122nd ASEE Annual Conference & Exposition
June 14 - 17, 2015
Seattle, WA
Making Value for Society
Paper ID #13026

Assessing the Ethical Development of Students in an Undergraduate Civil Engineering Course using a Standardized Instrument

Dr. Donald D. Carpenter, Lawrence Technological University

Donald D. Carpenter, PhD, PE, LEED AP is Professor of Civil Engineering at Lawrence Technological University where he teaches courses on ethics/professionalism and water resources. Dr. Carpenter has served as the University Director of Assessment and the founding Director of the Center for Teaching and Learning. He conducts funded pedagogical research and development projects, has published numerous engineering education papers, and provides faculty development workshops on effective teaching. In 2006, the Kern Family Foundation named Dr. Carpenter a Kern Fellow for Entrepreneurial Education recognizing his efforts to bring innovative team based problem solving into the engineering curriculum to promote the entrepreneurial mindset. In addition to his work on ethics and entrepreneurial skills, Dr. Carpenter is an accredited green design professional (LEED AP) and practicing professional engineer. As founding Director of the Great Lakes Stormwater Management Institute, he conducts research on water management and routinely provides professional lectures/short courses on innovative stormwater treatment design and its role in Low Impact Development implementation.

Dr. Janel Sutkus, Carnegie Mellon University

Dr. Janel A. Sutkus is Director of Institutional Research and Analysis at Carnegie Mellon University, where she is responsible for analysis and assessment of administrative and academic functions university-wide and within CMU's colleges. She holds a Ph.D. in organizational behavior and management from the Center for the Study of Higher and Postsecondary Education at the University of Michigan, a Master of Arts degree in Higher Education Administration from the University of Iowa, and a Bachelor of Arts degree in psychology and music from Cornell College.

Dr. Sutkus currently serves as lead methodologist on a multi-institutional, NSF-funded study to examine the relationship between engineering undergraduates' ethical development and their curricular and extra-curricular experiences and institutional culture. She is a member of the Association for Institutional Research, the Association for the Study of Higher Education, and the Association of American Universities Data Exchange.

Dr. Cynthia J. Finelli, University of Michigan

Dr. Cynthia Finelli, Director of the Center for Research on Learning and Teaching in Engineering and research associate professor of engineering education at University of Michigan (U-M), earned B.S.E.E., M.S.E.E., and Ph.D. degrees from U-M in 1988, 1989, and 1993, respectively. Prior to joining U-M in 2003, she was the Richard L. Terrell Professor of Excellence in Teaching, founding director of the Center for Excellence in Teaching and Learning, and associate professor of electrical engineering at Kettering University. In her current role, she coordinates faculty and TA professional development in the College of Engineering, conducts rigorous engineering education research, and promotes the growth of engineering education both locally at UM and nationally. Dr. Finelli's current research interests include evaluating methods to improve teaching, studying faculty motivation to change classroom practices, and exploring ethical decision-making in engineering students. She also has established a national presence in engineering education; she is a fellow in the American Society of Engineering Education, is an Associate Editor of the IEEE Transactions on Education, and past chair of the Educational Research and Methods Division of ASEE.

Dr. Trevor Scott Harding, California Polytechnic State University

Dr. Trevor S. Harding is Professor of Materials Engineering at California Polytechnic State University where he teaches courses in materials design, biomedical materials, and life cycle analysis. He has presented his research on engineering ethics to several universities and to the American Bar Association. He serves as Associate Editor of the journals Advances in Engineering Education and International Journal of Service Learning in Engineering. He serves as program chair for the Community Engagement Division of

ASEE. Dr. Harding was invited to deliver a workshop on Ethics in the Engineering Curricula at the 2009 NSF Engineering Awardees Conference and to participate in the NSF Project Based Service Learning Summit. He received the 2008 President's Service Learning Award for innovations in the use of service learning at Cal Poly. In 2004 he was named a Templeton Research Fellow by the Center for Academic Integrity. Dr. Harding received both the 1999 Apprentice Faculty Grant and 2000 New Faculty Fellow Award for his contributions to engineering education.

Rod Harris
Matthew L. Cole, Lawrence Technological University

Dr. Matthew Cole is a tenured Assistant Professor in the Department of Management and Marketing, College of Management, Lawrence Technological University. He is Chair of the Institutional Review Board, and Co-Chair of the Research Support Services Committee at Lawrence Tech. Dr. Cole teaches Business Statistics, Research Design-Quantitative Methods, Principles of Management, and Organization Development and Macro Change Theory. He received his PhD from Wayne State University (Detroit, MI) in Cognitive and Social Psychology across the Lifespan (CaSPaL), where he conducted research on longitudinal growth modeling of risk behaviors and perceptions among adolescents from the U.S. and Vietnam. Dr. Cole also holds an M.A. in Biopsychology from Wayne State University, and an M.S. in Clinical Behavioral Psychology from Eastern Michigan University. He conducts research on a Strengths, Opportunities, Aspirations, and Results (SOAR)-based approach to strategic thinking, teamwork, and coaching. He is also interested in the neuroscience of mindfulness and strategic thinking. Consulting contracts include state and international organizations to provide coaching and workshops on the application of diversity, SOAR-based strategy, and teamwork to strategic planning, and organization development and change.

