AC 2011-1385: COMPARISON OF ENGAGEMENT WITH ETHICS BETWEEN AN ENGINEERING AND A BUSINESS PROGRAMS

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Comparison of Engagement with Ethics between an Engineering and a Business Program

Introduction

In universities across the United States, there has been an increased interest in raising the ethical knowledge of students. The America COMPETES Act of 2007 stipulates that mentoring of postdoctoral fellows and ethics training of graduate and undergraduate students in science and engineering should be included in proposals to the National Science Foundation [1]. Professional schools, such as engineering and business, have been particularly concerned with future practitioners' ethical development [2]. Accrediting bodies, such as ABET and AACSB, have been especially keen to incorporate ethical knowledge of students as a part of the accreditation process for institutions. As per ABET criterion 3f, for example, an engineering graduate should demonstrate an understanding of professional and ethical responsibility (though no specific guidelines to achieve this objective are provided). A workshop, held at the National Academy of Engineering in 2008, summarized the issues related to ethics education and scientific and engineering research [3]. In response to such concerns about ethics instruction, in 2008, an interdisciplinary faculty group at Virginia Tech received an NSF grant, called Graduate Interdisciplinary Liberal Engineering Ethics (GILEE), to enhance ethics instruction in undergraduate and graduate engineering. As part of this grant, surveys and focus groups were developed to gather information about engineering students' perceptions of their current ethics instruction. Consequently, faculty in the College of Business at Virginia Tech became interested in this baseline assessment and other activities related to ethics instruction in the College of Engineering (CoE). Therefore, the survey used to gauge engineering students' perceptions of ethics instruction was also administered to students in the business college. This paper reports on the results of those two survey administrations, comparing the responses of engineering and business students at Virginia Tech in their perceptions of ethics instruction.

Such a comparison is particularly useful because the graduates of both professional schools have seen ethical issues publicized in both engineering and business. However, business has, for a longer period, been called upon to graduate ethical practitioners. Over the years, for instance, media attention on corporate ethics scandals has forced colleges and schools of business to respond about the ethical training of their students [4]. In fact, since 1974, the Association to Advance Collegiate Schools of Business (AACSB) International's business accreditation standards have required either specific courses or learning events related to ethics [5]. As a result, it seems ethics has been incorporated into syllabi more frequently in the business college at Virginia Tech than in the engineering college. In fact, in a review of course descriptions, only eight courses in the College of Engineering include the word "ethics." The investigators of GILEE project organized an ethics day in March '09 in CoE and repeated this in March '10. However, this is still not a part of regular annual activity in the CoE. In the College of Business, fifteen (nearly twice as many) courses include the word "ethics." Also, the

College of Business has, for the twenty years, declared an ethics day and brought in a prominent speaker to the campus community to discuss a topic related to ethics.

Nationally, schools of business have hired faculty to teach ethics courses and have spent considerable time infusing ethics instruction throughout their curricula [4]. The emphasis in these courses is to build competencies so that students identify, analyze, judge, and evaluate ethical matters in business so that they can, hopefully, apply ethics to real-life business decisions [6][7]. At VT, there is a professor in the College of Business who has been teaching an ethics course for years and is the "ethics person" in the College. He is one of the investigators on GILEE grant. In the College of Engineering, there is no such permanent course and no such person. GILEE investigators have, however, developed a team-taught ethics course at graduate level in CoE. This course was offered in spring '10 for the first time and is being offered in spring '11 too. However, low student enrollment is expected to adversely affect the long term sustainability of this course.

Understanding of ethics perception data from students in the College of Engineering can be enhanced through similar data collected in the College of Business. The business student data may provide a yardstick for interpreting engineering students' results. For example, if half the students in engineering tend to agree with a particular statement regarding ethical behavior it is difficult to know if that number represents a good result, a mediocre result, or a bad result. If, however, this number is compared to that of students in the College of Business where numerous ethics curricular efforts have occurred over a long period, then we have a better context for understanding what the results from the engineering students represent.

