AC 2012-3386: ONLINE AND IN-SEAT ETHICS INSTRUCTION: THE VIEW FROM BOTH SIDES

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Online and In-Seat Engineering Ethics Instruction: The View from Both Sides

Abstract

The ABET 2000 Criterion 3f states that engineering programs must educate students with "an understanding of professional and ethical responsibility." In addition, the Fundamentals of Engineering and Professional Engineering examinations also address the need for ethics instruction. As such, undergraduate engineering curricula must address ethics instruction within a designated course and/or across engineering coursework.

Traditionally, engineering ethics instruction has been conducted in a formal classroom setting. However, online instruction has gained rapidly in acceptance in many disciplines. Engineering programs are catching up with some programs offering all or part of their coursework online. Ethics instruction can be readily implemented in an online learning environment.

This paper will address the author's experience in instructing engineering ethics at multiple universities in the traditional lecture format and compare and contrast that experience with offering an online engineering ethics format. The author will describe engineering ethics course construction for use with traditional in-seat lecture and online instruction. Student scores appear to indicate that this topic can be implemented successfully online or in-seat. Online instruction allows for greater flexibility for students to fit required coursework into busy schedules.

Introduction

The Engineering and Computer Science (ECS) Department at West Texas A&M University (WTAMU) requires a one-credit engineering ethics course for civil and mechanical engineering and engineering technology majors. Practicing engineers realize the importance of *soft* skills such as technical communication (written and oral) as well as a need for ethics knowledge in their everyday dealings in the workplace and as mandated by continuing education requirements for Professional Engineering licensure. The Body of Knowledge document prepared by the American Society of Civil Engineers (ASCE) further emphasizes the need for ethics instruction along with business management competence and lifelong professional development. Identification of ethics solving skills can be nebulous concepts for engineering professors and students alike, as they are primarily trained in applied math, science, and engineering coursework that leaves little room for worthwhile soft skills.

While engineering technology has been well established at WTAMU for several decades, the mechanical (2003) and civil (2010) engineering programs are relatively new. Curricula for the newer engineering degree programs are similar to other ABET-accredited programs which are constrained in the number of credits that can be allotted to engineering coursework and required general education curriculum. Many engineering programs in the United States use one of three approaches to ethics instruction: 1) an ethics component built into modules presented in one or more engineering courses, 2) a required ethics or philosophy course outside of engineering, or 3) a dedicated course for ethics instruction, the latter of which is used at WTAMU and the focus of this paper.

The ECS Department is geared toward primarily undergraduate engineering instruction. Few engineering instructors and professors have specific training in soft skills such as ethics instruction and technical communications. However, the ECS departmental outreach coordinator and Communications Department instructor, Rhonda Diffurth, holds a master's degree in communications from WTAMU. Civil Engineering assistant professor Dr. Kenneth Leitch holds an MBA with an emphasis in Corporate Training which incorporates graduate-level education coursework, ethics instruction, and business principles. The authors are able to bring a fresh perspective on these soft skills in both the in-seat and online venues of engineering education.

Much has been written about the content and assessment of engineering ethics courses. A survey of engineering ethics courses is presented by Freyne and Hale (2009) to determine what universities are doing to incorporate ethics into engineering curricula. The primary focus in this paper is to address in-seat (i.e. traditional lecture) versus online

delivery of engineering ethics. It is helpful for engineering faculty and instructors to understand how to set up an online course such that it will successfully deliver the required content for assessment and ABET requirements.

Primary Mechanisms of Content Delivery

A survey of online course offerings and practices was conducted by Batts et al in 2007. These researchers collected responses from 44 respondents at two- and four-year institutions in regard to technology-related online coursework. Many respondents did not have prior training or experience before setting up online courses. However, the lessons learned from the respondents are invaluable. Best practices such as setting rules for a friendly online environment, using discussion boards and chat rooms, providing detailed syllabi, use of instant messaging, group and individual activities, online assessment tools, and interactive course content (i.e. video and audio clips, interactive presentations, web links, etc.) were presented. Many of these best practices were incorporated into the online development of the course described in the present paper.

Holdhusen (2009) compared in-seat, online (asynchronous), online (synchronous), and hybrid (in-seat and online) versions of an engineering graphics course. Asynchronous online courses allow students to interact with online content at a time of their choosing prior to a deadline while synchronous online instruction requires students to be present online at the same time in a chat room and/or via webcam, much like a traditional in-seat course or teleconference course with a designated meeting time. The author compared test results for all four delivery methods. The in-seat and synchronous online courses had similar results with test scores that ranked higher than the hybrid and the asynchronous online courses, respectively. The in-seat test scores were about 10% higher than asynchronous online test scores, using the same testing process.

