You See it Your Way, and I See it Mine: How All-Male and Co-ed First Year Project Teams View Team Leadership

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Abstract - **This study involves an evidence-based practice in which we discovered noticeable differences in the way men and women students perceive the behavior of their engineering design team over the course of a semester. While there are numerous factors that contributed to team success, we found it of particular interest to explore and compare perceptions of team leadership between all-male and co-ed teams. Trends in the data indicated a variety in type and depth of thought among the men and women students in our course population. Since this small, STEM-focused institution is actively involved in promoting diversity and inclusion, the campus culture ought to encourage students to be aware of the value of different points of view, and to apply them to teamwork, a fundamental engineering skill. Our results can begin to answer the question as to whether our campus culture has had this type of effect on first year students.**

This introductory engineering design course provides both an introduction to the engineering profession and an introduction to engineering design through a semester-long team project. Students were assigned to project teams by their instructors, using a skills and personality assessment. Effective and appropriate team leadership is often identified by students as a major factor in team success; we evaluated these aspects through student feedback in team contracts, peer evaluations and self-identification.

We formed the following research question as a basis for investigation:

How do students identify and regard team leadership on an all-male team vs. a co-ed team?

Our study population consisted of approximately 100 first year students during each of the fall 2014 and spring 2015 semesters, respectively. We also compared the final design report grades received by co-ed vs. all-men teams over the past five academic years, where a long time line can help to correct for confounding variables.

Our results indicated that the most highly regarded leadership trait for an all-male team was reliability, even to the extent that a "team leader" was sometimes identified as one who leads by example rather than by initiating or directing team activities. By contrast, co-ed teams indicated positively that their team leaders were members who were highly organized and focused, and exhibited these traits by guiding team activities through either suggestion or delegation. It was also noted that the team leaders on co-ed teams were often women who exhibited a high degree of dedication, reliability and concern for team welfare. Many women team members, and not just women team leaders, also documented negative team member attitudes and the need to remedy them, in order to strengthen their teams.

Index Terms – Team dynamics, leadership, first-year design.

INTRODUCTION

Our introductory engineering design course provides both an introduction to the engineering profession and an introduction to engineering design through a semester-long team project. Students were assigned to project teams by their instructors, using a skills and personality assessment. Since these teams were not self-selected, each team was constructed to contain one or more students who were confident in their ability to help fellow team members with specific skills, i.e., writing, speaking and graphics, providing a diversity and balance of existing and growing expertise. We have found, through experience, that a diversity of expertise enhances team satisfaction, as the project duration is only 15 weeks and that students need additional time to develop these skills for these projects.

When we ask students about their impressions of a successful team, one of the first characteristics that they identify is "leadership." A leader may be chosen by the team members at the outset, or a leader may emerge as the team member who always seems to be prepared, focused and willing to organize team activities and delegate tasks. [1] We have also observed that the role of team leader may also be

shared or exchanged among a few members, depending on motivation, discovery of additional resources, unexpected events, etc.

PROJECT BACKGROUND AND PURPOSE

It has been known for a long time that engineering work is often performed by teams of engineers and other professionals, and that industry surveys have revealed that many engineering graduates lack sufficient practice in teamwork to suit employers. [2] That is why project-based learning is often employed early in the undergraduate engineering curriculum to enable students to expand their focus on self-generated work to recognize and build on the work of others, each of whom is making the same transition. Eventually, through a combination of a course of study that includes non-technical as well as technical skills with workplace experience, these students can become engineering leaders with at least some of the following characteristics: [3]

- Build successful teams and work with team members to accomplish goals;
- Motivate, inspire, respect and reward team members;
- Takes calculated risks for the success of the project;
- Uses sound technical skills in their own area of expertise;
- Identifies and recruits team members with needed skills;
- Visualizes potential outcomes clearly and develops strategies for accomplishing them;
- Exhibits transparency, honesty, integrity and high ethical standards;
- Communicates effectively in both oral and written form;
- Listens carefully and is willing to learn from others, and
- Knows the importance of responsiveness to all stakeholders.

These characteristics, if considered as learning outcomes for engineering graduates, resemble the ABET Engineering Criteria 2000, which form the basis for accreditation of undergraduate engineering programs. [2,4] However, in an age where colleges of engineering continue to produce more and more technical knowledge, and feel obligated to provide ever-increasing amounts of it to their undergraduates, the result is a highly demanding technical curriculum where instructors and students have neither the time nor the energy to develop teamwork, communication or leadership skills. [3] However, the positive correlation between the leadership criteria described above and the ABET engineering criteria indicates that students must be exhibiting at least some of these "soft skills", or the programs would not be accredited. Progress continues to be slow, as discovered by investigators in 2012, who reported that, in some of the institutions that they studied, teamwork and leadership were not taught, and that it was up to the students to figure it out. [5]

Additional attributes of technical leadership, which can be applied to both students and professionals at any stage, include self-awareness, cultural sensitivity, adaptability, and the ability to understand the impact of engineering decisions in a societal context. [6] While these and other attributes of leadership may not apply to the pursuit of a first-year design project, they provide clues as to what the students are observing in the behavior of their team leaders, even if they do not describe this evidence in writing. What is very easily recognizable by students are more fundamental and mutual obligations: trust, ability to listen and fairness. [7]

Students approach the prospect of working on a team with varying opinions, based on prior team experiences and the realization that part of their course grade will depend on the performance of fellow team members. This is often unsettling to them, as they are used to having total control over the quality of their work. In fact, some believe that the only way to get it done right is to do it themselves. [8] By cultivating leadership qualities in all team members, in whatever number and extent is suitable for each, instructors can attempt to ease the burden felt by students that project-based learning and teamwork are unavoidably unfair.

