Does Education Have an Impact on Student Ethical Reasoning? Developing an Assessment of Ethical Reasoning for Engineering and Business Students

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Abstract

This paper outlines the development and assessment of ethical reasoning for Engineering and Business students at Arkansas Tech University. The main focus of this paper is to investigate the concept of how to teach ethics and assess in a cross-disciplinary fashion whether students are improving in how they reason their way through an ethical decision-making situation. The Defining Issues Test (DIT-2) and an internally developed assessment were used as instruments. For both instruments, students respond to questions about scenarios. The methodology was thoroughly described. The findings of the characteristics of the participants in these cross-disciplinary assessments have been carefully described in the tables and figures. The analysis compares responses across classes from freshmen to seniors and did not find statistically significant differences.

Introduction

Unethical choices on the part of professionals and organizations damage individuals as well as organizations. Such choices decrease society's confidence in professionals. Universities and accrediting agencies are concerned about influencing the ethical reasoning of graduates. They have therefore initiated efforts in various existing courses and in discipline-specific courses to “teach” ethics and to assess whether students are improving how they reason their way through an ethical decision-making situation.

Faculty and researchers have been spending time and effort to search for the most effective ways to improve ethics awareness and ethical decision-making in students training for jobs in business and engineering. O’Fallon and Butterfield[1] found an enormous increase in the number of research articles in the last several years reporting on empirical research in ethical decision-making as compared to the previous forty years.

In this paper we describe a cross-disciplinary assessment designed and conducted by an engineering department and a school of business. The authors administered a well-known measure of level of moral judgment called the Defining Issues Test (DIT-2)[23] and an internally-developed assessment of ethical reasoning to undergraduate students in both the Engineering Department and the School of Business at Arkansas Tech University, a small, public Southern university. Both of these groups at ATU are accredited by the Accreditation Board for Engineering and Technology (ABET) and the Association to Advance Collegiate Schools of Business (AACSB), respectively. The analysis examines the correlations between the two types of assessment and compares the ratings between sophomore and senior class levels as well as the ratings between disciplines.

Background

Both the Association to Advance Collegiate Schools of Business (AACSB) and the Accreditation Board of Engineering and Technology (ABET) have added a requirement that any accredited program should be composed of learning experiences aimed at the development of "ethical understanding and reasoning abilities"[2] (p. 15). Business and engineering schools have responded by adding ethics courses and integrating ethics education into existing courses. In addition, Schwartz[3] reported a widespread call for the need to implement corporate codes of ethics as a result of scandals such as Enron and WorldCom. However, there also seems to be some evidence that professionals are skeptical about the effectiveness of business ethics education[4].

The Accreditation Board of Engineering and Technology (ABET) requires that any engineering school trying to acquire or maintain the engineering accreditation must meet the following condition: "engineering programs must demonstrate that their graduates have an understanding of professional and ethical responsibility"[5] (p. 4). This requirement is clearly stated in the outcomes and assessment criteria. The stated ATU Electrical Engineering Program Objectives indicate that engineers who graduate from Arkansas Tech University with a BSEE degree will be:

1. "Intellectuals - with a commitment to ***ethics*** *(emphasis added)*, social and environmental responsibility, and lifelong learning.
2. Team Players - communicating, planning, coordinating, and managing projects and personnel with efficiency and effectiveness.
3. Problem solvers - learning new concepts, techniques, skills, and tools to aid in analyzing and designing electrical engineering systems.
4. Professionals - trained and competent in the fundamentals of engineering science, applied mathematics, laboratory practice, and principles of electrical engineering."[6]

The ATU Engineering courses that specifically address ethics in their technical objectives are ELEG/MCEG 1012 – Introduction to Engineering, MCEG 2023 – Engineering Materials, MCEG 3503 – Basic Nuclear Engineering, MCEG 3023 – Manufacturing Processes, MCEG 4443- Heat Transfer, MCEG – Basic HVAC, and ELEG/MCEG 4202 – Engineering Design.

