AC 2011-1837: EVOLVING IDENTITIES: UNDERGRADUATE WOMEN PURSUING THE ENGINEERING PROFESSORIATE

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Evolving Identities:
Undergraduate Women Pursuing the Engineering Professoriate

Abstract

Engineering in United States contexts has historically been the domain of Caucasian/white males. Programmatic efforts address the disparity in engineering by forming inclusive learning communities that support gender and racial diversity. FemProf is a comprehensive engineering education program that engages female undergraduates at two Hispanic-serving institutions in the United States. Program activities include multisite research experiences, professional development and community building. Workshops address cultural, gender and workplace biases the women may find in the engineering professions, as well as training regarding graduate school application, research presentation and publication. FemProf's explicit focus is preparing undergraduate women for success in graduate school and for future participation in the professoriate. For this research project, we studied FemProf with an eye toward identity development. A grounded, thematic approach to qualitative data analysis uncovered three themes evident in the process of Fem Prof undergraduate participant learning: "program support for professoriate trajectories;" "participant identification with engineering pathways;" and a third theme not anticipated: "participants advocate for gender equity in engineering." Based on our qualitative analysis, we argue FemProf supports inclusion of women into the engineering community, and makes explicit the pathway to the professoriate.

Introduction

Science in United States contexts has historically been the domain of Caucasian/white males.[1, 2] With declining enrollments in science and engineering fields in higher education across demographic groups, efforts to increase student diversity have become not only an issue of equity, but also an issue of fulfilling the industry's need for qualified candidates. Multiple programmatic efforts have formed to address the disparity in science and engineering by attempting to develop inclusive learning communities that support gender and racial diversity.[3, 4] At the same time, many concerned with equity in science critique the masculine construction and practice of science itself, [5, 6] and call for a change in the ways science is accomplished.

In this paper, we examine how one academic program focused on women in computing (FemProf), attempts to facilitate undergraduate Hispanic women's aspiration towards future entrance into the professoriate. The research questions that guide our analysis are:

1. How do participants engage with the social, cultural, and relational resources that are a part of FemProf as they develop (or do not develop) identities as (present and future) research scientists, and future professors?
2. In what ways do women critique the practice of science in their learning community/communities (if at all)?
3. How does the program, as implemented, encourage equitable learning opportunity for women in computing?

FemProf was created to address the underrepresentation of women students and faculty (particularly Latinas) in the computer engineering and computer science departments at Island

University (IU) and City University (CU). A short-term objective of the program is to increase the number of women who aspire to pursue doctoral training in computing. A long-term objective is to increase the number of female faculty in computing. While the long-term goal is not measurable within the timeframe of this study, our data indicate that nearly all program participants who have graduated from undergraduate programs have enrolled, applied, or intend to apply to graduate school within the coming year. We focus on the self-identification of women as future professors as well as the ways in which program participants navigate engineering pathways with academic goals in mind.

All students who engage in FemProf are assigned paid undergraduate research projects and mentors—the program works with faculty and students to find good matches for the women, and gives funding directly to the student so that any professor, regardless of research funding, can mentor undergraduates. FemProf is designed to provide participants with opportunities to engage in academic computing research, participate in professional computing conferences, and work with mentors who are faculty in computing programs. These activities are supplemented by seminars designed to help participants gain entrance to graduate school and thrive as women in the male-dominated field of computing. A grounded, thematic approach to qualitative data analysis uncovered three themes evident in the process of FemProf undergraduate participant learning: "program support for professoriate trajectories," "participant identification with engineering pathways" and a third theme not anticipated: "participants advocate for gender equity in engineering." We conclude with an analysis of the structures by which FemProf supports inclusion of women into the engineering community, and makes explicit the pathway to the professoriate.

Review of literature

There is a glaring absence of female graduate students and faculty members in computing departments in the United States. According to recent Taulbee Surveys focused on computer science education in the U.S. and Canada, the percentage of computer science and computer engineering degrees awarded to females is low and falling.[7] The numbers are even smaller when considering how many of these women are from non-dominant racial and cultural backgrounds.[8]

How are we to understand why so few women enter into and succeed in computing? Some have argued that women are not as cognitively competent as men. This view of women as deficient has been refuted in multiple studies focused on differences in the size and structure of women's and men's brains,[1] the cognitive abilities of women and men from birth to maturity,[9] and the shrinking gender gap between boys and girls in mathematics.[10] This research suggests that we need to turn our attention to the social world in order to understand how differences between men and women turn into problems for women in the sciences.

