A STUDY OF WOMEN ENGINEERING AND SCIENCE UNDERGRADUATES

Mary Ann Evans, Sally Hinders, and Holly Kanengieter

Program for Women in Science and Engineering
Iowa State University
Ames, Iowa

Introduction

The Program for Women in Science and Engineering (PWSE) was established in 1986 by faculty and staff women who were concerned about the underutilization of women in the sciences and engineering at Iowa State University. The founding women were particularly concerned about the chilly climate that confronted women faculty, staff and students in science and engineering departments and majors. However, primarily because of funding opportunities, most of the projects that we initiated during PWSE's first five years focused on recruitment and targeted pre-college girls, their parents and educators.

These initiatives were effective in meeting their goals. Overall, the enrollment of undergraduate women in engineering and the sciences increased by 27% between 1986 and 1992 and the enrollment of undergraduate women engineers increased by 17%. However, our campus council continued to express concern that we had done little to address the campus climate and other retention issues.

In order to begin to address these concerns, we conducted a survey of undergraduate women majoring in the sciences and engineering during the 1992 spring semester. Our research team designed the survey to determine who and what salient influences encouraged women students to choose ISU and their fields of study; what type of involvement they had previously had with PWSE; what barriers they faced at ISU; and what type of activities PWSE could sponsor to support them. Surveys from the University of Michigan, the University of Washington, Rutgers and Wellesley College were used as models.

The survey was mailed to a stratified random sample of 575 students out of a total population of 1663 and was completed by 259 students -- a 44.6% return rate. The responses were weighted to reflect the enrollment of women in each discipline. Because of the small number of women in many of these disciplines, the data was aggregated by college. The remainder of this paper will describe the results of the survey and will compare the responses of undergraduate women in the three largest colleges: Agriculture, Engineering, and Liberal Arts and Sciences.

Results

Students were asked to identify who or what provided them with information about their field or careers in their field. More than half of the engineering students identified a family member, while approximately 25% of the agriculture and LAS students selected this item. More than half of the students in agriculture and LAS indicated that a professional in the field provided them with information. Table 1 summarizes all responses.

Table 1. Who or what provided you with information?
(More than one response could be selected.)

Response	ENGR	AGRIC	LAS
Family member	52.6	24.6	27.0
College courses	42.4	28.5	43.9
Friends/fellow students	41.0	30.7	28.3
Professional in field	31.9	57.0	45.8
High school counselor	30.8	13.7	19.4
College faculty or staff member	30.1	28.5	21.9
Career conferences (i.e., ISU, high school, other . . .)	27.9	11.5	24.5
High school teacher	23.1	23.7	31.8
High school courses	19.7	23.5	25.4
Role model outreach program (guest speaker, workshops)	14.0	13.7	2.7
Other	12.7	15.2	13.6
Media	10.3	22.8	19.6
Work experiences	9.4	34.3	27.2
Summer internship in your major or field	7.9	7.0	3.9

Students were asked who encouraged them in their majors. More than 75% of students from all three colleges indicated family members with 89% of engineering students selecting this item. Teachers or counselors and friends were also selected by a majority of all students as encouraging them in their majors. Table 2 summarizes all responses.

Table 2. Who encouraged you in your major?
(More than one response could be selected.)

Individual	ENGR	AGRIC	LAS
Family members	89.3	81.3	75.4
Teacher or counselor	63.3	59.3	54.2
Friend or fellow student	56.3	57.0	59.4
Other adult	41.7	47.0	48.3
Professional in desired major or field of study	30.0	47.7	52.5
Other	2.5	6.1	5.0

Students were asked why they chose their major. Approximately 90% of all students identified personal enjoyment or interest in response to this question. Two-thirds or more of the engineering students also identified good pay, availability of jobs, prestige of major fields, and high school courses while less than half of the agriculture students selected these items. Overall, the differences in responses among the three groups were most striking on this question, summarized in Table 3.

Table 3 Why did you choose your major?
(More than one response could be selected.)

