Providing First Year Engineering Students with Cross-Discipline Groups

Jeffrey B. Connor, Timothy J. Robinson

Virginia Polytechnic Institute and State University

Abstract

An experiment was conducted to quantify the efficacy of cross-discipline groups to improve freshman engineers' academics, social adjustment, and appreciation of the liberal arts. One set of students was grouped in both their engineering and English classes. Another set of students was placed in engineering groups only. At the beginning and end of the semester all students completed a survey to measure their perceptions of group work.

Students generally had less enthusiasm for groups at the end of the semester, cross-listed students had no significantly different perceptions, and academically better students responded to groups less favorably than poorer students.

Background

Virginia Tech requires all first semester engineering students to take Introduction to Engineering I (EF 1015); a two credit course designed to introduce the profession and to develop problem solving skills. Engineering students are also required to take an introductory English class in the first semester. Both the English and engineering classes recognize that the ability to work well within groups is desirable both academically and professionally. Many studies have indicated the positive impact of group work on college students, academically and socially[1].

Study design

In four sections of EF 1015, 120 first semester engineering student were divided into heterogeneous groups of four according to SAT scores. 75% of the students are designated "non-Common" and 25% "Common". Common students are those that were in the same group of four in both their English and engineering classes and non-Common are those students that were not in the same English and engineering groups. At the beginning of the semester common students numbered 28. At the start and end of the semester all students rated the following statements on a scale of one to five (1, strongly disagree; 5 strongly agree):

1) The relationship between science and liberal arts is strong.
2) Scientific success is dependent upon communication skill.
3) A group will produce a "better" result than an individual.

4) A group will produce a result more efficiently than an individual.
5) I like the size of the University.
6) My engineering classmates are a positive influence on my academic work.
7) My engineering classmates are a positive influence on my social life.

Results

The ratings of these seven statements were examined from several perspectives. First, for each, did student attitudes change over the course of the semester? To answer this a paired t-test was used to determine whether mean responses, of both common and non-common students, at the beginning of the semester were significantly different than mean responses at the end of the semester. Mean responses and the standard deviation in responses are reported for common students in Table 1 and for non-common students in Table 2. The t-statistics reported in these tables are the paired t-statistics for the after versus. before comparisons (Tables 1 and 2). The results are discussed below.

Table 1

Responses of Common Students

	Before		**After**			
	Score	Std.Dev.	Score	Std.Dev	Paired T (After - Before)	p-value
Statement 1	2.731	0.874	2.808	0.939	0.42	0.678
Statement 2	4.038	0.999	4.000	0.693	-0.24	0.814
Statement 3	4.231	0.863	3.885	0.909	-1.81	**0.083** [a]
Statement 4	3.923	1.093	3.385	1.235	-1.97	**0.060** [a]
Statement 5	4.154	0.881	4.000	0.938	-1.00	0.327
Statement 6	4.038	0.720	3.731	0.874	-1.62	0.118
Statement 7	3.231	0.908	3.154	0.967	-0.42	0.678

Note: "a" implies significant at the 0.10 level and "b" is significant at the 0.05 level

Table 2

Response of Non-Common Students

	Before		**After**			
	Score	Std.Dev.	Score	Std.Dev	Paired T (After-Before)	p-value
Statement 1	3.132	0.929	2.908	0.912	-1.71	**0.091**[a]
Statement 2	3.987	1.026	3.921	0.935	-0.48	0.635
Statement 3	3.789	1.147	3.934	1.037	0.91	0.368
Statement 4	3.632	1.106	3.776	0.988	0.98	0.328
Statement 5	4.093	1.042	3.907	0.989	-1.50	0.137
Statement 6	3.974	1.006	3.658	0.946	-2.25	**0.027**[b]
Statement 7	3.042	0.926	2.931	1.092	-0.79	0.432

Note: "a" implies significant at the 0.10 level and "b" is significant at the 0.05 level

Next, for each statement, it was determined whether or not common students (those that were cross-listed) differed significantly from non-common students (those not cross-listed) in their mean response. To answer this, a pooled t-statistic was utilized[*]. Table 3 lists those statistics, comparing common versus non-common students for each of the survey statements. Again, the results are discussed below.

