

Extended Abstract - It's a Balancing Act: The Influence of Non-Self-Selected Project Team Formation on Team Satisfaction in a First-Year Engineering Design Course

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Abstract – The semester-long first year design course at a public engineering-oriented institution provides both an introduction to the engineering profession and an introduction to engineering design through a semester-long team project. Students are assigned to project teams by their instructors, based on an initial assessment that may include fundamental skills, personality traits and a variety of demographic data. We propose that the criteria used to assign students involuntarily to teams are important features that may influence team satisfaction. The purpose of the present study is to examine these features with a sample of first year engineering students, whose teams were assigned during either the first week or the fourth week of the semester and in consideration of a variety of skill and personality factors, with team satisfaction measured by average peer evaluation score. A total of 147 five-student teams comprised the study population. Peer evaluation data were compiled from the spring and fall 2012 semesters, each 16 weeks in length. This study will continue, using peer evaluation data from the spring and fall 2013 semesters, in order to reveal any trends in successful team formation. Preliminary results indicate that the timing of team formation is a significant predictor of team satisfaction. However, an extensive collection of personality and demographic factors do not significantly influence team satisfaction.

Index Terms – teamwork, skills assessment, peer evaluation, first year students

INTRODUCTION

Teamwork is a fundamental part of the engineering profession; therefore, students majoring in engineering often work in teams and complete group assignments together. Because a majority of students are likely to have a more effective learning experience when individual team members exhibit greater satisfaction with the performance of their fellow team members, we sought to determine how much student-supplied information is actually needed to form teams with a reasonable probability of this type of team success, as well as whether the timing of team formation has any effect on team satisfaction. Students who

are highly satisfied with their team's performance are also likely to learn more through an increase in cooperative learning experiences within their team [1]-[2].

Team assignments are based on a combination of an existing skills and personality self-assessment that each student completes at the beginning of the course. Typical skills include writing, speaking and graphics capabilities; personality traits often include introversion vs. extroversion, creative and physical activity interests, and overall outlook. Several of our instructors also ask about electrical, mechanical, and construction or building skills, believing that every team should have at least one member, if not more, who is highly skilled in one or more of these areas. Demographic factors such as gender balance, class year and English as a second language may be used to assign students to specific teams. Particular combinations of these skills and demographic features may prove to be more effective than others at optimizing team satisfaction, and that is what we intend to discern. Since the course is taught in multiple sections with different instructors assigned to each section, the specific combination of factors used to determine team assignments is subject to minor variations. Some of the instructors base team formation primarily on a student's self-assessment of their current proficiency in graphics, writing and/or speaking, while others weigh extrovert vs. introvert tendency, affinity for building or construction, or affinity for teamwork more strongly than the aforementioned fundamental skills.

Additionally, team assignments may be made from the first week to the fourth week of the semester. This is another factor that might contribute to the overall success of the team. We hypothesize that teams formed earlier in the semester (i.e., during the first week) will be more likely to express greater satisfaction at the end of the semester compared to teams formed after the first week of the semester. Similarly, we anticipate that team formation based primarily on skills assessment rather than on personality factors will lead to greater team member satisfaction. We also investigated differences between teams with and without one or more women students to see if this demographic variable has an impact on satisfaction. The end goal of this project is the identification of a common set of parameters for team formation which all instructors could

use to form team compositions which would contribute to a more worthwhile learning experience for their students. We also seek to determine whether certain parameters may be more useful than others.

PROJECT BACKGROUND AND PURPOSE

Our one-semester, first year design course is taken by nearly 800 first year students in either their first or second semester of college, and is taught in classes of 50 students each with two instructors per class. These classes may also contain small numbers of second- or third-year students, who were not able to take the course during their first year.

