From Marginality to Legitimate Peripherality: Understanding the Essential Functions of a Women’s Program

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ABSTRACT: The focus of this research was to understand how a program for women in science, mathematics, and engineering (SM&E) at college level in the southeastern United States functioned to influence women’s decision making in terms of participation in these fields. By employing Lave and Wenger’s theory of situated learning, we explored this program through two and a half academic years. We utilized a qualitative–quantitative mixed approach in our methodology. For the case study aspect, we focused on the cases of three women participating in the support program via participant observations and in-depth interviews. For a more general description, we developed a questionnaire and augmented this with interviews with a broad spectrum of students. Our findings illustrated that the program demonstrated a great potential to aid the traditionally marginalized to move from marginality to legitimate participation in the communities of science. The program functioned successfully in four ways, each interwoven with the others. One implication of these findings is that such programs should include a multitude of events and opportunities for cognitive, social,

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and emotional support. Being not tall orders financially, such programs may be considered as effective interventions in both national and international settings, where women are in disadvantaged status. © 2007 Wiley Periodicals, Inc. Sci Ed 92:33–64, 2008

INTRODUCTION

Women have lower participation rates than men and receive differential treatment in science, mathematics, and engineering (SM&E) fields during their education as well as in areas beyond education. National reports highlighting these issues provide detailed descriptions and statistical figures about women’s disproportionate distribution or differential treatment in these fields (Committee on Science, Engineering, and Public Policy [CSEPP], 2007a, 2007b; Freeman, 2004; National Science Board [NSB], 2006; National Science Foundation [NSF], 2003, 2007). In spite of substantial gains since the 1960s, gaps still exist between women and men in terms of their college-level enrollment in the (SM&E) majors.

Despite at least two decades of attention to these issues, women are still less likely than men to choose a career that involves SM&E and are more likely than men to earn bachelor’s degrees in nonscience and nonengineering fields. Among those that do choose a major in SM&E, the majority is still concentrated in certain fields such as biology, psychology, and the social sciences (Bystidziensky & Bird, 2006; Freeman, 2004; NSB, 2006; NSF, 2007).

College women intending to major in SM&E may face problems unrelated to the strictly cognitive aspects of academic work (Seymour, 1995; Seymour & Hewitt, 1997). According to Seymour’s (1995) 3-year ethnographic study, the science climate at college is a challenging one, and the first 2 years, she designates as the “weed-out system.” She describes the “weed-out system” as an ongoing socialization process of primarily one group, White men, consisting of a moral and intellectual challenge, aimed at testing the ability of young men to tolerate stress, pain, or humiliation with fortitude and self-control, in which the principle of “only the very best survive” (p. 460) operates. Seymour suggests that many of the challenges that women students face are related to this climate and to the attitudes of male faculty and their male peers.

Seymour explains that the more feminine perspective of many young women—and some young men—requires that they develop positive personal relationships with faculty. According to Seymour, many well-qualified women expect support, care, and advice, but very often they cannot find in the activities associated with a SM&E major. Lacking these positive interactions, they come to think that they perform badly and should not continue in the major, regardless of their actual progress.

Seymour argues that limited “personal pedagogical relationships” (p. 465) with science faculty, and the “impersonal” nature of SM&E activities, contribute much to women’s discouragement. Many women students are discouraged by the failure to be encouraged by faculty. The lack of support network with senior women peers knowing and working within the “weed-out system,” leaves the inexperienced women students alone in their struggle.

The findings of past research into women’s retention in SM&E fields have had implications for possible support systems. Having upper-ranked women peers or women SM&E faculty (Seymour, 1995) as role models, and exposing women students to life stories of women scientists (Wygoda, 1993) might facilitate women’s retention, but may not be effective strategies by themselves. Research suggests that taking action with joint approaches and connecting students and faculty is of key importance. Networks of women, both peers and scientists, in SM&E could be an effective component of women support programs.

However, programs structured around these implications are not numerous. According to Matyas (1992), few programs for SM&E in the United States are directly targeting undergraduate women students. Less than 10% of over 300 programs target women compared
with 51% targeting minority students. As importantly in terms of understanding the manner that these programs “work,” researchers evaluating those programs typically employ traditional quantitative methods, primarily consisting of comparing grades, grade point averages, and retention rates (Brainard & Carlin, 2001; Maton, Hrabowski, & Schmitt, 2000; Packard, 2003; Rosser, 1994, 1997). The purpose of these studies is to uncover whether programs have positive impact, and if they do, “what” factors are influential in that impact. Unfortunately, many of these evaluations do not delve into the question of “how” the mechanisms that have influence work, are largely atheoretical and offer little insight into the complexity of women’s underrepresentation in SM&E fields.

The proximal objective of this research was to understand “how” a women’s support program functioned to influence women’s decision making in terms of SM&E majors. The ultimate goal of this research was to understand the influences of women’s participation or nonparticipation (Wenger, 1998) in SM&E. By employing Lave and Wenger’s (1991) theory of situated learning/legitimate peripheral participation and Wenger’s (1998) social theory of learning, we scrutinized women’s participation forms in SM&E as well as the role of the support program in motivating and supporting women students in their intended SM&E majors.

THEORETICAL FRAMEWORK: LEGITIMATE PERIPHERAL PARTICIPATION AND CHANGING IDENTITIES IN THE COMMUNITY OF SCIENCE

Lave and Wenger (1991) characterize learning as “legitimate peripheral participation in communities of practice” (p. 30):

... we mean to draw attention to the point that learners inevitably participate in communities of practitioners and that the mastery of knowledge and skill requires newcomers to move toward full participation in the sociocultural practices of a community. “Legitimate peripheral participation” provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artifacts, and communities of knowledge and practice. It concerns the process by which newcomers become part of a community of practice. A person’s intentions to learn are engaged and the meaning of learning is configured through the process of becoming a full participant in a sociocultural practice. This social process includes, indeed it subsumes, the learning of knowledgeable skills. (p. 29)

In our research, we conceptualize the community of practice as the broad community of SM&E with undergraduate women aiming to participate in research. In light of the argument that science-related communities are no longer defined by the constraints of time and space (Brickhouse & Kittleson, 2006), we identify and understand a community of science extensively, to comprise the communities of both the academic and industrial scientists. Scientists, participants in the community of science, are basic/professional scientists at the university-level, postdoctoral fellows, and applied scientists affiliated with research institutes, scientists in various teaching and administrative positions. The community we choose to focus includes participants in mathematics, the natural sciences, and engineering.

The practices of this community of science concerned either the “producing” or “application” of science on a professional level, both in academic and industrial settings. These practices include implicit relations. Scientists perform “practice” in our research through engagement within their own communities of scientific practice, employing scientific norms and values, the tenets of scientific socialization (National Academy of Sciences, 1995).
Learning in a community is not simply about acquiring knowledge or skills but also about social participation. Learning changes “who we are and what we can do, it is an experience of identity. The experience is not just an accumulation of skills and information, but a process of becoming or avoiding becoming a certain kind of person” (Wenger, 1998, p. 215). Some participants “take on” the identity of the wider community and some choose to stay on the periphery of the community. But to “take on” the identity of the community is a continual process with participants establishing and re-establishing identity via practice with others. As participants successfully enact the practices of newcomers in the community, they become recognized as community members and as old-timers or masters in the community offer that recognition, the newcomer participation is legitimized.

With a women’s SM&E support program as our “reference ground,” we characterize “newcomers” as the first-year students in the program and “old-timers” as upper-class participants. “Full participant” refers to all of the professional scientists engaging in the activities organized by the support program. The upper-class peers, also program participants, are relative old-timers with respect to the newcomers, but are not yet full participants, as their preparation involves only part of the activities involved in full participation in science.

In this research, full participants are understood to have the professional knowledge and skills as well as the social skills required to maintain their status as full participants of the community of science. We understand the knowledge, skills, and experience in particular activities to evidence themselves in both explicit and tacit terms. Newcomers and old-timers are not considered to be full participants in the community of science and do not yet hold the implicit and explicit knowledge and skills required in that community.

The term legitimate means having control over, or access to, the resources of practice. The term peripheral suggests that “there are multiple, varied, more- or less-engaged and -inclusive ways of being located in the fields of participation defined by a community” (Lave & Wenger, 1991, pp. 35–36). In Lave and Wenger’s view, “peripherality is also a positive term, whose most salient conceptual antonyms are unrelatedness or irrelevance to ongoing activity” (p. 37, emphases in original). Peripherality has “attachment” and “involvement” inherent in its meaning. Although not characterized as full participants, the old-timers and newcomers have access to the resources and networks of the community of science, defining them as legitimate peripheral participants.

Peripherality, implying relations of power, can be source of power or powerlessness and so can be “enabled” or “disabled.” Peripherality may be an “empowering position,” if one moves toward full participation. For this, legitimacy is required. However, legitimacy is not a person’s choice; the community determines legitimate access (Davies, 2005). On the other hand, peripherality may be disempowering if one is kept from participating more fully. Within the context and through the functions of the program, the participants are encouraged to pursue or maintain their SM&E majors. Peripherality for the participants is an empowering position to gain legitimacy for their participation.

Wenger (1998) describes three types of membership in a community of practice: full, peripheral, and marginal forms of participation. Peripheral participation may turn out to be an inbound trajectory, with newcomers becoming prospective full participants. Marginal participation is likely to take its place on the outbound. Both peripherality and marginality include forms of participation and nonparticipation but whichever becomes more prevalent determines the trajectory of the individual.

