Teaming Backlash: Reframing Female Engineering Students

Susan G. Haag
Arizona State University
College of Engineering and Applied Sciences
Tempe, AZ 85287-5006

Abstract
Current interest in female and minority engineering students is widespread. Colleges of Engineering nationwide have developed complex programs to increase the retention of these underrepresented populations. Reform across subject areas through curricular integration achieves academic success and helps with the retention of engineering students. In an attempt to reform engineering education, seven institutions formed the Foundation Coalition (FC) with support from the National Science Foundation. One method utilized by the FC member schools was to offer integrated freshman programs. Embedded within this curricular reform were student learning outcomes that were established in the FC’s strategic plan and were implemented and measured across selected subject areas. Student learning outcomes were defined by the Foundation Coalition as “the abilities that we must develop, continuously improve and use in order to realize the overall mission and vision of the Coalition.”

The Foundation Coalition (FC) at Arizona State University (ASU) has incorporated strategies into its curriculum to: a) reform engineering curricula, b) aid in freshmen retention, and c) address the needs of and retain students from under represented populations. The student learning outcomes include: 1) improvement of the interactions that affect the educational environment through teaming; 2) utilization of technology-enabled education, 3) integration of subject matter within the curriculum, and 4) the promotion of life long learning. This report focuses on one of the participating member institutions, ASU, and one of the student-learning outcomes, teaming. This paper covers a two-year longitudinal data analysis and focuses primarily on how the teaming learning component impacts female engineering students. More specifically, we reveal specific gender differences and issues and identify teaming practices that are empowering for all students but more specifically provide, allow, and maintain a more equitable learning environment for female students. The presentation will shed light on practical strategies and actions to adopt in order to meet the needs, to ensure the success, and to improve the attitudes and retention of females in engineering.

Background
The FC program at ASU is a self-selection program and is publicized through Freshman Orientation as well as in a mailing to entering freshmen who have indicated engineering as their chosen major. At ASU, all FC students were engineering students who are required to take four specific core courses as a package, with no exceptions. These four courses included: Introduction to Engineering Design, Calculus with Analytic Geometry, Physics, and First-Year English Composition.
Based on the profile of the students in the FC group, a matched comparison group of freshmen students (called the non-FC group) was chosen at ASU. ASU selected its matched comparison group by sorting through the list of incoming freshmen students and selecting those who were: (1) enrolled as professional engineering students in one of the degree programs in the College; (2) taking at least the same course load as were the FC students (i.e., 13 hours or more); and (3) enrolled in at least three of the same courses in which the FC students were enrolled.

**Methods**

To gain a broad perspective of the program, a multi-method research approach was used. In order to assess cognitive, attitudinal, and ideological data, the research design incorporated survey research, collection and analysis of retention data on engineering students, document review, and student interview data. During the 1994-95 academic year, the FC program provided an integrated curricular program to engineering freshmen for which the Assessment and Evaluation Team (A&E Team) began to collect data. The A&E Team is a national team made up of representatives from each of the participating institutions.

Students completed surveys administered periodically during the year to assess student attitudes about engineering. This report contains outcomes from a standardized FC survey that the Coalition requires participating campuses to administer to exiting FC freshmen each year. The survey questions assess student attitudes towards the core learning strategies and about the program overall. All surveys had a five-point Likert scale with 5 - Strongly Agree, 3 - Neutral and 1 - Strongly Disagree. A nonparametric measure of association for ordinal or ranked variables was used during the SPSS analysis. For ordinal data (i.e., Likert Scale, found in this study), and for tables containing ordered values, Kendall’s tau-b and Kendall’s tau-c were employed to test statistical significance between groups. This presentation will compare results from two years of the FC Program, 1997/98 through 1998/99, and will discuss successful strategies and recommendations.

1997-98 - Of the 78 students in the FC Program in 1997-98, 50 responded to the exit survey (64% response rate). Eighty percent of the respondents were male and 20 percent were female.