Students are assigned by their instructors to serve on five-member teams, resulting in 5 teams for each of 22 sections; two sections meet together for the entire semester (i.e., 11 classes, 10 teams per class, with two instructors). Every team in every class works on the same design project for the 16-week semester. The course learning objectives include an ability to solve open-ended engineering problems through collaboration on a team, ability to select an optimal solution, and ability to effectively communicate the design solution and its intermediate stages: graphically, orally and in writing [3].

The importance of effective teamwork is made evident to the students in course grading, whereby approximately 50% of their grade is based on assignments consisting of one document produced by the entire team; all team members receive the same grade for these assignments, emphasizing the importance of team collaboration and cooperation. Conversely, individually-graded assignments emphasize the development of individual proficiency in specific fundamental engineering skills [3]. Another and more important reason for effective teamwork is the fact that students learn more effectively when they collaborate with other students in a hands-on environment encouraged by interaction on a team [1]-[2]-[4]. Satisfaction with fellow team members' performance also promotes individual engagement in the course, especially when the student is comfortable in working with fellow team members on a project and finds this experience to be useful to their learning [1]-[5].

Our specific research questions are as follows:

1. How should instructors form non-self-selected project teams to optimize team satisfaction in a first year engineering design course?
2. Does the timing of team formation have a statistically significant effect on team satisfaction?

It has also been observed and reported that women students, in particular, favor both collaboration with peers and enhanced course engagement as an important factors in their learning [2]-[5], even as far as identifying collaboration as the most important factor in course engagement [5]. Since approximately 63% of the teams in this study are co-ed, with one, two or three women as team members, we will also identify any differences in our study

results between all-men teams and teams containing both men and women students, as well as any influence by the number of women students on a co-ed team.

METHODOLOGY

We asked our faculty to describe the types of information that they collect from their students prior to assigning them to teams, as well as to provide peer evaluation scores determined by students at the end of the course. The team assignment criteria consist of, first, students' self-assessments of their current ability in certain fundamental technical skills such as graphics, technical writing, building or construction, computer programming, etc. Second, personality attributes such as introvert vs. extrovert, self-describing adjectives, or special interests were identified by the students. Finally, demographic data about gender, class year, hometown or native country, and/or native language were requested to aid in team assignment. These sets of student-supplied information were combined into three groups as shown below:

TABLE I
TEAM ASSIGNMENT CRITERIA, GROUP 1 (60 TEAMS)

Skill Self-Assessment	Personality Self-Assessment	Demographics
Graphics	Two Creative Activities	Gender
Writing	Two Physical Activities	First Year vs. Non-First Year Student
Speaking	Two Self-Describing Adjectives	Hometown (and state or other country as applicable)

TABLE II
TEAM ASSIGNMENT CRITERIA, GROUP 2 (67 TEAMS)

Skill Self-Assessment	Personality Self-Assessment	Demographics
SolidWorks/ CAD Ability	Creative vs. Conventional	Gender
Writing	Abstract v. Concrete	First Year vs. Non-First Year Student
Speaking	Leader v. Follower	Hometown and High School
Mechanical, Electrical, Computer Programming	Demanding v. Supportive	Native Language
"Tinkering" or Construction Projects	Artistic v. Analytical	Non-Traditional Student?
Teamwork	Introvert v. Extrovert	Significant Team or Work Experience?

TABLE III
TEAM ASSIGNMENT CRITERIA, GROUP 3 (20 TEAMS)

Skill Self-Assessment	Personality Self-Assessment	Demographics
CAD	Introvert v. Extrovert	Gender
Communication (writing and speaking)	Artistic vs. Analytical	Class Year
Technical Acumen	Is There Anyone in This Class With Whom You Would Like to Work?	Native Language
Leadership	Is There Anyone in This Class With Whom You Would Not Like to Work?	Significant Teamwork Experience?

