Integrating Ethics into the Curriculum through Design Courses

Prof. Scott A Civjan P.E., University of Massachusetts, Amherst

Scott Civjan is a faculty member at UMass Amherst where he has taught a wide variety of undergraduate and graduate courses over the past 20+ years. He has 4 years of consulting experience between obtaining his BSCE from Washington University in St. Louis and his MS and PhD in Structural Engineering from the University of Texas Austin.

Prof. Nicholas Tooker, University of Massachusetts Amherst

Nick Tooker is a Professor of Practice at the University of Massachusetts Amherst. He teaches courses ranging from Intro to Civil & Environmental Engineering for first year students to a seminar on Professional Practices and Ethics to seniors. He is also heavily involved with the online graduate program.

Integrating Ethics into the Curriculum through Design Courses

Abstract

To address shortcomings in traditional engineering ethics curriculum a series of assignments were integrated into a senior level steel design course. The goal of the ethics component being introduced in a steel design course was to improve student internalization of ethics curriculum through assignments that were relevant to the design class material and everyday practice. An end of semester survey was given to students only taking the design class, taking the class simultaneously with a capstone seminar course that included more traditional ethics curriculum, and only taking the capstone seminar course. Results indicate that integrating ethics assignments into design courses can complement traditional ethics instruction. Students enrolled in both classes responded with more consistent ethical decision outcomes, where students acknowledge other perspectives and were less likely to select decisions that avoid responsibility for their actions. Student responses also indicated a positive experience with the new content delivery method.

Introduction

Ethics instruction in the engineering curriculum is fraught with uncertainties, including how to deliver the material, what the goals are and how to assess effectiveness. Yet the inclusion of ethics instruction is critical. Studies have reported engineers to have higher incidences of ethical transgressions than other majors [1,2], with cheating in university situations a strong predictor of unethical behavior in the workforce [2]. In fields such as civil engineering, and others where public safety is at risk, this is troubling. ABET is the driving force for including ethics in the curriculum for most departments, with universities typically meeting this requirement through a few units on ethics, often in capstone and introductory courses. These units often rely on standard curriculum units which cover the ASCE and/or NSPE Code of Ethics and discussion of case studies [3]. However, ethics in the engineering curriculum has been reported to have mixed effectiveness, especially when delivered as an isolated topic within courses such as a capstone or purely through case studies. Instead, an effective supplemental framework for integrating ethics through the curriculum is needed in order for practicing engineers to make decisions with the integrity appropriate to the profession. Toward this goal, an initial implementation was made in a senior level design class where ethics questions were interspersed throughout the semester on day to day ethical issues that related directly to the course material. Twelve students took this course alone, while twenty-two were concurrently enrolled in a senior capstone seminar course that included a more traditional ethics unit, and twenty-seven students were enrolled only in the seminar.

Goals and objectives

The goal of the ethics component being introduced in a steel design course was to improve student internalization of ethics curriculum through modifying the ethics content delivery method. Individual assignments were included where students were asked to respond to questions related to ethics in everyday practice with context directly relating to the design class material. This was intended to complement the existing curriculum and evaluate whether it was practicable to include in an array of courses throughout the curriculum. Objectives included developing specific assignments, evaluating the effectiveness of the modified ethics curriculum through survey responses, and making recommendations on how to improve the assignments.

Background

The teaching of ethics can be very difficult to assess, as it is difficult to separate one's own moral guide from the decision process that individuals with different perspectives may use to evaluate an ethical dilemma. In order to circumvent this dilemma, class ethical discussions often revolve around case studies with clear "right" versus "wrong" perspectives, or graduated consequences to determine the "line" that is eventually crossed to make the decision unethical, which can include discussions of how determination of this "line" can vary among individuals (constituting the vagaries of ethical decisions). However, ethical decisions in everyday consulting practice can

be very different from those presented in case studies. Bucciarelli [4] seriously questions the lack of social context included in typical case study instruction, pointing out that the organizational structure provides context for individual choices that cannot be separated from the discussion. Lynch and Kline [5] specifically note the misleading simplifications that often accompany the Challenger explosion case study, where the overall culture of decision making over time and conflicting roles of individuals had much more of a role in the tragedy than typical presentations suggest. These simplifications of the ethical decision process can undermine the teaching of ethics and result in arms-length decision making process identifying "good" and "bad" behavior. Case study based instruction is often tied to professional codes of ethics, which confuses ethical choices with the minimum action to avoid liability. Herkert [6] argues against this approach and ethical conventionalism in general, also noting that while the inclusion of formal instruction of ethical theory is not always effective, the inclusion of introductory material is often sufficient.