Krishnamurthi (2000) mentions that one of the most difficult aspects of online instruction is the integration of student -teacher interactions. Communication is dependent not only on verbal cues but also body language, delivery tone, timing, and other non-verbal aspects that are hard to replicate with asynchronous online learning. Techniques suggested for improvement of student-teacher interactions include discussion forms, collaborative interactions (teamwork), individual activities, and evaluation of interactions.

Author History with Engineering Ethics Instruction

Dr. Leitch has constructed and instructed engineering ethics courses at three institutions, all of which have a dedicated course for engineering ethics instruction. As a doctoral candidate at New Mexico State University (NMSU), he was tasked with teaching during three consecutive summers (2000 – 2002), a combined Engineering Economics and Ethics course that consisted of the equivalent of one-credit hour of ethics instruction. A feature of instruction at NMSU was the use of National Society of Professional Engineers (NSPE) case studies that were discussed in a collaborative classroom format as well as also in a technical report and presentation at the end of the course.

At Valparaiso University (VU), Dr. Leitch constructed the ethics section of a course similar in scope and breadth to that at NMSU. The ethics portion of the course was overhauled to be the equivalent of one-credit hour of instruction with clearly defined objectives, as promoted by the National Effective Teaching Institute (NETI), and used some of the instructional techniques developed at NMSU. The overhaul of the course vastly improved student scores on the ethics portion of the Fundamentals of Engineering (FE) exam, with correct responses rising from an average of 60% to over 90% for civil engineering majors (Leitch et al, 2007).

While the NMSU and VU courses were traditional in-seat courses, Dr. Leitch has instructed the required ethics course at WTAMU as both in-seat and online. The WTAMU course (ENGR 1171, Engineering Ethics) is a stand-alone one-credit course that can be taken concurrently with the two-credit Engineering Economics course or may be taken separately as a student's schedule allows.

In-Seat and Online Ethics Instruction at WTAMU

The in-seat lecture version of Engineering Ethics was offered in Fall 2009 (as a three-credit course on an older course catalog) and Fall 2010 (one-credit course on present catalog). The online version of the course was offered

in Summer Session I 2011 and is likely to be offered in Summer Session I 2012 due to student demand. In each offering, the same textbook was utilized: Fledderman's *Engineering Ethics*, 3rd Edition. The book has been used by the ECS Department for several years and is suitable for a one- to three-credit hour course. For the three-credit version of the course, supplemental materials such as movies (*A Civil Action* and *Enron: The Smartest Guys in the Room*, shown nearly in their entirety) and additional readings and assignments were given. The one-credit version of the course stays closely with the subject matter of the Fledderman text with a few additional reading materials and movie clips from *The Smartest Guys in the Room* being utilized. Of note, the documentary *Enron: The Smartest Guys in the Room* (released in 2005) is about the ethical issues arising from the rise and subsequent fall in 2001 of Enron Corporation.

The course objectives (Appendix A), Fall 2010 schedule and grading (Appendix B), and Summer Session I 2011 (Appendix C) schedule and grading are for the current one-credit required engineering ethics course. The structure of the class is essentially the same with the use of the same textbook and instructional materials. The following section will compare and contrast the in-seat (Fall 2010) versus the online (Summer Session I 2011) offering of the class.

Results and Discussion

The in-seat version of the ENGR 1171 course was given during the Fall 2010 semester. This offering of the course was the first iteration to be given as a one-credit required course, reflecting a change in the university catalog to better align with ethics instruction offerings at other engineering programs in the USA. The class was a traditional 50-minute format offered once a week on a Friday. Since the course has no prerequisite, freshmen through senior students were all represented in three majors: civil and mechanical engineering and engineering technology. Only two of the 33 students were freshmen, as this course is really geared to students with at least some work and life experience that complement objectives stated in Appendix A.

The in-seat version of the course required students to work in groups of three students of their own choosing. Students were required to work on nine homework assignments in groups. The reasoning for group homework assignments is that students benefit from discussing ethical issues with one another. Students were encouraged to discuss multiple alternatives to ethical issues and document these in the homework assignments. Students were also required to submit twelve weekly summary memos documenting the weekly readings, class discussions, supplemental readings, and/or video clips. Grading the memos was very time intensive, but did serve to improve students' technical communication skills and helped them to learn how to write more succinctly. Some students wrote very little and some were far too verbose in their memos; by the end of the semester, most students were proficient in writing summary memos that were approximately one-half page in length and captured the essence of the weekly lesson. A sample memo is given in Appendix D. Many students remarked to the instructor and on evaluations that the engineering ethics course helped them to not only think and react better to ethical issues but also that the course was valuable from the standpoint of learning how to write and communicate better in regard to technical communication skills.

