

Evaluating the Impact of Ethics Instruction on Student Awareness

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Dr. William P. Schonberg, P.E., is Professor and Chair of the Civil, Architectural, and Environmental Engineering Department at the Missouri University of Science and Technology (formerly known as the University of Missouri-Rolla). Dr. Schonberg has 25 years teaching and research experience in the areas of shock physics, spacecraft protection, hypervelocity impact, and penetration mechanics. He received his B.S.C.E from Princeton University in 1981, and his M.S. and Ph.D. degrees from Northwestern University in 1983 and 1986, respectively. The results of his research have been applied to a wide variety of engineering problems, including the development of orbital debris protection systems for spacecraft in low earth orbit, kinetic energy weapons, the collapse of buildings under explosive loads, insensitive munitions, and aging aircraft. Since 1986, Dr. Schonberg has published over 65 papers in refereed journals on these topics, and has presented nearly 65 papers at a broad spectrum of international scientific and professional meetings, including several invited papers. To date, Dr. Schonberg has received over 35 contract and grants from a variety of federal, state, local, and private funding agencies, including the U.S. DoT, NASA, the Air Force Office of Scientific Research, the Army Research Office, Sandia National Laboratories, the U.S. Army Missile Command and the Engineering Foundation. In 1995 Dr. Schonberg received the AIAA's Lawrence Sperry Award for his work on the design of spacecraft protection systems. In 1998, Dr. Schonberg was promoted to the membership rank of Associate Fellow in the AIAA and in 2000 was selected to receive the Charles Beecher Prize for one of his recent papers on orbital debris protection systems from the Aerospace Sciences Division of the Institute of Mechanical Engineers in England. In 2004 and 2005, he was promoted to the member rank of Fellow of the American Society of Civil Engineers and the American Society of Mechanical Engineers, respectively. In 1997, he was a member of the National Research Council's Committee on Space Shuttle Micro-Meteoroid/Orbital Debris (MMOD) Risk Management, and in 2004 he served on NASA's Independent MMOD Risk Assessment Tool Validation and Verification (V&V) Committee. In 2007, Dr. Schonberg received a Friedrich Wilhelm Bessel Research Award from the Humboldt Foundation in Germany. This award enabled him to spend seven months at the Fraunhofer Ernst Mach Institute in Freiburg, Germany working on advanced MMOD protection systems for satellites and developing preliminary designs for safe lunar habitats using in-situ

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Dr. Patrick Gamez

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Abstract

Engineers must frequently make decisions during their careers without understanding or knowing the full set of consequences. These decisions can have unintended or harmful results. Therefore, it is imperative that engineers consider the ethical dimensions of their decisions while working to satisfy their employer's interests even if these decisions conflict with their organization's objectives or their own goals. Engineers have a responsibility to uphold a level of ethical standards that produces trust in not only their organization but also in their profession. Students entering the workforce must reflect the same level of ethical standards expected of their profession. Therefore, it is crucial to educate students on the importance of ethics and its impact on their future careers. This research examined the impact of ethics training in an upper-level engineering course consisting of 156 students. Students were presented with several scenarios that required them to make ethical judgments in the role of an engineer. A questionnaire, which evaluated the degree of ethical behavior of the students, was distributed at the start of the study. The same questionnaire was administered to the students after attending an educational session on ethics and ethical considerations in the engineering workplace. The responses were analyzed using the Chi-square test of independence and Wilcoxon signed-rank test to assess if ethics training had a significant impact on the ethical perspectives of the engineering students.

Introduction

The large amounts of capital and stakeholders involved in each stage of a construction project have made the industry vulnerable to unethical practices and have made the construction industry one of the most fraudulent industries in the world (Transparency International, 2005). Unethical practices such as bribery, bid-rigging, tender-manipulation, and conflicts of interest are increasingly prevalent in the construction industry (Adnan et al., 2012). Unethical practices lead to a waste of economic resources, missed opportunities for other businesses, and poor quality of completed projects (Rahman et al., 2007). Despite the reduction in the overall number of industrial accidents, the number of fatalities in the construction industry has risen (Adnan et al., 2012). Unethical behavior by engineers can erode the public's trust in not only their employers, but also in their professional fields. Therefore, it is important to educate the next generation of engineers on ethical decision making.

Ethics training in recent years has included various forms of ethics education including case studies, online programs, and role-playing. Engineering ethics education covering both moral ethics and professional ethics has been delivered through general and discipline-specific curricula (Abate, 2011). It is important for students to develop not only an understanding of ethical principles, but also the skills to make ethical decisions in a complex work environment with uncertain consequences. This paper examines the impact of ethics training in a class of civil engineering students. Several hypothetical ethical dilemmas from the construction industry were used to educate the students. The remainder of this paper is organized as follows. First, a literature review of current studies evaluating ethics training in higher education is presented. Next, the method of conducting the study is discussed and presented along with the results of the Wilcoxon matched-pairs signed-rank test and Chi-square test of independence of the students' responses to an ethics pre- and post-survey. Finally, a discussion of the significance of the results, their implications, and directions for future research are offered.