There are several moral learning theories that are relevant to ethical decisions. Three that could be used to explain the decision process are Kohlberg's stages of moral development [7], Social Intuitionism [8] and the Dual Process Theory [9]. Kohlberg's stages of moral development state that there are six stages that one progresses through. Simplifying the overall concepts, these progress from decisions based on one's own needs to accounting for decisions that conform to conventional thought, evaluation of institutionalized rules and the impact to societal over personal needs, and culminating in decisions made based on a higher moral conscience. This theory is based on the use of formal reasoning to arrive at a morally acceptable decision. Social Intuitionism takes a different approach and proffers that moral decisions are primarily intuitive "knee jerk" responses that are subsequently justified, exemplified by studies showing that moral actions correlate more closely with emotions rather than cognitive reasoning. Over time, one can be influenced to change the moral choices that are made through rational thinking, but in the moment the moral decision will be intuitive. While Social Intuitionism acknowledges rare cases where reasoning or reflection can change an intuitive moral action [8], Dual Process Theory explicitly merges aspects of the two theories. Specifically, the theory holds that most moral decisions occur over a time where there can be a dialogue between fast intuitive and slower rational processes. Therefore, in the moment of making a moral decision one can rationalize a response that differs from the intuitive reaction.

Pfieffer and Billiar [10] note that different well-developed ethical theories can result in equally valid opposing decisions. They recommend the inclusion of ethical theory course content that specifically includes this concept, as students do not gain this understanding through a typical case study based curriculum. This and other studies make a case for supplementing case study instruction with ethical instruction that is more closely tied with course content and every day decisions [5,10,11,12]. The use of case study examples where there is a correct answer and where there is a clear tragic outcome or heroic action suggests that ethical decisions are a once in a career event of major consequence. Further, arriving at a conclusion purely through discussion of the case indicates that ethical decisions are a purely cognitive process, dismissing any intuitive

response. This approach is likely to give students an arms-length perspective on ethics as events that happen to others and a belief that one can learn how to be ethical through observing other's behavior. Clancy III et al. [13] highlight that many engineering ethics teaching approaches "blur the distinction between ethical judgments/decisions and actions/behaviors" and point out ethical fading (where an individual does not perceive the situation to have ethical consequences and instead focuses on other aspects, such as profit or legality, to make a decision) as a major component in ethical lapses. Therefore, unethical actions may not be due to an unethical decision, but instead due to a lack of consideration of the ethical component. Herkert [6] points out the fact that most ethical decisions engineers face in practice are far more common and mundane than implied by case studies, with typical examples cited in Harding et al. [1]. Ethics instruction that does not address these every day decisions may promote ethical fading when those decisions are required. This is reinforced by McGinn [14] survey results which concluded that student ethical preparation was not sufficient for the ethical dilemmas that practicing engineers actually experience. Teaching students to internalize ethical decisions, ponder how they personally arrive at their decision and raise awareness of the multitude of ethical dilemmas they face may be more effective at altering future ethical decisions.

It is important to distinguish between the teaching of morals, laws and ethics [15, 16]. Students come to class with morals that have been developed over their lifetime up to that point and it should not be a goal to either affirm or change these. Attempting to do so will likely end up affirming the viewpoint of those who agree with the instructor's views and alienate those that do not. As Prince and Felder [17] point out, any teaching method that requires a sudden change in a student's cognitive model will not be effective. Instead, they recommend continuous revisiting and reformulating of a student's cognitive models. A possible approach to accommodate this in ethics instruction would be to have students understand their ethical decision making process, realize that the process can differ among individuals, and include an increasing number of perspectives into their ethical evaluation. Through this approach it may be possible to attain a higher level of ethical decision making and inherently shift thought from micro-ethics (focusing on individuals and clients) to meso-ethics (focusing on organizations) and macro-ethics (focusing on wider impacts to society) without needing to make an artificial distinction between these topics.

Students must be able to critique their own biases, prejudices and misconceptions in order to accept differing viewpoints. In order to consider wider consequences the student needs to include ethical reasoning in their decision making that is free from the unconscious bias of personal gains or preferences [15]. Unfortunately, Lambrinidou et al. [18] provide a compelling case of the reality of engineering instruction and the profession, where viewpoints of non-technical perspectives are neglected and opposing voices willfully disregarded. They emphasize the critical need for including perspectives that are often overlooked by engineers when defining engineering problems and solutions. It is not clear whether these examples demonstrate poor ethical decisions or ethical fading. Regardless, when asked to explain an action an individual can

often justify unethical decisions after the fact in order to maintain their self-image as an ethical person.

Clancy III et al. [13] state that expectation and preparation for ethical conflicts make an individual more likely to act ethically. They conclude that ethics should focus on the pragmatic value of ethics rather than vague discussions of virtue and that there is a need for engineering instructors to become examples, showing the importance of ethical behavior.