Assessing the Ethical Development of Students in an Undergraduate Civil Engineering Course using a Standardized Instrument

1. Abstract

ABET requires "*an understanding of professional and ethical responsibility*" but insuring students obtain these outcomes is program specific. Many programs struggle with how to include ethics in a robust technical curriculum. Consequently, there are numerous pedagogical approaches for teaching ethics including modules, individual courses, integration throughout the curriculum, or as part of a capstone experience. Institutions also struggle when they attempt to evaluate the impact of these various approaches. Motivated by this diversity of pedagogical techniques and strategies for assessing their impact, we developed the Survey of Engineering Ethical Development – Practical Assessment (SEED-PA) which is a practical instrument for assessing individual ethics initiatives at the, course, co-curricular, or single intervention level. This paper describes the application of a National Science Foundation funded research instrument across multiple offerings of a senior level stand-alone civil engineering course in ethics. The goal of this three semester pilot test was to determine the impact an upper level stand-alone civil engineering course on ethics and professionalism could have on a students' ethical development as measured through the SEED-PA. The course reinforces ethical behavior and discusses a wide range of contemporary issues using a variety of pedagogical techniques including asynchronous online learning. The pilot investigation demonstrated the SEED-PA could measure a student's ethical development and knowledge of ethics which was corroborated by direct and indirect assessment of course objectives.

2. Survey of Engineering Ethical Development for Practical Assessment (SEED-PA) Development

The underlying conceptual model of ethical development (Figure 1) that guides the work of the authors[7 8] is based on our hypothesis that a student's ethical development is influenced by multiple explanatory variables within four major domains: *student characteristics, institutional culture, formal curricular experiences, and co-curricular experiences*. The primary outcome variable of *ethical development* is measured using three constructs: *knowledge of ethics, ethical reasoning, and ethical behavior*.

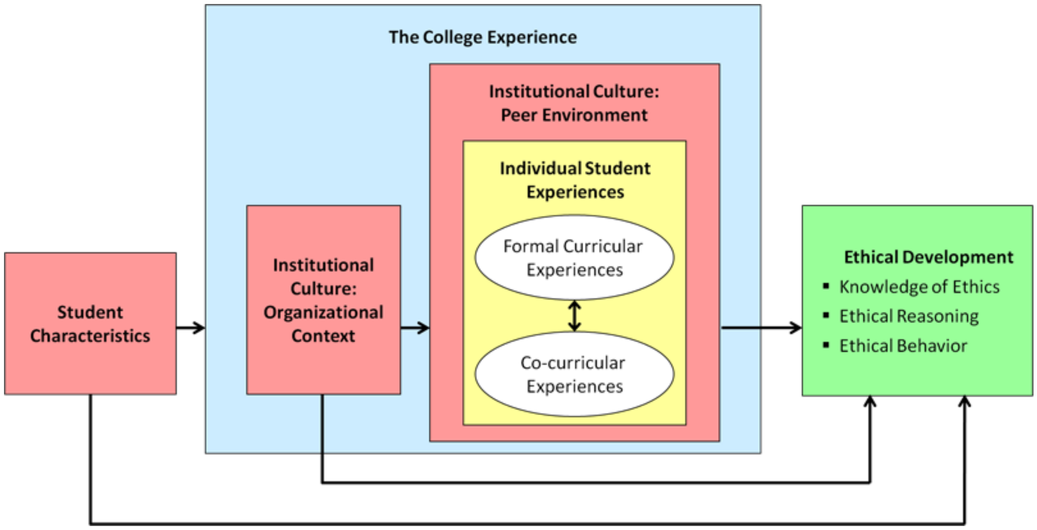

Figure 1. Conceptual model of the variables of ethical development[7].

A rigorous approach to instrument development included following guidelines in the survey methodology literature, including appropriate item formats, measurement properties of response scales, and memory and recall issues[7 8]. The final online version of the original Survey for Engineering Ethical Development (SEED) instrument included 152 items plus a link to the online Defining Issues Test (Version 2)[9]. Combined, these items comprise the *explanatory variables* of our model (i.e., student characteristics, formal curricular experiences, and co-curricular experiences) as well as constructs comprising our *outcome variable* ethical development (knowledge of ethics, ethical reasoning, and ethical behavior). *Knowledge of ethics* is a student's familiarity with professional codes of conduct and, to a limited degree, the engineer's role in ethical dilemmas. Knowledge of ethics is measured using five items similar to ethics questions on the Fundamentals of Engineering (FE) examination (administered by the National Council of Examiners for Engineering and Surveying). *Ethical reasoning* is a student's ability to apply reason and identify the right decision when faced with a moral dilemma in a professional context. This construct is measured using the Defining Issues Test Version 2 (DIT2)[10 11]. Finally, *ethical behavior* is the extent to which the student takes action that is consistent with identifying the right decision. We measured this construct with student reports of both pro-social behavior (volunteerism/community service) and anti-social behavior (academic dishonesty).

The original SEED Instrument was designed for our specific research purposes. It is useful for determining the individual and combined effects of many experiences, activities, and characteristics on students' ethical development, but it is lengthy and would be ineffective in assessing a singular program or initiative. One goal of the current research project was to adapt the instrument into one that can be used to assess individual ethics initiatives (SEED-PA) such as the course described in this paper which served as one pilot study instrument application. To better understand the instrument, a brief description of its development is included here.

The first step in reframing the SEED instrument into the SEED-PA instrument was to remove all items that were not related to the new purpose of testing the efficacy of a single ethics instruction or intervention. These included the majority of items serving as explanatory variables, including past curricular and co-curricular experiences, specific engineering major, and high school grade point average.

