Women in Technology: Attitudes, Perceptions, and Beliefs regarding their Majors and Intended Careers

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Abstract

A July 2001 report released by The National Council for Research on Women finds that much of the progress that women have made in science, engineering, and technology in the past two decades has stalled or eroded. Among other things, the report urges systematic change to invite and retain more women and girls in those disciplines. In 1998, at Purdue University, the student group Women in Technology was formed to promote leadership, networking, outreach, and mentoring among women, and to provide them with a sense of community. In this paper, we will present an overview of the organization; discuss the results of a survey of the members’ attitudes, beliefs, and perceptions regarding their majors and intended careers, foregrounding the voices of the participants; and propose strategies for better positioning the organization to recruit and retain women in the field of technology.

Introduction

The past two decades have seen the implementation of a variety of programs that have succeeded in attracting more women into the fields of science, engineering, and technology. Many of these women are now in highly visible positions. However, although women constitute 51 percent of the population of the United States and 46 percent of the labor force, less than a quarter of the scientists and engineers in this country are women. A July 2001 report released by The National Council for Research on Women finds that much of the progress that women have made in these areas has stalled or eroded. The report underscores the increasing need for a scientifically and technologically literate workforce as we enter the new millennium. One year earlier, the Morella Commission, charged with developing strategies to attract more women and minorities into science, engineering, and technology, reported to the Committee on Science of the House of Representatives that significant barriers to attaining that goal are present from elementary school through college and beyond.

Women and girls will comprise at least half of the available science, engineering and technology talent pool. Therefore, it becomes imperative not only to attract but also to retain women and girls in these disciplines, a problem exacerbated by the fact that, among other things, science, engineering, and technology are seen as male.

Male/female attitudes toward science and technology begin to differ as early as elementary and middle school and continue on into high school. It is during this period that girls develop an understanding of what social roles are appropriate for them. They have some reservations...
about the seemingly male “computer culture” as they watch boys utilizing computers for violent computer games and what they see as technology for its own sake. There is little software that appeals to them. Therefore, the tendency of boys to monopolize the computers is not being vigorously challenged. As a result, girls do not take advantage of after school computer clubs or enroll in higher-level computer classes.

Contributing to girls’ unequal participation in science, mathematics, and computer education are tracking, judgments about their ability, and access to qualified teachers and resources. By the time they are at the point where they must choose careers, girls have less experience with computers and perceive that they are behind, decreasing their likelihood of entering the fields of science, engineering, and/or technology.

Today, there is a dearth of young women enrolled nationwide in secondary school computer science advanced placement classes. Their absence does not appear to stem from disinterest in computers but rather from applications that seem more attuned to the interests of boys. Hence, as young women enter colleges and universities in the areas of science, engineering, and technology, they are disadvantaged by their lack of computer experience. They also appear to have career goals that are not as well defined as those of their male counterparts, and often lack confidence in their abilities. They encounter college and university classes that are unfriendly to them, impeding their learning. The absence of women faculty and mentors both within the classroom and outside of it, few women students in their classes, and the lack of supportive networks can create a “chilly climate” for women in non-traditional fields. It is during this critical period that many of them transfer into other fields.

In this paper, we present a case study of Women in Technology, a student organization at Purdue University, founded by the School of Technology administration to address a flat line in the growth of the number of women students over the past five years. We examine the results of focus groups with the student members in which they respond to the aggregate data from a survey of members’ educational experiences, attitudes, and perceptions about their majors and intended careers. They propose their own solutions to the problems identified in those data. Finally, we explore how the new networking mentoring/learning communities model for Women in Technology creates an environment for student-driven, rather than faculty or administration-driven solutions to their perceived problems as women in non-traditional environments.

A History of Women in Technology

Purdue University – West Lafayette is a Midwestern, Big Ten, Research I University with 37,871 students of whom 42% are women, and 1,870 faculty members, of whom 21% are women. Purdue’s School of Technology consists of eight departments: Aviation Technology, Building Construction Management, Computer Graphics Technology, Computer Programming Technology, Electrical Engineering Technology, Industrial Technology, Mechanical Engineering Technology, and Organizational Leadership and Supervision. Table 1 below shows that during the past five years, the number of female faculty has remained virtually unchanged at only 12% of the total faculty.
Table 1. Percentage of Faculty by Rank and Gender at Purdue University, School of Technology