Another factor affecting how students view teamwork and team leadership that we should consider is the overall perspective of the millennial generation. Often described as the "me" generation, we are considering their culture because we expect that the results of our study will reflect it, as we have noticed in a previous study. [9] Another reason to expect this influence is that the degree of self-centeredness among young people has been rising since the 1970's. [10]

A number of publications have described this generation as self-centered and fundamentally irresponsible, [11,12,13] but others have observed that, as students or as engineers, they have a great deal of enthusiasm and optimism for their work, as well as more of a willingness to be open-minded, energetic and adaptable. [14] As students, many already have a strong sense of collaboration and interdisciplinary acceptance due to their exposure to network computing and other group-oriented aspects of the Information Age. [11,14,15]. These conflicting views provide evidence to conclude that this generation is not a homogeneous group. [14] However, several of these characteristics, such as the potential for self-awareness, may enable millennial generation students to become highly effective leaders.

Since effective and appropriate team leadership is often identified as a major factor in team success, we focused on perceptions of team leadership among all-male teams compared to teams containing both male and female students. We formed the following research question as a basis for investigation:

How do students identify and regard team leadership on an all-male team vs. a team containing both male and female students?

METHODOLOGY

Our study population consisted of approximately 100 first year students during each of the fall 2014 and spring 2015 semesters, respectively, divided into teams of five students each. If the co-ed teams were more satisfied with the performance of their team with respect to teamwork than the all-men teams, a case can be made that a potential added value of a co-ed team is to provide an environment that encourages a greater number of positive attributes for team satisfaction and success. Practically speaking, however, the number of co-ed teams that could be formed in any one class would depend on the number of women students in the class, which has often been a small number in our experience. In addition, our co-ed teams contained at least 2 women on each team, which further limits the number of co-ed teams in a class.

We could also compare the final design report grades received by co-ed vs. all-male teams over the past five years, where a long time line can help to correct for confounding variables, such as the assumption that the final design report from a co-ed team had to have been of higher quality because it was written and edited only by women, who are automatically "better at writing" than men.

Each team developed a set of goals and behavioral commitments for their team's activities, independent of any goals they set for the quality or completion of their design project. These team contracts were initiated during the fourth week of the semester, and revised during the seventh week. Each team member signed both versions of the team contract to indicate their agreement with these goals and commitments.

Team members also recorded their impressions of their fellow team members with respect to reliability, attitude, technical competence, leadership, cooperation and adherence to the provisions of the team contract in three sets of written peer evaluations during the seventh, twelfth and fifteenth weeks of the course, respectively. The first and second peer evaluations were shared with fellow team members; the third was not, because it involved numerical scores that were entered as grades at the end of the course.

In addition to forming teams containing students who were adept at different skills related to the project, such as graphics, writing and speaking, we also placed students on teams with a balance among the number of self-identified introverts and extraverts. This arose from earlier experiences with teams of all introverts which lacked the amount of cohesion necessary for completion of the project within a semester's timeframe. We also drew on a common assumption that extraverts are more action-oriented, and introverts are more thoughtful and methodical. While our team assignments may not have always resulted in highly successful teams, certain common problems with team dynamics were also avoided by applying these paradigms.

Data Collection

Additional data were collected through the use of a reflective writing exercise, conducted at the end of the semester, containing these questions:

- What did your team do well?
- What did your team find to be the most difficult?
- Was working on a team worthwhile? Why or why not?
- Would your team have been more successful with a different project? Why or why not?

We did not ask about team leadership directly in this assessment, because we were also seeking team member feedback on a number of other aspects of their team experience, such as collaboration, coordination and the effect of a particular project on team success. Where possible, we compared these data to those collected from peer evaluations for possible trends in a team's dynamic over the course of the semester.

Data Analysis

We considered the team contract implications for all-male vs. co-ed teams, and placed a heavier emphasis on the impressions gained from peer evaluations and the overall quality of final design reports. Self-described introverts and extraverts were also identified from the skills and personality assessments, and these respective personae were compared to the identification of team members as leaders.

We also searched for the labels, "team leader" and "leadership" as applied to particular team members, especially when more than one student applied them. Having asked the students to provide examples to support their evaluations, they described a sizable number of specific actions, behaviors and situations to justify their use of these labels.

RESULTS

Team leaders in both all-male and co-ed teams were highly organized and focused individuals, who were willing to communicate clearly with all team members as often as needed to complete project tasks with high quality, had a notably positive outlook toward the team and the project, and met all team-based and course-based deadlines ahead of schedule whenever they had the power to do so. In addition, many team members identified their leaders as those who willingly shared their technical and/or interpersonal skills with fellow team members who lacked them.