So, how can this best be included in an engineering curriculum? Herkert [6] recommends that systematic inclusion of ethics within a curriculum is required, and studies have shown the effectiveness of across-the-curriculum models [10,11]. Survey results have also shown that faculty support ethics inclusion in multiple courses, and propose that ethics inclusion only in freshmen and senior classes can be detrimental by isolating ethics from the technical content, implying that students should prioritize the technical over the ethical [3,19]. Since many of the day to day ethical decisions of a workplace are not the extreme cases often used in case studies, perhaps the use of more subtle examples would lead to more ethical behavior in practice. It may be successful to present micro-meso-macro ethics as a progression of ethical thought along a spectrum, with the differences defined by the individual's experiences or stages of moral development, rather than making distinctions between them. The more that a student can be prompted to acknowledge the perspectives of a widening group of stakeholders the more that the effects on communities, populations and future generations will be considered. The more that a student can be prompted to acknowledge the ethical import of every day decisions the less likely that ethical fading will take place.

Course approaches

In the limited ethics content included in most engineering curriculum it is unrealistic to expect that instructors would observe ethical enlightenment in students or that advanced ethical thought processes could be evaluated beyond eliciting of a "correct" ethical response from students. This approach does little to advance the student's framework for making ethical decisions and has been shown to confirm student perceptions that ethics instruction is irrelevant if they do not agree with the "correct" response. Similarly, the authors propose that case studies are a misguided approach, with common examples relying too heavily on cognitive evaluation of situations, thereby missing the intuitive and reflexive components of ethical decision processes. Further, case studies are often concluded by comparing to an ethics board or lawsuit decision, thereby equating ethical decisions with legality or the minimum requirement to avoid disciplinary actions from the profession. The authors propose that an effective ethics curriculum should focus on the decision process, raise awareness of all stakeholders and differing perspectives, be integrated through the curriculum, and provide relatable situations for the students. The authors were the instructors of the two courses described. They intermittently

discussed the content of their classes, but there was no attempt to coordinate instruction or assignments. The intent was to evaluate whether ethics instruction could be improved through independent content introduced in a design course.

The first author teaches a senior level course in steel design. In Fall 2019 he introduced a series of ethics related assignments interspersed throughout the semester with the intent of integrating ethics topics into the design field. Ten of these assignments were included on various topics throughout the thirteen week semester, with ethical decision topics explicitly included. A brief overview of the information covered on each assignment is as follows:

1) Read definitions of three moral decision theories and state which best defines your ethical decision process and why. Provide a specific example and list stakeholders on a typical steel design project.
2) For loads calculated in the previous problem sets assume that a call from a field engineer tells you that the cladding dimensions changed and would affect your dead and wind loads approximately 1%. Work is complete so no additional fees for work are allowed, but project cost would be increased significantly by delays beyond the end of the day. State the stakeholders that are affected, what additional information you would like when making your decision, provide four options to address the issue on the phone call listing pros and cons of each, and justify your choice.
3) Read the university Academic Honesty Policy. Select one policy on “cheating”, “fabrication” or “other prohibited actions” and provide reasoning for why this action could be justified by a student in your major. Provide four examples of how the culture in your university, department or peer group supports this reasoning. Provide a scenario in an engineering office or construction site where work culture could similarly justify “unethical” behavior with a description of the scenario, similarities between the work culture described and the culture in their undergraduate curriculum, and three examples of how this culture could justify an unethical decision.
4) Review several NASCC/AISC resources and do a literature review on multiple academic and non-academic search engines, narrowing searches appropriately and comparing results. When obtaining such information state whether you believe it is appropriate to provide your boss with information that neglects sources that are not immediately accessible if they asked for you to give them all relevant information.
5) Compare the content of practitioner versus technical journals and when they would be used. Provide examples of unethical behavior that occurred in your undergraduate experience and how you responded in the immediate moment of observing the behavior. Provide a comparable office situation that relates to cheating on an exam or homework and explain if the academic and office situations differ in terms of ethics.
6) A series of six case studies were provided that focus on typical consulting office ethical decisions. Pick two cases and answer questions relating to decisions that could/should be made, listing additional information you would like that you could obtain within 30 minutes and additional information you would still like to obtain. Provide a valid

argument justifying a legal claim from a stakeholder who would disagree with your ethical decision.