According to Wenger, “women who seek equal opportunity often find that the practices of certain communities never cease to push them back into identities of nonparticipation” (pp. 166–167). We turn next to women’s historical underrepresentation in the SM&E fields as a portrayal of their marginal participation.
Women’s Historically Marginal Participation in the Community of Science

Women are less likely to enter SM&E majors at college level than men, and this is very closely related with women’s historically subordinated status (Eisenhart & Finkel, 1998). Clearly, explicit barriers, such as not accepting women to universities to pursue science in the 18th and 19th centuries (Schiebinger, 1989), worked to prevent women’s participation in science. However, implicit structures and practices may serve to make science more impenetrable than any policies or entry requirements—keeping women as marginal participants in the community of science. As Davies (2005) emphasizes, “... gaining legitimate peripheral participation is a matter of sanction from within the hierarchy... While practices may define the community, the community determines who has access to that practice” (p. 557). Feminist critiques of science point to bias in scientific inquiry, referring to masculine values and needs (Fausto-Sterling, 2001; Haraway, 1988; Harding, 2001; Hubbard, 2001), and to hegemonic structures and practices within the community of science (Schiebinger, 1989; Seymour, 1995). The masculine nature of science as a discipline (Lederman, 2003), established in the past primarily by not accepting women as participants, served as invisible, “repelling” forces from these fields (Nichols, Gilmer, Thompson, & Davis, 1998). Masculine values have come to constitute full participation in the community of science, serving to keep women on the margins.

Legitimate Peripheral Participation and a Women’s SM&E Support Program

Although the portrait we have drawn seems dismal in terms of attracting and retaining women scientists, in case of marginal participation, interstitial communities of practice may develop, with participants seeking ways to become full participants in the target community of practice (Lave & Wenger, 1991). According to Davis (2001), interstitial communities of practice (ICPs) “provide a context—often from the margins of the primary community—where interruptions to legitimate practice can be addressed and/or removed” (p. 372). ICPs that specifically target women can be very effective in facilitating women’s legitimate peripheral participation in science. They can address the problems women face during their peripheral participation and enhance women’s interest, retention, and success in the SM&E fields, transforming participation from outbound to legitimate forms.

The goal of this research is to understand the manner such a women’s SM&E support program functions in influencing women’s decision making in terms of participation and nonparticipation in the community of science. We hope to use this understanding to inform later designs of the program and inform our theoretical understandings of legitimate peripheral participation and community of practice. We regard a women’s SM&E support program as functioning as an ICP with the goal to serve as an intermediary in transforming women’s participation in the community of science from being marginal to peripheral to full.

METHODS

We employed a qualitative–quantitative mixed approach (Creswell, 1994) and “one-shot case study” design (Fraenkel & Wallen, 2003). This research extended through two and a half academic years. The largely quantitative part of the study focused on a general description of the influence of the program to understand the students’ sense of contentment with the program as well as their decision to continue to pursue SM&E majors. For this, we
developed a questionnaire that included Likert and open-ended questions and augmented this with interviews with a broad spectrum of students.

The second half of our research included case studies, drawing on the symbolic interactionist tradition, positing that human experience is mediated by interpretation (Blumer, 1969, as cited in Bogdan & Biklen, 1998). Within this tradition, individuals are understood in relation with the social group, and interactions are understood to make the crucial link between the two. For this aspect of the study, we developed cases of three women participating in the support program.

**CONTEXT OF STUDY**

The program at the center of our research, the program for Women in Science, Engineering and Mathematics (PWISEM), is a living-learning community in a research university in the southeastern United States. The program was founded in 2001 and targets undergraduate women with the purpose of enhancing their participation and retention in SM&E fields.

Previous evaluations describe the program as successful in retaining women in their intended SM&E majors (Kahveci, Southerland, & Gilmer, 2006). Earlier research of ours describes that, when compared with paired groups of program and nonprogram students, the women participating in the program were more likely to choose an SM&E major, even though no significant difference among the groups existed in terms of their interest, confidence, or academic potential. While useful, this past research provided scant insight into the reasons such programs are successful.

In the current research, by conceptualizing the large scientific community as community of practice in Lave and Wenger’s terms, and the program as an ICP, our focus was to describe and understand the aspects of the program that were responsible for its success in retaining women. We understand PWISEM to be an ICP, providing opportunities for master–apprentice relationships within the community of science. We consider scientists in some way linked with the program to be the “masters” and “apprentices” the program students.

**The Program’s Goals**

The explicit goal of PWISEM is the attraction of academically successful women to the SM&E fields, especially to the more nontraditional areas such as physics, computer science, and engineering (as stated in program brochure) and the retention and success of these women in the SM&E disciplines. Through providing the support, the program is committed to the success of women students in those fields (as stated in the program’s Web site). Other goals include increasing the visibility and success of all women engaged in the SM&E disciplines at the university and instituting programs that would benefit the entire campus community and local community (i.e., community-service programs in local schools promoting interest in SM&E among young girls) (Program director, personal communication, June 13, 2003).

**The Program’s Approach**

PWISEM is a living-learning community with students entering the program primarily in their first year as undergraduates and live together in an on-campus residence hall. Based on research reporting high drop-out rates due to the “weeding out” process (Seymour, 1995) unrelated with lack of ability, the goals of PWISEM are enhancing the participation
TABLE 1
PWISEM Students’ Academic Scores

<table>
<thead>
<tr>
<th>Academic Scores</th>
<th>Year 1 Students</th>
<th>Year 2 Students</th>
<th>Year 1 and Year 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>High school GPA</td>
<td>3.85</td>
<td>0.47</td>
<td>3.97</td>
</tr>
<tr>
<td>University cum. GPA</td>
<td>3.13</td>
<td>0.50</td>
<td>3.26</td>
</tr>
<tr>
<td>SAT Total Score</td>
<td>1117.00</td>
<td>115.00</td>
<td>298.00</td>
</tr>
</tbody>
</table>

N = 39  N = 35  N = 74

Source: The University Registrar’s Office, June 2007.

of academically successful women in the SM&E fields and ensuring their retention. Thus, participant candidates should demonstrate academically distinctive status and dedication to success in their college work. The academic qualifications of the PWISEM women reflected in their high school and most recent university cumulative GPAs (as of June 2007) as well as their SAT scores are shown in Table 1.

The program admittance is competitive. All first-year students accepted at the university and indicating a planned major in science, mathematics or engineering may choose to apply to the program. The admittance rate for the 2006–2007 academic year was 43%, resulting in 35 new PWISEM participants. A team of students from the Student Advisory Committee and members of the Faculty Advisory Committee independently score each applicant along several criteria.

Admittance criteria include high school GPA as a major factor. In addition, a letter of reference is required. Applicants are also required to answer several essay questions asking about their interest in a SM&E major and interest in participating in PWISEM, their high school science and mathematics courses, as well as their grades in those courses. The director states that they “look for people who show curiosity, enthusiasm and interest [in pursuing a SM&E major]” (program director, personal communication, June 15, 2007).

Although admittance to the program is competitive, this competition is not as highly catalyzed by its financial promises as for other programs for women and minority (ACCESS Program for Women in Science and Mathematics, 2006; Maton et al., 2000; Summers & Hrabowski, 2006). For example, the ACCESS Scholarship Program at the University of Utah is as much centered on providing high-amount scholarships and stipends as on networking women students with other women students and faculty in the sciences. ACCESS focuses on attracting the highest achieving women in their freshman year at college, thus offering a space for about 20 participants, at most. Similarly, the Meyerhoff Scholars Program designed for underrepresented minorities offers “a comprehensive financial package including tuition, books, and room and board,” (Maton et al., 2000, p. 632), contingent upon making a B average in a SM&E major.

Unlike these programs, scholarships or tuition funds are not provided to the PWISEM participants. Major financial support for the participants is in the form of funds provided for engaging in scientific research and through hiring tutors for mathematics, chemistry, and physics. The Research Experience Program (REP) provides PWISEM students with the opportunity to participate in current research with faculty in SM&E. The REP requires each participant to engage in research for 10–20 hours a week of effort for 10–13 weeks at the rate of $750–$1950 per semester, depending on workload. The REP financial support constitutes the largest portion of the PWISEM budget.

As stated in its Web site, the primary mission of PWISEM is promoting a supportive environment. For this, all first-year PWISEM students must live in the residence hall.
A small number of upper-class women continuing in residence as “peer leaders” have the responsibility to mentor their first-year peers. After the first year, women may continue their participation and have opportunities to participate in the PWISEM activities, including REP, as long as they major in SM&E.

In addition, the PWISEM employs a graduate assistant in higher education to help facilitate the program whom PWISEM students may contact for any issue or problem anytime. She has various responsibilities, including handling office procedures, maintaining the program Web site and the PWISEM BlackBoard site, moderating program listserves, tracking student grades and assessing eligibility for awards, arranging advisory board and other program related meetings, assisting the director in setting up schedules for the Women in Science Colloquium and in recruiting new PWISEM participants, and organizing the PWISEM events, activities, and opportunities, described briefly in the next section.

**Events, Activities, and Opportunities**

The program aims to create a supportive environment that encourages success, both through the interaction with faculty and scientists and continuous interaction with peers. The community provides support via role models, guest speakers, lectures, panel discussions, mentoring, advising assistance, research experiences (internships), tutoring, field trips, and awards for academic success.

The program provides opportunities for women students and faculty in the SM&E fields to interact. One formal mechanism for these interactions is a course required of all first-year students (*Women in Science Colloquium*) offered both in fall and spring semesters. The colloquium serves several purposes; the first is indicated as “building community” in the program manual. The curriculum is primarily built around guest speakers and laboratory visits. In this course, the students earn a letter grade through participation in activities, a presentation, and a paper.