Moving away from arguments focused on innate differences in aptitude, researchers of gender equity contend that the "gender problem" has emerged because women do not have the same opportunities as men and are treated differently than men because of their gender. Researchers report evidence of enduring bias against women in fields where they are underrepresented.[3, 11, 12] Wenneras and Wold found, for example, that female postdoctoral applicant needed to publish more articles than male applicants to attain positions.[13] Margolis and Fisher similarly report on

the bias of professors at one prestigious university who were more likely to perceive students with more experience in programming and fewer outside interests as better computer scientists—a stereotype that fit more males in the undergraduate program.[11] These studies draw critical attention to the need to investigate the social and cultural organization of gender and science.

Theoretical framework

As educational researchers, we take a situated learning perspective on learning and identity development.[14, 15, 16] From this view, learning is a process by which individuals gain expertise through participation in and identification with the social practices of a community. Through engagement in the community's practices, an individual can begin to use and understand the target community's "shared repertoire," or ways of talking, valuing, and using tools. Further, as an individual participates in the community's practices, she can gain a sense of "who" she might become and what kind of a person she might be allowed to be as a member of the community.

Gaining "accountable disciplinary knowledge"[17] along with taking on a valued and recognizable identity in the community are indications of successful learning. At the same time, knowing what actions and individual characteristics lead to acceptance in a graduate program and an eventual academic career assists students in navigating their engineering careers towards academia. In other words, a program participant who begins to be viewed by professors and peers as a researcher, as "graduate school bound;" who talks about what she will do as a professor; who goes to academic conferences and studies for the GRE could be seen as accepting the pathway towards the professoriate.

Individuals' learning pathways in a community arise from multiple factors related to the community's routine practices and the individual's historically-developed dispositions and ambitions.[18] The local community, or the specific group of people with whom a person is centrally learning a practice, constrains and affords different trajectories, or pathways, towards and away from more expert practice. For example, in Margolis and Fisher's study of computer science at Carnegie Mellon University, the authors found professors, who were predominantly male, had a myopic view of what a "good computer scientist" said and did.[11] These stereotypical images of qualified, talented students have real consequences for students, as they shape who become identified by peers, professors, and staff as "strong engineers."

Therefore, we consider how an institutional context of a computing department, its program leaders' views on the gender problem in science, and the program's curriculum are key resources for learners' identity and skill development. Because learning from this view involves transformations in knowledge and identity, paying attention to both the community's practices and the individuals engaged in that program simultaneously can provide a fuller understanding of the learning process.

In particular, learning environments that have been found to create greater equity in terms of who participates and succeeds in the community include: (1) participation that addresses basic psychological needs (e.g., a sense of belonging and comfort); (2) communities that make visible the structure of the domain and the discourses used therein, [in other words, show the big picture of what it means to be an engineer, including the ways engineers discuss their work in the field]; (3) participation that includes perspectives of more expert practice; and (4) communities that

provide timely and flexible feedback regarding a member's performance.[19] In this paper, we document ways in which FemProf aligns with this model of inclusive learning, and highlight possible next steps for extending the program's goals across the department.

Methodology

In this study, we use qualitative methods of data collection and analysis to identify the learning trajectories that FemProf offered to program participants and to analyze how participants used program resources to develop their views of themselves as students and future scientists.

The study focused on FemProf as it was enacted at Island University (IU) and City University (CU), both pseudonyms. At IU, participants are Hispanic and speak Spanish as a first language. The program served eight students per year for three years at IU, and four students per year at CU. Participants at CU are diverse in ethnicity and nationality—half of the undergraduate program participants are members of underrepresented ethnic groups, and all were women. The National Science Foundation externally funds the program, which served a total of 36 students in three years with research funding, travel to conferences, and program workshop development and implementation funds. The full program is being adapted for use for undergraduate students at collaborating institutions of CAHSI, with a reduced amount of funding.[20]

Data collection

To address our research questions, we drew on data sources collected by the first and third authors as part of a formal evaluation of FemProf. Primary data sources include fieldnotes from participant observations and audio-recorded telephone interviews with all FemProf participants. Data were triangulated with survey information from research mentors, program directors, and program participants at multiple points in the three year program.

