A Study of Team Underachievers in an Introduction to Engineering Course

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Abstract - **The University of Texas at Arlington (UTA), a large urban public university, offers an interdisciplinary Introduction to Engineering course, enrolling from 500 – 700 students in this course each fall and spring semester. Students, normally in their first semester of an engineering program, are assigned by the instructors to interdisciplinary teams of six students each. At the end of the semester, each student is required to submit a peer evaluation of each of his or her teammates as well as evaluate their own participation and contribution to the team's activities. The instructors read each of the team members' evaluations and note when a student consistently earns low marks from his or her peers. For the purposes of this extended abstract, those students rated low enough in peer evaluations for the instructors to reduce their project score are defined as "team underachievers." The authors hypothesize that there is a correlation between team performance in this first semester interdisciplinary group work effort and ultimate success in the College of Engineering. For this analysis we identify team underachievers from the Fall 2008 semester and track their academic career at UTA. We compare the number of team underachievers in each of the categories to a randomly-selected group of students from the same peer group who were not deemed team underachievers to look for significant differences in their educational path. Given that the College of Engineering seeks to increase its first-year retention rate, i.e., increase the number of first-year students who continue at UTA into the second year, we examine the utility of this non-grade-based metric gathered in a student's first semester of engineering study to predict a successful educational path. If the metric strongly correlates to lack of retention, earlier and more aggressive intervention by team mentors might be warranted.**

Index Terms – Engineering Success, Introduction to Engineering Course, Retention, Teamwork.

TEAM CONSTRUCTION AND EVALUATION

Students in the required, interdisciplinary Introduction to Engineering course at the University of Texas at Arlington (UTA) are assigned a semester-long group project each semester. Group project assignments account for 25% of each student's course grade. Students are assigned to interdisciplinary teams of six students by the instructors at the beginning of the semester. The teams include students from at least three different engineering departments. Teams are also constructed so that any team containing a female has at least two of the six members as female. Other than using these two rules, team assignment is random. These student teams work on several assignments together throughout the semester, all of which culminate in a team project to be completed by the end of the semester. Student teams are assigned a faculty member as their team mentor. The purpose of the mentor is to intervene and counsel all team members when one of the members self-reports that the team is having difficulty working together. At the end of the semester, each student is required to submit a peer evaluation of each of his or her teammates as well as evaluate their own participation and contribution to the team's activities. The instructors read each of the team members' evaluations and note when a student consistently earns low marks from his or her peers. For the purposes of this extended abstract, those students rated low enough in peer evaluations for the instructors to reduce their project score are defined as "team underachievers."

Students who were rated as team underachievers received rating from their peers of the type:

Didn't show up for meetings
Let all the rest of the members do all the work
Didn't participate
Stopped coming after the 1st meeting
Ignored our emails

DATA ANALYSIS

The authors hypothesize that there is a correlation between team performance in this first semester interdisciplinary group work effort and ultimate success in the College of Engineering. For this analysis we identified team underachievers from the fall 2008 semester and tracked their academic career at UTA. We categorized students into one of the following groups:

- Completed an engineering degree at UTA
- Completed a non-engineering degree at UTA
- Active (still enrolled) in engineering at UTA
- Active outside of engineering at UTA
- Discontinued enrollment at UTA

We compared the number of team underachievers in each of the categories to a randomly-selected group of students from the same peer group who were not deemed team underachievers to look for significant differences in their educational path.

In the fall 2008 semester there were a total of 708 students enrolled across three sections of the Introduction to Engineering course. Of those 708, 83 were identified as team underachievers. The status of each of those students (as of May 2013) was identified using the UTA's student information system. For comparison, 83 students in the same class who were not identified as team underachievers were chosen at random and their status was also identified. The collected data for those students can be found in Table I.

TABLE I
STATUS OF STUDENTS

	Team Underachievers	Not Team Underachievers
Completed Engineering Degree	8	26
Completed Non-Engineering Degree	8	4
Active in Engineering	8	12
Active Outside Engineering	21	12
Discontinued Enrollment	38	29

A chi-square test for association [1] was performed to see if there was a relationship between team achievement in the Introduction to Engineering class and the current educational status of students who took the class in the fall 2008 semester. For the test, the null hypothesis was constructed as being no relationship and the alternative hypothesis was that there was a relationship between team achievement and educational status. A level of significance (α) of 0.05 was chosen. The resulting χ^2=15.326 with four degrees of freedom was found to have a p-value=0.00407. A p-value < α indicates that the null hypothesis is rejected and there is a relationship between team achievement in the Introduction to Engineering class and educational status of the student population sampled.

To further examine the relationship, the categories were combined so that the Completed Engineering Degree and Active in Engineering were considered "Engineering Success", Completed a Non-Engineering Degree and Active Outside Engineering were considered "Other Success" and Discontinued Enrollment was considered "Failure". Another chi-square test for association was performed resulting in an even greater degree of correlation.

TABLE II
CATEGORIES OF SUCCESS

	Team Underachievers	Not Team Underachievers
Engineering Success	16	38
Non-Engineering Success	29	16
Failure	38	29

One more test, combining all Completed and Active in a category called "Success" and all Discontinued into a category called "Failure" was performed. Interestingly, the chi-square test for this test did not show a relationship between team achievement and ultimate success or failure at UTA. The results of the all chi-square tests are shown in Table III.

