with a B.S. degree in computer engineering. She was accepted to a top 40 computer science Ph.D. program. Yolanda met with her cohort of FemProf students on a weekly basis with one or more of the FemProf directors for seminars and workshops throughout the 2008-2009 school year. Participants were required to complete a statement of purpose, attend GRE preparation sessions, and apply for REUs during the course of their program. Yolanda says that attending the Grace Hopper conference helped solidify the FemProf student community – she mentions as did many of the other students that this trip to the Colorado conference allowed the girls to get to know one another better. She noted that though the women were all students in similar courses, many of them did not know one another before FemProf.

Yolanda was recruited by the FemProf directors of Island University to develop and present a panel on being a female in computing. She reflected on this experience in an interview and with her peers in FemProf during a focus group, saying she was surprised that a fellow student found the talk "counter-productive" for raising issues of gender bias. During the focus group conversation, the FemProf scholars defended the need for programs like theirs, since the numbers of women in the field are small, indicating gender bias keeps some women out of the field. The collective argument made by the FemProf cohort demonstrates the ways the local community makes meaning regarding program values and purposes.

Communities that promote diversity engage new members actively and ensure they receive feedback regarding their efforts in the community practice – in this case, the practice of becoming an academic computer scientist. This feedback is essential to the feeling of belonging to the group. Student feedback and direction is built into the Island University model. For example, students turn in Statements of Purpose at the beginning of the program, which the directors critique. During GRE workshops, students' performance on mock tests is graded by FemProf leaders. When Yolanda served on a student panel, she met frequently with her peers to develop the presentation, divide the work, and practice their delivery. Yolanda had her first FemProf research experience as part of a projects course delivered by a FemProf director. This format led to a more structured form of feedback than the research mentor/undergraduate researcher relationship commonly includes, because assessment is tied directly to the behavior of the student researcher. Yolanda also received feedback on her applications to conferences, graduate schools, and REUs through activities structured within the FemProf model as assignments for members to complete.

Despite her strong grade point average, maturity, and interest in research, Yolanda did not aspire to pursue a Ph.D. upon entering the FemProf program. This indicates that while she had all of the needed attributes for joining the academic computing community, she was not offered an "academic" identity, nor was she positioning herself towards such a trajectory. She said in an interview that she had always heard that companies would pay for a Master's degree, and her plan before joining the FemProf program was to receive an industry internship in the summer, follow that internship experience with an industry position, and then receive her Master's degree while working full time. The familiarity she has gained through FemProf of the myriad opportunities for research and academic careers with a Ph.D. has shifted her intended trajectory from a successful industry computer engineer to that of a computer science professor.

Yolanda states:

> "It (FemProf) is helping me to develop my communication skills. Being involved in activities with professional and successful women increases my self-esteem and makes me realize that I can still act and dress like a woman in this field without feeling unprofessional. Before there were times when I thought that I was in the wrong career because of the lack of role models but FemProf helped me realize that even though I am a minority in this field I can be as successful as men. It has also provided me with the greatest mentors. Because of FemProf I am motivated to continue graduate studies all the way to the Ph.D. level. (Yolanda, survey response, Spring 2009)

8. Adoption/Dissemination of the FemProf Model

One of the expected outcomes of the FemProf demonstration project was the adoption of the model by other institutions. This outcome was accomplished with the adoption of the model by the MentorGrad program of the CAHSI alliance. All the strategies of the FemProf model, with the exception of the empowerment strategy, were adopted by MentorGrad. The recruitment and workshops materials generated by FemProf are shared with MentorGrad. Six CAHSI institutions are participating in this program with 46 students currently supported. The FemProf model was presented at the Ignite Talks session of the 2009 Grace Hopper Conference. At this session we had the opportunity to disseminate the FemProf model, evaluation findings, significant experiences, and obstacles faced at the primary FemProf sites.

9. Lessons Learned

At one site, GPA seems to be a retention factor: Since the program started the spring of 2008 thirty eight students have been admitted. So far one of the students transferred to another university and eight eventually dropout of the program. Nearly all of the students who discontinued participation from one institution earned GPAs that were lower than the recommended graduate school acceptance threshold.

Extracurricular activities are a distracting factor: Some of the students who left the program were involved with extracurricular activities that were affecting their compliance with academic responsibilities. The experience with FemProf shows that these students put a high priority on these extracurricular activities because they view them as important activities for their career development, and this activity may hamper their success in achieving FemProf goals.

Recruiting early is preferred: Sophomore as well as junior students have been recruited for the program. The experience shows that recruitment is more successful with sophomore students very early in the fall semester. At this time they are rarely committed to an industrial summer internship and are more likely to view FemProf as a career development opportunity.

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