Defining Ethics

While universities are increasingly recognizing the importance of ethics as a component of their educational programs, there is no universally accepted definition of "ethics." One definition for the nature of ethics presented in *Engineering Your Future* is that "ethics is concerned with standards, rules or guidelines for moral or socially approved conduct such as being honest or trustworthy, or acting in the best interest of a society"[7] (p. 406). Oakes et al. provide as an example that a violation of ethical standards would exist if an engineer chose to use a substandard grade of materials in the construction of a bridge because of the danger to the public. In their book, they distinguish the differences between meta-ethics (the nature of ethics) and normative ethics (the recommendations of appropriate standards or guidelines for morally right or good behavior by people). They also define the nature of engineering ethics. They state that much of engineering ethics is an applied or more specific form of what could be called normative ethics, which are ethical standards which apply to any human activity or occupation.

There appears to be no universally accepted definition of "business ethics." One author reviewed eight business ethics textbooks and found eight different definitions.[8,9,10,11,12,13,14,15] Indeed, DePaul University's Ethics Across the Curricula Committee[16] has noted that it is helpful to posit that ethics are not equivalent to feelings, religion, or science, and that ethical conduct involves more than merely following the law or culturally accepted norms.

Despite the lack of agreement as to a definition of ethic, three recurring themes appear in the definitions found in these textbooks: (1) principles; (2) decision-making processes; and (3) conduct. The principles that form the foundation of business ethics can be thought of in terms of morality, i.e., what is right or wrong, good or bad.[8,9,10,13,15,16] Common ethical principles include honesty, fairness, justice, responsibility, and respect for the rights of others.[10,14,16] Jennings[14] (p. 4), offering a practical and user-friendly explanation of ethics, states: "Ethics is honesty, fairness, and justice. The principles of ethics, when honored, ensure that the playing field is level, that we win using our own work and ideas, and that we are honest and fair in our interactions with each other, whether personally or in business."

Just as ethicists have suggested different definitions of ethics, they have also presented many different decision-making models. Models tend to be an over-simplification of actual decision-making processes because a model tends to separate out different cognitive activities that are highly interdependent and may be performed at the same time.[16] An ethical decision-making model therefore may not be a reflection of actual decision-making processes in business contexts. In spite of this, in teaching ethics, professors hope to influence students' decision-making processes in ways that will result in ethical conduct. As explained by Hartman and DesJardins[12] (p. 6), ". . . students can learn and practice responsible ways of thinking and deliberating. We assume decisions that follow from a process of thoughtful and conscientious reasoning will be more responsible and ethical decisions. In other words, responsible decision making and deliberation will result in more responsible behavior." This study uses a decision model to measure whether the decision-maker is able to identify a moral dilemma, consider multiple alternative solutions, make a decision that conforms with the law and to professional and organizational codes of conduct, and consider the impact of that decision on various stakeholders.

In this study, the authors have conceptualized ethical reasoning as a moral development and normative construct rather than as content knowledge of moral theories (such as Kant, Descartes, Aristotle, Mill, etc.). The educational objective of the faculty is to prepare students to be sensitive to and recognize ethical dilemmas and then use a systematic reasoning approach and professional codes of ethics in making a decision that leads to ethical behavior.

Teaching Ethics

Engineering faculty of different universities have approached teaching ethics in a variety of ways. For instance, Cummings[17] used a Valued-Sensitive Design (VSD) approach to teach her students at Massachusetts Institute of Technology (MIT) the concept of ethical responsibility in engineering design through human-computer interaction research. In her work at MIT, she defined the major components of Value-Sensitive Design (VSD) as conceptual, technical and empirical and used a case study example which focuses on the development of a command and control supervisory interface for a military cruise missile. She concluded that her VSD methodology provides a bridge between analyzing ethical issues and the technical engineering design process. She further stated that, from an educator's viewpoint, even though VSD model could be implemented in a classroom simulation, it is probably better suited in the real world team-design projects.