The next step in reframing was to test a new set of items intended to measure whether students' pro-social and anti-social behaviors were intentional or happened as opportunities arose. In order to do so, we conducted three pilot test sessions with 24 undergraduate engineering students at a doctorate-granting, very high research institution. Each session was 50 minutes and all participants received a $20 electronic gift card. The test was developed in a progressive manner, with each group viewing and being asked about a set of items which were then rewritten based upon their feedback and tested with a subsequent group.

The final step in reframing was to create a pair of instruments administered before and after an ethics intervention. Items measuring demographics were removed from the post-survey as those data are measured in the pre-survey and the two response sets are intended to be merged together by a unique identifier. For most items the language was simply adjusted from plans and intentions in the pre-survey to actual experiences and behaviors in the post-survey. We also created items to measure students' satisfaction with and perception of value of the intervention just experienced, as well as a measure of the types of pedagogy they perceived were used, which was intended to be matched against the instructor's description of the actual pedagogical techniques. A listing of the types of survey questions used in this pilot is included in the Appendix.

3. Course Information

The course in question is a required senior level civil engineering course (ECE4051 Ethics and Professional Issues) that addresses a wide-range of issues that engineers are likely to face during their careers. Approximately 10 to 20 civil engineering students enroll in this course each semester. The course is used to address several of the "professional" outcomes associated with ABET and the American Society of Civil Engineers (ASCE) Body of Knowledge 2nd Edition (BOK2)[1]. While this course is not the sole conduit of information, it is the primary mechanism for "professional" student outcome inclusion in the curriculum and serves as a direct assessment vehicle to ensure coverage of the BOK2 student outcomes of contemporary issues, public policy, attitudes, life-long learning, professional and ethical responsibility, and globalization.

ECE4051 is a one-credit course that meets six times a semester for group discussion about the module completed prior to meeting. During the in-person course meetings, the instructor moderates student discussion and therefore is not the sole source of information or learning. The course management program, Blackboard, is used to post and receive assignments, link students to sources of information, facilitate online discussion forums between class meetings, view streamed video content, and conduct online surveys and quizzes. Using this format, students' learn about and form their own opinions on ethics and contemporary issues. In addition, students are required to participate in professional development activities by attending ASCE meetings, engaging in continuing education programs, and getting involved in community service events.

Specifically, the published course objectives are that by *the end of this course, a student should be able to:*

1. Develop and demonstrate critical thinking and writing capabilities with respect to ethical dilemmas and professional topics.
2. Describe and discuss the basic principles of the codes of professional conduct relevant to the civil engineering profession.
3. Apply the provisions of the codes to resolve ethical dilemmas and recommend the most appropriate course of action.
4. Demonstrate the use of classic ethical theories, such as utilitarianism, duty ethics and virtue ethics in the resolution of ethical dilemmas.
5. Explain the elements of the *Vision for Civil Engineers*, and discuss the relevance of the *Vision* to the career of a civil engineer.
6. Based on the outcomes set forth in the *Civil Engineering Body of Knowledge for the 21st Century, Second Edition*, explain the importance of a broad undergraduate engineering education and post-degree continuing education leading to lifelong learning.
7. Explain the impact of historical and contemporary issues on the civil engineering profession, and the impact of engineering solutions on the economy, environment, society, and the political landscape.
8. Explain how global issues such as natural disasters, climate change, emerging economies, natural resource depletion, and sustainability are related to professional practice of civil engineering.
9. Explain the role of a civil engineer as leader in an engineering organization and in society in general, and describe the attributes/attitudes that are supportive of the professional practice of civil engineering.
10. List and discuss the benefits of membership in professional engineering societies, such as the American Society of Civil Engineers, and explain the role of these societies in promoting, serving and protecting the civil engineering profession as well as society.
11. Describe the importance of the civil engineer's role in influencing public policy by advocating a position on a topic related to the civil engineering profession, and communicating this position to a public official.
12. Describe the benefits of passing the FE exam and becoming a licensed professional.

4. Assignments/Modules

The course is segregated into topical modules that include *Introduction to Ethical and Moral Theory*, *Ethical Decision Making*, *Professional Codes of Ethics*, *Application of Ethics*, *Anti-Corruption Training & Globalization*, *Civil Engineering Profession & Licensure*, and *Lifelong Learning*. The spring term offering and the fall term offering of the course are taught by different instructors, so there is some variability on module implementation and assignments. However, the course objectives are consistent regardless of whom teaches the course.

Introduction to Ethical and Moral Theory, Ethical Decision Making, and Professional Codes of Ethics

The first three modules can be thought of as a continuum and are devoted to establishing a foundation for ethics and ethical decision-making. Students are introduced to ethical and moral theory by completing a series of in-class exercises and discussion. In this assignment, students work in teams to answer questions such as "What is ethics?" and "How does ethics differ from morals?" In addition, student teams are asked to generate several lists including the duties that professors have to students, the duties students have to professors, the duties students have to each other, and the duties students have to society. These lists are shared and discussed in class. The exercise is repeated by listing student and professor "vices" and "virtues." In between the teamwork exercises, some basic concepts of ethical and moral theory are covered and definitions are generated. This is important to establish the tone of the course – one of discussion, debate, and general consensus. Typically, the students rapidly realize that they are, in fact, generating a code of ethics for the class by discussing the rights and responsibilities of the students and the professor. This also sets the stage for how codes of ethics are introduced into the course and how those codes have evolved over time. In addition, while the coverage of moral theory is limited to this one session, it's important for the students to be exposed to the topic of moral theory. In fact, it has been argued that the lack of including classical moral theory in the engineering curriculum is the single largest problem with regards to producing ethical engineers[2] [3]. The process for making an ethical decision is covered and various professional codes of ethics (ASCE Code of Ethics[4] and NCEES Model Rule for Professional Conduct[5]) are introduced.

