The ESTEAM Program’s Phase I Results: Faculty Views on Engineering Student Team Effectiveness

D. Moore  C. Lathan  Sarah Mouring
Continuous Quality Improvement  Biomedical Engineering  Naval Architecture,
P. Mead, M. Natishan, L. Schmidt  The Catholic University of  Ocean and Marine
Mechanical Engineering  America  Engineering
University of Maryland  Washington, D.C.  United States Naval
College Park, Maryland  Academy  Annapolis, Maryland

ABSTRACT

Engineering remains a male-dominated environment. How women engineering students and professionals learn and work continues to be perplexing and often bewildering for male counterparts sharing the same engineering classrooms, labs, and teams. While this makes life interesting, it can make the learning and working environments uncomfortable for the different thinker. In this paper we introduce the BESTEAMS Partnership. BESTEAMS brings engineering schools together with the aim of transforming professional engineering environments into places which comfortably sustain all types of learners. We report results of ESTEAM Program Phase I: Engineering Faculty Interviews, the Partnership’s gap analysis project. Results suggest that faculty have limited awareness of the circumstances facing women in engineering and could benefit from training targeted to meet the challenges of mixed-gender classrooms and teams.

1 MALE-CENTERED LEARNING ENVIRONMENTS AFFECT US ALL

Cognitive differences are differences in how people think. Some of these differences are physiologically based, such as the difference in number of right and left brain interconnects between men and women (women have many more) and hormonal variations effecting behavioral patterns and rhythms. Other differences appear to be linked to education and socialization methods. What we perceive as differences between the behaviors of men and women are the manifestations of these cognitive differences. Cognitive differences result in different communication styles, problem solving styles, analytical styles, and ways of perceiving and remembering events. These differences are often gender specific and often affect the ways in which men and women perceive and evaluate their peers.

In the United States, typical college curricula, including engineering, are skewed toward white-male cognitive development styles which favor an objectivist way of knowing. Objectivism is characterized by a separation of personal experience and emotion from analysis and logic, and discussion styles of doubting and argument. In general, women prefer a connectivist way of knowing in which there is no personal separation from

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knowledge, logic, and analysis. A connectivist trait is to assume all ideas presented in a
group setting are valid from the viewpoint of the presenter and the connectivist thinker
would seek to empathize with the presenter instead of automatically doubting and
arguing. A connectivist also tends toward collaboration and consensus-building.

As these opposing ways of knowing and behaving suggest, there are many challenges or
hazards to a female engineering student in a male-oriented curriculum or workplace.
What may be less obvious is that the same environment also short-changes male students.
Here are a few ways the current male-centered learning environment is harming both
female students and their male colleagues:

- Feelings of alienation can easily develop when an individual’s learning style is
distinctive from a prevailing learning and dominant teaching styles. These grow
because factors such as comfort level with natural behaviors and verbal support
from others impact a student’s perception of his or her ability to succeed. These
conditions combine into a learning system that alienates students with styles that
are clearly in the minority (be they a minority of men, or a majority of women).

- Overemphasis on the traditional analytical, logical, and clear-cut decision-making
skills, has created weaknesses in the ability to relate to one another in team
settings. So, students fall into traditionally defined gender roles: women as data
recorders and men as experimentalists. This channeling reduces all students’
versatility as team members.

- To adapt to objectivist ways of knowing and learning, women may find
themselves denying their natural tendencies toward connectivism and
collaborative learning behaviors.

- We are producing engineers schooled only in one way of learning, literally
ignorant of how a large segment of the world processes knowledge.

2 BESTEAMS PARTNERSHIP TO IMPROVE ENGINEERING ENVIRONMENTS

BESTEAMS stands for Building Engineering Student Team Effectiveness and
Management Systems. The BESTEAMS Partners are: University of Maryland, The
Catholic University of America, Morgan State University, and The United States Naval
Academy. The BESTEAMS Partnership brings engineering schools together to
transform the professional engineering environment to become comfortable for all
people. BESTEAMS (Table 1) focuses on teaming as a means to bring about permanent
change in the engineering environment because of the prevalence of teams in both the
engineering education system and in the profession itself. Team-based product design
and development delivers increased productivity, significant time-to-market reductions
and profitability gains. Universities are responding to industry demands for team skills
by developing curricula with increased focus on teamwork. BESTEAMS standardized
team skills training module will include information on gender-based and culture-based
cognitive style differences and how they influence teamwork.
Table 1 The BESTEAMS Partnership Charter

<table>
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<tr>
<th>MISSION:</th>
<th>We are creating BESTEAMS Partnership training materials that will be the international standard for engineering student team training.</th>
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<tr>
<td>VISION:</td>
<td>The engineering learning and professional environment will become comfortable for all, allowing free and voluntary entry and exit based on individual career preferences. Discomfort associated with male dominant style characteristics will be reduced for women and minority professionals.</td>
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<td>VALUES:</td>
<td>BESTEAMS Partnership activities will focus on team settings, be implemented according to standard educational research protocols and will be open to the entire engineering population.</td>
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Table 2. ESTEAM’s Engineering Faculty Interview Questions

| 1.   | What are some of the ways you use students groups or teams in your teaching? |
| 2.   | Why do you use teams? What do you hope to achieve by using them? |
| 3.   | How does use of teams impact your instructional preparations? |
| 4.   | What kind of preparation do you provide for students before they work in groups? |
| 5.   | How do you form or structure student teams? What have you observed about how they form? |
| 6.   | Have you observed that gender, ethnic, and learning style characteristics influence team performance and success? If so, how? |
| 7.   | How do you know when a team is working well? |
| 8.   | How long does it take for a team to begin to work well together? |
| 9.   | What could be done to help them form (gel) quickly? |
| 10.  | What are the most typical problems that you experience when using teams or groups in instruction? |
| 11.  | Have you observed differences in behavior of mixed gender, ethnic, or learning style groups? If yes, what differences did you observe? |
| 12.  | How do you know when a team is not working well? What are the signals? |
| 13.  | What kinds of interventions, if any, do you make? |
| 14.  | In terms of evaluation, how do you evaluate groups or teams? . . . the product of teams efforts? . . . the individual members of a team? |
| 15.  | How effective are teams in attaining the goals of the course? |
3 BESTEAMS FACULTY INTERVIEWS UNDER THE ESTEAM PROGRAM