7) State whether you would feel comfortable using data provided to you from different sources in your design (geotechnical engineer providing bearing pressure, engineer from your company providing loads for design, engineer from another company providing loads for design). Discuss whether your answer would change if the provided numbers differed more than 20% from a previous project of similar scope. Discuss any legal responsibility you would have for each of these if errors if the provided numbers led to damage requiring repair or a death.
8) Get feedback from three non-engineers on what concerns them about the infrastructure, and who they think is responsible for addressing these problems Have them provide an example of where an engineering project inconvenienced or negatively impacted them, discussing whether they believe the design engineer considered their perspective and whether they think that the profession acts ethically (always/almost always/sometimes/rarely).
9) Watch sections of the ASEE session panel presentation by activists regarding specific civil engineering crises [20]. Provide a personal reaction on whether the views expressed are credible and whether the activists and engineers understand the issues. Reflect on how community input could be obtained when designing a structural engineering project and discuss opposing equally ethical and valid reasons for why the structure should or should not be constructed. List stakeholders on a typical project.
10) Complete survey on ethics in class at end of semester.

These assignments were typically followed up with an email to the class providing general feedback on student decisions and trends in answers, along with some insight into other viewpoints that some students provided. None of these were phrased as a “right” or “wrong” answer, merely providing an overview of insight that student answers provided and occasional statements. Occasionally insight from the instructor was included, such as the following:

> “Very few of you listed ‘get advice’ from a colleague or superior at your firm. When this was mentioned it was often mentioned as a ‘con’ that you would look like you don’t know how to do your job. Please get out of this mindset if you can. These are the types of situations where talking it through with others can lead to an ideal solution.”

Some brief comments from the instructor were also made throughout the semester alluding to student responses on these assignments or asking how these questions could relate to a new design topic being introduced. The class was intentionally not formatted to allow for extensive discussion of ethics, specifically because these discussions are included in the seminar class and because the intent was to find ways of interleaving ethics into design courses without requiring an instructor to make significant changes to their class (at least initially).

The second author taught the capstone seminar class in Fall 2019. The class employed the format listed below during the first three weeks of that course. Some additional ethics discussions were included throughout the seminar class, where the instructor would mention specific ethical case studies or scenarios that were relevant to the weekly course topic, but these were minimal.

1) Two case studies from the instructor's consulting experience were presented and discussed in small groups.
2) Group discussion on the "moral compass" (defined as the ability of a person to distinguish right from wrong).
3) Introduction of the ASCE and NSPE Codes of Ethics.
4) Read/review a case study from ASCE website, followed by small group discussions of cases and case decisions by the Committee on Professional Conduct. Provide an overview presentation to the class and group report summary discussing the case.
5) Summary of other ethics cases and discussion of whether actions were or were not ethical.
6) Small group play acting walk through of Hyatt Regency Walkway Collapse scenario with decision points to discuss what a young design engineer would do at different stages based on company culture and specific events. This was followed by full class discussion about the case, company culture, moral compass and how seemingly inconsequential decisions can lead to a disastrous outcome.
7) A final case study was presented and followed by an assignment to report on what the engineer should say when asked to testify, evaluating violations of the NSPE Code of Ethics and reflecting on how their time in college has shaped their moral compass.
8) Complete survey on ethics in class at end of semester.

The survey distributed at the end of the semester was identical in each class. There were a total of 61 individual students, twenty-two students enrolled in both classes (receiving ethics instruction in both courses that semester), twelve students only enrolled in the steel design course, and twenty-seven students only enrolled in the capstone seminar class.

The survey evaluated perceptions of ethics (questions 1-7), obtained direct feedback on course content (questions 8-13 with prompt for comments) and included three short case study scenarios where students were asked to choose the two best actions of eight possible choices for resolving the scenario. The case studies were based on EDM Pre-test scenarios (Mumford et al. 2019), but heavily modified to be specifically applicable to structural engineering applications. One scenario related to representation of a company team member's credentials in marketing materials, one related to the importance of meeting an OSHA standard for wearing hardhats in the absence of any hazard (team member forgets to bring the hard hat), and one relates to a design error causing a project delay and how to present this to the owner/architect/project manager in a project meeting. The full scenarios are appended to this paper. These were specifically chosen to address three different aspects of consulting experience in structural engineering. The survey was answered in a 15 minute period on the last day of each class.

Statements 1-7 were rated on a scale of 1-7 with 1=strongly disagree, 4=neutral and 7=strongly agree.

1) Ethics is the difference between “right” and “wrong”
2) An ethical dilemma can have multiple decisions that are equally ethical
3) The ethical decision making process is a rational, thought based process
4) Two people can arrive at different decisions to an ethical dilemma and still be ethical
5) A person’s experiences can influence their ethical decisions
6) An office culture can influence ethical decisions
7) A person’s culture can influence ethical decisions

Questions 8-13 were rated on a similar scale, with the questions asked once for each class and students filling in the content for the course(s) they were enrolled in. Questions 8-10 were answered for the capstone course and questions 11-13 were answered for the steel design course.