First and third authors acted as participant observers in FemProf activities. They attended conferences with participants, observed selected workshops and meetings, and attended research symposia that featured FemProf students' research. Fieldnotes focused on the intentional programmatic structure for equity and facilitating participants' growing understanding of and expertise related to scientific research practice.

Telephone interviews conducted with each woman in each program throughout 2009-2010 asked students about what influenced them to major in computing, the challenges they faced as females in a male-dominated environment, their experiences in the FemProf program, and their future career aspirations. Students from previous year's cohorts were re-interviewed annually, and so we were able to track their responses over time and experience with the program.

Data analysis

We used a thematic analysis approach[21] to analyze fieldnotes and transcripts of interviews. We identified three themes that helped us understand the process of participant learning in FemProf: "program support for professoriate trajectories;" "participant identification with engineering pathways;" and a third theme we did not anticipate: "participants advocate for gender equity in

engineering."[1] Using these codes as an entry point into the data, we identified interview excerpts that seemed to indicate a shift in the development of the women's identities. Specific excerpts were chosen for analysis with an emphasis on understanding shifts in students' dispositions towards science given how program structure emphasized development of engineering professoriate identities for FemProf participants.

Data from the two sites were combined in this study because the findings indicated that students in both sites share similar experiences. Students in both institutions are proportionately represented in the forthcoming survey results and interview passages.

Findings Section A: Program support for women's professoriate pathways

FemProf leaders, research mentors, and peers serve as resources for FemProf participants. According to interviews, eight participants explicitly describe their trust of faculty members of FemProf, and eight say they view their faculty leaders or mentors as role models of success in the disciplines. See passage below.

> ***Interviewer:*** *How did FemProf help you think about graduate school?*
> ***FemProf Participant****: Even though I already did research, I didn't really understand very well the whole entire master's/Ph.D. degree process. At the first school I was a tutor, and really enjoyed that. Since I'm studying engineering, I just don't want to be a teacher in high school, and didn't understand how to become a professor. FemProf coordinators have given me seminars and how about grad school works, and I have talked to them individually about their experiences in the doctoral degree, as the doctoral degree sounds like a super-hard thing but it's actually not as scary as it seems.*

Program directors highlight ways women can support one another in their scientific, academic pursuits. Through research mentoring and workshops, participants learn how to cope with their involvement in a challenging, male-dominated major.

> ***Interviewer:*** *How does [FemProf] help you become a professor and find research?*
> ***FemProf Participant:*** *They make conferences about women in society, in the university, they talk about how I can learn about the research, they told me specific things that I need to know about being a woman in society, how I can act in the school, in the research. They say that how many men are in the department, to not be afraid of anything, that I have the same or better knowledge. They told me that I must do the best for me, to never be afraid of being the only woman.*

Many of the FemProf participants indicated they had seen other women in the program around the halls, but had not had occasion to meet and talk with their peers. Attending the Grace Hopper conference, an international computing conference for women in the field, broke the ice for students, and led to additional communication following the conference. In addition, peers became an additional resource for the women in the program.

[1] While the themes overlap, the first and second differ in the way participants describe the changes and shifts that occur—in the first section, the focus is on community resources, or what the program "gives" participants; the second theme shows how participants take up, or self-identify as future professors and researchers.

Women and other represented groups in technical fields are more likely to be unaware of the academic reward system and graduate education and opportunities.[22, 23] FemProf aims to address this lack of knowledge and in so doing, empower its members with knowledge about how to proceed in their fields of interest. Through this gradual participation in professional development, task-related evidence of programmatic support show women developing their academic pathways.
In surveys, students answered questions about what they have learned and accomplished to become better prepared for graduate school. For the most part, students reported that they are performing these graduate school preparatory tasks as undergraduates.