1998-99 - Of the 72 students enrolled in the Foundation Coalition Program, 52 responded to the exit survey (72 % response rate). The FC Exit Survey sample was comprised of 42 males (81 percent) and 10 females (19 percent). All female students in the FC responded to the survey.

After the survey was administered to the exiting freshmen in 1997-98, the results were presented to the FC faculty and staff during planning for the 1998-99 academic year. The purpose of one of the planning sessions was to review the assessment, discuss perceived weaknesses identified, and recommend strategies to correct deficiencies. FC strategies were modified and implemented at the beginning of the FC 1998/99 academic year.

**Results**

**Survey data**

As shown in Table 1, the majority of exiting freshmen felt that the FC was effective in providing the opportunity for teaming. However, during 1997-98, female students felt that there was opportunity for improving this component. When we disaggregated the data, we found that female responses were more neutral or negative than male responses on the majority of questions.
associated with teaming (e.g., training, working in teams, team assessment, and viewing teaming as a learning tool) and several of the differences were significant. See Table 1 for teaming learning outcomes.

### Table 1

**Teaming Learning Outcomes**

**Gender Analysis 1997-98**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Overall Mean SD</th>
<th>Male Mean SD</th>
<th>Female Mean SD</th>
<th>Statistical Significance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(FC – Exit Survey)</td>
<td></td>
<td></td>
<td></td>
<td>[<em>Kendall tau-b</em>] p=.05</td>
</tr>
<tr>
<td>Q26 I received formal instruction on basic team skills</td>
<td>3.89 .77</td>
<td>4.2</td>
<td>2.7</td>
<td>*</td>
</tr>
<tr>
<td>Q27 I was assigned to work in groups on a regular basis</td>
<td>4.24 4.44</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q28 My instructors monitored and assessed my teaming skills</td>
<td>3.10 .871</td>
<td>3.41</td>
<td>1.9</td>
<td>*</td>
</tr>
<tr>
<td>Q35 Working in assigned teams helped me understand the material presented in class</td>
<td>3.87 .780</td>
<td>4.21</td>
<td>3.5</td>
<td></td>
</tr>
</tbody>
</table>

From the data in Table 1 we concluded that females felt less strongly about virtually every aspect of teaming in the classroom. Although most of the gender differences were not significantly different, the disparities were noteworthy. However, regarding two important teaming components, the differences were statistically significant. It was evident that females felt less strongly about receiving formal instruction (question 26) and faculty monitoring and assessing their teaming skills (question 28) than the males.

Two formal strategies were implemented during 1998-99 due to feedback from the FC’s 1997-98 assessment data which helped improve female teaming responses: 1) the adoption of the "Team Process Check" and 2) "Team Time." Females in 1997-98 felt that faculty were not providing adequate team training and were less likely to agree that faculty were monitoring and assessing their team's performance.

The Team Process Check is a two-page document that all students fill out to assess: 1) overall team performance, and 2) their personal team performance. The document is collected from the students and subsequently the team meets formally with the instructor to discuss team dynamics. The process allows students to collect data on how their team is functioning, enables faculty to review student concerns and issues, and uses feedback to facilitate team performance.

Team Time is a designated time-period outside of class which serves many functions. For example, it allows time for formal team training, provides time to work in teams (above and beyond class time), and enables faculty to monitor team performance and formally meet with teams to discuss team issues or concerns.

Several areas were noteworthy in the FC teaming core competency in 1998-99. It is likely that these areas of improvement resulted because of faculty effort over the year to strengthen the teaming component of the program. First, it was apparent that students were more aware of faculty involvement overall in the teaming core competency. FC students in general felt more
strongly that the faculty monitored and assessed their teaming skills in 1998-99 than in 1997-98 and the difference was statistically significant (.01). In fact, student perceptions associated with monitoring their teaming skills were higher in 1998-99 than in any other academic year at ASU. Additionally, among all groups of interest, no significant differences were uncovered statistically regarding the teaming component. Female responses not only were more positive, they exceeded the males’ on all teaming questions in 1998-99 (see Table 2 for female and male means, standard deviation, and statistical significance).