Another major function of the PWISEM is to involve the students in the REP. The purpose of the REP is to provide students with exposure to conducting research under the supervision of a professor. All program students are eligible for participating in REP, but they are responsible for finding the professor with whom to work. Along with the living-learning community aspect and the Women in Science Colloquium, the REP constitutes the backbone of the PWISEM. The director emphasizes:

> I encourage them almost constantly to get involved in research! Every chance I get. To get over the timidity, I point out that people love to talk about what they do, and if a student knocks on a door and says she is interested in a professor’s work and could s/he tell her more about it and then say she’d like to work with her/him and has financial support from PWISEM, she is very unlikely to be turned down! I have never heard of a student being turned down. I point out that they are in college to have new experiences and that research isn’t boring and dry or done in isolation. Everything I can think of. (Program director, personal communication, June 15, 2007)

The PWISEM students also have opportunities for leadership experiences through participating on the Student Advisory Board, University’s LeaderShape Program, and access to support networks (both academic and industry). In addition, the PWISEM provides its students financial backing for personal tutors to further support participants in their academic activities and maximize academic achievement. In turn, as newcomers transition to old-timers, the peer leaders begin serving as mentors, tutors, and role models for the incoming participants.
RESEARCH PARTICIPANTS

Broad Description of the Influence of the Program

The participants for the broad description were all of the PWISEM students enrolled in the program during a two-and-a-half-year timeframe. We named those students Year 1 and Year 2 students, referring to two PWISEM student populations starting the program (and university) enrollment in two sequential academic years, 2002–2003 and 2003–2004. The age range for participants was 18–19 years as they began the program, the norm for first-year students at the university. Slightly more than half of the PWISEM student population consisted of Caucasian women and about one third were African American. We presented the exact figures on the students’ distribution according to their race in Table 2 for both years.

We collected data from Year 1 students at the end of their first year at the university, and from Year 2 students before and after their first/freshman year using a questionnaire. The population of Year 1 students was 48 (response rate 83%), and that of Year 2 students was 35 (response rate nearly 100%).

To gain more insight into the broad description afforded by the questionnaire, we employed stratified purposive sampling (Fraenkel & Wallen, 2003, p. 100) to select interview participants from Year 1. Attending to the purposeful nature of the sample, we selected students to interview based on their responses to the questionnaire. For example, we invited similar numbers of students with positive and more negative attitudes toward the program, and similar numbers of students changing their major either within the SM&E fields or to majors out of these fields. Eventually, eight students agreed to be interviewed: one was former resident in the hall, three were “returners” to the hall, and four were first-year students. The number and the position of the students interviewed reflected the number of students at different stages of the program. We conducted the interviews by the time the Year 1 students were completing their freshman year, in April 2003.

Case Studies

In Year 2, we began the case studies. The first author employed a purposive sampling approach (Fraenkel & Wallen, 2003) to select the research cases from among the Year 2 students. We wanted to represent a range of experiences in these cases, so we purposefully selected individuals that varied along two main dimensions: (1) intended majors and

<table>
<thead>
<tr>
<th>Race</th>
<th>Year 1 Students</th>
<th>Year 2 Students</th>
<th>Year 1 and Year 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasians</td>
<td>59</td>
<td>63</td>
<td>61</td>
</tr>
<tr>
<td>African American</td>
<td>31</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>Spanish American</td>
<td>5</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Asian</td>
<td>2.5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>2.5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>


a Error due to rounding off.
TABLE 3
Case Study Interview Participants From Year 2

<table>
<thead>
<tr>
<th>Participants</th>
<th>Intended Majors</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carol</td>
<td>Environmental Engineering</td>
<td>Spanish American</td>
</tr>
<tr>
<td>Lena</td>
<td>Civil Engineering</td>
<td>Caucasian</td>
</tr>
<tr>
<td>Reyna</td>
<td>Biology</td>
<td>Caucasian</td>
</tr>
</tbody>
</table>

(2) ethnicity. We hoped our selection of cases would embody balance and variety, as described by Stake (2000).

How did we select our case participants? As a first step, we examined the PWISEM survey responses, and then recorded the names and the intended majors of the students. At first, we considered eight students, from whom we planned to select at most four. (We sought to restrict the number of participants to allow for more intensive study.) As a second step, we contacted the eight students via electronic mail and made appointments with each of them separately for short informal conversations. After these conversations, we selected four students to be the case studies of the research. One of these students, Debbie, intending to major in Nursing, and an African American, withdrew from the study, prior to our in-depth case study interviews. After her withdraw, we had three case study participants to start, outlined in Table 3.

Why did we decide on those students? Stake (2000) also points that balance and variety are important but “opportunity to learn is of primary importance” (p. 447) and that the “potential for learning is a different and sometimes superior criterion to representativeness” (p. 446). Besides ensuring balance and variety, during our informal conversations, we felt that we could learn from these particular women the most. We realized that we employed a specific criterion, talkativeness, during our conversations to select them. These students were open and willing to share their ideas, thoughts, and experiences, and so showed promise as case study participants.

DATA COLLECTION

Broad Description of the Influence of the Program

Questionnaire. We designed the survey instrument with the input from the program director and a member of the advisory board. The questionnaire involved the following three parts:

1. Six Likert-scale items asking the students to rate their opinions primarily about the relationship between the program and their interest in a SM&E major
2. Four open-ended questions about activities the student liked most/least about the Women in Science Colloquium, any PWISEM influence on any change of their major, and about any suggestions that they would give to improve the program
3. Six questions about student demographics (i.e., major/intended major, minor/intended)

The survey was administered once for Year 1 students and twice for Year 2 students, and we discuss the results in detail correspondingly in Kahveci (2004) and Kahveci et al. (2006).
Interviews (Semistructured). We conducted interviews with eight students from Year 1. The interview questions for Year 1 students centered on issues including the interactions among the PWISEM students, the influence of the program on their major, and the PWISEM events and activities. The interviews ranged from about 45–85 minutes in length and were audiotaped and transcribed verbatim. (See Appendix A for the interview protocol.)

Documents. We used documents as supplemental data to the survey responses, fieldnotes, and transcripts (Bogdan & Biklen, 1998). Some of these documents were formal (i.e., description of the program, program Web site and brochure, program manual prepared by the PWISEM graduate assistant, meeting fliers, class handouts, course syllabi). Other documents were personal to the one of the three case-study participants (i.e., personal Internet homepages, self-descriptions written by the participants, e-mail correspondence). For demographic and academic variables (race, university entrance and/or graduation date, SAT scores, high school GPA, major, university cumulative GPA,) we obtained information from university application and university records ensuring research confidentiality.

Case Studies

According to Bogdan and Biklen (1998), in case studies the major data gathering technique is participant observation which could be supplemented with formal and informal interviews and review of documents. By employing interviewing and participant observation methods, our focus was to understand the role of the PWISEM in the women students’ participation in the SM&E fields.

Participant Observation. The first author extensively participated in the events and activities of the PWISEM, attending the all-day “Ropes” course in the beginning of the academic year (Year 2) designed to bond the program students together, the Women in Science Colloquium held weekly, the research facilities trips, as well as a number of meetings involving the director and the student advisory board members. Her presence became customary for the students, and she developed close relationships with many of them; many regarded her as a program participant.

To both document and make sense of her participation, she used fieldnotes (Bogdan & Biklen, 1998; Emerson, Fretz, & Shaw, 1995). She took fieldnotes each time she participated in a PWISEM event or activity. For program activities that were mobile, she recorded her notes as soon as she returned to a computer. In more stationary settings such as lectures, classes, and study lessons, she maintained these notes in her field journal.

The fieldnotes consisted of two parts: descriptive and reflective (Bogdan & Biklen, 1998). Her descriptive fieldnotes took the form of a narrative flow of description (with special attention paid to the participants, their activities, and interactions, and a summary of conversations) organized around time markers. These notes became reflective as the researcher inserted her own thoughts, interpretations, and questions into the narrative flow. These reflections were marked with an OC [observer comments]; these comments would be inserted both during and after the observation session. An example observer comment includes the following:

OC: I think the “Ropes” course was a very good idea to socialize the students. Especially for the PWISEM students it fit very well both considering the nature of the Program and because of the comments about the last year’s problem of lack of interactions. This year this seems to be a better beginning. Also, I got to know the girls and they became familiar with me. Since I am going to be around with them this year again, I think this was crucial.
The fieldnotes were a primary source of data to understand the program, as well as an initial site for data analysis.

**Case Study Interviews (In-Depth).** During and after Year 2 (into Year 3), we explored the three PWISEM students’ experiences in the program. In conjunction with participant observation, we again employed interviews to collect data about the cases and the PWISEM. We had interview protocols (see Appendix B for a sample) to guide these conversations. We had three interviews on average with each participant, each about an hour long. In addition, we sought follow-up information or clarification through e-mail correspondence with the women. We initiated the interviews before their sophomore year and extended our conversations through the academic year into Year 3. Through the interviews, we sought the nature of the interactions that were taking place among the peripheral and full participants of the community of science in the context of the PWISEM.

**DATA ANALYSIS**

**Broad Description of the Influence of the Program**

For the quantitative data analysis, we employed descriptive statistical methods using SPSS software. We calculated median values for the six Likert-scale questions as well as the 25th and 75th percentiles to find the interquartile ranges of the responses for each item. We also calculated means and standard deviations for other questions in the survey. In addition, we looked at the frequency distributions for each of the closed-ended questions to see more clearly the central tendency of the response data. We used the qualitative data from the open-ended questions as a source of triangulation of the quantitative questionnaire data (Creswell, 1994).