Table 3

Comparison of Common vs. Non-Common Student Responses

	Before		**After**	
	Pooled T Statistic	(p-value) $\mu_C-\mu_N\neq0$	Pooled T Statistic	(p-value) $\mu_C-\mu_N\neq0$
Statement 1	-1.94	(**0.055**[a])	-0.51	(0.610)
Statement 2	0.23	(0.820)	0.39	(0.700)
Statement 3	1.97	(**0.052**[a])	-0.23	(0.820)
Statement 4	1.29	(0.200)	-1.39	(0.170)
Statement 5	0.29	(0.780)	0.41	(0.680)
Statement 6	0.30	(0.760)	0.29	(0.770)
Statement 7	0.85	(0.400)	0.81	(0.420)

Note: "a" implies significant at the 0.10 level and "b" is significant at the 0.05 level

[*] For pooled t-tests, the null hypothesis was that the difference in means was zero versus the research hypothesis that the means differed significantly from zero.

This study was intended to shed light on three general questions:

I. For those students who have worked together, do they see a relationship between English and engineering?
II. Does cross-listing groups help social adjustment?
III. Does cross-listing groups help academically?

Statements 1 and 2 of the survey address the issue of a relationship between English and engineering. In statement 1 students were prompted for their opinion on whether or not the relationship between science and liberal arts is a strong one. Referring to Table 1, it appears that grouping had no effect on student's attitudes about the relationship between English and engineering as there was no significant change in opinion (p-value = 0.678). In statement 2, students consider whether scientific success is dependent upon communication skills. Again the results in Table 1 seem to suggest that grouping had no significant (p-value = 0.814) effect on student's attitudes regarding this assertion.

Regarding social adjustment, statement 7 of the survey requires an opinion on the following: "My engineering classmates are a positive influence on my social life". Notice in Table 3 that common students do not feel any differently about this than non-common students at the beginning of the semester (p-value = 0.40) or at the end (p-value = 0.42). Tables 1 and 2 indicate that students did not change their attitude on this on this matter over the course of the semester. This was true for common students (p-value = 0.678) as well as non-common students (p-value = 0.432).

General question III can be answered by analyzing the results from statements 3, 4, and 6 of the survey. In rating statement 3, students decided whether or not a group produces a better result than an individual. At the beginning of the semester, Table 3 shows that common students felt significantly more (p-value 0.052) favorable about the success of group work than did the non-common students. This result may be similar to the classic medical 'placebo' effect in which individuals receiving a treatment (in this case being grouped) perceive that they are getting well (analogous to having a positive attitude about the effect of grouping). When students considered the same statement at the end of the semester, there was no significant difference (p-value 0.82) between common and non-common students. Why is there no significant difference between the groups at the end of the semester? This can be answered by comparing how opinions on statement 3 changed over the course of the semester for each group. In Table 2, non-common students have no significant change (p-value 0.368) in opinion over the course of the semester. However, when comparing opinions before and after the semester for the common students, we find that these students are less favorable (p-value 0.083) of groups at the end of the study than they were at the beginning.

To determine if a grouped student's opinion of the value of groups is dependent on the student's academic quality, both the common and non-common students were dichotomized into those that performed above the overall median (a final average above 66.42%) and those that performed below the overall median in the engineering course. Eleven common and thirty-seven non-common students performed at a level above the median, whereas thirteen common and

thirty-five non-common students performed below the median. In Table 4, paired t-statistics that compare average responses before and after the semester for each of the four groups are presented[*]. It is interesting to note that the only group experiencing a significant change (p-value 0.089) in opinion for statement 3 before and after the semester, is the grouped common students who performed above the median. The negative sign of the t-statistic indicates that these students were more negative about grouping after the semester than they were at the beginning. A bar graph comparing the four groups is presented in Figure 1.