Table 2
Teaming Learning Outcomes
Gender Analysis 1998-99

<table>
<thead>
<tr>
<th>Questions (FC – Exit Survey)</th>
<th>Overall Mean SD</th>
<th>Male Mean SD</th>
<th>Female Mean SD</th>
<th>Statistical Significance* [*Kendall tau-b]</th>
<th>Non-Minorities Mean SD</th>
<th>Minorities Mean SD</th>
<th>Statistical Significance* [*Kendall tau-b]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q26</td>
<td>3.77 0.92</td>
<td>3.738 0.939</td>
<td>3.9 0.876</td>
<td>0.59</td>
<td>3.762 0.983</td>
<td>3.75 0.707</td>
<td>0.696</td>
</tr>
<tr>
<td>Q27</td>
<td>4.13 0.86</td>
<td>4.071 0.894</td>
<td>4.4 0.699</td>
<td>0.28</td>
<td>4.214 0.813</td>
<td>3.875 1.126</td>
<td>0.491</td>
</tr>
<tr>
<td>Q28</td>
<td>3.5 1.08</td>
<td>3.405 1.083</td>
<td>3.9 0.994</td>
<td>0.177</td>
<td>3.595 1.419</td>
<td>3.125 0.641</td>
<td>0.074</td>
</tr>
<tr>
<td>Q35</td>
<td>3.21 1.09</td>
<td>3.143 1.138</td>
<td>3.5 0.85</td>
<td>0.275</td>
<td>3.31 1.07</td>
<td>2.75 1.165</td>
<td>0.215</td>
</tr>
</tbody>
</table>

Interviews with Female FC students
The FC A&E Team interviewed females in the freshman FC program at the end of 1998-99 to elicit female attitudes, concerns, and issues associated with the teaming process. All 10 of the female engineering students in the FC were interviewed after the survey was completed. Female students responded more positively to the two new strategies in terms of "perceiving" that faculty were more involved in assessing and monitoring team performance. They felt that their team was being formally monitored and assessed during team time and through the team process check. They felt they had an active process in place through which they could voice their concerns and complaints. In 1998-99, the female mean average for question 28 was higher than mean averages for any other group over a two-year period (question 28, instructors monitored and assessed my team skills).

However, according to the interview data, the team process check needed further refinement. Although both female and male students believed that the process check was good in theory, they felt it could be improved to allow for student anonymity. Despite the fact that the documentation allowed students to voice issues, problems, and team dysfunction, the process can be deadlocked. Some students were reluctant to write critical comments about others fearing retaliation. Others were reluctant to reflect critically on their own attitude, behavior, and performance and have those comments voiced publicly during the focus group. According to students, if this policy is to become more effective, both faculty and students need to take the process more seriously by rendering document contents more confidential to protect students’ identity and anonymity.

Gender Ratio
Although numerous studies have been done to assess the effect "gender ratio" has on a group and its members, the literature is inconsistent. Some researchers feel that increasing the proportion
of females in a group will have a positive effect on its members. Others disagree and propose that an increase in female proportion in certain areas could have a detrimental effect. The FC female evaluation findings (including attitudes and implications), although more consistent with new research in other disciplines, are somewhat inconsistent with the paradigms and ideologies underlying current teaming practices in engineering education. We found that a higher proportion of females in teams did not have increased benefit, a finding consistent with current research in math, sociology, and psychology.