**Case Studies**

We analyzed the three cases without a strict concentration on comparison to avoid glossing over the uniqueness and complexities of the cases (Stake, 2000). We first analyzed each case separately and then looked across the cases. Specifically, our analysis of the fieldnotes, all interview transcripts, and documents (if appropriate) consisted of three stages: (1) open coding, (2) selecting themes, and (3) focused coding (Emerson et al., 1995). For this purpose, we utilized QSR N6, a version of the NUD*IST software, for qualitative data management in our work. By first arranging our fieldnotes and interview transcripts into many paragraphs, we went over all of the data and attached meaningful codes. After the initial coding and memoing, we selected core themes for further exploration (Emerson et al., 1995).

We particularly paid attention to the interactions among these PWISEM students and others involved in the program since interactions were central in meaning development in symbolic interactionism. While coding, we created themes such as participation in communities of science, enabling us to look through the lenses of the theory of situated learning. For example, we explored the women’s sense of full participation in SM&E and how they came about to learn the meaning of full participation.

Similarly, we looked for patterns that clued us to the key factors of the program’s functioning as an ICP. During open coding, we clustered comments similar in meaning and attached representative codes to each of the groups. In the selection of themes, we grouped and selected the codes of interest to us. Particularly, we paid attention to the codes that had common implications clueing us into the factors making the program influential. At this
stage, our shared conclusion was that overall, four themes were prevalent in data regarding factors that were important in the program’s success. Our consensual categorization of these four themes was as follows: academic assistance, academic support, emotional support, and exploration of identity. Then, in focused coding, we utilized these themes to code and re-code our data looking for patterns that connected codes under our major themes (see Figure 1 for a coding example).

**Question:** How do you see your experience of living together with the other PWISEM students on the same on-campus residence hall?

<table>
<thead>
<tr>
<th>Response</th>
<th>Open Coding</th>
<th>Focused Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>All it helped me, like, the good thing about living in [the Hall] I am sure was living with girls that are involved in your line of work, in your major, so we are all taking same classes, you know, we all had the same ideas into school, and they are all like... I think last year, the first year on the floor, being around the smartest set of girls, the ones that got the most awards and stuff, so there were very intelligent ladies... it was a good experience, like, I don’t regret it at all, like I wouldn’t have other... but there, so I guess it just helps me stay... really, it was easier for me to get through the first year considering that you don’t know anybody and you are away from home.</td>
<td>Shared schoolwork</td>
<td>Academic support</td>
</tr>
<tr>
<td></td>
<td>Proximity with “smart” students</td>
<td>Emotional comfort</td>
</tr>
<tr>
<td></td>
<td>Getting through the first year</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. A coding example from our data.

**RESEARCHER**

In this research, we saw ourselves as active/interventionist researchers. We embraced the assertion that “in learning about others through active participation in their lives and activities, the fieldworker cannot and should not attempt to be a fly on the wall” as the research places “researchers themselves as observers and participants in the lives of the people being studied” (Lofland & Lofland, 1995, p. 3). Mindful of this, the presence of the first author in the context of the PWISEM became an important dimension in the PWISEM students’ experiences since she interacted with them frequently and sometimes profoundly. These interactions might not only have revealed the students beliefs, but might have also altered them, thus having some impact on their lives.

On the other hand, researchers as individuals have their own positionalities (Alcoff, 1988). Clearly, these positionalities shaped the research. For example, each of the three of us began this process acutely aware of the academic support and academic assistant aspects of the program. After we were far involved in making sense of the cases, we noticed the salience of the issue of identity and the struggle for the women participants to find
an academic identity that “fit.” Our own strongly cognitive theoretical bias, and our own emersion in the fields of science, made the notion of identity (with its strong affective ties) and the possible clash of identities a “late comer” in our analyses.

**FINDINGS**

In this section, we first present the findings that focus on the broad description of the program with particular emphasis on the survey data we collected in both Year 1 and Year 2. Being descriptive in nature, the Likert-type item findings portray the students’ collective views on the different aspects of the program, whether the item had any role in their decisions of participation or not. Along with the quantitative portions of the survey, we present the findings from the open-ended questions. Following this, we present the findings from our interviews with Year 1 students and the case study from Year 2.

**The Questionnaire**

Analysis of the data from the six Likert-scale items in the questionnaire in Year 1 suggested that the PWISEM students

1. *Slightly agreed* that their interest in a SM&E major *has increased* due to their participation in the PWISEM,
2. *Disagreed* that their interest in a SM&E major *has not* changed due to their participation in the PWISEM,
3. *Agreed* that if they were new students again they would still choose to live in the residence hall as part of the PWISEM,
4. *Strongly disagreed* that their interest in a SM&E major *has decreased* due to their participation in the PWISEM,
5. *Strongly disagreed* that they would *not* recommend the PWISEM to a friend who is interested in SM&E, and
6. *Agreed* that PWISEM activities such as internships, workshops, and field trips helped to keep their interest in a SM&E major (Kahveci, 2004).

Table 4 shows median and interquartile range values. The collective results from the six items indicate that overall the students regard their participation in PWISEM as influential in their pursuit of SM&E majors.

For example, to the question “Has your major changed since you arrived? If so, how did PWISEM influence you, and what other factors influenced you?,” more than half of the PWISEM students indicated that their major remained the same as originally declared as an SM&E major at the start of their first year of college (see Table 5 for detailed information on major decisions). Nearly half of those remaining in the same major expressed a PWISEM influence, meaning that the PWISEM played a significant role in their retaining in a SM&E major. Here is one example of a student response to this question:

My major is still Biology, and I intend to keep this major. Being in PWISEM has encouraged me to continue studying in this major by providing helpful opportunities such as colloquiums, field trips, tutors, networking with people in the same fields. (PWISEM survey, March 2003)

Participation in the community of science through the PWISEM enabled the students to know the scientific community more closely. The data suggest that events and activities in
### TABLE 4
Median and Lower-Upper Quartile Values for the Likert Scale Items

<table>
<thead>
<tr>
<th>Items</th>
<th>Median</th>
<th>Lower Quartile (25th Percentile)</th>
<th>Upper Quartile (75th Percentile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. My interest in a mathematics, science or engineering major has increased due to my participation in the PWISEM</td>
<td>Slightly agree&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Slightly agree</td>
<td>Agree</td>
</tr>
<tr>
<td>2. My interest in a mathematics, science or engineering major has not changed due to my participation in the PWISEM</td>
<td>Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>3. If I were a new student again I would still choose to live in the residence as part of the PWISEM</td>
<td>Agree</td>
<td>Slightly agree</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>4. My interest in a mathematics, science or engineering major has decreased due to my participation in the PWISEM</td>
<td>Strongly disagree</td>
<td>Strongly disagree</td>
<td>Disagree</td>
</tr>
<tr>
<td>5. I would not recommend the PWISEM to a friend who is interested in mathematics, science or engineering</td>
<td>Strongly disagree</td>
<td>Strongly disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>6. PWISEM activities such as internships, workshops, and field trips helped to keep my interest in a mathematics, science or engineering major</td>
<td>Agree</td>
<td>Slightly agree</td>
<td>Strongly agree</td>
</tr>
</tbody>
</table>

Source: The PWISEM Survey (questions 1–6), March 2003, N = 40, Miss. Data = 8.
<sup>a</sup> Likert-scale options: 1 (strongly disagree), 2 (disagree), 3 (slightly disagree), 4 (slightly agree), 5 (agree), 6 (strongly agree).

### TABLE 5
Percentage of PWISEM Year 1 Students’ Major Status Since College Enrollment

<table>
<thead>
<tr>
<th>Major Status</th>
<th>Percentage of Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>55.6</td>
</tr>
<tr>
<td>Change within SM&amp;E</td>
<td>16.7</td>
</tr>
<tr>
<td>Change (direction not specified, currently SM&amp;E major)</td>
<td>16.7</td>
</tr>
<tr>
<td>Change from SM&amp;E to other</td>
<td>8.3</td>
</tr>
<tr>
<td>Change from other to SM&amp;E</td>
<td>2.8</td>
</tr>
<tr>
<td>TOTAL 100.1%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(N = 36, Miss. Data = 12)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Error due to rounding off.

the program, as well as peer and faculty interaction, helped the students narrow their focus on one of the SM&E majors. Half of the students deciding to change majors within SM&E fields indicated the PWISEM influence on their decision:

Yes, I came into my freshman year as a Biology major and during my sophomore year, I changed my major to Exercise Physiology. PWISEM influenced me by showing me the
specific topics that would be covered in the Biology major. Although they did not seem impossible, certain courses such as Molecular Cell Biology, Botany, or Immunology did not seem to hold my interest. Through hearing other students’ past experiences as well as those of professors, I discovered Exercise Physiology would better keep my interest. (PWISEM survey, March 2003)

The students indicated that the variety of topics and speakers helped them to know more about SM&E-related fields and broadened their horizons in terms of their future careers.

The second most frequent comment was that the colloquium presentation revealed the amount of work a career in a SM&E field required and how women mathematicians, scientists, and engineers dealt with the demands. Historically, in a marginal position, women have learned to “adopt” some of the burden of being scientists (long hours, masculine interaction patterns, a workplace that ignores the demands of family), an outcome of the first-wave (sameness) feminist movement arguing for equal opportunities in absolute sense with men (Weedon, 2000). While this adoption of traditionally masculine norms can be understood in a negative fashion, marginal position does enable women to eventually become peripheral and finally full participants in the scientific community. Women’s lectures as masters in the community of science gave the newcomers insight into SM&E careers for women:

[I found it useful] Having speakers come and give us some insight on their professions, what impacts their careers have on their personal lives and the effort and work it took to achieve their position in their profession. (PWISEM survey, March 2003)

Thus, the women masters in the community served not only as role models in terms of their actions in the community, but also in terms of the way they meshed the personal and professional, something that was fundamentally important to many of the newcomers in the program.