Prince[18] proposed to teach Engineering Ethics using role-playing in a culturally diverse student group. In his work at York University, he stated that the city has huge diversity in its own cultural background. He began by using scripts or scenarios for his students to illustrate ethical issues. Students from various ethnic groups took on specific roles (mediator, resource, critic or provocateur) and followed those scripts in a "role-play" session. They then led group discussions based on those scenarios. He stated in his paper that once the initial shyness and reluctance of some cultures were overcome through the building of rapport in this exercise, his students were able to develop their own scenarios and write their own scripts appropriate to ethical, social and cultural factors. Prince finally stated that his innovative method is now being adopted in a short course format to assist the professional integration of foreign trained engineers.

Fleischmann[19] at Grand Valley State University School of Engineering in Michigan found that teaching ethics required more than memorizing a code of ethics. She discussed different approaches that the faculty has taken in teaching ethics as an engineer's way of life. She adapted the approach used by the U.S. Military Academy at West Point to teach this principle to her students. She introduced an adaptation of the Military Honor Code as part of a larger "Honor Concept" at the very beginning of their program. She then tried to implement that concept by making it an integral part of their preparation as engineers and teaching the students to apply the honor code in every aspect of their lives using required co-operative courses and voluntary community service experiences.

Assessing Ethics

In developing an assessment methodology, the authors considered the ways in which ethical decision-making is taught to students at their institution and the learning objectives of their programs. Both groups integrate ethics across the curriculum by introducing ethical issues and discussion of problems or hypothetical cases in different courses in ways that are relevant to the course content. For example, marketing courses include discussion of ethical issues in advertising. In the Introduction to Engineering course, students view a video depicting an ethical dilemma such as "Incident at Morales"[20], hear a lecture from the instructor, engage in a class discussion, do a reading assignment that includes other scenarios, and write a report analyzing those scenarios. Arkansas Tech University offers an elective course in business ethics that includes both education on various moral philosophies, such as utilitarianism, the Golden Rule, deontological ethics, virtue ethics, and social justice theory, and interactive discussion and decision-making based on cases and problems.

The learning objectives of both the Engineering Department and School of Business at ATU are aimed at having students identify ethical issues in professional contexts and equip them to make sound ethical decisions. Therefore, the authors identified two specific assessment objectives: ethical awareness and ethical reasoning. While ethical conduct is the goal of ethics education, the authors believe that such conduct cannot be measured effectively through convenient approaches such as written instruments administered in a classroom setting. Written assessments can measure students' self-reported behaviors as to what choices they might make, but such assessments cannot measure actual conduct. Instead, our assessment focuses on ethical awareness and reasoning skills that may influence future behavior.

Defining Issues Test 2

The Defining Issues Test version 2 (DIT-2) is consistent with the approach described above and has been used to examine the relationship between moral reasoning and personal values among undergraduate business students.[21] The DIT-2 and its predecessor have been employed in numerous (hundreds or maybe even thousands) research studies and has known validity and reliability characteristics as well as normalized data.[22,23] For this reason, the DIT-2 was selected as a means to validate the internally-developed instrument. For example, the DIT-2 was used in a study of Information Systems (IS) students which found that students who had a higher stage of reasoning on the DIT-2 were better able to recognize unethical behavior in scenarios similar to the ones being used in this study.[24]

Do students consider multiple alternatives and stakeholder perspectives? Do they consider the consequences of implementing each of the alternatives on the various stakeholders? Are the students able to readily apply a systematic approach to thinking their way through to an ethical decision in the presence of stress due to time pressure, political pressure, or other complications? The DIT-2 does not provide a great deal of information about the actual reasoning process that students use in arriving at an ethical decision. The internally-developed essay-question response rating is designed to provide diagnostic insight into this decision-making process to guide faculty in making adjustments to the curriculum for improving such decision-making processes.