8/11) The ethics instruction/assignments included in this course were enjoyable

9/12) The ethics instruction/assignments included in this course were thought provoking

10/13) The ethics instruction/assignments included in this course were new to me

Evaluations

As described previously, a series of ethics and work environment assignments were introduced into a senior level steel design course. Approximately 2/3 of the students in that course were concurrently enrolled in a capstone seminar that addressed ethics using a more traditional case study-based approach. A third group of students, who were enrolled in other design courses, were provided ethics instruction only in the capstone seminar. The new material introduced into the steel design course were short assignments related to ethical theory, work environment, and decision making that included brief case studies directly relevant to class content. The capstone seminar included a three-week section focused on ethics that included the ASCE and NSPE codes of ethics and general civil engineering case studies.

A survey was administered to students in each course to evaluate their experiences and collect comments on how the two methods of instruction were received individually and as a co-experience. The students who were exposed to only the traditional approach of ethics instruction in the capstone seminar were used as a basis for comparison to the mixed method of instruction. It must be noted that no control was placed on any other ethics instruction that students may have had throughout the curriculum. It is known that the topic is covered in the required first year Introduction to Civil and Environmental Engineering course and in an ad-hoc fashion by some instructors in other core classes and electives.

Results of the numerically tabulated data are presented in Tables 1 and 2. The shaded regions indicate results from students enrolled only in the capstone seminar. Results are reported as averages with standard deviations. Ratios of the average values for a specific group to the average value from the group of students taking only the capstone seminar were determined to facilitate comparison among the different student groups. A ratio of less than one indicated that students scored this parameter lower than the students taking only the capstone seminar. With the low number of students in the survey and lack of ability to randomly assign student groups (students were self-selected by their course enrollment) the data is meant to be for general comparison only.

Table 1. Student Perception of Ethics

	Student Enrollment			Ratio of Average to Capstone Only		
	Steel Design Course	Capstone Seminar	Both Classes	Steel Design Course	Capstone Seminar	Both Classes
Statement	Avg (StDev)	Avg (StDev)	Avg (StDev)	Ratio	Ratio	Ratio
1. Ethics is the difference between "right" and "wrong"	4.91 (1.38)	5.62 (1.10)	4.59 (1.05)	0.87	1.00	0.82
2. An ethical dilemma can have multiple decisions that are equally ethical	5.91 (0.83)	5.81 (0.94)	5.91 (0.87)	1.02	1.00	1.02
3. The ethical decision making process is a rational, thought based process	6.00 (0.77)	5.54 (1.30)	5.00 (1.48)	1.08	1.00	0.90
4. Two people can arrive at different decisions to an ethical dilemma and still be ethical	6.45 (0.82)	6.23 (0.86)	6.00 (1.02)	1.04	1.00	0.96
5. A person's experiences can influence their ethical decisions	6.55 (0.69)	6.58 (0.70)	6.61 (0.65)	1.00	1.00	1.00
6. An office culture can influence ethical decisions	5.91 (0.94)	6.23 (0.76)	6.07 (1.24)	0.95	1.00	0.97
7. A person's culture can influence ethical decisions	6.00 (0.77)	6.15 (0.97)	6.52 (0.63)	0.98	1.00	1.06
Total enrollment	12	27[a]	22	12	27[a]	22

Note a: one student's responses were invalid (response of "1" to all questions which was a significant outlier to other responses, student may have mis-read scale) these responses were neglected in averages and standard deviation calculations)

Table 1 shows that students exposed to the ethics lessons integrated in the steel design course tended to see ethics less as a "right" and "wrong" issue than those taking only the capstone

seminar. The students in the capstone seminar only or taking both classes exhibited a trend toward seeing ethics as less purely rational, indicated slightly more acceptance of the possibility of duality in ethical decision making, and acknowledged a slightly higher influence of a person's cultural influence on their ethical decision making.