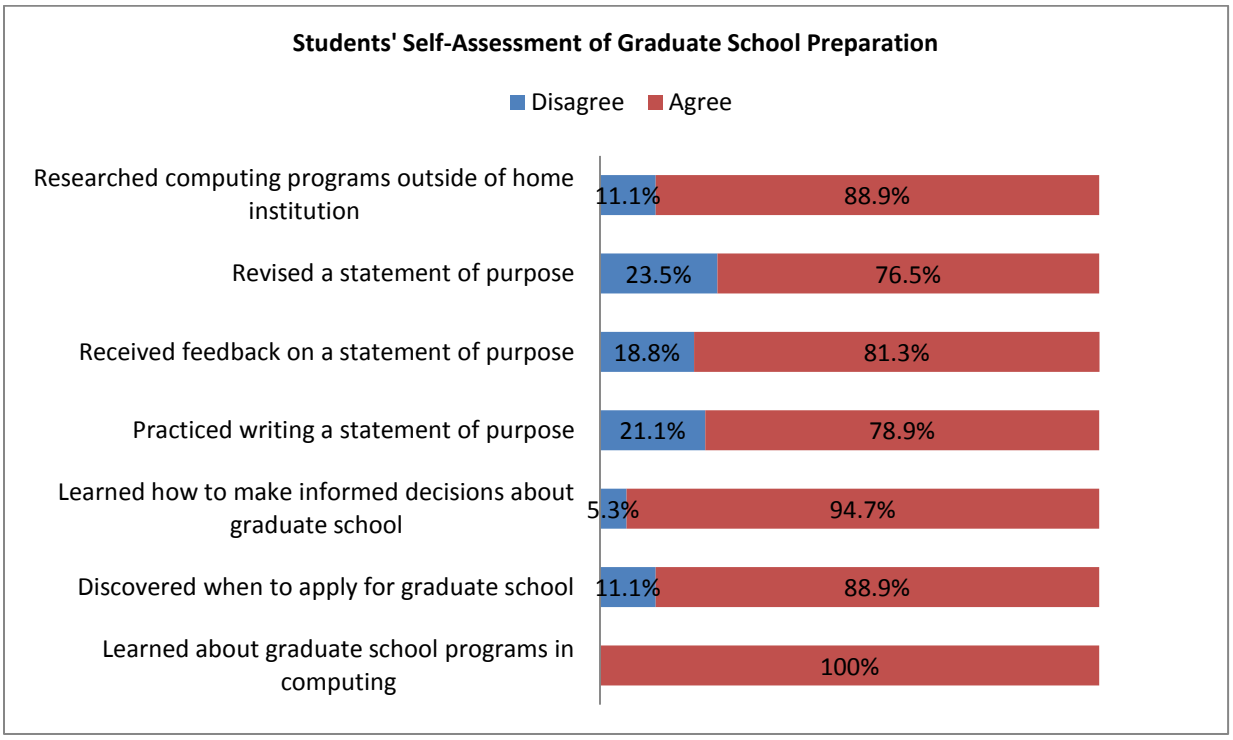

Figure 1: Students' preparation for graduate school through FemProf

The FemProf community is one that highlights inclusion of underrepresented groups into the elite community of computing research and academia. Specifically, the program *cultivates local communities of women in science/engineering* in which more experienced members in the community describe and exemplify success in community practice and give details to young women regarding how community members are meeting (or not meeting) expectations.

Findings Section B: Participant identification with engineering, professorial pathways

Women in FemProf are discovering the ways they can engage in the engineering profession. FemProf made visible for its participants the steps toward developing elite identities as academic researchers and professors. Our analysis suggests that many of the young women intentionally took up these engineering identities as offered, through shifting aspirations towards academia and through their preparatory work towards graduate school.

The program combines undergraduate research opportunities, known to be particularly effective in increasing participation of underrepresented groups in academic pursuits[24] with social justice content, women's empowerment content, and women professors' perspectives on completing graduate study and becoming a professor in engineering. The program benefits from the participation of four female professors and one female instructor-this allows for the inclusion of personal narratives regarding the barriers they face as well as specific steps they took to become marketable for faculty positions. The women in the program are expected to participate in a summer research experience for undergraduates (National Science Foundation-funded "REUs") at another university, attend the annual retreat and related meetings, and submit their work to academic conferences.

In interviews, many students raved about their research experiences. Many (14 out of 29) students expressed a strong interest in research, and several (9 out of 29) revealed that their involvement in research prompted a greater interest in science/engineering.