The DIT-2 instrument is a revision of the original DIT developed by Dr. James Rest[23] and is distributed by the University of Minnesota's Center for the Study of Ethical Development. The instrument consists of a number of short scenarios illustrating ethical dilemmas and elicits responses to closed questions about these scenarios. The instrument is based on Kohlberg's research and theories concerning six identified stages of moral development and reasoning.[25,26,27,28] The instrument takes up to forty-five minutes to complete. The Center for the Study of Ethical Development at the University of Minnesota publishes this instrument, provides scoring and analysis services, and maintains norming data as well.

Scenarios

Gilbane Gold is a hypothetical case that describes a dilemma faced by David Jackson, an engineer at the Z-Corp manufacturing plant.[29] This engineer is dealing with the level of contamination in sludge sold by a city to be used by farmers for fertilizer. The city uses the income from these sales to lower the tax burden on citizens. Jackson must deal with the measurement of the level of toxic waste that his employer discharges into the city's sewer system. The possible outcomes include consequences such as threats to company profitability, plant viability, public health risks, city revenues, and the city's taxpayers. Because this scenario is appropriate to both business and engineering students, it facilitates cross-disciplinary efforts in assessing student learning in this area. *Gilbane Gold*, is also in the public domain.

There are a number of cases that could be part of an assessment instrument that sets the scene for an ethical decision. One such scenario is called *Ardnak Plastics.*[30] This relatively short passage is a description of a situation in which a plant manager must plan a course of action involving a pollution problem in smoke-stack emissions. Possible outcomes include consequences such as considerable extra expenses, unfavorable legal sanctions, plant closure with loss of jobs, loss of a professional engineer license, unfavorable publicity, and health risks to the general population. This scenario is available in the public domain in a form adapted by Schwab[32] from *Something's Rotten in Hondo*, an Arthur Andersen Ethics in Business case by J. Fraedrich.

Other example cases include *This Land Is Your Land, It's Right by My Land*[31] and *Design/Build – A TE/STI Relationshpi*.[32] The first case describes a situation in which an engineer and a project manager must get a subdivision platted, designed, and built in a compressed time frame. In the second case, a principle engineer must design an intelligent transportation system to relieve traffic congestion and improve safety. There are numerous other examples of cases which illustrate the importance of ethics in professional engineering settings. These cases are used in engineering departments in an attempt to facilitate a discussion of ethics involving an engineer with whom students might identify.

Methodology

The authors coordinated the ethics assessment activity during the spring 2008 term. Undergraduate students from both disciplines and in freshman- or sophomore-level classes and senior-level classes participated in a required in-class activity. Collecting responses from students at the beginning and at the end of their academic programs will allow an evaluation of whether the college experience makes any difference in students' ethical decision-making process.

In the first session, the participants filled out a demographic questionnaire. They then either watched a video version or read a transcript of the *Gilbane Gold* scenario. Finally, they responded to a set of questions about that situation. These questions were developed as part of a pilot study conducted in the fall of 2007. The questions use the dilemma facing David Jackson, the Z-Corp engineer in the case.

1. What are the goals and objectives David Jackson should consider?
2. What alternatives should David Jackson consider?
3. What should David Jackson do and why?
4. Who will be affected by this decision?

Students were not alerted to address ethical issues in their answers because one of the purposes of the study was to determine whether students would identify the existence of ethical issues without being prompted to do so.

In a second and separate session, these same students responded to the DIT-2 instrument. The participants recorded their student identification numbers in both sessions so that their responses could be combined. Students were promised confidentiality on their individual responses and access to their DIT-2 scores on request. To improve motivation, students were awarded class participation points and additional points based on the quality of their responses as determined by the instructor of their respective courses.

Each student response sheet was labeled with a randomly generated identification code on the name/demographic sheet and the short-answer question response sheet. These two sheets were separated and the short-answer question response sheets were sorted into numeric order. Copies of the re-ordered short-answer question response sheets were distributed to a panel of trained raters. This approach limited the ability of the raters to know whether the students were seniors or sophomores, engineering or business students, or to guess the identity of the respondents.