Application of Professional Codes of Ethics

Once the foundation is set, students are given several ethical dilemmas and asked to analyze them based on the ASCE Code of Ethics as well as using the theoretical foundation they have been provided. Students are asked to explicitly utilize "the steps for making an ethical decision" as part of the assignment and apply classical ethical tests. Students generate a memo (submitted and graded) based on their resolution of the dilemmas and take turns leading in-class discussion on the case analysis. Students are also provided with another series of cases and asked to specifically apply the NCEES Model Rules for Professional Conduct acting as a member of the

State Board of Professional Licensing. They prepare an analysis memorandum for the Enforcement Officer for each case and then lead an in class discussion for those cases.

Anti-Corruption Training & Globalization

The second opportunity for student to analyze and resolve ethical dilemmas is through the Global Anti-Corruption Education and Training project (ACET) and the ETHICANA™ movie (http://ethicana.org/). The training session begins with a virtual viewing of the movie followed by discussion of various elements of corruption and unethical behavior portrayed in the movie. Students are assigned specific topics to reflect and write about and then lead an in-class discussion based on the findings. The video is streamed for repeated viewing through the secure course Blackboard site and the students complete a fairly lengthy discussion memo submitted online prior to the course meeting.

Civil Engineering Profession and Licensure

Civil engineers must focus on becoming experts in their field and exercise their leadership abilities to benefit themselves, their families and society as a whole. To reinforce our role as a professional, students are asked to interview a civil/construction engineer with a PE license and generate an executive summary. The starting point is to determine what makes a successful civil engineer based on the interview with an industry practitioner and determine their views on numerous topics including:

- *Education*: opinion on formal vs. informal education, life-long learning, continuing education requirements, licensure, BOK, etc.
- *Engagement*: active in professional associations, educational institutions, communities (churches, community organizations, city organizations, etc.), ASCE, etc.
- *Attitude*: attitudes toward the engineering profession, construction industry, mentoring, service, ASCE etc.
- *Sustainability*: sustainability's role on design, effect on the profession, etc.
- *Contemporary & Historical Issues*: contemporary issues facing our profession such as globalization, natural disasters and climate change, pressing social and economic issues, politics, BOK, etc.

The final assignment associated with this module is on political advocacy. The students are introduced to ASCE statements on current events through the ASCE Advocacy website[6] and are asked to write a letter to an elected government official(s) regarding a civil engineering issue of their choice. To complete the assignment, the students must mail, email or fax a copy of the letter to their elected official and submit a copy in class. They are instructed that they may choose to use the template provided by the ASCE advocacy website as a starting point, but they are expected to personalize the letter with their signature, the fact they are an engineering student, and at least one local/personal talking point. This assignment also serves to enlighten them on how few elected officials have science, technology, engineering, and mathematics

(STEM) backboards and the importance of advocacy to the civil profession, which is closely connected to elected officials through funding and regulations.

Life Long Learning

Students are asked to pursue "continuing education" credits and embrace lifelong learning by attending at least three professional meetings during the course of the semester (limited to one ASCE on campus meeting). For each meeting, students are required to write a brief description of the meeting (one or two paragraphs that should include date, speaker(s), names/titles, technical information presented, venue, etc.) and a personal reflection (another paragraph) of what they professionally gained from attending.

5.0 Results

5.1 SEED-PA Results

Demographic Characteristics of the Sample

Table 1 reports the demographic characteristics of the sample. The sample (N = 31) was organized into three semesters, 2013 Spring (n = 6, 19.4%), 2013 Fall (n = 11, 35.5%), and 2014 Spring (n = 14, 45.1%). Students were essentially equally distributed among sex and age groups, and cumulative GPA was essentially equal across semesters with mean (standard deviation) GPA ranging from 3.06-3.17 (0.38-0.64).

Attitudes about Ethics

Table 2 presents the mean (M) and standard deviation (SD) from four self-report survey items that asked students to rate at the beginning of the class (pre) "How important do you consider learning about professional engineering ethics to be to your engineering education?" and "How satisfied have you been with the quality of education regarding professional engineering ethics at this institution?" and to rate at the end of the class (post) "How valuable was the ethics instruction in the class?" and "How satisfied were you with the ethics instruction in the class?"

Results of paired-samples *t* tests comparing the pre-post difference in mean scores for the importance and values items found the total sample had pre-post satisfaction difference significant at the 95% level of significance; students in the 2013 Spring class were found to have significant pre-post satisfaction difference at the 90% level of significance.