> ***Participant:*** *I love doing [research], I cannot describe the impact it's had on my life. I've spent two months in Poland, and gone to the Czech Republic to do research. Plus, the experience I've had doing the research and using the machines are incredible. This fall I'm going to Stanford to use a machine, the only one in United States, so the experience I'll get is second to none. And here in [my campus] I have a machine in the physics lab, the only one in the state of Texas, so I'll be able to say I know everything about this machine, this is a valuable experience.*
> ***Participant:*** *Doing research we can actually see what we're studying for, and see how much more we have to go before we understand all of it. I like it, it's fun. We have to read a lot, we have to work on it, it won't just come, but in the end, it works.*

Several students also described that their research experiences led to a new topic interest or a narrowing of their interests. For example, one student explained that her research opportunity will give her a chance to decide if she enjoys focusing on a particular topic:

> ***Participant:*** *I'm going to be doing research next semester, [my professor] has some projects, and one project [will be] about security, so I'll see if it's good. If it's good I'll try to keep on with my professor and [continue] the project with security.*

Evidence of shifting aspirations come in two forms—those who attend graduate school describing the influence of FemProf on their change in perspective, and the current undergraduates who describe their changes in perspective. Most indicate they had not considered an academic pathway before interacting with FemProf. One participant described her change in perspective in this way:

> ***Participant:*** *FemProf has helped me see more clearly what I want to do. I've come a long way because at first I didn't consider professorship as an option … After I graduate I would really like to become a professor, so it has helped me to define how I see myself in the future and how I define my career goals.*

FemProf offered participants opportunities to imagine new identity and learning trajectories for themselves. As the above quote underscores, the social organization of FemProf helped shape

this participant's desire (what she describes as what she "*want(s)* to do") for a career as a faculty member.

Findings Section C: Some participants recognize bias, advocate for gender equity in engineering

In the course of our interviews with FemProf women, we found the program made a difference in participants' *awareness of underrepresentation, identification of gender bias in their academic experiences,* and, for some, *led to increased action for equality.* We note that in nearly all of their academic environments, FemProf students are in subordinate roles based on their undergraduate student status (in comparison with graduate students, staff, and faculty, all of whom have more explicit power), their employee status if they work on a research team, and of course, as women in a male dominated profession. Given these multiple factors, empowerment is defined broadly in this analysis, and begins with noting bias exists, forming a community of like-minded students, and recognizing specific incidents of bias.

Gender bias in local department/community

Students described barriers to success in myriad ways: as causing discomfort/knowledge of being underrepresented in the field, as leading to fewer and less strong relationships with (generally male) professors, competitive group work atmosphere in class, and feeling like one had to prove herself to a greater degree because of her gender. These themes have been well documented in the gender and engineering literature[25, 26]—we describe them briefly to illustrate the sometimes conflicting stances women take to the issues of gender underrepresentation within their lived experiences. In a few cases, FemProf participants specifically listed gender differences or stereotypes as causing their discomfort, while at other times they were neutral about these events, or attributed the slights to personality differences.

Unapproachable professors

According to interview data, many women in FemProf view their professors as unapproachable, and some mention their relationships with male professors were less strong than those with women. While students do not always view the issue as a gender issue, some did mention they did not experience the same feelings with the female FemProf professors, perhaps because they had more out-of-class time interacting with them. See passage below.

> ***Interviewer:*** *Do you feel comfortable approaching other professors?*
> ***Participant****: Most are male, and I don't feel comfortable approaching a male professor and bothering him. I shouldn't feel this way, but I do.*
> *Interviewer: Do you think it has anything to do with their gender?*
> *Participant: Probably just how I feel, I don't know if it's gender per se, I think it's just that I don't know them that well. If I do know them, I wouldn't mind.*

Proving you belong

Women in computing disciplines have stated they feel a need to "prove they belong" by out-performing the men they encounter in the classroom. Seven FemProf women did state they felt the need to prove themselves as being smart in their field, though a pair of students is beginning

to see that these expectations to be better than the men in class may be unjustified. In the first passage below, a student describes tensions she experiences in the competitive major as a woman. In the second passage, a student describes how FemProf participation is helping her to see that she does not need to prove her worth, just try her best.