Reason	ENGR	AGRIC	LAS
Personal enjoyment or interest in major or field	88.6	93.4	94.1
Good pay	80.6	20.7	47.7
Availability of jobs	80.4	33.1	67.2
Prestige of major or field	74.0	29.8	49.1
High school course(s)	65.9	43.6	54.7
Its importance for preparation for intended career	61.2	72.7	69.3
My talent in my major or field	54.5	59.7	66.2
Strong background in major or field	37.7	56.5	41.3
Work experiences	18.1	64.3	31.0
Other	4.7	7.7	4.7

Students were asked what PWSE-sponsored events, if any, they participated in during high school. A higher percentage of engineering students participated in these events than students in agriculture or LAS; 11.4% of the engineering students participated in the career conferences, the program with the highest participation of all three groups. Table 4 summarizes these results.

Table 4 What PWSE events did you participate in?
(More than one response could be selected.)

Events	ENGR	AGRIC	LAS
Career conference	11.4	7.3	7.7
Summer internship	4.1	1.0	1.1
Other	2.3	0.3	0.0
Role model program	1.2	1.0	0.0

We wanted students to identify barriers that they had encountered while at ISU but we did not want to lead them to identify barriers which they in fact had not encountered. We, therefore, asked a two-part question: (1) What do you think are barriers that have led to the underrepresentation of women in technical fields? and (2) Have any of these been problems for you? Overall, the three barriers most often identified by students in all three colleges were lack of contact with women in scientific fields, inadequate academic and career counseling, and the competitive atmosphere in technical classes. The differences in responses between students in engineering and students from the other two colleges on four other items that appear in bold print on Table 5 suggest that engineering students may feel more isolated than students majoring in the sciences.

Table 5. Have any of these barriers been a problem for you? (By college)
(More than one response could be selected.)

Reason	ENGR	AGRIC	LAS
Lack of contact with women in scientific fields	**48.4**	**42.6**	**36.4**
Inadequate academic advising and/or career counseling	35.6	44.5	47.8
Competitive atmosphere in technical classes	33.7	32.7	35.6
Lack of information about careers in scientific field	31.7	24.7	30.0
Limited mentoring experiences	31.6	29.2	28.0
Discriminatory attitudes toward women on part of teachers or others in technical fields	**30.3**	**22.6**	**24.6**
Women's lack of confidence that they can handle the work	**26.2**	**10.6**	**16.4**
Limited opportunities to participate in informal groups with professors	25.9	35.2	20.5
Limited opportunities for meaningful internship experiences in the field	25.1	25.9	18.1
Possible conflicts between career and family	23.1	29.5	23.0
Lack of encouragement from teachers or counselors in high school	20.1	20.9	33.6
Limited opportunities to join informal study and/or social support groups with other students	**19.4**	**14.9**	**10.8**
Limited opportunities to participate in formal research	16.5	23.5	21.4
Lack of encouragement from college faculty and advisors	11.7	15.2	21.1
Limited opportunities for advancement in the field	11.5	21.2	8.9
View that scientists are cold and impersonal	10.2	3.7	1.5
Long years of formal preparation	6.8	34.7	29.2
Lack of encouragement from family and friends	6.4	15.3	9.8
View that women in the technical fields are unfeminine	4.4	7.6	4.9

When we analyzed the same barriers question by class, a very interesting pattern emerged. First year women identified barriers less often than sophomores, juniors or seniors, and more juniors identified barriers than women in the other classes. This pattern repeated itself in 10 of the 19 items. These 10 items are identified in bold type in Table 6 below.

Table 6. Have any of these barriers been a problem for you? (By class)
(More than one response could be selected.)