Table 2. Student Feedback on Course Content

	Student Enrolled in Single Class			Student Enrolled in Both Classes		
	Steel Design Course	Capstone Seminar		Steel Design Course	Capstone Seminar	
Question	Avg (StDev)	Avg (StDev)	Ratio	Avg (StDev)	Avg (StDev)	Ratio
8. The ethics instruction/assignments included in this course were enjoyable	N/A	5.27 (1.19)	1.00	N/A	4.48 (1.35)	0.85
9. The ethics instruction/assignments included in this course were thought provoking	N/A	5.65 (1.13)	1.00	N/A	5.09 (1.19)	0.90
10. The ethics instruction/assignments included in this course were new to me	N/A	4.69 (1.35)	1.00	N/A	4.77 (1.19)	1.02
11. The ethics instruction/assignments included in this course were enjoyable	5.40 (1.07)	N/A	1.02	5.18 (1.26)	N/A	0.98
12. The ethics instruction/assignments included in this course were thought provoking	6.10 (0.88)	N/A	1.08	5.68 (1.09)	N/A	1.01
13. The ethics instruction/assignments included in this course were new to me	6.30 (0.48)	N/A	1.34	5.20 (1.20)	N/A	1.11
Total enrollment	12	27		22	22	

Note a: same student left these answers blank

Table 2 shows student feedback and perceptions of the course content. For those taking an individual class a notable difference was that students rated the integrated ethics teaching in the design class as being new material to them. This likely indicates the fact that the ASCE code of ethics is also introduced in the first year introductory class, using a similar case study-based approach. The fact that it is not "new" may simply indicate that the concepts were previously

discussed, even though student evaluations and discussions were in much greater depth in the capstone seminar than in the first-year course. Students in the steel design class tended to indicate that the assignments were more thought provoking than the students in the capstone seminar. A better comparison may be between the students taking both courses, where the results provide a direct comparison to students exposed to both methods of ethics instruction. The responses to the three prompts were consistently rated higher for the ethics content in the steel design class (assignments were enjoyable, thought provoking, and new to the student, respectively). Students taking both courses also consistently rated the capstone seminar content lower than their peers taking only the capstone seminar, and gave higher ratings to the material in the steel design course. It is also noted that those taking both courses rated these criteria lower than those only taking the steel design course. This latter data likely shows that there was overlap between the two courses that students found redundant (there were only two comments provided, one noting redundancy between course content and the other stating a preference for the steel design course assignments).

A comparison of answers to the case studies showed differences between responses of students who had different exposures to ethics instruction. Students who took both the steel design class and the capstone seminar were fairly consistent in their top two responses to each scenario, with 75% choosing c and/or f (for Scenario 1), 82% choosing f and/or h (for Scenario 2) and 83% choosing a and/or h (for Scenario 3). Of the cohort only taking the capstone seminar with traditional ethics instruction 74%, 62%, and 69% of responses chose the same options, while those only taking the steel design class were less consistent in their responses, with 59%, 60%, and 66% choosing those same options, respectively. Most of the other options for the scenario responses are regarded either as more passive (tending towards a perspective of “it’s not my problem”) or more active (taking significantly more action up through whistleblower actions).

For Scenario 1 the only other options selected more than once by those taking both classes were a (16%) and h (5%), both more passive actions. For the cohort receiving only traditional ethics instruction in the capstone seminar, multiple students chose a (6%), b (9%), d (6%), and e (4%) which include both passive and active selections including reporting the information to outside clients (option b). For those only in the steel design class other options selected more than once were a (14%), d (9%) and g (9%), generally passive or neutral approaches compared to the most frequently selected options.

For Scenario 2 the only other options selected more than once by those taking both classes were a (5%), c (5%) and d (5%). For the cohort receiving only traditional ethics instruction in the capstone seminar, multiple students chose a (4%), c (20%), d (6%), and g (4%). The largest difference between the two cohorts was the number of students choosing the option of not completing the assignment by limiting all potential liability (option c, do not let person without a hardhat do any possible task) and the only group to choose to shift the ethical infraction to

another team member (option g). For those only in the steel design class other options selected more than once were a (10%), c (10%) and d (15%). These were similar to those for students enrolled in both classes but in higher percentages.

For Scenario 3 the only other option selected more than once by those taking both classes was e (10%), an option which results in a slight shedding of responsibility from the individual to the team members. For the cohort receiving only traditional ethics instruction in the capstone seminar, multiple students chose b (7%), c (4%), d (4%), e (11%) and g (6%) which include significantly more active (option b, transferring all blame to a team member) and passive (options c, d and g being more evasive in the information provided in the meeting). For those only in the steel design class other options selected more than once were d (11%) and e (11%).

While the data is limited, the case study responses indicate that the combined ethics instruction led to more consistent evaluations of the scenarios and tendency to take more balanced actions, avoiding extreme responses such as a whistleblower action or shedding of responsibility that were chosen by some students exposed to the traditional instruction method only. Similarly, students taking both courses showed a tendency to see ethics as more nuanced than those taking either course separately. This indicates advantages to integrating the two methods of teaching ethics into the curriculum, with some student preference for integrating ethics assignments into the design class curriculum.