> Passage 1: Proving you belong
> ***Interviewer:*** *Have you felt it has impacted your learning at all, that you are one of the only women in math*[2]*?*
> ***FemProf Participant:*** *I think it makes me try harder, because I feel like I have to stand up and make, not a precedence, but because there are so few, I affect the statistics more and I want to make sure that the stigma of—"because you are a woman you can't do this kind of, you don't understand math, you should stay with English"—I want to break that kind of stigma.*
> Passage 2: Proving you belong
> ***Interviewer****: Have you had any challenges as a woman in a male-dominated class?*
> ***Participant:*** *At first, I had the experience of being one of two women, but sometimes so many guys and most are outspoken and I'm kind of shy, and even though I know the answer I'm afraid to say it out loud because I'm the only girl there. And I don't want them to think there's only one girl here and she's not smart. I've been getting over that, so I feel better now, due to the seminars, and what my goals are. I can't be shy to be a professor.*

For three FemProf students, *group work* highlighted gender differences, as peers were not always viewed as supportive of women in the group. Students described differing instances of gender bias they experienced in the classroom during group activity. See quote below.

> ***Interviewer****: Have you found this [group work] to be challenging?*
> ***Participant****: Sometimes, it's challenging (to do group work) because when you are the only woman, some people (classmates) do not pay attention to you, not help too much, they just study because they want to be the best, and can be challenging because I try to understand something and if sometimes they do not want to help me because they want to be better. I just study more and try to do the best for me.*

FemProf leads to awareness of gender disparity, pride in being a woman in engineering

Over half of the interviewed FemProf participants stated they learned about or became more cognizant of the gender disparity in technical fields through FemProf. In some cases, this knowledge motivated women involved in FemProf to continue through graduate school, to become role models for other women in the field. Passage 1 (below) exemplifies the participants' recognition of gender disparity due to FemProf, while the second passage shows a student who is planning to tip the scales by continuing the effort to engage more women in computing.

> Passage 1: FemProf leads to awareness of gender disparity
> ***Interviewer****: So why did you think FemProf would be a good idea?*

[2] While FEMPROF began as a program serving computer science and computer engineering departments, the program expanded its reach to serve women in science at CU and women in multiple engineering disciplines at IU.

***Participant**: Because being a professor…I think that was a really good idea, and that is something really cool I'd like to do...So becoming a professor is something I'd like to do at some point – I don't know exactly where or when, but at some point. FemProf has the idea that there aren't that many girls in engineering, and computer engineering particularly.*

Passage 2: FemProf leads to awareness of gender disparity

***Interviewer**: What do you want to do with your degree when you graduate?*
***Participant:** I want to be computer grad student. I hope to do a Ph.D.*
***Interviewer:** Is this a recent decision?*
***Participant**: I changed my mind recently because FemProf gave me info about graduate school, and I liked it...I want to attract more females to continue to grad school.*

A Vignette: Trying on expert roles in empowerment- students present on gender bias

Four FemProf undergraduate students stood at the front of the presentation room. As requested by program directors, they developed a presentation about gender discrimination in society, gender discrimination in the workplace, and about personal experiences as a married woman in an academic computing track. The IU women spoke in English, not in their native tongue of Spanish, to the assembled audience—approximately 75 individuals, mostly male undergraduate and graduate students, along with a few professionals from technology companies, non-profit organizations, and colleges.

Near the end of the panel presentation, a young woman raised her hand with a comment. "Isn't this whole thing counter-productive?" she said. "Why are you bringing this up? I don't think being a woman is a problem in this field." At this point in the presentation, program participants developed their own arguments for the importance of supporting women in engineering, taking up critical stances on their learning environments and on their engineering discipline itself.

Three months later, Claudia (a pseudonym), a presenter who addressed the question during the panel presentation, was still thinking about the woman's comment. She struggled with what to say, and she continued to build critiques of the reasons for a focus on equity in engineering.

"I keep having (her question) in my head… I keep going through other answers I could have had for her. I still see articles that I could have given to her. The President of the Society for Women in Engineering at IEEE was (writing) about why it was important to keep on promoting women and every time I see one of those articles, I remember that girl, and (I want to say) 'See! I have another answer for you!'"