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<tr>
<td></td>
<td>%</td>
<td>n</td>
<td>Men</td>
<td>%</td>
<td>n</td>
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<tr>
<td></td>
<td>Female</td>
<td></td>
<td>Women</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Prof.</td>
<td>8.7</td>
<td>23</td>
<td>18.9</td>
<td>23</td>
<td>18.9</td>
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<tr>
<td>Assoc.</td>
<td>10.2</td>
<td>59</td>
<td>47.7</td>
<td>59</td>
<td>47.7</td>
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<tr>
<td>Asst.</td>
<td>15.9</td>
<td>44</td>
<td>33.3</td>
<td>44</td>
<td>33.3</td>
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<tr>
<td>Total*</td>
<td>11.9</td>
<td>126</td>
<td>99.9</td>
<td>126</td>
<td>99.9</td>
</tr>
</tbody>
</table>

*Percentages may not add to 100 due to rounding.

Despite the growth of career opportunities for women in all areas of technology and heavy efforts to recruit women into the areas of science, engineering and technology, Purdue University’s School of Technology experienced no growth in the proportion of women students enrolled during the most recent five year period. As shown in Table 2, women continue to represent only 15% of the school’s student body.

Table 2. Students by Gender at Purdue University, School of Technology

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<tr>
<td></td>
<td>%</td>
<td>n</td>
<td>Percentage</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
<td>Women</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>84.9</td>
<td>3,526</td>
<td>84.9</td>
<td>3,600</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>15.1</td>
<td>629</td>
<td>15.2</td>
<td>646</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>4,155</td>
<td>100.0</td>
<td>4,246</td>
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</tr>
</tbody>
</table>

In an effort to address this issue and to assist in the recruitment and retention of women students, the School created Women in Technology as a student organization in December 1998. Its stated purpose was “promoting the leadership of women in technology through networking, encouragement, mentoring, and outreach” (Women in Technology Constitution). Seventy-five women from the School of Technology joined the new organization. Four months later, the woman who was then faculty advisor applied for funds to support Women in Technology Assertiveness Training. The grant applications stated that “based upon her research, women and men in team projects need to be more assertive. Women tend to think their behavior is already assertive while their peers would disagree and label women’s behavior and communication skills as unassertive. Men students generally reported that they knew they were being unassertive” (AlliedSignal Grant Application, 1999). The group requested and received funds to conduct assertiveness workshops. As described in the grant application, the program would consist of workshops on conflict management, sexual harassment, and interpersonal communication. The
grant was partially funded, and the assertiveness training program was implemented. It was designed to last the entire school year, but fell far short of that goal, as noted below.

When we became faculty advisors to Women in Technology, we found an organization that appeared to be in disarray. The membership, which had initially stood at seventy-five women, had dropped significantly. Few women were attending meetings, and we were told that the assertiveness training program scheduled for the spring semester had been cancelled. The first several meetings we attended seemed largely focused on process, with few interpersonal interactions occurring and little input from the members in attendance. Many of those members seemed not to know one another. There seemed to be no agreement on what the organization’s goals should be or on how to achieve the goals that had been set.

It was our belief that if we did not intervene, we would find ourselves presiding over Women in Technology’s demise. As we saw it, the students were taking little responsibility for the organization, looking instead to faculty for direction. We were in agreement that if, in fact, Women in Technology were to survive, it would have to move from a faculty-driven to a student-driven organization. For that type of change to occur, and with it an increased responsibility for the group by its members, we would need the buy-in of the officers and the members 18, 19.

One of the authors had been instrumental in creating networking mentoring groups for women faculty and staff on the Purdue campus, as well as a research support group for doctoral students 20, 21. Both groups contained elements of networking mentoring and learning communities (see below). Building upon lessons learned from those groups, we believed that the networking mentoring/learning communities model held promise for rebuilding Women in Technology.

A Networking Mentoring/Learning Communities Model

Among the recommendations suggested by the National Council for Research on Women report was to support women undergraduates by investing in mentoring programs with role models who can put a human face on science, engineering, and technology2. Two models for achieving these goals are networking mentoring and learning communities. Organizing students into learning communities is a strategy that can connect students on what can seem dauntingly large and lonely university campuses 22. Learning communities can be organized around common interests and curricula. “These can be used to build a sense of group identity, cohesiveness, and uniqueness … and to counteract the isolation that many students feel” 23.