Conclusion

An integrated method for introducing ethics into a steel design course was implemented. This complemented a more traditional method of instruction in a capstone seminar course. Three cohorts of students were compared, the students only in the capstone seminar, those in the steel design course, and those taking both courses concurrently. Students in the integrated ethics curriculum tended to see ethics less in terms of “right” and “wrong.” The students exposed to both methods of instruction were more likely to accept multiple responses to ethical decisions and arrive at more consistent responses in case studies presented in an end of year survey. The student perception of the integrated topics were that it was a more enjoyable and thought provoking method, but this could be due to the traditional method being addressed elsewhere in the curriculum. It is likely most effective to include a combination of these approaches, highlighting ethics specific to course content and also presenting more traditional ethics content as in the capstone seminar. Ideally, similar topics would be developed within a series of individual design courses and ethics assignments such as these integrated throughout the curriculum.

References

[1] Harding, T., Finelli, C. and Carpenter, D. (2006). Cheating in college and its influence on ethical behavior in professional engineering practice. ASEE Annual Conference Paper ID#2006-636.

[2] Finelli, C., Harding, T., Carpenter, D. and Mayhew, M. (2007). Academic integrity among engineering undergraduates: Seven years of research by the E^3 team. ASEE Annual Conference Paper ID#2007-2446.

[3] Canney, N. E., Polmear, M., Bielefeldt, A. R., Knight, D., Swan, C. and Simon, E. (2017) Challenges and opportunities: Faculty views on the state of macroethical education in engineering. ASEE Annual Conference. Paper ID#17874.

[4] Bucciarelli, L. L. (2008) Ethics and engineering education. European Journal of Engineering Education. 33(2) Pp. 141-149.

[5] Lynch, W. and Kline, R. (2000) Engineering Practice and Engineering Ethics. *Science Technology and Human Values*. V25(2). Pp. 195-225.

[6] Herkert, J. (2000) Engineering ethics education in the USA: Content, pedagogy and curriculum. European Journal of Engineering Education. 225(4) Pp. 303-313.

[7] Levine, Charles; Kohlberg, Lawrence; Hewer, Alexandra (1985). "The Current Formulation of Kohlberg's Theory and a Response to Critics". Human Development. 28 (2): 94–100.

[8] Haidt, Jonathan (2001). "The emotional dog and its rational tail: A social intuitionist approach to moral judgment". Psychological Review. 108 (4): 814–834.

[9] Greene J. D. (2017). The rat-a-gorical imperative: Moral intuition and the limits of affective learning". Cognition. 167: 66–77.

[10] Pfieffer, G. and Billiear, K. (2017) Teaching Ethics in Engineering: A “Blended” Approach of Theory and Practice. ASEE Paper ID #19886. *Annual Meeting of ASEE*.

[11] Liang, V., Jesensky, Z. Moore III, M. Rogers, J. F., Pfiefer, G. and Billiar, K. (2016). Teaching engineering students how to recognize and analyze ethical scenarios. ASEE Annual Conference Paper ID#16117.

[12] Newburry, B. (2004) The Dilemma of Ethics in Engineering Education. *Science and Engineering Ethics*. V10. Pp. 343-351.

[13] Clancy III, R. F., Seessford, J. R, An, L. and Ge, Y. (2017). Which factors are correlated with engineering students’ expectations of ethical issues? ASEE Annual meeting Paper ID #18716.

[14] McGinn, R. (2013). ‘Mind the gaps’: An empirical approach to engineering ethics, 1997-2001. Science and Engineering Ethics. 9. Pp. 517-542.

[15] Paul, R. and Elder, L. (2009a) Critical thinking: Ethical reasoning and fairminded thinking, Part 1. Journal of Developmental Education. 33(1). Pp. 36-37.

[16] Paul, R. and Elder, L. (2009b) Critical thinking: Ethical reasoning and fairminded thinking, Part II. Journal of Developmental Education. 33(2). Pp. 42-43.

[17] Prince, M. J. and Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons and research bases. Journal of Engineering Education. 95(2). Pp. 123-138.

[18] Lambrinidou, Y. Rhoads, W. J. Roy, S. Heaney, E., Ratajczak, G. A. and Ratajczak, J. H. (2014) Ethnography in engineering ethics education: A pedagogy for transformational listening. ASEE Annual Conference Paper ID#10155.

[19] Katz, A. and Knight, D. Factors related to faculty views toward undergraduate engineering ethics education. ASEE Annual Conference. Paper ID#18383.

[20] Community Engagement Ethics – First Steps in a Conversation with Affected Communities. (2019) Session: W252: Distinguished Lecture Panel.ASEE Annual Meeting.

Appendix: Case Studies Used in Survey:

The following scenarios will be followed by a series of options. Choose **TWO** options that you think are the optimal responses to the given issue.