Each team member received final peer evaluation scores from their fellow team members, using a scale of 1-10. These were averaged arithmetically to determine the peer evaluation score that was entered as 5% of their final grade. An average of these final peer evaluation scores was then calculated for each team. The team averages were then compared within each team selection criteria group, and among all three groups. As one might expect, Team Assignment Criteria Groups 2 and 3 teams were given a more detailed peer evaluation form for team member performance evaluation than the teams in Group 1, albeit with a consistent 1-10 scale.

We are aware of computerized team assignment and peer evaluation systems, such as Team-Maker© and CATME [7] for team assignment and peer evaluation [7], as well as WebPA® [8] for peer evaluation. We, have not used them as of yet, but plan to investigate their use with current and future data. While it can be argued that “a project team is a project team” whether it is at the cornerstone or capstone level, it appears that Team-Maker© may be more suitable for teams of longer duration, such as a capstone team. In addition, the level of project complexity for a capstone design team may require more careful selection of team members, particularly when more specific types of technical expertise are necessary for successful completion of the project, as well as more frequent outside-of-class-time meetings and longer and more intensive working relationships among team members

PRELIMINARY RESULTS

We conducted an Analysis of Variance to examine differences in team satisfaction by group and by number of women on a team. There was a significant effect of timing of team formation: $(2,135) = 7.53, p = 0.001$, whereby teams formed later in the semester (Group 3) reported greater team satisfaction than teams formed earlier (Groups 1 & 2). A post hoc comparison revealed that there was no significant difference between team satisfaction for Groups 1 and 2, with $t(125) = 0.76, p = 0.45$. Moreover, the number of

women on a team did not have a significant effect on team satisfaction: $F(3, 135) = 0.94, p = 0.42$. See Figure 1, below, for mean scores for both types of teams.

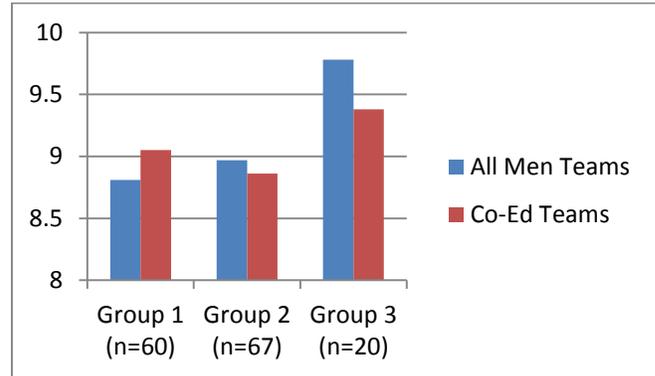


FIGURE 1
TEAM AVERAGE PEER EVALUATION SCORES FOR ALL MEN TEAMS VS. CO-ED TEAMS

DISCUSSION

Students awarded generally high (80%+) peer evaluation scores to their fellow team members for performance, despite the time-intensive nature of technical writing, presentations, open-ended problem solving and research, and often contributing a general student dislike for this type of process-based course [6]. Students recognized and appreciated the efforts of fellow team members to do their share of the workload, no matter how much work there was.

The higher level of team satisfaction achieved by teams formed later in the semester could be attributed to the fact that these teams first came together with a completed individual writing assignment in hand, which indicated their current understanding of the project and writing skill to fellow team members, and gave the team a foundation for its next task: combine these five versions into a cohesive, team-written document as the first team-based deliverable. The lack of significance in the amount of personality and demographic information used to form teams appears to indicate that the initial skills assessment, which all instructors use, is of greater importance to team satisfaction than a balance of personalities.

CONCLUSIONS AND RECOMMENDATIONS

We plan to continue this study, using similar data from upcoming semesters in order to determine, more conclusively, whether there is a common set of factors that enhance team satisfaction and therefore contribute to a more worthwhile learning experience for students. Since our first year course serves over 1,000 students during each academic year of which approximately 800 are first year students, and is required for all majors at our institution, whatever we can do to enhance our students’ learning

experience in our first year design course would help them to form a stronger foundation for the study of engineering.

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