Virginia Tech offers one of the largest engineering programs in the country, enrolling about 6,000 engineering undergraduates. Engineering freshmen are introduced to professional ethics using in-class discussion of ethics case studies, ethics videos, reading and writing assignments, and online instructional materials. However, coverage of ethics instruction in upper level courses has not been well documented and one aim of the 2008 NSF GILEE grant was to do exactly that. Therefore, comparisons between students in engineering, where, beyond the first year, emphasis on ethics might be strengthened, and students in business, where ethics instruction appears to be more thoroughly embedded would be informative in terms of guiding further ethics instruction development in the College of Engineering.

Ethics Survey

As part of GILEE project, a survey was developed to provide a baseline measure of how students perceive their ethics instruction and how they understand ethical issues, particularly as they relate to global differences, issues of advocacy and ethical leadership, and ethics and emerging technologies. The survey consisted of two sections. The first was focused on "perceptions of the curriculum" and included 11 items. For each item, students were asked their level of agreement or disagreement according to a six-point scale: 1 (strongly disagree), 2 (somewhat disagree), 3 (disagree), 4 (agree), 5 (somewhat agree), and 6 (strongly disagree). Items in this section included such questions as "in my curriculum, there has been a substantial emphasis on teaching ethics," "in my classes, cultural differences in ethics have been discussed, and "I have been taught the differences between ethical relativism and ethical absolutism." The second section of the survey included 11 statements to which students could agree/disagree on the same six-point scale. This section focused on "perceptions of ethical issues" and included items such as "if a professional practice is legal, then it is also necessarily ethical," "ethics do not vary from situation to situation, and "ethical issues do not pertain to technological advances."

After approval from the university's IRB, an email was sent to all undergraduate and graduate engineering students at VT through the engineering listserve to which all engineering students have access and where they typically receive announcements regarding events, registration, course changes, etc. Similarly, an email was sent out through the Dean's Office in the College of Business soliciting students' responses. The email contained a brief overview of the purpose of the survey, asking for their response and assistance. The email contained the link for the web-based survey. No identifying information related to individuals was collected, though demographic items on the survey included age, gender, level of study (freshman, sophomore, junior, senior, master's, doctoral), primary area of engineering or business major.

This survey was implemented in both engineering and business programs: 566 engineering students and 276 business students (undergraduate and graduate) responded to the survey. For the business sample, 51% were male; 80% were between the ages of 18 and 24; 6% were freshmen, 16% sophomores, 22% juniors, 32% seniors, 24% master's, and less than 1% were doctoral level students. Most represented majors included accounting and information systems (16%), MBA (20%), and finance (19%). For the engineering sample, 74% were male; 85% were between the age of 18 and 24; 21% were freshmen, 17% sophomores, 15% juniors, 25% seniors, 10% were master's, and 12% were doctoral level students. Most represented majors included civil and environmental engineering (18%), mechanical engineering (17%), aerospace engineering (10%), and chemical engineering (8%).

Analysis of Survey Data

In the following sections, we: (i) discuss results of a college-wide survey administered to gauge the perceptions of undergraduate and graduate students, both in engineering and business programs, regarding their current ethics instruction and (ii) compare the key differences in students' engagement with ethics in engineering and business programs. Table 1 below presents the frequencies, means, and standard deviations for each of the items in the first section of the survey. These descriptive statistics are presented for both engineering students and for business students.

Table 1: Frequencies, Means, and Standard Deviations for both Engineering (E) and Business (B) students on the Student Perceptions of Teaching Ethics Scale