Networking mentoring has a long, rich tradition within academe as a strategy for bringing women together for their mutual benefit and support 24, 25. Defined as “an ever-changing series of dyadic contacts in which each person plays the role of mentor or mentee to differing degrees in each dyad” networking mentoring is an empowering strategy that has been successful in assisting women with academic progress both as faculty members and students 24. Its power comes from the fact that each woman involved in a networking mentoring group spends some time as a mentor and some time being mentored, depending upon the situation. Each member is encouraged to take leadership in areas where she has particular knowledge and/or interest and to seek mentoring in those areas where she is less knowledgeable, thus lessening the hierarchy that
can develop in organizations of this sort. However, if we were to be agents for change, we first needed to gain an understanding of the women students who chose to join the organization.

Method

The following sections describe the initial efforts of a study that we conducted to help the School of Technology understand factors that contribute to the attitudes, beliefs, and perceptions regarding the majors and intended careers of the members currently involved with Women in Technology, and to help empower the organization to become self-directed.

Although the school is aware that the women comprise of only 15% of the total enrollment, no formal study has been conducted to investigate student views or perceptions. In order to solicit student responses regarding these factors a survey was administered to the current members of Women in Technology. Of the 81 students involved in the group, 51 responded to the survey, for a 63% response rate.

The survey questions were modified from the WEPAN Pilot Climate Survey, designed to assess engineering students’ perceptions of the educational climate at their universities. One study identified those factors as isolation, the perceived irrelevance of theoretical preparatory courses, negative experiences in laboratory courses, classroom climate, and lack of role models. Other studies have suggested that the different learning styles of women may influence their desire to enter engineering or technology fields. Finally, Santovec contends that the problem is the image that engineering and technology is not about helping society, a frequently cited desire of female students.

The survey consisted of both open and closed form questions to allow for both structured and greater depth of responses. The structured questions were rated on a 5-point Likert scale with responses ranging from strongly agree to strongly disagree. In addition, the open formed question allowed for more specific and individualized responses and minimized the imposition of predetermined responses when gathering data.

Patton recommends utilizing multiple methodologies when studying a phenomenon in order to strengthen the design. That process is termed “triangulation”. To triangulate the data, we examined the Women in Technology documents: its Constitution, program announcements, grant applications, and events brochures. However, we recognize that studying the members of Women in Technology limits the inferences we can draw from our data. Members of an organization self-select, which means they may be more or less committed to their careers. They may also have very different experiences from the rest of their cohort. Additionally, we have neither a control group nor comparable data from male technology students from which to draw comparisons. However, we believe the findings are consistent with the literature cited above, and that the power of the women’s voices will permit some limited inferences to be drawn. One final point: Because Women in Technology members come from such diverse departments as Organizational Leadership and Computer Programming Technology, we do not believe that findings are specific to any particular discipline, but can be applied to other non-traditional programs in which women are enrolled.
Findings: Structured Questions

The structured questions focused on classroom climate, technology abilities, and career choice. The results are seen in Table 3 below:

Table 3. Women in Technology Survey Responses to Structured Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>SA</th>
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<th>U</th>
<th>D</th>
<th>SD</th>
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<tbody>
<tr>
<td>1. The professors in my technology classes treat women and men equally in</td>
<td>20%</td>
<td>42%</td>
<td>6%</td>
<td>20%</td>
<td>12%</td>
</tr>
<tr>
<td>the classroom.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I am often one of only a few women in my technology classes.</td>
<td>33%</td>
<td>43%</td>
<td>4%</td>
<td>18%</td>
<td>2%</td>
</tr>
<tr>
<td>3. I participate equally in group projects with male teammates.</td>
<td>22%</td>
<td>44%</td>
<td>10%</td>
<td>22%</td>
<td>2%</td>
</tr>
<tr>
<td>4. I feel comfortable asking questions in class.</td>
<td>31%</td>
<td>37%</td>
<td>12%</td>
<td>18%</td>
<td>2%</td>
</tr>
<tr>
<td>5. I feel comfortable going to my technology professors for assistance</td>
<td>20%</td>
<td>46%</td>
<td>10%</td>
<td>20%</td>
<td>4%</td>
</tr>
<tr>
<td>outside the classroom.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I feel confident in my abilities in my technology courses.</td>
<td>18%</td>
<td>52%</td>
<td>24%</td>
<td>6%</td>
<td>0%</td>
</tr>
<tr>
<td>7. I feel a technology career is an appropriate choice for women.</td>
<td>45%</td>
<td>25%</td>
<td>22%</td>
<td>8%</td>
<td>0%</td>
</tr>
<tr>
<td>8. My family supports my career choice.</td>
<td>55%</td>
<td>33%</td>
<td>4%</td>
<td>6%</td>
<td>2%</td>
</tr>
<tr>
<td>9. My friends support my career choice.</td>
<td>51%</td>
<td>31%</td>
<td>6%</td>
<td>12%</td>
<td>0%</td>
</tr>
</tbody>
</table>