The raters and the authors conducted an initial short frame-of-reference training session using three sample responses[33,34] and a four-dimension rating scale (identification of the ethical dilemma, consideration of stakeholder viewpoints, identification and analysis of alternatives, and consequences; scale available on request). The authors had previously developed an anchoring rubric for the rating points, which were grouped by twos into four categories: unacceptable, marginal, acceptable, and exemplary. This resulted in an 8-point scale, which the raters then used to rate the rest of the responses independently.

Analysis and Findings

The Table 1 describes the characteristics of the participants in this study. There were 198 participants and 191 usable responses due to missing data or responses purged by the Center for the Study of Ethical Development analysis due to inconsistent or missing responses.

Table 1 Participant Demographic Data

	Major		Class
Management/Marketing	79	Freshman	16
Economics/Finance	29	Sophomore	60
Accounting	26	Junior	39
Business Education	3	Senior	76
Total School of Business	**137**	**Grand Total**	**191**
Mechanical Engr.	12		
Electrical Engineering	15		**Gender**
Total Engineering	**27**	Female	72
Agri. Business	12	Male	113
Hospitality Admin.	6	Undeclared	6
Emergency Admin. Mgmt.	2		**191**
ComSc/IS/IT	2		
Total Systems Sci	**22**		**Citizenship**
General Education	1	United States	174
Pre-Law	1	Japan	13
Pre-Vet	1	Vietnam	1
General undeclared	2	China	2
Total Other	**5**	Nigeria	1
Grand Total	191	**Grand Total**	**191**

DIT-2 Comparison of Classification Levels for All Majors in the Sample

The results for the DIT-2 test for (undergraduate) college classification level are displayed in Tables 2 and 3 and Figure 1. Table 2 contains the means and standard deviations on the DIT-2 test while Table 3 reports the results of an ANOVA test. Finally, Figure 1 uses box plots to display the data visually. The ANOVA test did not produce statistically significant results using the traditional (alpha = 0.05) cutoff.

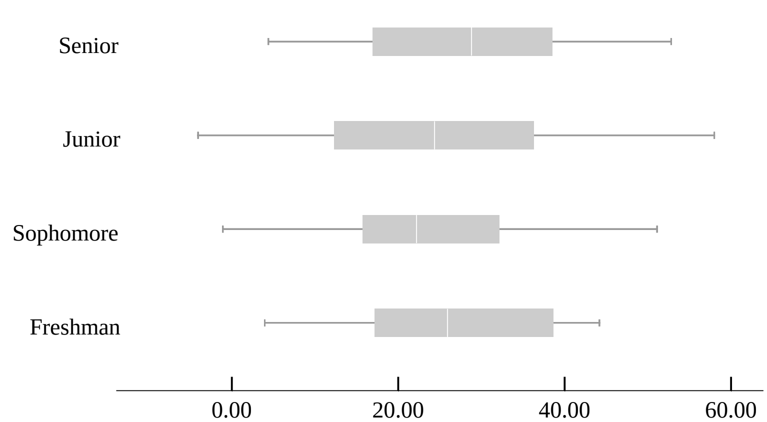
Table 2 - Descriptive Statistics for DIT-2 and College Level

	n	Mean	Standard Deviation
Freshmen	16	26.36	12.36
Sophomores	60	24.19	12.03
Juniors	39	24.30	15.19
Seniors	76	28.47	12.61
Total	191	25.81	12.34

Table 3 - ANOVA table for the Effect of College Level on DIT-2 Scores

	Sum of Squares	*df*	Mean Square	F	p-value
College Level	785.85	3	261.95	1.535	.207
Error	31902.26	187	70.60		
Total	32688.12	190			