TABLE III
CHI-SQUARE RESULTS

	Degrees of Freedom	χ^2	p-value	p-value<0.05
All Five Categories of Educational Path	4	15.326	0.00407	True
Grouped Categories of Educational Path	2	13.9274	0.00094	True
Success and Failure Grouping	1	2.027	0.15451	False

Looking at the data from the point of view of the engineering fields provides an interesting perspective. A comparison of the number of students from the two groups (team underachievers and controls) in the Fall 2008 class who remained in engineering shows a marked difference (Figure 1 and Figure 2).

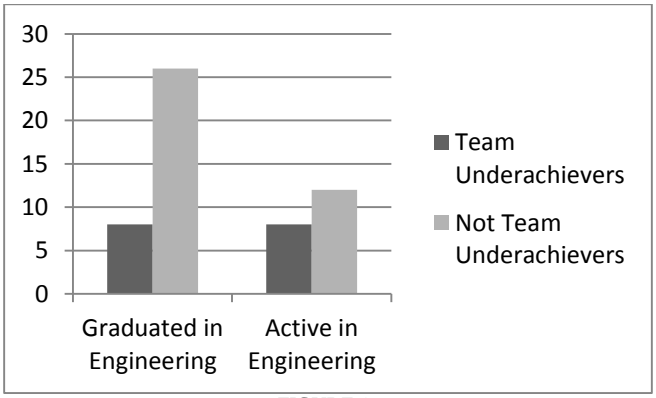

FIGURE 1
RELATIONSHIP BETWEEN PERFORMANCE IN A TEAM IN THE FRESHMAN YEAR AND ULTIMATE SUCCESS IN ENGINEERING EDUCATION

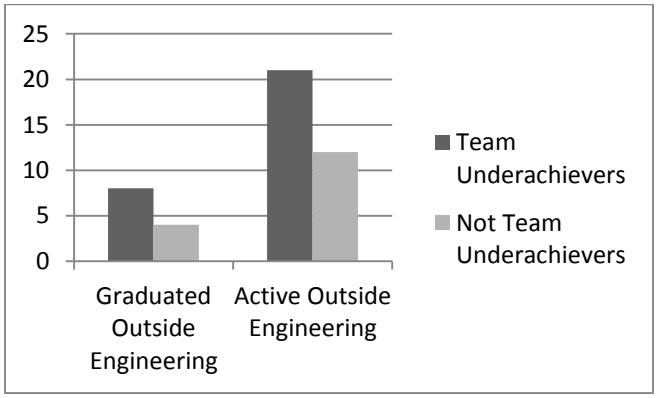

FIGURE 2
RELATIONSHIP BETWEEN PERFORMANCE IN A TEAM IN THE FRESHMAN YEAR AND EDUCATIONAL SUCCESS OUTSIDE OF ENGINEERING

IMPLICATIONS OF RESULTS

The statistical evidence of the relationship between performance in a team in the freshman year and ultimate success in engineering education is quite significant. As seen in Figure 3, the further evidence that performance in a team does not relate to educational success overall is also significant. These results suggest that while it not is necessary to be good at team work to be successful in university level education it is necessary to be successful in engineering education.

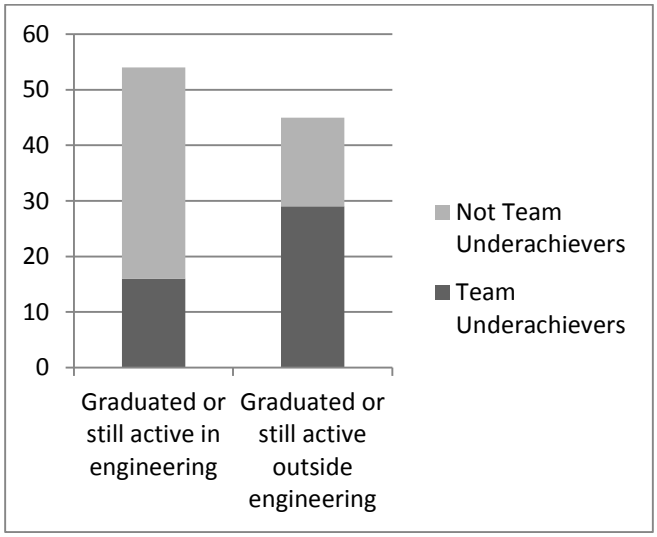

FIGURE 3
RELATIONSHIP BETWEEN PERFORMANCE IN A TEAM IN THE FRESHMAN YEAR AND EDUCATIONAL SUCCESS OVERALL

This suggests that more time should be spent in the Introduction to Engineering class trying to help students to be successful team members. Students come in with varying levels of experience working on teams. Some students have a lot of experience and already know the pitfalls of teamwork and have personal strategies for dealing with the pitfalls. Other students have little to no teamwork experience and may feel very frustrated in their experience in working on a team in an engineering classroom for the first time. The fact that they are taught that teamwork is very important in the engineering profession coupled with their frustration in their first experience could discourage them from continuing on in engineering. More time may need to be spent in the freshman year not only giving students experience working on teams but counseling them on how to be good team members and relieving some of the frustration and stress that may come with this new experience.

FUTURE STUDY

More study and analysis can be done in this area. Logistic regression analysis could be done to further examine the relationship between the categories of educational path and team achievement. This type of statistical analysis used to predict outcomes based upon categorical dependent data. It would also be interesting to study whether this team achievement in Introduction to Engineering is a better indication of ultimate success in engineering education than GPA at the end of the first semester of a student's career. A longitudinal study of similar data across many semesters would also be warranted.

REFERENCES

[1] Whitney D., "S and Chi Square Tests of Association: An Empirical Comparison", *American Educational Research Journal*, 9, 1, 1972, 113-122.

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