Among the other aspects of the colloquium series in the program that the students saw as most valuable was providing an opportunity to be together as a community with the other PWISEM students, mutually engaging in learning about scientific practice. Not only were the colloquia a context for speakers representing role models, the newcomers were making sense of these colloquia as a group:

The fact I got to meet other people in my field and taking classes that I am taking. I liked living in a learning community with these same girls building friendships with like-minded people. (PWISEM Survey, March 2003)

As practice in a community involves both explicit and tacit components (Wenger, 1998), apparently, the students in the PWISEM also shared the more tacit aspects, sharing the practices of daily life:

Well, all [interactions] have definitely to do with our classes, homework, laboratory report or something, but you know, because you live together you share the other parts of your life that is not only the academics . . . (PWISEM Survey, March 2003)

The Year 1 Interviews

Our analysis of the data from the interviews with the eight Year 1 PWISEM students supported and expanded on the data obtained from the items in the questionnaire.
Several themes emerging from the interviews were common among all students interviewed. The student comments served as a lens to examine more closely the functions of the program from their perspective, the aspects that were valuable and other aspects that needed improvement.

“Why PWISEM?” Most of the interviewees responded to this question based on their vision of being a female in “male-dominated” fields. They knew being a female in the SM&E fields was unusual. Because nonparticipation was the dominant mode of relation of women in the community of science, “the sense of community” and getting support from old-timer peers was essential. Such mutual engagement involved in the practices of a community may be particularly important to many women (Peltz, 1990). The students emphasized the importance of “relationships” in their comments:

[I participated in the Program because] I wanted to be able to have the common ratio of being . . . inside . . . being a female in such a male-dominated field, I wanted to have a basis, someone I can call, someone I can come, you know, like, “I am not understanding this stuff.” You know, being able to walk through the hall or sort of things, “Oh, you know, I wonder what is going on there?” . . . So, I am thinking like the common mindset, the common goals, and wanting to succeed in the same field, and having those personal experiences that you are able to bring . . . and also I am being like, “Oh, science is cool, science is fun,” but you are not going to get that if you are not to live in the dorm 24/7 [24 hours/seven days] with same people . . . (emphasis ours). (Ashley, April 18, 2003)

The sense of community was very important in terms of participation in SM&E. As Wenger (1998) states, “developing a practice requires the formation of a community whose members can engage with one another and thus acknowledge each other as participants” (p. 149). PWISEM became the meeting ground for conscientious students intent on pursuing SM&E majors:

[By living in PWISEM] you are not going to be stuck with people who did not know what they wanted to do; you are going to be with people that had pretty good ideas of what area they wanted to go to, instead of getting stuck with doleful, undecided people who [do] not take their class schedules seriously . . . (Nancy, April 15, 2003)

Staying in the residence hall made a substantial contribution to the formation of a community as the women had endless opportunities to relate to one another in both academic and nonacademic ways. As implied by the students, staying in the hall together as newcomers and also old-timers provided a continuous support in their participation in SM&E. Besides the transferring of knowledge and skills related with scientific practice, the idea of having others going through the same or similar experiences contributed toward the building of more positive attitudes toward SM&E.

Another point of the PWISEM students was the perceived difficulty of their majors compared with other majors outside of the SM&E realm. The common experience of being in the same “difficulty” of classes contributed to the sense of community in the program. By sharing their knowledge and experiences, explicit and tacit, the students were able to support one another and succeed in their pursuit of SM&E:

Especially living on the same floor, that has been nice because I have some friends who have been in other floors who have people who have very . . . a much easier major in certain senses, and they do not have to study nearly as much as we do, so living on the floor
has really given a sense of community and . . . you know, I can walk on the hall and ask somebody the questions on my homework because they are doing the same homework and you do not feel so alone, you have a person to study this stuff. (Mary, April 16, 2003)

Studying together and going to classes together was one of the most important gains that the newcomers experienced in the program. If confused about some aspect of a topic in science classes, the women had valuable chances to share that “state of confusion” and resolve the confusion. Such cases were valuable opportunities, with newcomers transferring their knowledge and skills to one another, a way of learning the practice in their community. In addition, old-timer students helped the newcomers achieve their courses and often gave them informal academic advice by sharing experiences. Without that academic support, most acknowledged that dropping out of the SM&E majors would have been easier. One student stated that “peer backing” was the most important component of being in the program:

I think it [PWISEM] has helped me to stay in it [my major] because a lot of times I wanted to change my major because I am tired, and I get exhausted . . . I think the peer backing . . . is the most important thing in [the hall] . . . . Having . . . being able to have your peers surrounded. . . (Ashley, April 18, 2003)

Role modeling was another important function of the PWISEM. This function was twofold: one component dealt with the role modeling enacted by the faculty and scientists coming to share their experiences with the PWISEM students in the colloquium series, the other was the role modeling fulfilled by the old-timer PWISEM students (returners and former residents, then sophomore/junior/senior students). These forms of role modeling opened up the practice to the newcomers by providing access to “mutual engagement with other members, to their actions and their negotiation of enterprise, and to the repertoire in use” (Wenger, 1998, p. 100). The first-year PWISEM students engaged in the SM&E practices as primarily enacted by the full participants, and got a sense of how the community of science operated and the way the women were involved. Mutual engagement with the other members of the SM&E community contributed to enhancing the younger students’ confidence in doing SM&E:

Probably . . . I gained more confidence, like, I can pursue a career in science because here these other women have made it so, it was like and I . . . “Why can’t I?! I should be able to do anything that they do!” (Dorothy, April 14, 2003)

The field trips had an important function in encouraging the women students to pursue SM&E fields. Many Year 1 students responded to the survey about improving the program and indicated that the field trips were very helpful and that their number and diversity needed to be enhanced. The field trips provided a more authentic context of experiencing SM&E and also meeting scientists, mathematicians, and engineers involved in scientific practice. They also got to know the community of the scientists, mathematicians, and engineers, and some sense of the experiences of being a mathematician, scientist or engineer. For instance, the students visited the meteorology department at the university. An associate professor and interim chair described the latest meteorology research being conducted in the department, their work with the National Weather Service, as well as describing his own collaboration with middle school teachers. The class explored various laboratories throughout the facility as he discussed the work that was conducted in each.
TABLE 6
Year 2 Students’ Reasons for Participating in the PWISEM

<table>
<thead>
<tr>
<th>Items</th>
<th>Mean a</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>The opportunities of the program attracted me</td>
<td>1.03</td>
<td>0.17</td>
</tr>
<tr>
<td>To be in a safe environment away from home</td>
<td>1.89</td>
<td>0.72</td>
</tr>
<tr>
<td>The dormitory provided looked nice</td>
<td>1.97</td>
<td>0.79</td>
</tr>
<tr>
<td>My parents wanted me to do so</td>
<td>2.03</td>
<td>0.75</td>
</tr>
<tr>
<td>A friend previously in the program recommended me</td>
<td>2.03</td>
<td>0.75</td>
</tr>
<tr>
<td>To learn more about science/math/engineering</td>
<td>2.20</td>
<td>0.83</td>
</tr>
<tr>
<td>To be in a supportive environment for women in science/math/engineering</td>
<td>2.63</td>
<td>0.60</td>
</tr>
<tr>
<td>To have it on my resume</td>
<td>2.63</td>
<td>0.60</td>
</tr>
</tbody>
</table>

aLikert-scale options: 1 (very important), 2 (somewhat important), 3 (not important).

As access into the practices of the community of science, the PWISEM enriched the students’ understanding of the SM&E fields. These field trips to the locations of scientific and engineering work helped the PWISEM students become enculturated in legitimate peripheral participation, as a characteristic of ways of belonging and a condition of learning. The trips provided access to the practices of the community of science and thereby learning opportunities about these practices.

Overall, we understood the strongest aspects of the program to be the ability afforded newcomers to share a membership in the community with full and other legitimate peripheral participants, to learn the practice within a master–apprentice relationship, and to gain access to academic support from peers. Students’ responses to the survey (shown in Table 6) revealed that they were initially attracted to the array of opportunities that PWISEM provided. We understood these opportunities as providing newcomers the ability to share a membership in the community with full and other legitimate peripheral participants, to learn the practices within master–apprentice relationship, and to gain access to academic and emotional support from peers.

Case Studies

Thick descriptions of the three cases that follow illuminate the role of the program in the participation of the undergraduate women in the community of science and its functions.

Carol. The following is Carol’s description of herself that she wrote in response to our request during a member check process, richly portraying and delineating Carol’s personality as well as her ideas about science and being a woman scientist:

I am a sophomore in college majoring in environmental engineering. I am very confident and independent. I am not afraid to speak my mind. I am a very outgoing person who is not afraid to approach people. I also believe that I am very easy to get along with, and I find that I befriend people very easily. I am not afraid to walk up to someone and introduce myself. I am a very goal-oriented person. When I set my mind to doing something I will do everything in my power to achieve it. While at times I do face bumps on the road, I always do everything in my power I can to overcome them. I am a very strong believer

1 All of the participant names and the name of the program in this paper are pseudonyms.
that everything happens for a reason. I believe that it is very important to have a social life because you must have social skills to face the real world. I am a very feminine woman and while that is often not accepted in my field I am not willing to change that for anyone. The way that I am is the way that I am, and I feel that does not make me any less of a person than someone not as feminine or different than me. I do not believe that anyone can tell you that you are not good enough or that you cannot do something. I believe that if you want to do something and you set your mind to it you can accomplish anything you want in life. I feel that my confidence, independence, and open mind will help me become a successful engineer who will add personality and femininity to a male-dominated field.