Table 1. Demographic Characteristics

Attributes	2013 Spring N	%	2013 Fall n	%	2014 Spring n	%	All Students n	%
Total Sample	6	100.0	11	100.0	14	100.0	31	100.0
Gender								
Male	4	66.7	6	54.5	9	64.3	19	61.3
Female	2	33.3	5	45.5	5	35.7	12	38.7
Age								
21	0	0.0	4	36.4	2	14.3	6	19.4
22	3	50.0	3	27.3	4	28.6	10	32.3
23-25	3	50.0	3	27.3	6	42.9	12	38.7
26.29	0	0.0	1	9.1	2	14.3	3	9.7
Citizenship								
U.S. Citizen	5	83.3	11	100.0	12^{**}	85.7	28^{**}	90.3
Non U.S. Citizen	1	16.7	0	0.0	2	14.3	3	9.7
Race								
Asian	1	16.7	0	0.0	0^{**}	0.0	1^{**}	3.2
Black	0	0.0	0	0.0	1	7.1	1	3.2
White	5	83.3	11	100.0	13	92.9	29	93.5
GPA (Mean and SD)	3.07	0.38	3.17	0.57	3.06	0.64	3.10	0.56

Note. Number (n) and percent (%) of ECE students (N = 31) from the 2013 Spring semester (n = 6), the 2013 Fall semester (n = 11), and the 2014 Spring semester (n = 14) who reported demographic characteristic; GPA presented as mean and standard deviation. ** $p < .01$ Chi-square test for equality of distribution.

Table 2. Attitudes about ethics

Knowledge of Ethics Item	2013 Spring M	SD	2013 Fall M	SD	2014 Spring M	SD	All Students M	SD
Importance of Ethics (pre)	3.33^{+}	0.52	3.09	0.83	3.50	0.52	3.32	0.65
Value of Ethics Class (post)	3.83	0.41	3.00	0.78	3.36	0.63	3.32	0.70
Satisfaction with Ethics (pre)	4.20^{+}	0.45	3.75	0.71	4.27	0.47	4.08^{*}	0.58
Satisfaction with Ethics (post)	4.80	0.45	4.00	0.93	4.46	0.52	4.37	0.71

Note. Mean (M) and standard deviation (SD) of knowledge of ethics items in ECE students (N = 31) from the 2013 Spring semester (n = 6), the 2013 Fall semester (n = 11), and the 2014 Spring semester (n = 14). Importance and Value items were scored along a 1-4 Likert scale (low-high), and Satisfaction items were scored along a 1-5 Likert scale (low-high). The pre-course measure of Importance of ethics education was coded as follows: 1 = Very unimportant, 2 = Unimportant, 3 = Important, 4 = Very Important; post-course measure of Value of ethics instruction was coded as follows: 1 = Not valuable at all, 2 = A little bit valuable, 3 = Somewhat valuable, 4 = Very valuable. The pre-course measure of student satisfaction was coded as follows for the purposes of the paired-samples t test: Missing = No ethics education, 1 = Very Dissatisfied, 2 = Dissatisfied, 4 = Satisfied, 5 = Very Satisfied; the post-course measure of student satisfaction was coded as follows: 1 = Very Dissatisfied, 2 = Dissatisfied, 3 = Neither Satisfied or Dissatisfied, 4 = Satisfied, 5 = Very Satisfied. $^{+}$ $p < .10$ $^{*}p < .05$ pre-post difference in mean scores according to paired-samples *t* test.

Methods Used for Ethical Instruction

Table 3 presents the results of frequency analysis on the methods used for ethical instruction across the three semesters and in totality. For the most part, the students are correctly identifying the methods of instruction they received in class based on instructors commentary about instruction, but what is interesting about these results is that students did not always consider the "out-of-class instruction" they received when selecting the "instruction" they received. Students completed mentoring interviews with a professional engineer and also continuing education assignments that typically included lectures but clearly did not include those in their results (based on the small percentage of respondents selecting "speaker on personal experience" and "presentation by engineer") even though the SEED-PA question didn't specify "in-class". The column labeled "future" is in response to the question "which of these do you think will be most useful when you are confronted with a future professional ethical dilemma?" The top two answers are presentation by a speaker discussing their own experiences and discussion in small groups. This reinforces the concept that the professor is not the oracle of knowledge that the students will reflect on first when making ethical decisions but rather external mentors and peers are identified as more impactful in future decisions.

Table 3. Methods Identified for Ethical Instruction and Future Usability

	2013 Spring		2013 Fall		2014 Spring		All Students	
Method	Instruction	Future	Instruction	Future	Instruction	Future	Instruction	Future
Professor	100.0	0.0	100.0	9.1	100.0	14.3	100.0	9.7
Speaker on Personal Experience	16.7	33.3	45.5	36.4	35.7	28.6	35.5	32.3
Presentation by Engineer	16.7	0.0	45.5	0.0	14.3	0.0	25.8	0.0
Small Groups	100.0	50.0	72.7	36.4	100.0	35.7	90.3	38.7
Movie or Film	100.0	16.7	0.0	0.0	85.7	0.0	58.1	3.2
Skit	16.7	0.0	0.0	0.0	7.1	0.0	6.5	0.0
In-Class Game	0.0	0.0	0.0	0.0	7.1	0.0	3.2	0.0
Role Play	33.3	0.0	36.4	9.1	42.9	21.4	38.7	12.9
Online Simulation	16.7	0.0	27.3	9.1	57.1	0.0	38.7	3.2

Note. Percentage of students reporting particular method used for ethical instruction in ECE students (N = 31) from the 2013 Spring semester (n = 6), the 2013 Fall semester (n = 11), and the 2014 Spring semester (n = 14). Current method reflects percentage of total students within each semester; Future method reflects percentage of total students across all semesters.