n = 51

The questions pertaining to classroom climate indicate that a significant number of women still feel isolated, and/or lack confidence in their technology skills. Nearly one third of the women believe that the professors in their technology classes do not treat women and men equally, and approximately one quarter of them do not feel comfortable going to them for assistance outside the classroom. Although the vast majority of the women surveyed say that they feel confident in their abilities in their technology courses, several indicate that they did not feel like equal participants when working on group projects with male teammates. More than 80% of the women feel they have the support from their family and friends for their intended careers, but 85% of the women indicate that no one influenced their career choice. Those who did have role models indicate that they were mostly men who were either family members or high school teachers.
By far, the most compelling results of the survey are the voices that express the individual experiences of being a female student in the School of Technology. Those responses are discussed below.

Findings: Open Questions

The survey contained three open questions:
1. Are you pleased with your choice of a career in technology? Why or why not?
2. What, if any, gender-specific problems have you encountered as a woman in technology?
3. How can the School of Technology best support its women students?

The responses to the questions indicate that the students have many similar concerns. It is clear from the comments received that many female students feel outnumbered and even intimidated in class:

Nothing really specific. I just feel uncomfortable, like people are staring at me sometimes when I’m the only girl in the class. They probably aren’t, but I feel like they are.

Being the only female in one of my lab classes is kind of nerve racking.

The only problem I’ve had is being outnumbered like 10 to 1.

I’m the only female in a class of 20. You really feel alone.

I’m always one of the few females in class. That gives me a lot of pressure.

I had an experience in one of my classes where I felt that men thought the women in the class did not exactly belong there or were stupid.

My roommate freaked out one semester when the teacher made remarks about what she was doing in there with the guys. Something like, other girls would love to change places with her. What an idiot.

Particularly challenging for women students are the group projects that are the hallmark of science, engineering, and technology classes:

The men don’t want us to work with them on projects. When we do, they give us these stupid jobs to do. If we say anything, they look at each other, so I just stopped saying anything.

My computer classes don’t usually have any girls I know … when there are any other girls in there. I feel like all the male students know each other. I end up with the other girls whether or not I want to work with them.
When I have guys who don’t want me in their groups or don’t give me enough to do, I just shut up. If more women would do this, there wouldn’t be so many problems. I think doing stuff like this just makes it worse for everyone.

I feel funny in some of the groups. The male students would rather be by themselves than with me. The professors don’t help. They let everyone pick their own groups and don’t think about what happens if you don’t get picked. You have to walk up and say, “Can I work with you?”

Male students say things and do things that make them hard to deal with sometimes. They don’t want you in their group.

I hate group projects. The guys don’t really want to work with me. Most of the professors don’t seem to care one-way or the other. I think they’d all be happier if we just disappeared.

Some of the women surveyed appear to be demoralized by the male students in their classes who seem more knowledgeable and confident in their abilities. They feel a lack of respect for their abilities:

Computers are not enjoyable for me anymore because I feel stupid in my classes when guys overachieve in everything they do. They always answer all the questions.

Men often times think that women are not knowledgeable with computers. They think they are more logical.

Guys in my classes sometimes have that “I am better and can do it better” attitude. That really makes me mad.

At times before they know you, men assume that you are less qualified or less intelligent than they are.

I know some of the members think (or SAY they think) there’s no problem. There is. There is a big problem. Ignoring it won’t get rid of it.

It should be noted that some women students, though a decided minority, did react positively, seeing their small numbers as a challenge to succeed:

It is a great feeling to excel in an area that is mostly males.

It gives women a great opportunity to excel in a predominantly male career.

Guys tend to take over the groups and try to do everything. It’s fun though, because I know more than most of them. I just sit there and wait for them to mess up.
Many of the students believe that both the male and female faculty need education about issues concerning women students in mostly male classrooms:

Some of my professors are really not so friendly to the girls in the class. I have a woman professor who definitely favors the guys. She always has something good to say about what they do, even when I know they didn’t do as well as some of the rest of us.

Some of the professors kind of roll their eyes when you ask a question. They don’t seem to think you have any brains.

Professors sometimes disrespect me in class. That hurts.

I like some of the professors, but others just don’t seem to care whether we learn or not. They act like this is something for guys and not for us.