The most highly regarded leadership trait for an all-male team was reliability, even to the extent that a "team leader" was sometimes identified as an introvert who leads by example rather than by initiating or directing team activities. By contrast, co-ed teams indicated positively that their team leaders often guided team activities through either suggestion or delegation, and openly or secretly volunteered to complete tasks on their own. It was also noted that the team leaders on co-ed teams were often, but not always, women who were highly dedicated to team welfare as strongly as to successful project completion. However, men who led co-ed teams also exhibited greater empathy for all team members than the leaders of all-male teams.

Typical peer evaluation feedback about team leaders from all-male teams included the following:

- Shows very high reliability in meeting deadlines with valuable contributions
- Initiates discussions and creative ideas, especially if extraverted
- Takes charge, but may be overbearing if extraverted or action-oriented
- Suggests highly specific and easily measurable team goals
- "Works hard" in the eyes of other team members, showing commitment to project
- Demonstrates high technical competence and helps others to learn technical skills
- May exceed team expectations for individual performance
- Is well respected by all team members
- Maintains an upbeat yet realistic outlook; may add occasional "fun"
- Easily approachable and highly responsive when contacted
- Makes the decision when the team reaches an impasse

Peer evaluation feedback about leaders in co-ed teams often included these observations:

- Diligently tracks team and individual progress toward task completion
- Holds team members as well as self accountable for assigned tasks
- Actively fosters a collaborative environment during team meetings; open minded
- May be reluctant to confront team members to make a decision when needed
- Often exceeds team expectations for individual performance
- Willing to help other team members with whatever they need
- Brings positive energy or optimism to the team
- Gives direct feedback about performance, including the effect of negative attitudes
- May do too much on their own instead of delegating with trust
- Tends to be less critical of lazy team members
- Identifies non-obvious or incomplete work products and completes them

Table 1, shown below, gives the average final design report grades for all-male and co-ed teams over the past five academic years. These reports were weighted more heavily in final grading than all other graded assignments. There were seven semesters in which co-ed teams received higher average final report grades than all-male teams, two semesters in which the all-male teams' average final report grades were higher, and one semester that contained only co-ed teams:

Table 1: Average Final Report Grades for All-Male vs. Co-ed Teams

Semester and Year	Average % All Male Teams	Average % Co-Ed Teams
Spring 2015	91.8	93.1
Fall 2014	91.8	92.1
Spring 2014	N/A	94.5
Fall 2013	84.0	92.6
Spring 2013	92.0	91.0
Fall 2012	90.8	93.8
Spring 2012	91.0	94.8
Fall 2011	80.7	88.5
Spring 2011	89.6	91.7
Fall 2010	88.8	84.3

DISCUSSION

Most team leaders were identified as such by other team members through their peer evaluation comments. A few teams did not identify a leader, but described a highly-valued member using some of the terms identified above for leaders: reliable, does more work than expected, always completes work on time. One team identified their leader as "the glue that holds the team together", which is reflected in many of the repetitive behaviors described in the Results section.

While leaders of all-male teams will make a team decision by themselves when a consensus is difficult to reach, leaders of co-ed teams will go to nearly any length to reach a consensus. These leaders will also "carry" the team by taking on a larger workload, especially when they discover gaps in the quality of team deliverables in view of an impending deadline. Team welfare, which can also be influenced positively by a higher grade on a deliverable, seems to matter more to leaders of co-ed teams than to leaders of all-male teams. This was personified by the willingness of women team members to call out others' negative attitudes in approximately 80% of their peer evaluation comments.

Our observation that co-ed teams, on average, earned higher final report grades than all-male teams is a reflection of the fact that our first year design course contains a heavy emphasis on written deliverables, such as well-illustrated technical reports. While we do not expect the degree of technical rigor in these reports to match those for senior design projects, many of our teams received lower grades when they did not follow directions for report requirements sufficiently. Examples of insufficient adherence to directions include providing fewer drawings than necessary to describe their design completely, or omitting required topics. It seems that co-ed teams, and especially their leaders, pay more attention to detail, leading to better adherence to written assignment requirements and higher grades.

CONCLUSIONS AND RECOMMENDATIONS

Since this small, STEM-focused institution is actively involved in promoting diversity and inclusion, the campus culture ought to encourage students to be aware of the value of different points of view, and to apply them to teamwork, a fundamental engineering skill. Our students appear to be open-minded about considering design ideas from fellow team members, and readily use decision making tools to choose an optimal design.

We have shown the differences in leadership styles between leaders of all-male and co-ed teams, and demonstrated several advantages that co-ed teams seem to have in achieving team success. However, since it is not always possible to have many co-ed teams in an introductory engineering course, instructors can work with all-male teams to develop greater empathy and inclusiveness, where necessary and appropriate, as a way to prevent and mitigate conflict among team members. All-male teams could also be more proactive in identifying and mitigating negative attitudes among their team members, since they already have shown that they value team member attitudes that are positive and enthusiastic.

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