The online version of the course was adapted from the course material developed from the in-seat version of the course, essentially doubled up in weekly content as the fall semester has fourteen weeks and the summer session is compressed into six weeks. As such a few changes were made. No midterm exam was given, with only a final exam given on the last day of the course. Summary weekly memos were replaced with four weekly discussion forums where students were evaluated on their discussion of the course materials and on a weekly ethical discussion question.

The online version of the course also depended on weekly group homework submittals, where five assignments covered the same material as nine assignments in the in-seat version. Groups were assigned by the instructor based on student level (freshman, sophomore, etc.). Groups initially had three students each, but a few groups lost a student due to dropping. Thus, some groups had only two students. The course finished with 41 students in 15 groups. Anecdotally, the groups of two students said that it was easier to collaborate than the groups of three, a point to consider in online coursework. Since the students were taking the course in an asynchronous manner (working on assignments at their pace, not in real-time), collaboration is somewhat more difficult than when students see each other face-to-face.

Online discussions were very educational for some students. Each student was required to have at least one main original posting and at least one original reply to another student. Many students enjoyed this format and participated above the required level. However, approximately five of the 41 students did not participate at all and hence lost at least one letter grade as a result. This was puzzling since the online discussion was fairly simple and was conducted over a one-week period to allow for students with asynchronous schedules to participate.

In comparison of grades for like categories using the same materials, the average assignment scores were 83% and 90% for the in-seat versus online courses. The final exam average scores were nearly identical at 92% for each class. This appears to indicate that given the same course content, the engineering ethics course can be successfully implemented in-seat or online.

Conclusions and Recommendations

Virtually all engineering faculty are very familiar with traditional lecture and laboratory course instruction. However, many instructors have not had the opportunity to offer the same material in part or in total online for an engineering course. Dr. Leitch experienced eight of thirteen required courses for an MBA degree (2008-2009) online and saw that the same techniques applied there could also be adapted for an engineering ethics course. The online offerings in Summer Session I 2011 (engineering ethics and engineering economics) were the first of several courses that WTAMU sees filling a need for a student population with a large number of non-traditional and working students. Many engineering faculty may be leery of online instruction because they have no experience with it. With careful planning, online courses offer flexibility to students and a possible new revenue stream in regard to distance learners that may never set foot on campus.

In setting up the online course, it is helpful to consult with others that have experience especially when the instructor has not had an online learning and/or instructional experience. Make sure that the educational objectives and expectations are very clear. Ensure prompt communication with the students by email, discussion forum, and/or by webcam (such as with Skype) since the students will not have the full range of cues that instructors deliver in lecture by sight and by the tone of voice. Of all lessons learned, this last one is the key to success in online instruction.

Using scores from the Fundamentals of Engineering examination, the author intends to also check to determine if there is any significant difference in scoring of ethics questions in regard to whether a student took the ethics course in-seat or online. This could also be determined for the in-seat versus online versions of engineering economics and any other required engineering courses that are also offered online in the future.

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Appendix A – Course Level Objectives for ENGR 1171 Fall 2010 and Summer Session I 2011

Learning Objectives: Upon completion of this course, the student should be able to

1. Explain the importance of engineering ethics.
2. Identify and utilize a professional code of ethics (i.e. NSPE, ASME, ASCE, etc.)
3. Discuss and apply ethical theories for engineering applications.
4. Utilize ethical theories and codes to resolve hypothetical and real cases.
5. Identify factors that affect risk, safety, and accidents in engineering design.
6. Discuss the rights and responsibilities of engineers in relation to their clients, employer, and the public.
7. Determine and discuss ethical issues that arise in regards to the environment, computer systems, and the course of research and data collection.
8. Determine how ethical problems can be avoided and/or resolved in order to make a satisfactory decision.
9. Communicate technical content related to the concept of engineering ethics using homework, memoranda, online/oral discussions, and/or by examination.

Appendix B – Course Schedule and Grade Components for ENGR 1171 Fall 2010

Course Schedule (Subject to Revision):

Week #	Date	Lecture	Reference
1	03 Sep	Course Introduction; Licensing Requirements	Syllabus; Notes
2	10 Sep	Introduction to Ethics	Ch 1
3	17 Sep	Professionalism and Code of Ethics	Ch 2
4	24 Sep	NSPE Code Studies; SOX & Whistleblowing	Notes
5	01 Oct	Ethical Theories	Ch 3
6	08 Oct	Case Studies	Ch 3
7	15 Oct	Ethical Problem-Solving Techniques	Ch 4
8	22 Oct	Risk, Safety, and Accidents; Midterm Exam	Ch 5
9	29 Oct	Case Studies; Introduction to Law	Ch 5
10	05 Nov	The Rights and Responsibilities of Engineers	Ch 6
11	12 Nov	Case Studies; Ethical Issues in Engineering Practice	Ch 6 & 7
12	19 Nov	Case Studies	Ch 7
13	03 Dec	Doing the Right Thing; Course Review	Ch 8; all
14	10 Dec	Final Exam (8 – 10 AM)	All