Table 4

After - Before

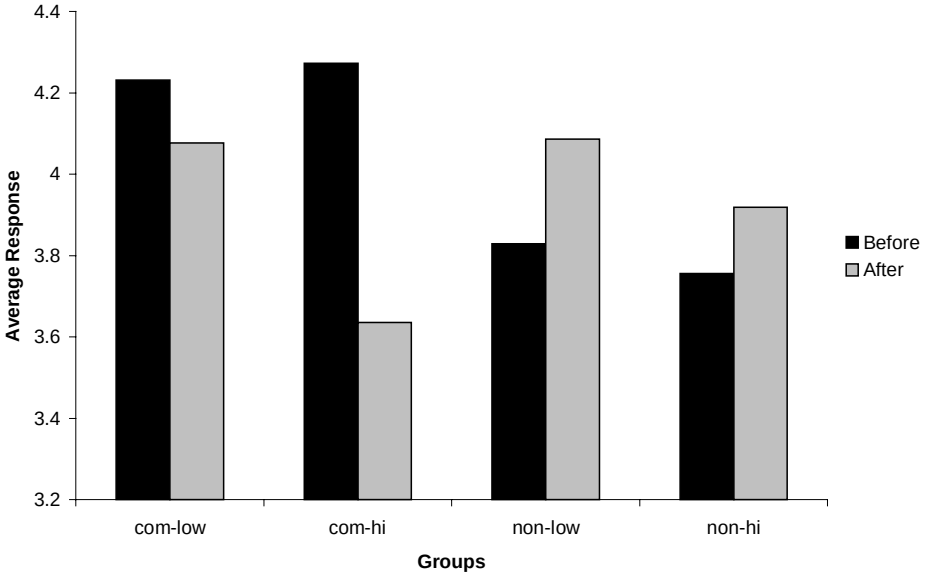
	Common		**Non-Common**	
	High	Low	High	Low
	Paired T (p-value)	Paired T (p-value)	Paired T (p-value)	Paired T (p-value)
Statement 3	-1.88 (**0.089**[a])	-0.69 (0.502)	0.86 (0.394)	0.93 (0.358)
Statement 4	-1.10 (0.295)	-1.72 (0.111)	0.90 (0.376)	0.95 (0.347)
Statement 6	0.43 (0.676)	- 1.98 (**0.071**[a])	-2.30 (**0.027**[b])	- 0.78 (0.439)

Note: "a" implies significant at the 0.10 level and "b" is significant at the 0.05 level

[*] For determining whether or not there was a significant change in attitude over the course of the semester, differences in scores were calculated (after minus before) for each statement. The null hypothesis was that the average score-difference was equal to zero versus the research hypothesis that the average score-difference was significantly different from zero.

Figure 1

Response to Statement 3



In statement 4, students were prompted to give their opinion on whether: "A group will produce a result more efficiently than an individual." As with statement 3, Tables 1 and 2 show a significant change in opinion (p-value = 0.06) occurring among the common students but not among the non-common students (p-value = 0.328). The negative t-statistics in Table 1 suggest that this change in opinion over the course of the semester is a negative one. In order to determine if this is dependent on the academic quality of the student, we again look to Table 4. Based on the p-values in Table 4, it appears that those students performing at a lower level than the median were less favorable about group efficiency than those performing at a higher level.

Statement 6 addressed whether engineering classmates were a positive influence on academic work. As a whole, common students showed no significant difference regarding their feelings on this topic before or after the semester. However, the results in Table 4 suggest that the lower achieving students felt more negative (p-value = 0.07) about the influence of their engineering classmates at the end of the semester than they did at the beginning of the semester. Among the higher achieving students, there was no significant (p-value = 0.676) change in opinion on this statement during the semester. Among non-common students, results in Table 2 suggest that these students were more negative (p-value = 0.027) in their opinion of the influence of their fellow engineering classmates at the end of the semester than they were at the beginning. This was particularly true among the higher performing non-common students (p-value = 0.027).

Conclusions

- At the end of the semester common students perceived group work as resulting in poorer results and being less efficient than at the beginning of the semester.

- Over the course of the semester, the level of appreciation for the relationship between liberal arts and science decreased among non-common students.
- Over the course of the semester, favorable opinion of the academic influence of their engineering classmates decreased among non-common students.
- Compared to students grouped only in their engineering class, students belonging to the same English and engineering groups had no higher opinion of the effectiveness of group work.
- At the end of the semester common students that had greater academic achievement disagreed that groups will produce a "good" result.

Bibliography

[1]L. Springer, M. E. Stanne, and S. Donovan, "Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta Analysis," (Madison, WI: National Institute for Science Education, 1997).

JEFFREY B. CONNOR is a visiting assistant professor in the Division of Engineering Fundamentals at Virginia Polytechnic Institute and State University. He received his M.S. degree in civil engineering from VPI&SU and B.S. degree in civil engineering from the University of Lowell and is currently pursing a Ph.D. in civil engineering from VPI&SU where he teaches freshman engineering.

DR. TIMOTHY J. ROBINSON is an assistant professor in the Department of Statistics at Virginia Polytechnic Institute and State University. His primary research interests are in robust regression techniques, variance modeling, generalized estimating equations and design of experiments with applications to engineering sciences. He has worked in the pharmaceutical industry with Procter & Gamble corporation where he researched applications of generalized estimating equations to various longitudinal data studies. Dr. Robinson received his B.S. from James Madison University and his M.S. and Ph.D. degrees in statistics from Virginia Polytechnic Institute and State University.