Scale Item	Percent Agree	Mean (SD)
1. In my curriculum, there has been a substantial emphasis on teaching ethics.	E- 72% B- 75%	E- 4.06 (1.32) B- 4.20 (1.40)
2. I have been taught about an engineer's (business person's) core values and their relationship with effective ethical leadership.	E- 80% B-79%	E- 4.36 (1.21) B- 4.35 (1.31)
3. The textbooks and course materials I have used in this program often cover ethical issues. *	E- 60% B- 84%	E- 3.68 (1.36) B- 4.51 (1.22)
4. My curriculum has informed me of the many ways in which professionals can become effective advocates for ethically relevant decisions and legislation. *	E- 58% B- 68%	E- 3.61 (1.39) B- 4.04 (1.35)
5. As a whole, my professors have avoided discussions of difficult ethical issues. *	E- 32% B- 28%	E-3.00 (1.24) B- 2.79 (1.33)
6. In my classes, cultural differences in ethics has been discussed. *	E- 41% B- 58%	E- 3.14 (1.40) B- 3.60 (1.44)
7. In my classes, I have often had the opportunity to initiate discussions regarding ethical issues. *	E- 38% B- 46%	E- 3.08 (1.31) B- 3.29 (1.35)
8. Many examples of the relationship between emerging technologies and ethics have been discussed in the classes that I have taken.*	E- 35% B- 53%	E- 2.91 (1.39) B- 3.54 (1.34)
9. I have been taught the differences between ethical relativism and ethical absolutism. *	E- 30% B- 36%	E- 2.63 (1.43) B- 2.84 (1.59)
10. As a whole, my professors demonstrate a great deal of knowledge regarding ethical issues. *	E- 64% B- 72%	E- 3.80 (1.28) B- 4.00 (1.31)

11. My professors have often expressed concern over ethical issues in applied settings. *	E- 58% B- 66%	E- 3.67 (1.32) B- 3.86 (1.30)

*Note: Items with an * indicate significant (p<.05) mean differences in how engineering and business students responded to that item.*

As seen in Table 1, business students perceived greater engagement with ethics education than did engineering students, though ironically there is no difference in average responses between business and engineering students on item #1 – "in my curriculum, there has been a substantial emphasis on teaching ethics." In both groups, approximately 75% agree with this statement. For more specific items, however, there are systematic differences between the engineering students and the business students. For example, business students were more likely ($p < .05$) to believe that their textbooks and course materials often covered ethical issues; more likely to say that their "professors demonstrate a great deal of knowledge regarding ethical issues"; and more likely to say that their professors "expressed concern over ethical issues in applied settings." Engineering students were more likely to respond that "my professors have avoided discussions of difficult ethical issues." In fact, on 9 of the 11 items, business students provide more positive responses in regards to ethics in their curriculum.

Table 2 below presents the frequencies, means, and standard deviations for each of the items in the second section of the survey. Again, these descriptive statistics are presented for both engineering students and for business students.

Table 2: Frequencies, Means, and Standard Deviations for both Engineering (E) and Business (B) students on the Student Perceptions of Ethics in the Profession Scale

Scale Item	**Percent Agree**	**Mean (SD)**
12. Ethics in engineering (business) is accepted as the same across cultures and nations.*	E- 36% B- 19%	E- 2.99 (1.40) B- 2.38 (1.32)
13. Ethical concerns do not apply to most of us in engineering (business) because engineering (business) is separate from society. *	E-12% B- 3%	E- 2.06 (1.09) B- 1.48 (.81)
14. If an engineering (business) practice is legal, then it is also necessarily ethical. *	E- 18% B- 10%	E- 2.31 (1.32) B- 2.04 (1.11)
15. In general, ethics is independent of the country or culture in which it occurs. *	E- 41% B- 26%	E- 3.19 (1.48) B- 2.59 (1.37)
16. Active advocacy on the part of an engineer (business	E- 14% B- 10%	E – 2.38 (1.07) B – 2.22 (.99)

person) has no potential to influence legislation.		
17. Ethical leadership is not a concern in engineering (business). *	E – 4% B – 2%	E – 1.90 (.99) B – 1.48 (.69)
18. Ethics is too complicated and cannot be taught. *	E- 12% B – 8%	E – 2.11 (1.16) B – 1.81 (1.02)
19. Professional ethics and personal ethics are too separate things. *	E-44% B- 32%	E – 3.19 (1.45) B – 2.81 (1.34)
20. Ethics do not vary from situation to situation. *	E-30% B- 23%	E – 2.92 (1.42) B- 2.67 (1.37)
21. Ethical issues do not pertain to technological advances.	E- 8% B – 6%	E – 1.99 (1.06) B – 1.92 (.84)
22. In general, the accepted practices of cultures in other countries determine what is ethical. *	E- 44% B- 55%	E – 2.11 (1.16) B – 3.46 (1.28)

*Note: Items with an * indicate significant (p<.05) mean differences in how engineering and business students responded to that item.*

As with responses to the first section of the survey, business students responded differently to nearly all of the items (9 of 11) when compared to engineering students. For example, engineering students are more likely ($p < .05$) to believe that "ethics is accepted as the same across cultures and nations." Engineering students are also more likely to believe that "if an engineering practice is legal, then it is also necessarily ethical." Engineers, when compared to the business majors, are also more likely to respond that "professional ethics and personal ethics are two separate things." They are also more likely to believe that "in general, ethics is independent of the country or culture in which it occurs." Business majors, however, are more likely to believe that "in general, the accepted practice of cultures in other countries determine what is ethical."