Figure 1 - Descriptive Statistics for DIT-2 and College Level



DIT-2 Comparison of Classification Levels for Engineering Majors

The results for the DIT-2 test for (undergraduate) college classification level are displayed in Table 4 and 5 as well as Figure 2. Figure 2 visually shows range, variation, and groupings. Because of the small sample size, Table 5 shows that the freshmen and sophomores were combined into one group and the juniors and seniors were combined into another group for the analysis. Using a two sample t-test, there was no significant difference between the two groups (p-value = .085). The statistical analysis found no difference in class levels on the N2 measure of the DIT-2. This finding suggests that the students were stable in their solutions to ethical dilemmas as they progressed through the curriculum.

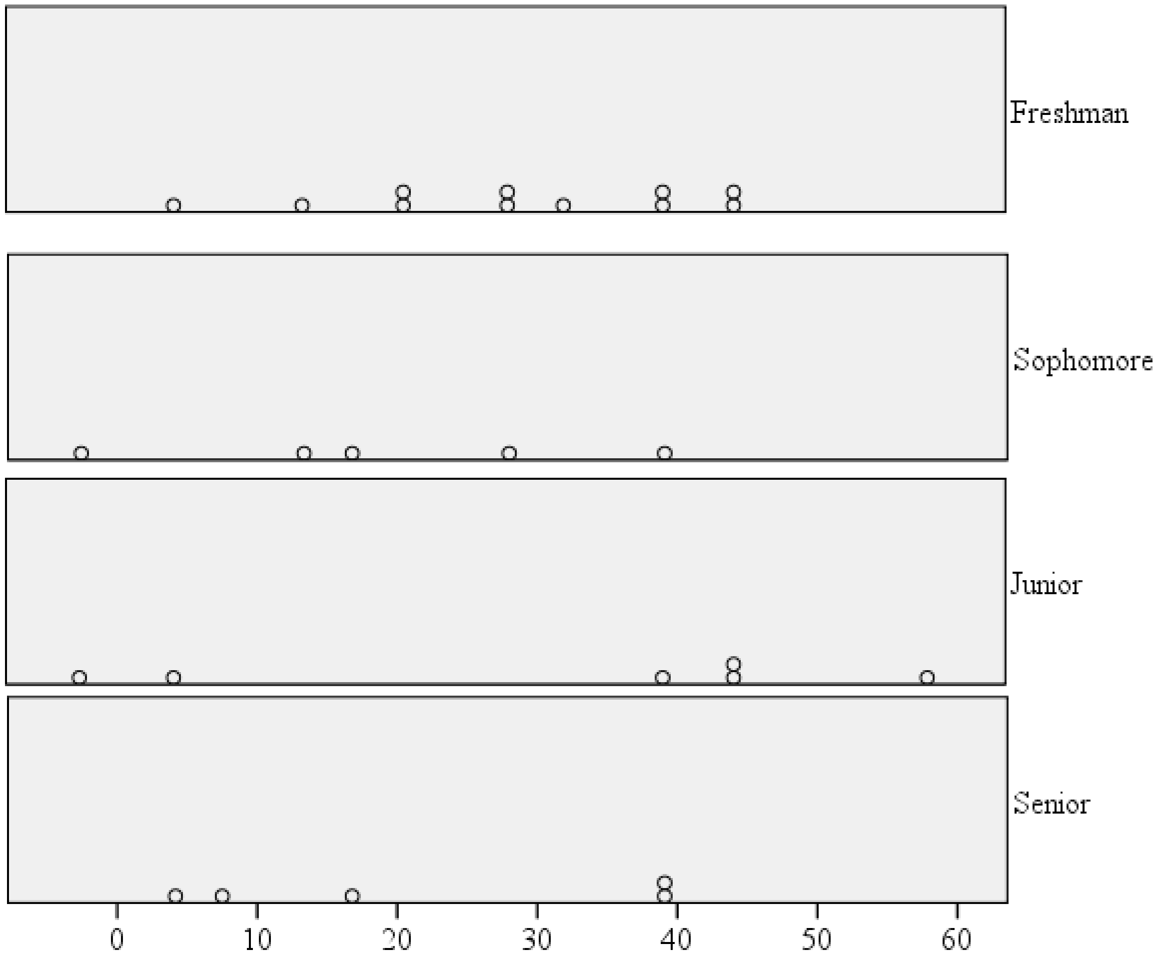
Table 4 - Descriptive Statistics for DIT-2 and College Level for Engineering Majors