The BESTEAMS' mission begins with ESTEAM, the Engineering Student Team Effectiveness and Management Program. The ESTEAM Program’s goal is identifying gaps in faculty and student team training and their needs and expectations in these areas. This task spawned the ESTEAM Program’s Phase I: Engineering Faculty Interviews.

A set of 15 open-ended questions (Table 2) was developed by the ESTEAM Team to detail how often student teams were used, how teams were formed, and how students were prepared for or assisted in teams. The ESTEAM Team included a number of undergraduate research assistants who conducted the 30-minute interviews after receiving training with the protocol conducted.

Thirty-six professors from BESTEAMS Partner institutions were interviewed for this study. The distribution included 16 mechanical engineers, six chemical engineers, five electrical engineers, four aerospace engineers, two nuclear engineers, one biomedical engineer, one materials engineer, and one civil engineer. The average years of teaching for the group interviewed was 13.2 years; the range spanned from one to 35 years. One third of the faculty reported five or fewer years of teaching experience (33.3%), over 40 percent between six and 19 years (41.7%), and nine reported 20 or more years of teaching experience (25%). Thirteen of the 36 faculty taught undergraduates exclusively (36.1%). Over 60 percent taught a combination of beginning and advanced students (63.9%).

Nearly two thirds of the faculty (23/36, 63.9%) had taken no courses or workshops on team management. One third had taken at least one course (workshop) on team management. One third indicated some familiarity with use of learning style information to facilitate student groups. About 20 percent had exposure to use of the Myers Briggs Type Indicator, a frequently-used, team selection tool (19.4%). More faculty indicated they had participated in training courses focused on the use of group dynamics (44.4%).

4 INTERVIEW HIGHLIGHTS

4.1 Use of teams: Frequency and Rationale.

Faculty described use of engineering project teams as a necessary component of student preparation for the transition to the work environment. Most reported that upper division courses involved semester long design project accomplished exclusively within student teams; success in the course depended entirely on successful team process and products. At the lower division levels, faculty structured multiple lab or homework assignments within a course enabling students to gain a variety of team experiences focused on a broad range of specific skill and content applications; success in the course did not rest entirely on student team process or products.
4.2 Student team formation.

Current practice involved ad-hoc procedures ranging from random to faculty determined teams that were based on a combination of student reported skills, abilities, and interests. Satisfaction with current strategies was limited and reflected continued experimentation for improvements. Further, effective procedures for formulating teams with diversity across gender, ethnic, or learning style dimensions is very limited at present.

A small number of faculty allow students to form their own groups. In these instances, they observed students tended to select students they knew previously and with whom the experience had proved successful. It was also observed that female students came together to support each other in these instances.

4.3 Observations on gender characteristics and performance and success.

On this topic the most frequent response among the faculty, about half, was that no differences had been observed with respect to gender, ethnicity, or learning style characteristics and that diversity along these three dimensions was too limited to influence team performance or success in engineering courses. Most comments were about gender rather than ethnicity/cultural differences or learning styles. A couple of those interviewed suggested that the influence of engineering discipline had more impact on team performance than did the three areas raised by interviewers.

4.4 Typical team problems.

The problems reported were of two broad types, those involving interpersonal dimensions and those involving productivity hurdles. The most frequently reported interpersonal problem involved unequal contribution of efforts. Teams struggled with dominating members and with passive or inactive members. Interpersonal conflicts reported in mixed gender teams involved women who stopped participating after becoming frustrated with men who seemingly ignored or discarded their ideas. The second broad group of team problems involved hurdles to productivity: schedule conflicts (particularly associated with external commitments like paid employment), lack of responsibility for completing assignments, unevenness of technical skills, and inadequate team planning.

5 IMPLICATIONS FOR WOMEN

Of the faculty who commented on gender influences on team performance, the variety of observations was quite broad. A number observed that mixed gender groups were more efficient and cohesive than same gender groups. In contrast, several recommended avoiding mixed gender groups assignments in which a single female student was grouped with multiple strong males. In these instances the imbalance had occasionally resulted in females accepting organizational rather than technical roles and support rather than leadership roles. As group leaders, females were reported as highly successful by a few, and by a few others, as falling behind male counterparts who were characterized as ‘on the ball’.
6 NEXT: ESTEAM PROGRAM'S PHASE II

Phase I of the ESTEAM Program identifies faculty perceptions of effective team behavior. Unfortunately, what we have learned is that many faculty members have not been given the tools or the training on how to build effective teams. Interventions in the form of developing team training materials for faculty to use in the classroom are needed, as is the student’s view of engineering project teams. We have begun conducting a series of student focus groups at each of the BESTEAMS Partner institutions to collect perceptions of the effectiveness of project team experiences. The results will be used to verify companion data collected by faculty surveys.

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REFERENCES