Literature Review

Zhu and Jesiek (2017) present a review of current approaches to ethics education in engineering and propose a more practical approach to ethics education with a focus on real-world problems faced by engineers. A case study format to ethics training is recommended by Abate (2011), who cautions against equating ethics training with morality, arguing that training based on morals itself cannot equate to the benefits of a case study approach that will force the students to use analytical and critical thinking, and pattern recognition to solve ethics problems. A review of several historic cases involving engineers is presented by Billington (2006) to illustrate the ethical issues that engineers face in various engineering disciplines. Perri et al. (2009) present a methodology for ethics instruction where students analyze various ethical situations in different contexts and choose ethical solutions to those situations. Alpay (2013) presents a student-centered pedagogical method for ethics education where the students select the ethics education activities that are related to their discipline.

van der Burg and van de Poel (2005) describe the development and features of a web program that students can use to train their ethical understanding and skills using case studies. A study by Chung and Alfred (2009) analyzing different forms of engineering ethics training showed a 32% statistically significant improvement in student scores for the group using an interactive multimedia web-based training simulator compared to the group provided with non-interactive web-based resources.

A study to examine the impact of ethics education on the moral reasoning of students by May and Luth (2013) revealed that ethics education in engineering had a positive effect on the students. However, a study conducted by Jones and McGuire (2016) did not find any significant impact of business ethics education on the students' response to ethical situations. Bairaktarova and Woodcock (2017) present a model that measures the ethical awareness of the students and predicts their ethical behavior.

The existing studies have investigated training methods, modes of instructions, impacts of ethics education, and measured ethical awareness of students in higher education. These studies have been useful to develop questions regarding ethical work practices and workplace scenarios for the current study.

Methods

The study was carried out using a cohort of 156 civil engineering students enrolled in a required senior seminar. The data were collected using surveys in the 2018 fall semester at Missouri University of Science and Technology. The surveys were disseminated to students using the Qualtrics online survey platform. The questionnaire contained 19 scenarios based on regular ethical work practices and workplace situations such as handling contract bidding, employer and client interests, contractor relations, and several additional similar scenarios identified through the literature review that are typically encountered by civil engineers. The students were asked to respond to each statement using a 5-point Likert scale including strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, and strongly agree. The statements are provided in Table 1.

Table 1. Survey Statements

QID	Statements
1	It is important to adhere to applicable laws and regulations even when unethical actions cannot be traced back to you.
2	Your obligation to your employer is secondary to your obligation to society.
3	During an open bid for a project, it is acceptable to work with other contractors to determine their bids.
4	It is acceptable to underbid on a contract and then add extras as you anticipate your subcontractors will do the same.
5	It is normal to show a subcontractor a rival's bid to obtain the best price for your firm.
6	As long as one's actions are not illegal, they are ethical.
7	Bad decisions made from ignorance are just as unethical as those from greed.
8	The degree of your ethical behavior is influenced by that of your peers.
9	It is okay to share confidential information with one's partner if he/she does not work in the same industry.
10	It is more important to be ethical on public projects than private projects as you are spending tax dollars on the former.
11	One must place their client's interests before his/her employer's interests.
12	Slight misrepresentations of one's qualifications is acceptable if they can be easily acquired when needed.
13	It is sometimes acceptable to give small gifts to officials as it is not equivalent to bribing because you have no intention of swaying the official's decision on your project.
14	It is important to intervene when you see a colleague participating in unethical activities.
15	It is appropriate to accept small gifts from contractors who are bidding on your firm's projects.
16	Inappropriate behavior outside one's work environment reflects poorly on his/her employer.
17	It is acceptable to take travel funding from companies bidding for your firm's projects.
18	In a competitive bidding environment, it is acceptable to spread negative rumors about your firm's rivals as they are probably doing the same.
19	It is acceptable to take clients with you when moving from one firm to another.

The study used a within-subjects pre- and post-survey design to evaluate the impact of an ethics lecture on the perspectives of a group of civil engineering students enrolled in a one-hour senior seminar course. The ethics lecture provided an overview of the following topics:

- What is the difference between ethics and morality?
- What do we mean by “profession”? What is a professional?
- Why do we have engineering registration / licensure?
- What are the basic tenets of the engineering profession?
- What are the seven canons of the ASCE Code of Ethics?
- What are the consequences of an ethics violation?