	n	Mean	Standard Deviation
Freshmen	11	28.60	12.65
Sophomores	5	18.43	14.98
Juniors	6	31.11	25.02
Seniors	5	21.35	16.47
Total	27		

Table 5 - Descriptive Statistics for Engineering Majors on the DIT-2 by College Level

	n	Mean	Standard Deviation
Freshmen and Sophomores	16	25.42	13.79
Juniors and Seniors	11	26.68	21.16
Total	27	25.93	16.8

Figure 2 - Dot Plot for Engineering Majors



DIT-2 Comparison of Between Engineering and Business Majors

The results for the DIT-2 test for (undergraduate) between Engineering and Business majors are displayed in Table 6 and 7 as well as Figure 3. The statistical analysis found no difference between these two groups. The p-value for difference between population means was 0.69 (not a significant difference). In general, both sets of students reacted to the materials in equivalent ways.

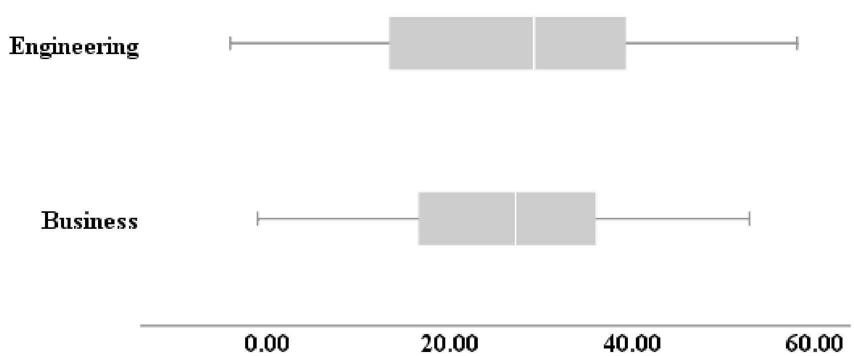
Table 6 - Descriptive Statistics for DIT-2 for Engineering and Business Majors

Major	n	Mean	Standard Deviation
Business	134	27.07	12.69
Engineering	27	25.93	16.80
Overall (Business and Engineering Majors)	161	26.87	13.41

Table 7 – T-Test table for the Effect of Major on DIT-2 Scores

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
N2 Score	Equal variances assumed	7.078	.009	.737	118	.463	1.93	2.61	-3.25	7.10
	Equal variances not assumed			.683	66.254	.497	1.93	2.82	-3.70	7.55

Figure 3 - Box Plots for DIT-2 and College Level for Engineering and Business Majors



Preliminary Findings for Gilbane Gold Essay Ratings: A Comparison of Classification Levels for All Majors in the Sample

Ratings for the essays were more time consuming, and that data is just now being analyzed. Preliminary findings on the entire sample indicate that the trend in ethical reasoning is in the desired direction for every dimension addressed by the rating rubric. For many dimensions, there is a significant improvement somewhere between the freshman and junior levels. This improvement could reflect the impact of general education and/or introductory courses in the student's major field. Then, for all dimensions, there is another significant improvement between the junior and senior levels. This improvement could reflect the impact of the upper-division courses that each student completes for his or her specific degree. Taken together with the finding that there were no differences in mean scores on the DIT-2, the claim that the improvements are related to learning (in school) is strengthened.