The idea the women wanted to convey in their panel (and felt was discounted or misunderstood by the audience member quoted above) was that diversity of thought strengthens the work of the field. Including minorities and women in the production and creation of new technologies enhances those technologies, they said. Following the presentation, one FemProf woman stated the following:

> *"(As a woman) you bring ideas for reasons that maybe no one can explain –but it is good for the field. And in the same way more diversity is important. More Puerto Ricans, more Mexicans, more Chinese (involved in computing) is also promoting that."*

FemProf provides confidence to women in engineering

Women who are underrepresented in their fields often lack support networks, describe feeling reluctant to seek help when they need it, and report lack of confidence contributing to group work.[27] According to FemProf participants, the program is assisting them in their confidence in these areas, as well as in their overall confidence as women in the sciences. In fact, two thirds of women surveyed (68%, or 13 of 19) found the program increased their confidence asking for help on assignments, while three students (15%) already had this confidence before joining FemProf. Similarly, all women in the program now have at least some confidence in voicing their opinions in group work, while prior to FemProf only three students held this confidence. Overall, the women in FemProf are confident as to their roles in the sciences—twelve of them (63%) attribute a great amount of this confidence to FemProf.

FemProf leads to action to combat sexism in the field

Our survey, interview, and observational data indicate FemProf women are beginning to take up advocate roles in their local academic and research communities. In one instance, a student was having difficulty in an REU placement—a male group member was not including her or her colleagues' work in the final reports to their faculty mentor. One FemProf participant enlisted help from her school-based faculty mentor, who encouraged her to address the problem with her research mentor. The REU faculty mentor stated he felt the group was not functioning properly, but did not interfere. Following the students' comments, he restructured their assignments so that all researchers' achievements were sent directly to the professor, rather than through the filter of one male student researcher. This change, brought on by the FemProf participant's advocacy, made the research experience more meaningful for the participant.

During an interview, one FemProf participant described her intention to become a professor as a way to advocate for women in technical fields. She discussed how her presence as a female professor in a technical field will allow her to serve as a visible role model in the field. She showed how her aspirations were in fact intentions for creating equity.

> *"I never thought about becoming a professor, but with the information (from FemProf) I thought about it. There are not many female professors and (by following this path) I can be a model for females to become a professor."*

We note that not all participants perceive gender bias; some are reticent to describe incidents as such, and some notice and identify activities as possible gender bias issues, but do not take action against such behaviors, slights, or impressions. This is an important point, as it highlights the tendency for men and women alike to maintain the status quo in the practice of engineering.[28]

However, some women engaged in the FemProf program espouse a new awareness of gender inequity in their engineering fields and a desire to challenge it. Preliminary analyses indicate

another way in which a local community's structure may promote inclusion—by developing critical advocates for equity within the larger community of practitioners. Participants describe FemProf as a community that is addressing the gender disparity in computing and encouraging women to consider academic careers as a means for addressing the lack of female role models. A few participants are taking up these goals, and view their advancement in science as integral to reshaping the field into one that values and encourages women to succeed. For example, one FemProf participant stated she wanted to become a professor so that she would be in a position to attract more females to graduate school in her computing field.

Findings Section D: Significance of the program model

FemProf aligns with situated learning theory, as through participation individuals learn how to be members of an academic or professional community through *belonging, becoming, experiencing and doing*. As they engage in authentic activity, individuals begin to see themselves (or not) as more competent and knowledgeable regarding the social practice. An individual's professional identity is also shaped by others' perceptions of his or her belonging within the community. We view identity formation through social practice as key to learning within FemProf—as an individual becomes more competent in doing research, for example, she may develop a "researcher identity."

A novice participant may begin her early research efforts by locating literature that her research advisor uses to write a manuscript. Over time and with experience, she may be invited by her mentor to help formulate the research design for a study. She may request for another student member to read over her written conference proposal, and ask a program facilitator for assistance regarding where to send the proposal for review. When a FemProf newcomer uses the language of the community and its tools with increasing ease, when she demonstrates understanding of a practice's ways of thinking through her actions, beliefs, and talk, she is learning the community's practice.