Further, eight scenarios that engineers might encounter in the workplace were discussed. These scenarios addressed the following topical areas:

- Information sharing with the general public

- Change orders and cost increases
- Subject matter competency
- Responsibility to society
- General vs specific experience and training
- Need for professional registration
- Bidding irregularities
- Insider information

The Wilcoxon matched-pairs signed rank test was used to analyze if the ethics lecture had a significant impact on the median responses of the students between the ethics pre- and post-survey. The Wilcoxon matched-paired signed rank test was selected for the analysis as the survey compares matched samples for the pre- and post-survey. The null hypothesis of the Wilcoxon matched-pairs signed rank test for each question is that there is no difference in the median response of the students from the ethics pre-survey to the post-survey.

The Chi-square test of independence was used to analyze if the ethics lecture resulted in a difference in the distribution of the student response between the ethics pre- and post-survey. The null hypothesis is that there was no difference in the response pattern between the pre- and post-survey.

Results

The data were processed by excluding incomplete surveys and responses of participants who did not complete both the pre- and post- seminar surveys. A total of 156 completed surveys were available from the pre-survey, and 143 completed surveys was available from the post-survey. Only 75 student responses (48.1%) to the pre- and post-seminar surveys could be paired for the Wilcoxon matched-pairs signed rank test. The Wilcoxon matched-pairs signed rank was used to analyze the change in median responses from the pre-survey to the post-survey; the non-parametric version of the paired test was used as the pre- and post-surveys were given to the same group of students. A significance level of 0.05 was used for the analysis. The number of paired responses to the questions in each category of the scale used and Wilcoxon matched-pairs signed rank values are presented in Table 2.

Table 2. Wilcoxon Matched-pairs Signed-Rank Test Results

QID	Questions	Strongly disagree		Somewhat disagree		Neither agree nor disagree		Somewhat agree		Strongly agree		WSR Significance
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	
1	It is important to adhere to applicable laws and regulations even when unethical actions cannot be traced back to you.	2	3	1	1	2	2	3	2	67	67	0.763
2	Your obligation to your employer is secondary to your	4	7	5	10	8	5	17	15	41	38	0.212

	obligation to society.											
3	During an open bid for a project, it is acceptable to work with other contractors to determine their bids.	43	53	25	11	3	11	3	0	1	0	0.306
4	It is acceptable to underbid on a contract and then add extras as you anticipate your subcontractors will do the same.	43	55	23	17	5	3	2	0	2	0	0.003*
5	It is normal to show a subcontractor a rival's bid to obtain the best price for your firm.	58	58	15	8	2	8	0	0	0	0	0.397
6	As long as one's actions are not illegal, they are ethical.	55	54	16	18	3	2	0	1	1	0	0.975
7	Bad decisions made from ignorance are just as unethical as those from greed.	3	3	19	14	9	6	25	15	19	36	0.112
8	The degree of your ethical behavior is influenced by that of your peers.	15	18	9	12	13	5	27	29	10	11	0.907
9	It is okay to share confidential information with one's partner if he/she does not work in the same industry.	41	48	23	21	7	1	4	5	0	0	0.143
10	It is more important to be ethical on public projects than	38	37	16	20	9	8	7	3	5	7	0.909

	private projects as you are spending tax dollars on the former.											
11	One must place their client's interests before his/her employer's interests.	1	5	19	24	23	19	23	14	9	13	0.197
12	Slight misrepresentations of one's qualifications is acceptable if they can be easily acquired when needed.	43	47	16	23	11	2	4	3	1	0	0.085
13	It is sometimes acceptable to give small gifts to officials as it is not equivalent to bribing because you have no intention of swaying the official's decision on your project.	31	43	20	13	9	13	13	5	0	1	0.197
14	It is important to intervene when you see a colleague participating in unethical activities.	0	0	0	0	3	2	22	12	50	61	0.011*
15	It is appropriate to accept small gifts from contractors who are bidding on your firm's projects.	40	45	19	15	12	10	4	5	0	0	0.706
16	Inappropriate behavior outside one's work environment	0	1	4	1	3	5	24	26	44	41	0.589

	reflects poorly on his/her employer.											
17	It is acceptable to take travel funding from companies bidding for your firm's projects.	41	47	21	18	11	8	2	1	0	0	0.125
18	In a competitive bidding environment, it is acceptable to spread negative rumors about your firm's rivals as they are probably doing the same.	71	66	1	4	2	5	1	0	0	0	0.194
19	It is acceptable to take clients with you when moving from one firm to another.	20	35	12	16	27	13	13	8	3	3	0.002*

There was a significant difference in the median responses on the acceptability of underbidding on contracts with the anticipation of adding extras in the future ($p = 0.003$), which indicates that the ethics lecture may have enabled more students to make ethical choices during a bidding process (QID4). The hypothesis that the ethics lecture had no effect on the median responses for intervening when witnessing unethical activities can be rejected (QID14, p -value 0.011) as more students leaned towards making the ethical choices in the post-lecture survey. The lecture had a significant impact (QID19, p -value 0.002) on the median student responses for the acceptability of taking clients when moving firms.