The professors call on male students more than on us. I even had a women professor do that.

We need to help the professors to “get it” if you know at I mean. They need to treat us like they treat the guys, and I don’t just mean the male professors. It’s like they’d rather we weren’t in the class.

Educate some of the faculty about female students. We’re just as good, sometimes we’re better.

They should not make girls feel stupid if they can’t answer right away. Sometimes the women professors are just as bad. They get impatient. It takes me awhile to think about answers. I don’t want to get it wrong because I talked before I was ready.

Some of my computer classes are a little strange. I know what’s going on, but the professor is so rushed that he doesn’t even wait for me to answer sometimes. He goes and asks the person next to me, even when I tell him I know. It’s like he thinks a boy will do it quicker. It’s frustrating.

We need to learn to speak up for ourselves when we have professors who don’t treat us equally. What should we say to them so that we don’t get a bad grade? I feel funny saying anything when I know I may see the same professor next semester.

The students identified women mentors and role models as critical needs for women students in the School of Technology:

They need to get more women professors and encourage more women to be in Technology.

Open the doors of the School of Technology and let more women faculty and students in.
I wish we had more women professors we could go to with our problems. We don’t know what to do that won’t make people angry with us. Who do you complain to?

I’d like to meet more women who have computer-type careers. Maybe then I’d get some idea of what I’d like to do.

I think that more women professors would be good. I don’t think they give enough credit for the way they think and for their abilities.

I think I would have liked to have a mentor, maybe some one from business. I didn’t meet any female professors, especially in my computer classes, who seemed to care. I’m changing majors. I think I might have stayed if I had someone to talk to.

Don’t worry so much about getting people to come to the school. Worry about what happens to us when we get here. I hope there’s going to be a mentoring program. That’s what you should really do. Get mentors for the students that are here already.

Focus Groups

At the last Women in Technology meeting of the semester, we shared the results of the survey with the students, taking time to respond to their questions. Although the members were keenly aware that women were a minority within the School of Technology, many of them were shocked by exactly how few women faculty and students there are. They were also relieved to hear how many of their struggles were shared by the other members of the group.

We then discussed some of the research surrounding empowerment through student-driven, rather than faculty-driven organizations, and some of the theory behind networking mentoring/learning communities. Then, we divided them into focus groups and asked them to identify strategies that would address the concerns that were revealed in the surveys. Seven suggestions for the group emerged from those discussions:

1. Invite the women professors to dinner so that we can all get to know them.
2. Create a living-learning center so that women students in technology can study together, live together, and take classes together. (There are others on campus.)
3. Begin a mentoring program for all students. Perhaps we could also have women mentors already in the workplace, especially ones who have gone through this program.
4. Create support groups within departments so we can discuss common problems and concerns and how to deal with them.
5. Have a retreat so that the members will really get to know one another. Keep networks between members open. Go out to dinner, hang out, discuss things, and get to REALLY know each other.
6. Create an outreach program with area high schools to encourage more women to go into technology careers.
7. Devote one Women in Technology meeting a month to discussing the issues from
the survey, like how to get more women students into the School of Technology, how to make women more comfortable in the School, etc.

In addition, there was one suggestion for us as their faculty advisors: Educate the faculty about issues affecting women students in the School. To that end, we plan to share these data with our colleagues and strategize ways to make our women students more welcome in our classrooms.

Potential Impact of Women in Technology

In the near future, we will present these student recommendations to the members and support their efforts to implement them. The group’s effectiveness will be measured by the leadership the members show in directing the organization; specifically the number of programs they present that address the concerns of the group, and the number of active members at meetings. As is the case with all student-run organizations, the turnover of the membership each year, as students graduate and new students join, threatens the continuity of initiatives, limiting the group’s effectiveness.

A continual effort that seeks to understand the student issues and address their needs is a necessary first step. As faculty advisors, we will continue to gather data and information in order to assess the progress that has been made and to target areas that still need to be improved. Above all, we will continue to listen to the voices of our women students and to involve them in all of our efforts. The problems identified above are, in the final analysis, their problem and they need to be at the center of any solution.

Bibliography


Biographical Information

SUSAN G. MILLER is an Assistant Professor in the Department of Computer Graphics Technology at Purdue University. She received her Master of Science from Purdue University in 1997 and her Bachelor of Science from The Ohio State University in 1988. Prior to working in academia, Susan worked as a professional graphic designer for Purdue, and spent time working for an advertising agency and an architectural firm.

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