We have evidence from FemProf that shows students demonstrated shifts in their dispositions towards computing research, and their sense of belonging in the academic computer science community. Confirmation from participant observation, interview data, and survey data indicates that FemProf exemplifies the equitable community of practice model. See figure for detail regarding how the elements of FemProf fit inclusive learning paradigm described by Nasir and colleagues.[19]

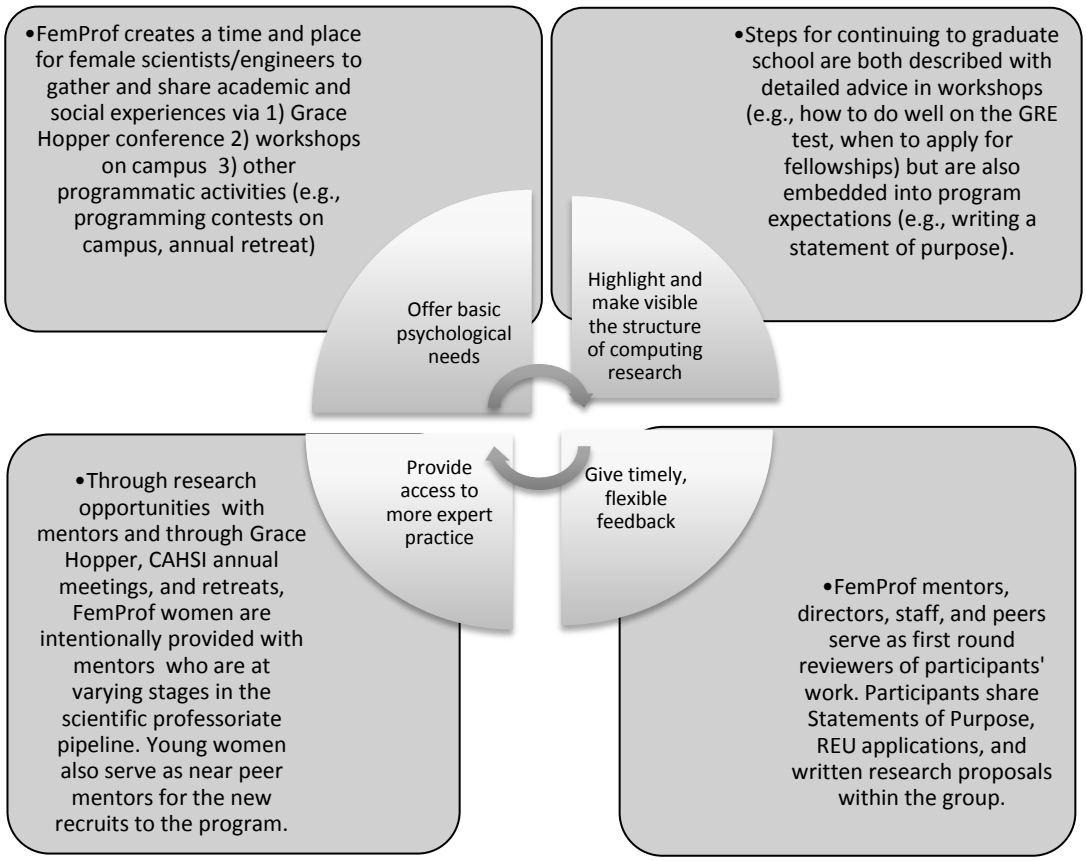

Figure 2: FemProf Model for Supporting Women in Engineering

Conclusion

FemProf is reaching its short-term goals of increasing equity through providing a community in which aspiring female academic computer scientists and engineers are the norm rather than the exception. By attending to social, academic, and technical needs of women, FemProf creates contexts for learning how to become a computing professor. Based on our qualitative analysis, we argue FemProf supports inclusion of women into the computing community, and makes explicit the pathway to the professoriate.

The program currently works from the bottom up, encouraging young women to take a critical view of their learning environments and to persevere in engineering. The program itself is beginning to move towards top-down critique and improvement of departmental conditions, though much could be gained in this area across IU and CU. As it stands, the program focuses efforts on students, describing but not explicitly addressing the broader, top-down, systemic issues that influence underrepresentation in engineering. What is needed is the cooperative building of support for women in engineering at the departmental, institutional and indeed, the national levels of administration and practice.

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