<u>Factor analysis and the ethics scales.</u> Because the two sections of the survey were theoretically derived to be two separate scales: one scale for perceptions of ethical training in the curriculum and one scale for perceptions related to ethics generally, a factor analysis was conducted to determine if these scales could be derived and were reliable indicators. For part one of the instrument, initial exploratory factor analysis (EFA) using maximum likelihood estimation resulted in the retention of a two-factor structure explaining a total of 63.35% of the total variance in the data. Upon inspection of the factor structure, however, we found one item with a factor score below .40 and a factor correlation of .71 indicating one bad item as well as highly correlated factors. This item was "As a whole, my professors have avoided discussions of difficult ethical issues." We removed the item and conducted a second EFA, extracting a one factor solution explaining 52.1% of the total variance. The ten items retained constituted an initial scale assessing student perceptions of ethics training in their curriculum. This scale

also demonstrated a high degree of internal stability (α = .91 for engineers; α = .88 for the business majors), with item inter-correlations ranging from .40 to .75.

Scale scores for students' perceptions of ethics in the curriculum scale reflect the differences between engineering and business majors on the individual items that make up the scale. The total scale score for engineers was 3.49, with a standard deviation of 1.22; the total scale score for the business majors was 3.82, with a standard deviation of 1.01. As with most of the individual items, the scale scores are different ($p < .05$) between the engineers and the business majors, with business majors indicating a more positive response toward the use of ethics in the curriculum.

For part two of the instrument, initial exploratory factor analysis using maximum likelihood estimation resulted in a two-factor structure explaining 50.6% of the total variance. Upon inspection of the factor matrix, it was noted that two items had factor loading under .40. One by one, we removed those items and ran another EFA each time. The final structure consisted of two highly correlated factors ($r = .72$) accounting for 57.1% of the total variance. Item and reliability analysis of the two scales resulted in an even more muddled picture of the part two assessment. Three items made up the first scale, with no theoretical ties between them to identify the content of the scale. In fact, the scale consisted of items designed to assess student perceptions of global differences, advocacy, emerging technologies. Indeed, the scale demonstrated poor internal consistency (α = .67 for engineers and α = .59 for the business majors). Consequently, part two of our developed instrument did not lend itself to the creation of single-scale scores as was the case with part one of the survey and no scale scores can be reported for this part of the survey.

Conclusions

As Schurr [8] has famously noted, "a profession is as good as its ethics" (p. 334). Higher education provides the training for leaders in the business and engineering professions, and any discussion of ethics in higher education must include the creation of "institutionally initiated and maintained social support systems" that can raise and resolve ongoing ethical dilemmas in the relevant contexts of culture and society [9]. Results of this survey indicate that students in engineering perceive that their ethics training is less positive than those of business students. These results are not surprising given that business schools and this College of Business in particular has done much in the last several years to include ethics in a systematic way throughout its curriculum and related experiences. Over the last 20 years, there has been a formalized ethics day for business students specifically, but advertised to the university campus at large. Course descriptions in the business courses are more likely to include ethics than are those descriptions in engineering. These results thus document existing differences in the structure of ethics education in these two colleges.

This survey also provides documentation that incorporating ethics in the curriculum and in extra-curricular activities can lead to improved student perceptions regarding their ethics training. These results provide some directions for curricular planning for colleges of engineering. These results also provide a baseline for VT's College of Engineering as it begins to increase ethics coverage in the curriculum and to involve students in ethical problem solving within their classes. In recent years, some faculty members have taken initiatives in weaving ethics instruction throughout the engineering curriculum. A NSF supported project under its department-level reform (DLR) program is an example of such an initiative [10].

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