The Chi-Square test does not require a paired comparison. Therefore, all pre- and post-survey data was used for the analysis. The number of responses to the questions in each category, and Chi-Square test values are presented in Table 3.

Table 3. Chi-Square Test Results

QID	Questions	Strongly disagree		Somewhat disagree		Neither agree nor disagree		Somewhat agree		Strongly agree		Chi-Square Exact Significance
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	
1	It is important to adhere to applicable laws and regulations even when unethical actions	5	6	3	4	3	4	10	5	135	123	0.752

	cannot be traced back to you.											
2	Your obligation to your employer is secondary to your obligation to society.	14	11	11	13	17	8	37	29	77	81	0.385
3	During an open bid for a project, it is acceptable to work with other contractors to determine their bids.	85	100	38	22	22	18	10	3	1	0	0.027*
4	It is acceptable to underbid on a contract and then add extras as you anticipate your subcontractors will do the same.	98	107	41	26	10	6	5	2	2	1	0.217
5	It is normal to show a subcontractor a rival's bid to obtain the best price for your firm.	113	113	27	15	14	12	2	1	0	1	0.394
6	As long as one's actions are not illegal, they are ethical.	111	103	37	33	5	5	2	2	1	0	0.995
7	Bad decisions made from ignorance are just as unethical as those from greed.	9	6	35	28	21	16	51	41	40	51	0.434
8	The degree of your ethical behavior is influenced by that of your peers.	35	35	25	23	19	13	56	55	20	17	0.916
9	It is okay to share confidential information with one's partner if he/she does not	84	84	43	43	17	9	10	6	2	1	0.551

	work in the same industry.											
10	It is more important to be ethical on public projects than private projects as you are spending tax dollars on the former.	84	82	34	31	18	14	14	11	6	5	0.968
11	One must place their client's interests before his/her employer's interests.	6	10	41	35	50	39	43	37	16	22	0.457
12	Slight misrepresentations of one's qualifications is acceptable if they can be easily acquired when needed.	93	95	35	35	17	6	10	7	1	0	0.154
13	It is sometimes acceptable to give small gifts to officials as it is not equivalent to bribing because you have no intention of swaying the official's decision on your project.	76	86	38	28	18	22	21	6	1	1	0.026*
14	It is important to intervene when you see a colleague participating in unethical activities.	0	1	1	0	3	5	46	26	106	111	0.056
15	It is appropriate to accept small gifts from contractors who are bidding	86	90	38	29	17	16	14	7	1	1	0.581

	on your firm's projects.											
16	Inappropriate behavior outside one's work environment reflects poorly on his/her employer.	0	2	7	2	7	8	56	48	86	83	0.294
17	It is acceptable to take travel funding from companies bidding for your firm's projects.	74	82	43	29	27	24	10	7	1	0	0.352
18	In a competitive bidding environment, it is acceptable to spread negative rumors about your firm's rivals as they are probably doing the same.	138	125	11	6	4	12	2	0	1	0	0.042*
19	It is acceptable to take clients with you when moving from one firm to another.	43	46	29	42	56	37	24	13	4	5	0.055

Student responses were significantly different between the pre-survey and post-survey when asked whether it is acceptable to work with other contractors to determine their bids (QID3, p -value 0.027). There was a significant change in the response pattern on the acceptability of giving small gifts (QID13, p -value 0.026) with more ethical choices in the post-survey. The lecture also had a significant impact on the student responses for the acceptability of spreading negative rumors about rival companies with significant differences (QID18, p -value 0.042) in student responses between the pre-survey and post-survey, since a greater number of students leaned towards making ethical choices after attending the ethics lecture. There was no significant change in the student responses for the other questions. The majority of students were already making ethical choices for most of these questions, indicating a good sense of ethical integrity among the students.

Conclusion and Limitations

This study evaluated the impact of an ethics seminar on the students' awareness and perspectives towards ethical work practices in the engineering field. The Wilcoxon signed-rank test was used to evaluate the impact of ethics training on student perspectives. The Chi-Square test was used to analyze the differences in responses to various ethical scenarios and practices pre- and post-ethics training. This study suggests that most engineering students made ethical choices even

before the ethics training for a majority of the scenarios. This study can be used to model ethics training programs at engineering institutions. However, this study has a few limitations that need to be considered. The study was conducted across only a single classroom of senior engineering students from the civil engineering department. The time period of evaluation was also restricted to one semester. Conducting the study across multiple semesters and using students from different departments for the study may provide more information about the impact of the ethics lecture. Evaluation of different modes of instruction and development of interactive case study approaches will be considered for future work.

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