Discussion

In general, this study found no differences using the DIT-2 instrument but did detect improvements in ethical reasoning using the Gilbane Gold essay instrument. One possible explanation is that a number of engineering freshmen were purged from the analysis for inconsistent responses, perhaps affecting the outcome. In addition, freshmen may be less adept at taking these types of tests or may have less developed reasoning skills in general. Seniors may have tried harder than other groups on the essay responses, perhaps because they identified with the program and program instructors. To the extent that this explanation is true, the results may simply reflect greater effort on this task by seniors rather than a true learning effect. The fact that the improvement trend (whether or not there were statistically significant differences) occurred at every stage along the way strengthens the claim that the improvements are related to learning (in school).

Another explanation is that the findings are due to limitations in the research design. Because this study was cross-sectional, we do not know how these particular seniors might have responded to the DIT-2 when they were freshmen. These particular seniors might actually have improved their moral reasoning. And, of course, a third (albeit less desirable) explanation is that the university's curriculum had no impact on the students' ethical reasoning.

Limitations

There are several limitations to these findings. Because this study was exploring methods for assessing the program objective of graduating engineering professionals with a commitment to ethics and social responsibility, the sample size was small. Although the sample was generally representative of the engineering student population as a whole at this university, respondents were selected for participation on a basis of convenience rather than randomization. The DIT-2 is a self-report instrument and does not involve observations of actual student behavior. A significant number of freshman responses were purged from the DIT-2 for inappropriate or illogical patterns in the answers. This study was cross-sectional. Longitudinal measures of the same students over time might result in a different finding.

Implications for Curriculum

The implication of the curriculum for the course of ELEG/MCEG 1012 Introduction to Engineering involves the following. First, in order for the students to get interested in the topics of engineering ethics, a movie production of "Incident at Morales - an Engineering Ethics Story" by the National Institute for Engineering Ethics[20] will be played in class. Afterward, a class open–forum discussion of the movie content will be conducted by the instructor. Then, the instructor will deliver a lecture corresponding to the Chapter 15 "Ethics and Engineering" from *Engineering Your Future*.[7] Students will read this chapter material after the lecture. At this point, students will have more detailed knowledge of engineering ethics. Depending on student's major, the instructor will then distribute the Code of Ethics of either ASME (American Society of Mechanical Engineering) for Mechanical Engineering students or IEEE (Institute of Electrical Engineer) for Electrical Engineering students. The instructor will run an in-class exercise and activity centered on the engineering disaster case study "Ford Pinto Car Design." Students will use their professional society-specific Code of Ethics to identify at least three ethical violations for the "Ford Pinto Car Design" case study and document their respective findings in their Engineering Weekly Report.

Directions for Future Research

The directions for future research include increasing sample size and taking longitudinal measures. This study was primarily an exploratory effort to evaluate the feasibility of one approach to assessing student learning with respect to ethical reasoning. In future, we plan to increase the sample size to include more engineering students. Over time, we will be able to collect data from the same students at the beginning of their college experience and at the end as they complete the coursework for their degree. We plan additional analysis of DIT-2 sub-scores and the essay responses as well as a cross-examination of the results from the two instruments to ensure the completeness of the study. We could use randomization and control groups to take measures from students who do and do not experience curriculum interventions to evaluate the effectiveness of curriculum interventions as described in the previous section. We could also try different case scenarios and different questions to prompt students to show other aspects of their ethical reasoning process.

Conclusion

Both the summary statistics and the box plots support the notion that there are little to no differences for the freshman, sophomore or junior years in the DIT-2 scores. There is, however, a decided increase in the scores for seniors. The Gilbane Gold essay instrument did detect improvements overall in ethical reasoning from freshman to senior years. Though we did not hypothesize a "senior" effect, its presence, if confirmed and examined further in future research, is interesting. Possible explanations for a senior effect are (a) the cumulative effect of four years of college, (b) increasing identification with one's profession as education proceeds from general education to degree-specific courses, or (c) "sudden" maturation as the student realizes that he/she will soon be in the real world.

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