Knowledge of Ethics

Student knowledge of ethics was measured as the number of students selecting the correct response on five statements from the Fundamental of Engineering (FE) exam style questions that were administered pre- and post-instruction (Table 4). The use of actual FE exam results or similar style questions is a common direct measure of ethical knowledge used by programs for ABET accreditation. When considering each question individually, results found significant pre-post differences only on one item (the title of the survey question - "Muriel") during the Fall 2013 administration. However, it cannot be explained why 8 out of 11 students got the question correct in the pre-test and only 2 out of 11 in the post-test for that the one semester.

When considered in aggregate, the overall mean score (out of 5 correct) was 3.42 for pre-test and 3.32 for post-test and that includes the "Muriel" question. It was determined that over half of the 31 pre-post comparisons across the three semesters were consistent or improved. Figure 2 shows the distribution of the number of correct responses and while more students received a perfect score (5 out of 5) in the post-test, the shift based on Muriel question is evident in the histogram. Overall, it can be inferred that the students' "knowledge of ethics" as measured by the FE style questions was good before the course and was not significantly improved by the course.

Table 4. Formal Knowledge of Ethics (number of correct responses on FE Style questions)

Knowledge of	2013 Spring (n = 6)				2013 Fall (n = 11)				2014 Spring (n = 14)			
Ethics	n	%	D	*p*	n	%	D	*p*	n	%	d	*p*
Engineers_Pre	4	66.7	16.6	.497	7	63.6	9.1	.646	9	64.3	21.4	.177
Engineers_Post	5	83.3			8	72.7			12	85.7		
Jean_Pre	5	83.3	0.0	.999	8	72.7	-9.1	.646	10	71.4	0.0	.999
Jean_Post	5	83.3			7	63.6			10	71.4		
Muriel_Pre	4	66.7	0.0	.999	8	72.7	-54.5	.002**	8	57.4	7.1	.698
Muriel_Post	4	66.7			2	18.2			9	64.3		
Andrew_Pre	6	100.0	-16.7	.273	8	72.7	-9.1	.646	11	78.6	-7.2	.661
Andrew_Post	5	83.3			7	63.6			10	71.4		
Langdon_Pre	5	83.3	-16.6	.497	5	45.5	27.2	.176	8	61.5	-11.5	.543
Langdon_Post	4	66.7			8	72.7			7	50		

Note. Number (n), percent (%), and difference (d) scores between pre- and post-administration correct responses to the Knowledge of Ethics, Fundamentals of Engineering Exam style questions. $^{**}p < .01$ pre-post difference according to two proportions test (2-tailed).

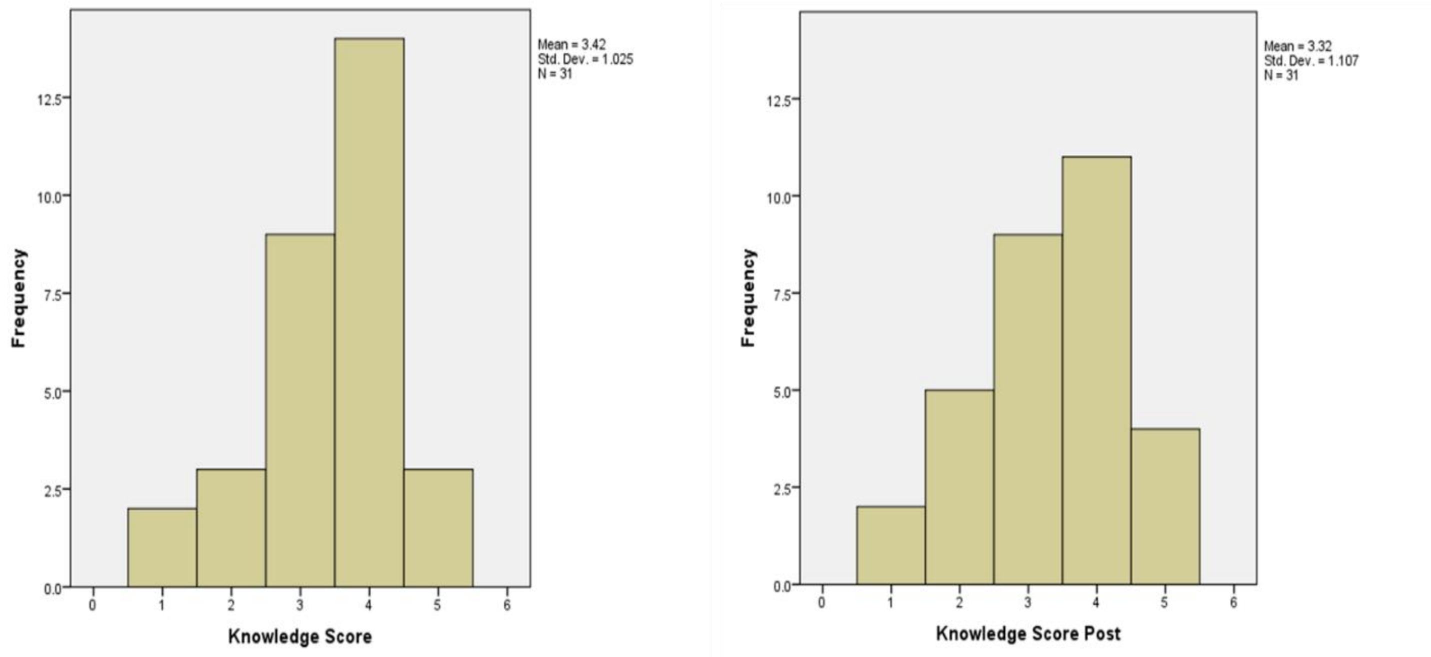

Figure 2: Histogram of Correct Responses (Before and After)