(Carol, electronic mail, March 5, 2005)

Becoming a sophomore enhanced Carol’s already positive sense of confidence in pursuing environmental engineering. During her freshman year, she learned more about the practices in her major and balancing her initial expectations, as expressed in the following words:

Oh, [my confidence] is probably higher. I am more confident now because last year it was just all brand new to me, and now it’s like I understand and I have learned [that] you are not always going to get the grade you want in a class and you are not always going to get the best professor. (Carol, Interview 2, October 28, 2004)

According to her description, Carol’s learning was not merely about the subject matter of engineering. She was learning about the process of participating in the community of her academic major as well as the tacit practices of this community. She learned that even a “good” student could get a “bad” grade and that this was not uncommon; in fact, getting a low grade was part of the practice itself. Low grades and emotional tests were part of the “weed-out” system in the university SM&E majors, as described by Seymour’s (1995).

Carol witnessed many of her peers in the major dropping, or being “weeded” out of, engineering:

The people that I had in my first year experience class . . . so many . . . they are just dropping like flies . . . until I found it I didn’t expect it at all, I just had thought they were scaring us, you know . . . to scare us, but it’s true. (Carol, Interview 2, October 28, 2004)

Despite Carol’s seemed confidence, in general, Carol found it difficult to approach her teachers. “It’s just really hard to get a relationship with your professors here [at the University]; I don’t think I have ever had a relationship with any of my professors here” (Carol, Interview 2, October 28, 2004). Although she was involved in master–apprentice relations with her professors in her role as a newcomer in the community, this statement demonstrates that she had hoped for personal pedagogical relationships (Seymour, 1995). Her expectations challenged the formal, impersonal, and work-based nature of master–apprentice relationships that she experienced even within the confines of the program. This omission was unfortunate as Carol mused that having closer relationships with faculty would have enhanced her learning:

Especially in something like math, science and engineering [there are] skills that you need to work with people. Not one person makes a pill; it takes a group of people to make a pill (Carol, Interview 2, October 28, 2004).

We understand that such a recognition is evidence of Carol’s legitimate peripheral participation in the community of engineering, since to be a competent participant, some learning along the three dimensions of mutual engagement, joint enterprise, and shared repertoire.
is inevitable (Wenger, 1998). By improving her social skills, she was improving her ability of mutually engaging with the other members of the community. Her perspective on collaboration with others in scientific research can be understood to be an indicator of her understanding of the enterprise. By viewing scientific practice as one of collaboration, Carol also had a sense of the community’s shared repertoire of tools and ways of doing things (Wenger, 1998).

Carol considered her participation in the PWISEM as very valuable. She explained that her involvement in the program and especially staying together with the other PWISEM women for her freshman year helped her in the major and in adjusting to college. “Really, it was easier for me to get through the first year [because of participation in the program] considering that you don’t know anybody and you are away from home” (Carol, Interview 2, October 28, 2004). Carol’s emphasis on her first-year peers revealed a third aspect in the role-modeling function of the program. In addition to the role modeling enacted by the scientists and old-timer students, the strong relations among the newcomers made possible remaining within the practices of the community of science. In particular, Carol emphasized that being with others taking the same courses and being in the same major as the old-timers provided an invaluable source of aid adding to the academic support:

I guess it would have been harder schoolwork and stuff [if I had not been in PWISEM] because if there wasn’t someone around or next to you, [sic] would be like, “Oh, so, do you understand how to do this problem?” It just would have been, I think, a totally different experience. . . . (Carol, Interview 2, October 28, 2004)

Although not as involved as she was the previous year, Carol did not lose her contact with the program. At the time of our conversations, Carol was living with a few of the PWISEM women in an apartment off-campus. She also kept in touch with Kate (the director of the program) meeting, e-mailing, and talking to her. “Yeah, it’s more like a mentor relationship [with Kate], not so much like personal relationship, it’s just more of like a mentor, she is just higher up, and I ask her for advice in regards to school and stuff” (Carol, Interview 2, October 28, 2004). By maintaining her mutual engagement with her first-year peers and the director, Carol kept her participant identity in the ICP, and thus smoothed the route to her entry in the larger community of science.

Lena. Lena’s first attempt to describe herself was very straightforward. In this description she included mainly aspects of her appearance, that is, her height, eye, hair, and skin color. This first description echoes aspects of her personality; Lena was direct, and she spoke simply and to the point. With prompting for a more detailed description about her personality, Lena wrote the following:

I’m smart, funny, a good listener . . . . I am an individual and a loner. I enjoy the company of others. I tend to procrastinate, but given a task that I truly enjoy, I will sit for hours on end to complete it . . . . Sometimes I am serious, but I also like to joke and have a unique sense of humor. Mostly, I enjoy quoting movies with my friends and family. I am a good listener and like to be there for my friends when they need me. I enjoy being active and playing sports and attending sporting events at [the University]. I am currently working at an engineering firm and love watching something being developed from nothing. (Lena, electronic mails, March 22 and March 31, 2005)

In her sophomore year as the civil engineering major, Lena’s goals reflected the intentions she had in the freshman year. She wanted to be a civil engineer and work for an independent
firm on a private scale. Although her interest remained high, Lena’s confidence in pursuing civil engineering had been disturbed by the difficulties she experienced in her second year of core courses, physics, and calculus. This was quite an astonishing situation since Lena had talked the previous year about how much she enjoyed her science and mathematics classes and how easy they were for her. Through the challenges she experienced in her courses, Lena recognized both the rigorous nature of work in her academic major and her position in the community as a newcomer and apprentice.

In her first year, Lena lived with the other PWISEM women and found this very supportive:

“All girls could sit in the lobby and all do homework together because you all have the same classes... All girls, we took chemistry and we studied chemistry together. I know they helped me out as well as I helped them out. (Lena, Interview 2, October 28, 2004)

During an interview, Lena stated that “it would have been too easy to drop the classes”—and eventually the major—had she not been involved in the program. The sense of belonging she experienced by living in the dormitory and socializing with her peers would have been difficult to “give up” if she left SM&E fields. The network served not only a support function but also a conservative function, as the students’ comfort and sense of ease was derived, in part, from being a close-knit member of this community. For Lena, “living together” was the most influential aspect of the program.

Another factor influential in Lena’s decision to continue pursuing civil engineering was the internship she had with a private engineering firm. In fact, Lena was still working in the same firm she had interned at the time of our conversations:

“... But since I have had the job, I have been working with engineers and doing their work, too, so I know what they use and all those physics and math stuff... it is not all they use, you know, so I am like, if I can get through this I will be able to do it. (Lena, Interview 2, October 28, 2004, emphasis ours)

Her internship was a driving force for her to persist in the major because for her, the internship represented a more “realistic image” of the field. Through this experience, she came to understand that being successful in engineering involved more than being academically competent. Given her difficulties, her arguments were supportive of Lave and Wenger’s (1991) notion of learning as practice in real communities. The proponents of the situated learning theory criticized the formal “in-school” learning primarily because of its lack of providing authentic experiences to learners (Driscoll, 2000). According to Wenger (1998), learning is not only about the subject matter but also about participating in an ongoing practice, something Lena allowed us to recognize:

“So, [in my internship] you can see the big picture, it is not all physics and calculus, [engineering] is different [from physics and calculus] and you can do that. (Lena, Interview 2, October 28, 2004, emphasis ours)

Reyna. Like Carol and Lena, Reyna also constructed an intense summary and description that is very clear and delineates the core aspects of her personality:

“I love to hang out with my friends, meet new people, and generally for there to be people and movement going on around me. I’m very close to my sister who is graduating this year with a biology degree of her own. I used to be shy but when my sister left for college I had to start being more outgoing and “find myself.” So I have found that I love music and hanging out. I am sarcastic a lot and I love joking around, I really am not that good at being
seriously. I also do procrastinate with my schoolwork, but I’ll get it done eventually. I love
God and want to live for Him everyday—can’t wait to be with him in heaven. That’s about
the gist of me, God loving, music crazy, and sometimes studious person. (Reyna, electronic
mail, March 3, 2005)

Reyna was interested in her major, biology, and her confidence in pursuing the goal was
even higher as a sophomore than during her freshman year. She explained the rise in her
confidence as being due to her developing knowledge of biology, previously unknown for
her. Her membership in the program during her freshman year allowed her to develop a more
informed understanding of the practices of the specific scientific community that interested
her—biology. In Reyna’s view, the practices of the community of biology differed from the
practices of other natural science communities that she experienced:

... For the first test I was really like, “I don’t know, how do I study?” because it’s not like
math and chemistry where you just do the problems in the back of the book and stuff, but
biology is different, you just memorize it, you just memorize, “Okay, this is how such and
such works.” (Reyna, Interview 2, November 6, 2004)

We understand Reyna’s comment to reflect on the “doing” of biology in her classes at
the university—with freshman biology classes of 1500 students often typical and student
assessment largely to the knowledge levels on Bloom’s taxonomy.

Understandably, Reyna seemed confused about her goals with her biology degree in
the future. As she was learning more about biology, she found many of the aspects of
biology uninteresting and unappealing, and her lack of interest often manifested itself in
an hesitation to engage with the material in a thorough manner:

Actually the [biology] test that’s coming on Monday is, I think, going to be the most
difficult for me, because it’s on the human genome and stuff, and I know genetics is cool
and everything but personally I’m not interested in it. And, you know, DNA augmentation
and changing... I don’t want to do that. (Reyna, Interview 2, November 6, 2004)

Reyna’s lack of interest in molecular biology caused her to look beyond her coursework
for ideas for a possible career, and she mulled over for a short time being a veterinari-
ian. However, the very different nature of an anthropology course (an elective in her
biology program)—and specifically her anthropology instructor attracted her interest else-
where. Reyna came to understand anthropology as “a different kind of science” (Reyna,
Interview 2, November 6, 2004), with scientists collecting data, performing experiments,
in short, using methods of science. Interestingly, because of the different nature that an-
thropologists presented knowledge claims and the evidence for these claims, Reyna came
to think of anthropology as requiring more “scientific work” than biology, and she came to
seriously consider changing her major and her career track.