Grade Components:

Memoranda, Homework, and/or In-Class Activities	60% of total
Midterm Take-Home Exam	15% of total
Final Exam	25% of total

Appendix C – Course Schedule and Grade Components for ENGR 1171 Summer Session I 2011

Course Schedule (Subject to Revision):

Week #	Dates	Lecture	Reference
1	01 – 04 Jun	Course Introduction; Licensing Requirements; Introduction to Ethics	Notes; Ch 1
2	05 – 11 Jun	Professionalism and Code of Ethics; NSPE Code Studies; SOX & Whistleblowing	Ch 2; Notes
3	12 – 18 Jun	Ethical Theories; Case Studies; Ethical Problem-Solving Techniques	Ch 3 & 4
4	19 – 25 Jun	Risk, Safety, and Accidents; Case Studies; Introduction to Law	Ch 5; Notes
5	26 Jun – 02 Jul	The Rights and Responsibilities of Engineers; Ethical Issues in Engineering Practice; Case Studies	Ch 6 & 7
6	03 – 06 Jul	Doing the Right Thing; Course Review	Ch 8
6	07 Jul	Final Exam (due by midnight, online submittal)	All

Grade Components:

Homework, Online Discussion, and/or Memoranda	75% of total
Final Exam	25% of total

Appendix D – Sample Student Memo for ENGR 1171 Fall 2010

To: Dr. Kenneth R. Leitch, PE
From: A. Good Student *ags*
Date: 02-Mar-12
Re: ENGR 1171 Class Week 8: Risk, Safety, and Accidents

During the beginning of class, Dr. Leitch showed an excerpt from *The Smartest Guys in the Room* which was about the Enron scandal. The carelessness which the leadership of Enron clearly exercised hurt not only those that worked for them but everyone around the country feeling the consequences of their negligence. Dr. Leitch then covered a presentation on Risk, Safety, and Accidents. The fundamental duty of every engineer is to protect the well-being of the public. The NSPE also illustrates very openly the degree to which engineers should hold the safety of all citizens. Within the designs that an engineer builds, a factor of safety is integrated into it. Safety is very vague in its definition because of its subjective nature. The class discussed what makes people feel safe and security was brought up. Security may look like a rifle to one person and an alarm system to another. An old military Jeep® illustrated how safety has been modified over the years into the newer, more protected design with a roll cage and solid windshield.

There is a direct relation between safety and risk. It is impossible to design a completely safe product but it's desirable to eliminate risk (as much as possible). Risk is defined as "the possibility of suffering harm or loss, danger." Safety is defined as "freedom from damage, injury, or risk." Voluntary risk can be safe; whereas, involuntary risk can be unsafe. These make sense because if a person voluntarily understands the risk he or she could be taking but decides to do so anyway is much more aware of consequences. The person who involuntarily takes a risk is put in danger for the very reason of not being aware of the situation. It is not only important for an engineer to keep in mind safety as well as risk in the design of a product but also if it can be misused by anyone. If an engineer can possibly avoid any possible dangers by thinking ahead to any way the product could be misused, then this could save lives. Three types of accidents were also discussed and they are procedural, engineered, and systematic.

Appendix E – Sample Homework Submittal for ENGR 1171 Summer Session I 2011

Chapter 6 Problem #5:
BART was a very innovative design that went well beyond the other mass transit systems that were currently in existence. What guidance does "accepted engineering practice" provide in such an innovative design?

Solution:
The design that BART was working on incorporated a large scale of new technology some that had not yet been tested. While human drivers who communicate and receive instructions from dispatchers operate most mass transit systems, this new system relied upon an onboard sensor system that determined the train position and location. Engineers questioned the reliability and the effect that these untested components might have on the peoples' safety. Whether this system would function well or not has created concerns for engineers motivating them to review the testing procedures. Some engineers have problems understanding the documentation of this system and it will be reflected in their support of such a system.

Chapter 6 Problem #6:
When pointing out safety problems, an engineer is rightfully concerned about maintaining his job. However, how effective is an anonymous memo? Can anyone be expected to pay attention to something that a person won't sign?

Solution:
Though an anonymous memo keeps the writer secret, the memo will create concerns and initiate an investigation hopefully correcting or addressing area of concern. The most important thing is that the memo reaches those with the authority and ability to make the changes. If the situation is serious enough to cause whistle blowing then the engineer concerned should not stop if the memo is ignored. It has become nearly a standard policy in large companies to have anonymous comment boxes to allow employees to leave their serious concerns without fear of discrimination for bringing the situation to light. Safety is the number one concern in NSPE guidelines along with ethical and honest practice, for a concern to be ignored would raise question to the employer's moral standards and employee regard.