Ethical Reasoning

Table 5 presents results of pre-post instruction differences on the primary variable for measuring ethical reasoning from the DIT-2 (represented by the N2 Score). The N2 Scores improved for both spring sections of the course with the Spring 2013 section being significant at the 90% level of significance. The spring sections are taught by an instructor who focuses more attention on ethical decision-making and moral philosophy than the fall instructor who spends more instructional time on code application. The improvement of ethical reasoning in the spring semesters may be a result of instruction, but small sample size makes it difficult to make a definitive statement. For context, the mean N2 score for undergraduates is 34.76 with a standard deviation of 15.45 based on approximately 33,000 students who have completed the DIT-2 in previous investigations[12].

Table 5. Ethical Reasoning Scores (N2 based on DIT-2)

Ethical Reasoning	2013 Spring				2013 Fall				2014 Spring			
Variable	M	SD	D	*P*	M	SD	d	*p*	M	SD	d	*p*
N2Score (pre)	35.24	12.22			37.93	12.40			30.10	16.34		
N2Score (post)	44.74	11.14	-9.50	.066⁺	35.15	15.51	2.78	.456	31.94	17.46	-1.84	.529

Note. Mean (M), standard deviation (SD), and difference (d) scores between pre- and post-administration of the DIT2. $^{+}$ $p < .10$ pre-post difference according to paired-samples t test (2-tailed).

Pro-Social and Anti-Social Behaviors

The frequency of students reporting pro- and anti-social behaviors, and the mean score on pro- and anti-social behavior items are presented in Table 6 and Table 7, respectively. Results of frequency analysis found approximately 50% of the students reported intention to volunteer and be part of any volunteering project, and less than 10% of the students reported anti-social behaviors in terms of cheating. As expected, higher mean scores were found on pro-social vs. anti-social behaviors. No significant differences in behaviors were found between the three courses according to Chi-square test for association and ANOVA.

Intercorrelations between Study Variables

The intercorrelations between the study variables in the total sample of students were also investigated. There were very few correlations between variables at a level of 95% or greater level of significance including no statistically significant correlations between ethical reasoning (N2), knowledge of ethics (FE), and ethical behavior (pro- or anti-social). There were also no statistically significant correlations between outcomes and importance and values measures as reported by the students. In other words, how “important” or “valuable” a student views their ethics education was not correlated with their ethical development as measured by the SEED-PA. Results with significant correlations were found between pro- and anti-social behaviors, with a positive correlation between the frequency of volunteering and the number of organizations the student volunteered for, a negative correlation between the number of organizations the student volunteered for and the frequency of cheating in high school, and a positive correlation between cheating in high school and cheating in college.

5.2 Instructor Assessment Results

The purpose of this investigation was to determine whether the SEED-PA could be used to measure ethical development based on course. However, in addition to the SEED-PA pre- and post-test administered anonymously online, there were additional assessments of student learning conducted directly by the instructors. Most significantly was direct assessment of student learning by collecting samples of student work to assess if course objectives were achieved. Specifically, students were evaluated on how well they met the required level of achievement (based on Bloom’s taxonomy) related to course objectives on contemporary issues, public policy, attitudes, life-long learning, professional and ethical responsibility, and globalizations. These represent the student outcomes covered in the course that need to be assessed by the department for ABET accreditation purposes. Instructors reported at least 80% of students’ demonstrated mastery of the student outcomes based on required level of achievement where 80% is the target level for the course In addition, an end of course objective survey is given where students are asked to self-evaluate their ability to meet course objectives (indirect assessment). Nearly 100% of students report being capable of performing objectives. As such, based on instructor and student feed-back, course objectives and student outcomes are being met. These results could not be correlated with SEED-PA results because of student anonymity on the survey but demonstrate that other methods of assessment corroborate the findings of the SEED-PA.

Table 6. Frequency of Pro-Social and Anti-Social Behavior

	2013 Spring		2013 Fall		2014 Spring		All Students	
Behaviors	N	%	N	%	N	%	N	%
Pro-Social Behaviors								
Intention to Volunteer	2	33.3	5	45.5	8	57.1	15	48.4
Part of Any Volunteering Project	2	33.3	5	45.5	9	64.3	16	51.6
Created a Plan for Volunteering	0	0.0	5	45.5	2	14.3	7	22.6
Already Have a Plan for Volunteering	1	16.7	3	27.3	5	38.5	9	29.0
Anti-Social Behaviors								
Intention to Cheat	0	0.0	1	9.1	1	7.1	2	6.5
Created a Plan for Cheating	0	0.0	1	9.1	0	0.0	1	3.2
Already Have a Plan for Cheating	0	0.0	1	9.1	0	0.0	1	3.2

Note. Number (n) and percent (%) of ECE students (N = 31) from the 2013 Spring semester (n = 6), the 2013 Fall semester (n = 11), and the 2014 Spring semester (n = 14) who reported "Yes" to the behavior. Between-semester differences in frequency was tested with Chi-square test for association.