Reyna’s discomfort with the identities as enacted by her biology professors sparked
the initial recognition of the strong role identities play in communities of practice in this
research. Reyna’s coming in contact with another community, anthropology, gained her
some sense of qualities she did not have but wished she had—in short she was examining
her identity in relation to her chosen community of practice. According to Wenger (1998),
learning transforms “who we are and what we can do, it is an experience of identity.
It is not just an accumulation of skills and information but a process of becoming or
avoiding becoming a certain person” (p. 215). Reyna’s consideration of switching to another
academic community was largely due to her avoidance of taking on the identity, as enacted by her biology professors:

My biology teachers and everything are so boring to me. I mean, [my biology professor] is so boring, like, he told us this DNA thing was his specialty, he was . . . excited, he said, “Yeah, guys, I really like this one.” And he . . . puts me to sleep every class even when he was excited about it. I’m like falling to sleep trying to write. It’s terrible, it really is. I don’t want to be that. (Reyna, Interview 2, November 6, 2004)

Her role as a newcomer in the program allowed Reyna to understand that she did not want to experience her future as exemplified by the biologist she had come to know during her first year. She gained some insights into biologists and found them lacking. In other words, she did not see the university biologists she met as viable role models and could not “mutually engage” with them. These experiences caused her to consider leaving biology.

In contrast, Reyna “loved” her anthropology professor and was excited to identify with her. “I liked her. She was cool. She was very exciting” (Reyna, Interview 2, November 6, 2004). The fact that this professor was a woman, and an engaging woman, was an important piece that attracted Reyna to consider anthropology as a career:

. . . If I saw a male teacher into it and more exciting, I would like it, and if I saw a female one who is more exciting into it, I would like it, too. . . . But, I think, she would make more of an influence on me probably than him, just because I could relate better to her, her being a female and everything. I would be like, “Wow, look at her,” and the guy [may say] “that would be cool,” [but] I would be like “Wow, that’s cool!” but I could still relate better to her. (Reyna, Interview 2, November 6, 2004)

The anthropology professor’s engaging personality, the ways she portrayed anthropology as an active, changing science, combined with her gender identity served to attract Reyna to this discipline.

However, Reyna’s consideration of anthropology was brief, and she came back to biology as her academic home. Interestingly, paleontology attracted her back to biology as her major. “I am going to make it my goal to be a paleontologist” (Reyna, Interview 3, March 3, 2005). She was attracted to the ability to be able to study the natural history of vertebrates, but without the emotional and moral quandaries sometimes required in laboratory biology. She compared being veterinarian to being paleontologist and justified her decision in the following way: “I still learn about animals—except they are dead. I do not want to have to hurt live animals even though I know it is to help them” (Reyna, Interview 4, March 18, 2005). With this statement, Reyna exhibited a caring attitude often attributed by girls to biology as a discipline (Jones, Howe, & Rua, 2000).

Reyna’s tentative position in the community of science and her search efforts to find a scientist identity that fit her own suggests a strong need of positive role models in these fields. This need can be effectively addressed within programs like PWISEM by means of having carefully selected scientists from different disciplines meet newcomers in events or activities, both formal and informal. Reyna explained that being in the program helped her resolve the confusion she was having about her major. The program functioned in academically supportive and informative ways:

Oh, I think it [being in PWISEM] just showed me my options better because speakers came in from different areas of science, you know, and they came and talked to us. I went to the Colloquium, actually to the ones I was interested in, and they helped me, I guess, narrow down what I wanted to do with biology. (Reyna, Interview 2, November 6, 2004)
### TABLE 7
PWISEM Students’ Percentage Distribution According to Academic Status

<table>
<thead>
<tr>
<th>Academic Status</th>
<th>Year 1 Students</th>
<th>Year 2 Students</th>
<th>Year 1 and Year 2 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduated with BS or BA</td>
<td>74</td>
<td>54</td>
<td>65</td>
</tr>
<tr>
<td>Graduates who majored in SM&amp;E</td>
<td>83</td>
<td>89</td>
<td>85</td>
</tr>
<tr>
<td>Still enrolled</td>
<td>8</td>
<td>31</td>
<td>19</td>
</tr>
<tr>
<td>No bachelor’s degree and have left university</td>
<td>18</td>
<td>14</td>
<td>16</td>
</tr>
</tbody>
</table>

*(N = 39) (N = 35) (N = 74)*


As a participant in the PWISEM community, Reyna could study and go to classes with the other PWISEM women, and they supported one another through academic tutoring. Moreover, as a sophomore and more of an old-timer, Reyna volunteered to be a mentor for the new students in the program. In PWISEM, being a mentor meant helping the new students one on one so that they adjust easier to college life and to their majors by sharing information and resources as well as providing emotional support:

> I will help her with her classes and stuff and choosing her professors, and if she needs help finding a tutor or that kind of business, but I think also I would help her just adjust to being in college, like, if she was feeling homesick she will find me as someone to talk to... (Reyna, Interview 2, November 6, 2004)

Reyna’s intention to be a mentor and help freshmen was an indication of her caring personality and her mutual engagement with the PWISEM students.

### DISCUSSION

Past comparisons of the retention of PWISEM students with comparison groups of nonprogram students demonstrate the efficacy of the program in retaining women in SM&E majors (Kahveci et al., 2006). In addition, most recent academic data from university records confirm the PWISEM’s success in terms of graduation rates and majoring in SM&E (Table 7). For example, 6-year graduation rate for all students entering the University in 1999 is 66%, whereas the graduation rate for the Year 1 program participants starting college in 2002 and finishing in just under 5 years is already 74% with still 8% of the participants enrolled. The focus of this research was to describe the factors that make the program so effective, in part to allow for an understanding of the influences on women’s participation and also nonparticipation in SM&E.

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2 To compare with 6-year retention rates for first time in college (FTIC), the PWISEM rate is 72% already, and the 6-year span is not completed yet. Still 8% of the FTIC students are enrolled. For Year 2 program participants, the graduation rate in just less than 4 years is 54% with still 31% enrolled. The FTIC graduation rate for Year 2 PWISEM students is 48% in 3.75 year so far, with still 37% enrolled. With time, these graduation rates will almost certainly rise. Looking at only the graduates, 83% and 89% of the Year 1 participants and Year 2 participants, respectively, majored in SM&E. The percentage of students who left the university so far with no degree was 14% for both Year 1 and Year 2 PWISEM participants. So far, the time to degree for the FTIC students who have already graduated was 4.0 year and 3.8 year for the Year 1 and Year 2 PWISEM students, respectively.

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Looking across these cases and our surveys, we found that the PWISEM functioned in four ways, each interwoven with the others: academic assistance, academic support, emotional support, and exploration of identity. We define academic assistance as guidance provided to the young women as to elements each of the SM&E majors comprised and expectations for these majors (i.e., broad descriptions of the fields, coursework, professors) as well as assistance toward undergraduate research. Scientists and upper-class students within the context of the PWISEM were in primarily academically assistive roles.

Academic support, differing from academic assistance, was support for student development of the specific content knowledge and skills required in the subject area; one way for providing academic support was tutoring, both peer to peer and from tutors hired by PWISEM. On the other hand, academic assistance was more informal and its ultimate goal was to get the students to know more about their intended majors, navigate the bureaucracy of the university, and find appropriate mechanisms to obtain academic support.

Emotional support was more obvious among the newcomers since they lived together in their freshman year. A sounding board for anxiety and fear about coursework was essential for these young women; likewise, having a community that recognized the significance of superior performance in a difficult class was equally as valuable. Late night study sessions were as much about sharing and lessening anxiety as they were about academic support.

One definition of identity is the “actions and interactions that define [an individual] as playing a certain set of roles” (Gee, 2004, p. 46). The “up front seats” afforded the newcomers entry into the working lives of scientists and allowed them to vicariously explore the identity of scientists both from a professional and personal view. Not only did the masters allow for such insight, but also participation in the ICP allowed the newcomers to “try on” new scientific identities to see if they were satisfying. The newcomers closely examined the identities engendered through different communities, and their persistence or lack of persistence was at times as much to the future identities they saw for themselves, the ways they perceived they would act within their communities, as the cognitive demands of the fields themselves.

Both the broad description and the case studies can be understood as sources of understanding how the program academically assisted the participating students through providing a context for their legitimate peripheral participation in the communities of SM&E. By establishing a context that provided access to SM&E, the program (as an ICP) guided the young women to an inbound trajectory, with full participation envisioned as opposed to an outbound one where historically and traditionally women were regarded as marginal participants (Wenger, 1998). Given the program’s successful role in retaining undergraduate women in those majors, this ICP demonstrated a great potential to aid the traditionally marginalized to move from marginality to legitimate peripherality, or from nonparticipation to legitimate participation, in the communities of science. For this success, we support Maton et al. (2000) in their suggestion that a variety of program components are essential as opposed to a selected few.

The program functioned in academically and emotionally supportive ways by enhancing a sense of community and mutual engagement among its members. The means of the emotional support in the ICP is straightforward—having peers to share difficulties and to look for advice and solace. The evidence for academic support via this community is less obvious; by sharing their knowledge and experiences, explicit and tacit, the PWISEM students shared knowledge and skills with one another, another way of learning the practice of their communities.