Barrier	FR	SO	JR	SR
Lack of contact with women in scientific fields	**33.8**	**38.8**	**48.6**	**44.4**
Competitive atmosphere in technical classes	**33.0**	**34.0**	**42.7**	**21.5**
Inadequate academic advising and/or career counseling	29.4	45.5	47.6	47.9
Limited opportunities for meaningful internship experiences in the field	25.0	18.6	21.5	20.8
Limited opportunities to participate in informal groups with professors	24.7	15.9	36.5	26.7
Long years of formal preparation	22.9	30.1	23.7	13.0
Possible conflicts between career and family	21.8	31.4	28.1	21.1
Limited opportunities to participate in formal research	20.9	14.4	30.1	16.9
Limited mentoring experiences	**19.8**	**22.5**	**38.4**	**30.5**
Limited opportunities to join informal study and/or social support groups with other students	18.6	16.5	9.5	9.7
Lack of encouragement from teachers or counselors in high school	**18.4**	**20.5**	**41.0**	**28.8**
Lack of information about careers in scientific field	**15.7**	**23.0**	**42.4**	**39.9**
Women's lack of confidence that they can handle the work	13.9	11.8	25.0	22.5
Discriminatory attitudes toward women on part of teachers or others in technical fields	**13.8**	**21.6**	**33.3**	**28.3**
Limited opportunities for advancement in the field	10.1	8.3	22.4	13.5
Lack of encouragement from college faculty and advisors	**4.6**	**16.0**	**30.0**	**18.3**
Lack of encouragement from family and friends	**4.3**	**7.4**	**25.8**	**16.0**
View that women in the technical fields are unfeminine	**1.5**	**3.6**	**10.2**	**8.1**
View that scientists are cold and impersonal	**1.1**	**6.6**	**8.0**	**6.5**

Students were asked to identify PWSE-sponsored events that they would participate in if they were available. More than 50% of the students indicated they would participate in every one of the events listed. The patterns of responses were similar for students from all three colleges with engineering students indicating a higher response rate for nine out of ten possible events.

Table 7 What PWSE events would you participate in?
(More than one response could be selected.)

Events	ENGR	AGRIC	LAS
Research and internship opportunities	95.5	85.6	97.6
Career options sessions	88.3	82.5	85.2
Social events (i.e., aerobics, pizza parties..)	83.8	71.8	80.8
Opportunity to be affiliated w/chapter of professional organizations	81.5	75.5	81.7
Formal workshops on graduate school, research grants, scholarships, etc.	80.6	77.5	82.1
Peer study groups	71.7	55.0	68.0
Informal student seminars	70.6	62.8	65.3
Planning informal discussions with faculty	70.4	64.7	65.5
An orientation program for women in technical studies	69.1	62.9	59.7
Brown bag lunches with others from your department	50.6	52.5	54.4

Summary

This study found some major differences between undergraduate women engineering students and those in the sciences. Engineering students more often identified family members as sources of information and as persons who encouraged them in their majors. Engineering students' decisions about their choice of majors were more apt to have been influenced by the promise of good pay, the availability of jobs, and the prestige of their major or field. They were also more apt to have participated in PWSE's pre-college programs and they indicated a higher level of interest in proposed PWSE programs, even though our engineering college supports an active student chapter of the Society of Women Engineers.

The data suggests that engineering students may feel more isolated than women in the sciences. This is not surprising because the representation of undergraduate women in engineering is no more than half of that of women in the sciences within their respective colleges. While a lower percentage of seniors than juniors identified barriers that had been problems for them as they pursued technical majors, the data suggests that engineering and science students may become more sensitive to barriers they confront as they progress through their undergraduate programs up to their senior year. This is an intriguing finding and encourages us to draw many conclusions about the cumulative nature of micro-inequities and the process by which perceptions about micro-inequities are changed, we cannot draw such conclusions from a study of one group of students at one point in time.

It is our hope that future research will be conducted at ISU and elsewhere to determine if our findings are replicated among other groups of women science and engineering students. It might lead us to a better understanding about the persistence of women students in technical fields. In the meantime, we will use this data to inform ISU faculty and administrators of the chilly climate for women in their colleges. We will also use it to develop programs that will address the campus climate and other retention issues.