Table 7. Mean Number of Pro-Social and Anti-Social Behaviors

	2013 Spring		2013 Fall		2014 Spring		All Students	
Behaviors	M	SD	M	SD	M	SD	M	SD
Pro-Social Behaviors								
How Often Volunteering	4.00	1.27	3.73	1.19	3.64	1.60	3.74	1.37
# of Volunteer Projects in High School	3.83	1.84	3.55	1.70	4.43	1.28	4.00	1.55
# of Volunteer Organizations	2.17	1.17	3.00	1.84	2.93	2.13	2.81	1.85
Anti-Social Behaviors								
How Often Cheating	1.67	1.03	2.00	0.89	1.31	0.63	1.63	0.85
How Often Cheating Post-Class	0.67	1.03	1.00	0.89	0.31	0.63	0.63	0.85
# of Times Cheating in High School	2.33	1.21	1.91	1.04	2.00	1.04	2.03	1.05

Note. Mean (M) and standard deviation (SD) number of pro- and anti-social behaviors among ECE students (N = 31) from the 2013 Spring semester (n = 6), the 2013 Fall semester (n = 11), and the 2014 Spring semester (n = 14). Between-semester differences in mean score tested with ANOVA.

6.0 Conclusions

The goal of this three semester pilot test was to determine the impact an upper level stand-alone civil engineering course on ethics and professionalism could have on a students' ethical development as measured through the SEED-PA as described. Though small sample sizes made it difficult to make definitive statements, it appears as if the course might influence a student's ethical reasoning ability but not a student's knowledge of ethics or ethical behavior based on the results from the survey. Instructor variability is also a possible factor that affects a student's ethical development. However, it is clear the SEED-PA could be used as a direct assessment of students' ethical development and applied towards ABET accreditation with regards to student outcomes on ethics and professionalism.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant Numbers 1130175, 1140233, and 1140165. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. We gratefully acknowledge the support of the instructors who participated in the pilot investigation.

Bibliographic Information

1. American Society of Civil Engineers (2008). Civil Engineering Body of Knowledge for the 21st Century, Preparing the Civil Engineer for the Future, Second Edition".
2. Haws, D. R. (2001). "Ethics instruction in engineering education: A (mini) meta-analysis," *Journal of Engineering Education, 90(*2), 223–229.
3. Haws, D. R. (2004). "The importance of meta-ethics in engineering education," *Science and Engineering Ethics, 10*(2), 204–210.
4. ASCE Code of Ethics. http://www.asce.org/code_of_ethics/
5. NCEES Model Rules for Professional Conduct. http://ncees.org/about-ncees/publications/.
6. ASCE's Internet Advocacy Website, *American Society of Civil Engineering*, http://www.asce.org/pressroom/publicpolicy/advocacy.cfm
7. Finelli, C. J., Holsapple, M. A., Ra, E., Bielby, R. M., Burt, B. A., Carpenter, D. D., Sutkus, J. A. (2012). An assessment of engineering students' curricular and co-curricular experiences and their ethical development. *Journal of Engineering Education, 101*(3), 469-494.
8. Carpenter, D., Harding,T., Sutkus, J. and Finelli, C. (2014) "Assessing the Ethical Development of Civil Engineering Undergraduates in Support of the ASCE Body of Knowledge." *Journal of Professional Issues in Engineering Education and Practice*
9. DIT2 http://ethicaldevelopment.ua.edu/dit-and-dit-2/
10. Rest, J., Narvaez, D., Bebeau, M. & Thoma, S. (1999). A neo-Kohlbergian approach: The DIT and schema Theory. *Educational Psychology Review, 11*(4): 291–324.
11. Rest, J., Narvaez, D., Thoma, S. & Bebeau, M. (1999).DIT2: Devising and Testing a Revised Instrument of Moral Judgment. Journal of Educational Psychology 1999, Vol. 91, No. 4,644-659
12. Dong, Y. (2009). Norms for the DIT-2 (http://ethicaldevelopment.ua.edu/files/2014/03/Norms-for-DIT2.pdf)

Appendix

SEED-PA Survey Items	
Formal Curricular Experiences Items about overall satisfaction with ethics instruction to date and the importance of professional ethics to engineering education Items about the specific ethics intervention: satisfaction with instruction, value of instruction, type of pedagogical method experienced, and perception of value when used to confront future professional ethical dilemma	Pre-survey: 2 items Post-survey: 1 item
Co-curricular Experiences A multiple-response item about participation in a range of student organizations	1 item
Student Characteristics Class level, transfer status, age, gender, citizenship, race, ethnicity, full-time/part-time status, current college grade point average, primary language, political orientation	Pre-survey: 11 items Post-survey: None
Knowledge of Ethics Ethics questions from Fundamentals of Engineering exam	5 items
Ethical Reasoning DIT2 Scores calculated by the Center for the Study of Ethical Development (Rest, et al., 1999) P score, N2 score, Personal Interest score, Maintaining Norms score	85 items
Pro-social Ethical Behavior Items about participation in volunteer service in college and high school, intent to volunteer in the current term, plan for accomplishing volunteer service Items about participation in volunteer service in past term and creation of plan for accomplishing volunteer service	Pre-survey: 4 items Post-survey: 2 items
Anti-social Ethical Behavior Items about frequency of cheating in college and high school, intent to cheat in the current term, plan for accomplishing cheating Items about cheating in the past term and creation of a plan for cheating	Pre-survey: 4 items Post-survey: 2 items