The PWISEM students’ legitimate peripheral participation—a way of understanding learning—in the communities of science involved their changing membership from being newcomers to becoming old-timers within master–apprentice relationships. This
membership enabled the students to get to know the scientific communities and their practices more closely. The first-year PWISEM students engaged in the SM&E practices as enacted by the full participants/masters and got a sense of the operations within the community of science as well as the way the women were involved in this community. They came to realize the rigorous nature and other essential characteristics of scientific work, as well as some specific practices in their own academic major communities via the research experiences encouraged by the program and the mentoring of the old-timers in their group.

The specific strategies of the program in engaging the full participants and newcomer students included the Colloquium lectures, the Research Experience Program, career panel discussions and other formal and informal meetings with scientists. The speakers served as role models at these lectures and discussions, with master–apprentice relationships repeatedly enacted. The women scientists’ lectures provided insight into SM&E careers and made these scientists as role models for the new apprentices. The field trips to scientific research facilities provided a more authentic context of experiencing SM&E, as well as meeting scientists, mathematicians, and engineers involved in scientific practice. The research opportunities provided through PWISEM had the same function of immersing the students into the practices of the communities of SM&E. The case studies demonstrate that this immersion included more than simply the cognitive aspects of scientific practice; indeed, recognition of the social nature of this work served an important motivational role, particularly if students had difficulties with their coursework.

The “sense of community” and getting support—both academic and emotional—from old-timer peers emerged as being among the vital experiences that the newcomer PWISEM students had in the program. Indeed, we found that the strong relations among the newcomers constituted an important supportive aspect of the program as an ICP. As most of the students emphasized, without the interactions and relationships they had in the context of the program, they would have switched majors outside the SM&E realm much more easily. In earlier we compared like-minded program and nonprogram students of similar interest, confidence and GPA scores in SM&E in terms of retention in those majors and found program students to have higher retention rates (Kahveci et al., 2006). Living together as a community and the “peer backing” function made staying in their majors easier, or more difficult to leave, as leaving the major would also mean leaving a close-knit community.

In this sense, our work suggests that in the theory of situated learning (Lave & Wenger, 1991) newcomer interactions are a key aspect and so, deserve a stronger emphasis and broader elaboration. We argue that considering newcomer interactions only in terms of being effective means for circulation of knowledge (Lave & Wenger, 1991) is extremely limiting. Other aspects involved in the newcomer interactions, being affective rather than strictly rational, play a significant role in their prospective full participation in the communities of practice.

Likewise, the case studies serve to complicate the nature of the master–apprentice relationships and complicate the nature of the full participants’ role model function. The women in our study looked at the masters as possible role models—not just in terms of their cognitive contributions, but also in terms of the identities they enact with their students. Our case studies demonstrate that women in SM&E fields look closely at the masters of the fields with whom they interact to see whether the identities they perform were compelling. The ICP serves, not only to make the ideas and skills required in the sciences familiar, but also to make possible identities familiar. This familiarity does not always allow for comfort—and often-increased insight into full participation (and full participants) allows women to see the shortcomings of their select SM&E community. Our cases suggest that roles required of masters in master–apprentice relationships are far more than conceptual.
and even beyond emotional: masters serve as windows into a meaningful vision of “doing” science and “being” a scientist. The way these masters enact their scientific identity is up for scrutiny.

**IMPLICATIONS AND FUTURE RESEARCH**

These findings point to the need not only of providing academic support, but also of involving students in open discussions with SM&E practitioners about the nature of their fields as well as the characteristics of full participation in these communities. Maintaining membership in SM&E fields is not only a cognitive endeavor, and students need not only cognitive tools but social and emotional ones as well to maintain their membership. Thus ICPs such as women support programs, must include facets that support students’ cognitive, social, and emotional development—they must provide windows into, not only the work of scientists, but their lives as well.

Programs such as PWISEM show promise for success in recruiting women not only in the U.S. context but also in other countries around the world where women are disadvantaged in their pursuit of SM&E education and careers. Documents and research reporting women’s underrepresentation internationally depict alike patterns of women’s disproportionate distribution in the SM&E fields with women predominantly pursuing non-SM&E majors in higher education (Cronin & Roger, 1999; Öğrenci Seçme ve Yerleştirme Merkezi, 2007) and women scientists making up the very low proportions of scientific workforce (Normile, 2006, for instance). Program interventions on global level may be designed in response to international women’s needs intent to pursue careers in SM&E.

Our research suggests that to have significant outcomes, university-based intervention programs such as PWISEM targeting underrepresented groups should include a multitude of events and opportunities for cognitive, social, and emotional support. Components such as establishing a living-learning community, forming support networks, arranging lectures, panel discussions and social events, providing opportunities and financial support for research experiences, making SM&E tutors available, and in many ways, offering academic backing and assistance, would clearly not be possible without bureaucratic and administrative support as well as a sound budget base. Illustrating a successful case, the PWISEM costs an average of $1900 per first-year PWISEM student per year, being not a tall order. Mainly for the continuing students (second through fourth year), PWISEM pays the students to participate in scientific or engineering research. Currently, 16 students participate in the research experiences, and the average cost is $1500/student/year. The rate of graduation and the percentage of graduates majoring in SM&E are encouraging (see Table 7).

Clearly, more research is required in this area. On a local level, a need for longitudinal studies exists to examine where PWISEM women “go” in their professional lives, how their identities change, if they completely “take on” the norms and practices of their scientific communities, or if they challenge community expectations. Exploring potential differences from other women in similar status in SM&E but not having been a part of such programs would be another appealing question to explore. Also, in-depth research is called for on international level to look into the factors discouraging women from pursuing SM&E careers, to diagnose the challenges they face, and to open ways for active and proactive steps by means of interventions at the levels needed. Additional theory-driven qualitative studies like ours that explore existing national and international interventions directed toward increasing the representation of women in SM&E, and making these interventions and their significance more visible to science and science education communities are needed.
APPENDIX A: INTERVIEW PROTOCOL FOR GENERAL DESCRIPTION OF PROGRAM

- How do you describe a scientist? Please draw a picture of an ideal scientist and explain your drawing. (What is the image of an ideal scientist that you have? What sparks in your mind immediately when you think of an ideal scientist?)

- Is your gender an important consideration for you in deciding to participate in science? Why/why not?
  - Do you think in the broader scientific community that it is important that women participate in science? Why/why not?
  - Do women add anything unique to science?

- What was your main reason for choosing to attend the PWISEM? How did you hear of it?

- What is like to stay in the residence hall as a PWISEM student? Who do you socially interact with, and why? Is it primarily due to common interest in the discipline of science/math/engineering, or is it by proximity to each other in the hall? Are there any other factors? Please explain.
  - How do you academically interact with other PWISEM students, for example, by studying together or going to academic activities together?
  - Is living as a PWISEM student in the hall different from living in other dorms on campus? How/why?

- In the PWISEM program, there are opportunities such as:
  - Peer mentoring
  - PWISEM-sponsored internships
  - Seminars
  - Other activities—field trips, receptions, panel discussions, and such.

If you will not be living in the hall next year with the PWISEM students/If you will be living again in the hall as a second year student in PWISEM, how do you envision being involved with PWISEM in the future? Which one(s) of these activities interest you the most? Why are you attracted to these? Why not the others?

- Tell me three things that you would say were the most influential in your stay here (either positive or negative). What made these so influential?
  - Did these activities influence your interest in science/math/engineering? Or your basic understandings of science/math/engineering? What I’m trying to get at here—help me understand what aspect of your science/math/engineering orientation is impacted by PWISEM - interest/understanding/comfort/self-confidence, or something else.
  - Do you recall any particular moment in your life in the hall/during your participation in PWISEM that you felt something strong about science, either sympathy or a feeling of being distant from science? When and where?

- Could you draw links among the concepts My Life, Science/Math/Engineering and PWISEM and name the links (draw a concept map)? Please explain. (Here is an example.)
What suggestions do you have to improve the first year experience of PWISEM students?

Do you think a program like PWISEM is necessary at all? Why/why not?

(Showing her the picture of the ideal scientist that she drew in the beginning) Do you think you would have drawn the same picture before your participation in the PWISEM? How, why?

APPENDIX B: SAMPLE INTERVIEW PROTOCOL FOR CASE STUDIES

1. Why do you prefer to pursue a major in science or engineering rather than majoring in any other field?
2. How have you got interested in science or engineering? What influenced you?
3. How interested are you in pursuing a major in science or engineering?
4. How confident do you feel about pursuing a major in science or engineering?
5. How do you describe science?
7. How do you see yourself as a scientist?
   a. Do you think there are certain characteristics that you will need to develop in order to be a good scientist or engineer? If yes, what are these? If you believe that you already have them, please tell about them to me.
   b. What do you imagine your life will look like when you become a scientist or engineer?
   c. What is your eventual goal in becoming a (woman) scientist? Is this goal any different given that you are a woman?
8. Why did you choose to participate in the PWISEM?
9. So far, what did you like most about the PWISEM? Why?
10. So far, what did you like least about the PWISEM? Why?
11. How do you interact with your peers in the program and with the upperclassmen PWISEM students? Are these interactions productive in terms of achieving your goals as a science or engineering major? How?
12. What do you think about the PWISEM Colloquium and the associated research facilities trips? Is there anything they contribute to you as a student intending to major in science or engineering? If so, what?
13. So far, are the science/math courses at the University matching your expectations or not? How?
   a. So far, what do you like and dislike about the science/math courses at the University?
14. Considering all of these (the above), can you think of any factors that distract you in your way of becoming a scientist or engineer?
15. Why do you think there are fewer females than males in the science, math, and engineering fields?

16. Have you ever felt any discrimination or discomfort based on your gender in the context of science/math courses?

17. Do you think in the broader scientific community it is important that women participate in science? Why/why not?
   a. Do women add anything unique to science?


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