Engineering teaming practice has been based on the assumption that an increase in female proportion helps. Some researchers argue that when women, or members of any group, comprise a small percentage of an organization (e.g., schools) their numbers make it easier for women to feel confident and perform well. Gender integration problems may be a function of the number and proportion of females in the organization. Advocates of this assumption assume that when minority membership in a group is minimal (i.e., less than 15 percent), the minority member status may be identified as "token." This token status affects group dynamics in a very negative way (Kanter, 1977).

However, other research emerging in the 1990s challenges the above assumption (Allmendinger and Hackman, 1995; Cohen and Swim, 1995; and Steele, 1997). These researchers suggest that increasing the number of females in a group will not necessarily have beneficial effects. The new research reveals that self-confidence will moderate the negative impact of tokenism on women's expectations. Additionally, high self-confidence buffers women in an environment where the female proportion is low (Cohen and Swim, 1995). Allmendinger and Hackman argue that increasing the number of women in a group introduces a set of new problems for women. As men feel threatened by the increasing presence of women, their behavior may become increasingly more negative, thus creating a more hostile environment. According to Steele, as an individual's minority status becomes more salient in a group, there is an increase in stereotype threat. Thus, the increase in the number of women in a group could increase the stereotype threat, create a more hostile environment, and increase the females' level of anxiety.

The FC female data are consistent with this national data. The majority of females openly discussed their attitudes about gender ratio. As they reflected on the various teaming arrangements during the semester, the majority felt that the most beneficial arrangement targeted student ability rather than gender. Women in the class: 1) were aware that they were being placed in a team in pairs, 2) were cognizant of research that prescribed at least two females per team, and 3) felt that faculty framed them according to their gender rather than their ability. As a result, female students challenged this teaming arrangement. Females stated, "If you are going to put teams together, do it randomly or create teams based upon our ability not our gender." This strategy would also help them in the engineering workplace. Females commented that they chose engineering as their field and that they were aware that it was a male dominated field when they enrolled. "We knew going into engineering that we were in the minority. We consciously made that decision. Don't stick us into a group because of a ratio." Students felt that a successful team was comprised of peers with diverse abilities. For example, if one student was proficient in calculus, he or she could help a student who was less competent in this area. One student reflected and provided this statement, "My weakness was another team member's strength."
Conclusion
After careful analysis of the multiple sources of data, it became evident that the perceptions and attitudes of engineering students were related to retention and differences across gender cohorts. The population of females, who were more neutral or negative towards many core competencies such as teaming, were less likely to persist in engineering. As a result, the FC implemented strategies that addressed specific issues related to gender.

The formative evaluation feedback has inspired and promoted program modification. As a result of the feedback, faculty and staff examined gender differences and determined strategic curricular and non-curricular actions to diminish learning and attitudinal discrepancies. Based upon the 1998-99 data, faculty members have already improved the teaming component. The team process in 1999-2000 allowed for teams to collect data on how the team is functioning; used the feedback to improve team performance; and maintained student confidentiality and anonymity. Each student filled out the document privately, placed it in a sealed envelope, and delivered it to the Director of Assessment. The documents were read by individual instructors who later met with the teams to acknowledge team strengths and opportunity for improvement. As a result, students were 1) appreciative of the confidentiality, and 2) were more honest in their assessment incorporating more self-reflection than in the past. Students were more likely to reflect critically on their own performance and develop strategies to monitor and improve their own attitudes and behavior rather than engage in criticizing others.

In summary, several improvements were made to the FC Program as a result of the attitudinal and qualitative data: 1) team time was adopted, 2) the team process check was adopted and later modified to increase confidentiality, and 3) gender ratio and issues associated with tokenism were identified. Females felt that a process was adopted through which they could voice their teaming concerns and issues. Although the team process check seems like a modest modification, females regarded this as an "insurance policy" in the event that a crisis may occur. Another positive outcome became evident because of the assessment data. Females are beginning to be "framed" through a new lens. Rather than being viewed only by their gender, instructors are more likely to see students holistically which encompasses not only their gender, but their academic ability, prior knowledge, and life choices.

References