Scenario 1) Modified from EDM Pre-test (Mumford et al. University of Oklahoma):

Price is an engineer who has just started a job with a company that does specialty vibration designs for engineering structures, including pedestrian bridges, antennae support structures and space satellite systems. Price's job will be to review and analyze preliminary designs before they are presented to clients.

After working at the company for two weeks, Price notices that there are a number of individuals in the analysis group who do not have advanced degrees or formal training in the advanced analysis that the company does. The group's expertise is represented differently in marketing materials sent to prospective clients to solicit new business. The individuals work hard and seem knowledgeable about the designs, but their work is relatively unsupervised.

What should Price do? Choose TWO of the following:

a. Try to get along with these individuals since she will be working closely with them
b. Inform the clients which are being solicited for new business
c. Discuss the education levels of the people in this group with a senior manager
d. Reevaluate the marketing materials after she has been on the job for 6 months
e. Take initiative in collecting information to find out if anyone in the analysis group is enrolled in graduate school or other training
f. Talk to the manager supervising the analysis group about the marketing materials
g. No action is needed because it is not her decision and she personally has the necessary expertise
h. No action is needed since these individuals know how to do their jobs

Scenario 2) Modified from EDM Pre-test (Mumford et al. University of Oklahoma):

John is a mid-level engineer specializing in field instrumentation. He has been very productive in his company and present team, which he has been part of for the last couple of months. The current project involves going to a remote site over the weekend when the construction crews are not working in order to install instruments to monitor deformations of the structure during the construction process. The travel time is somewhat extensive and when the team arrives, he realizes that one of the team members, Rob, did not bring his hard hat. Rob is the most experienced member of the team and is relied on to troubleshoot potential instrumentation problems. Although there is little danger of injury happening on the site, wearing a hard hat is required for any field work at the site. There is no time to go back and get a hard hat, yet John needs every one of the team members to be working on the instrumentation in order to complete it on time.

What should John do? Choose TWO of the following:

a. Have Rob sign a special waiver releasing the firm from liability
b. Have everyone return back to the office and plan for a return outing the next weekend
c. Have the remaining team members do what they can to complete the instrumentation, while Rob waits in the vehicle
d. Have Rob work on something that has a very limited chance of doing him any harm
e. Have Rob be fully involved in the instrumentation, even though he doesn't have his hard hat, since the hard hat isn't really needed
f. Call the office and see if someone can bring a hard hat to the site later in the day
g. Have the team member with the least dangerous job give their hard hat to Rob
h. Send Rob to a local hardware store to purchase a new hard hat, while John and the rest of the team start to work on the instrumentation

Scenario 3) Modified from EDM Pre-test (Mumford et al. University of Oklahoma):

Jenn is leading a group designing a university building renovation. The project schedule is critical to ensure that construction can start on time and the building can be ready for the Fall semester. The design team includes four engineers and an intern. A month into the design Jenn finds out that the initial calculations used to determine the wind loads used outdated wind load maps that the intern found on the internet and provided to one of the engineers. This was an obvious mistake that should have been noticed by someone on the design team, but wasn't. The building design is well underway and will be significantly changed by the corrected wind loads. Specifically, a large open space already discussed with the owner and architect will need to be significantly altered unless significantly more engineering work is done to fully evaluate other options. It is expected that it will take 2 weeks to re-do the necessary calculations.

Jenn has a meeting (these occur every two weeks) with the owner, architect and project manager in two days where she is supposed to provide an update on the design progress. She was planning to tell them that everything was on schedule and that she would be providing them information to start ordering materials for construction at the next meeting in 2 weeks. The owner, architect and project manager are not going to be pleased with news of any delays.

What should Jenn do? Choose TWO of the following:

a. Tell the owner, architect and project manager in the meeting that the design needs to be significantly revised, but that a design will be ready for discussion in the next two weeks
b. Reassure the owner, architect and project manager that a delay is due to a dumb mistake by an intern, and the problem will be resolved in the next two weeks
c. Because of the loss of confidence that could come from explaining the problem in the meeting, do not tell the owner, architect and project manager about the problem, but mention that she did not get a complete update of the current schedule from the team
d. Avoid potential embarrassment by telling the owner, architect and project manager in the meeting that the design is some unforeseen complexity and will likely need a slight extension
e. Explain to the owner, architect and project manager that these kinds of mistakes are fairly typical for a young team to make and that that the design will be completed within two weeks
f. Do not attend, or try to cancel the upcoming meeting and use the extra two weeks time to rectify the problem
g. Attend the meeting and vaguely explain that there will be a delay in the design
h. Tell the owner, architect and project manager that a design mistake was made, but that she will have the team work overtime in order to get the project back on schedule