AC 2007-866: FINDING A "PLACE" FOR READING AND DISCUSSION COURSES: DESIGN AND ASSESSMENT OF "SOCIAL AND ETHICAL IMPACTS OF TECHNOLOGY"

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Finding a "place" for reading and discussion courses: Design and assessment of "Social and Ethical Impacts of Technology"

Abstract

This paper discusses the development and assessment of a reading and discussion course entitled "Social and Ethical Impacts of Technology." Taught in the University of Wisconsin-Madison's Department of Engineering Professional Development by members of the department's technical communication faculty, the course combined assigned readings, an in-class and an online discussion, and an end-of-semester writing assignment to help students achieve the following learning outcomes:

- Outcome 1: Articulate connections among engineering, ethics, community, history, social change, and politics by actively listening and participating in a small discussion setting
- Outcome 2: Recognize and work with the role of uncertainty in engineering and its relationship to social and ethical dimensions
- Outcome 3: Analyze and assess the social and ethical impact of technology on society by critically thinking about the readings and discussion topics
- Outcome 4: Communicate effectively by writing and speaking
- Outcome 5: Identify, formulate, and solve engineering problems related to professional and ethical responsibilities, including interdisciplinary approaches to said problems

Our three-pronged assessment scheme measured success of the learning outcomes through (1) interviews with a student focus group and with individual instructors; (2) written student surveys, including a short mid-semester evaluation and Elaine Seymour's Student Assessment of Learning Gains (SALG) protocol at the end of the semester; and (3) review of the online discussion forum transcripts and the final research projects. Results suggest that students satisfactorily achieved Outcomes 1–3 but that adjustments should be made to the course to help students better succeed with Outcomes 4–5. The authors discuss future plans for the course as well as exportable lessons for those interested in trying to find a place for similar courses at their own institutions. Throughout the paper, the authors also argue that flexible, interdisciplinary, student-centered discussion courses like this one have the potential to teach some of the ABET professional skills in way that students and faculty alike will find refreshing, exciting, and effective.

Introduction

In his "Ethics Instruction in Engineering Education: A (Mini) Meta-Analysis"[1] David Haws examines 42 papers on the subject of engineering ethics instruction, all of them from the ASEE annual conference proceedings, 1996-1999. His paper identifies six common pedagogical foci for courses in engineering ethics: "the Professional Engineer's Code of Ethics, humanist readings, grounding in theoretical ethics, ethical problem solving heuristics, case studies, and service learning." He goes on to evaluate the effectiveness of each approach in light of three objectives that will help students deal with ethical problems: "we need to enhance the efficacy of our students' divergent thinking, help them see engineering outcomes through the eyes of non-engineers, and give them access to the common vocabulary of ethical articulation."

If the quantity of papers on the subject at last year's annual conference is any measure of ASEE members' interest in and concern about teaching ethics, there is good reason to be optimistic about the future of such instruction. On the other hand, we don't seem to be much closer to agreement about how best to go about this increasingly important task. In fact, most of the papers featured at the 2006 conference describe courses and workshops that appear to use a wide variety of approaches, running the gamut from codes of ethics[2,3,4,5] to humanistic readings[6] to problem solving heuristics[2,3,4] to past and (hypothetical) future case studies[2,3,4,5,6,7,8] to theoretical grounding[4,8].

If an optimal solution to teaching engineering ethics truly exists—for his part, Haws suggests "[t]heoretical grounding, combined with service learning to make it 'real' and case studies to make that reality sufficiently broad"—should we be concerned that our approaches are not converging to this ideal solution? Furthermore, should those of us using one of the approaches Haws criticizes fear that we are not being effective?

We believe the answer to both questions is "not necessarily." As developers, instructors, and assessors of a one- to two-credit reading and discussion course at the University of Wisconsin-Madison entitled "Social and Ethical Impacts of Technology," we were initially a bit discouraged as we began to compile and report our findings from two semesters' experience with a course that Haws probably *would* criticize. Indeed, when the preliminary abstract for this paper received its review for ASEE, one reviewer wrote, "there is nothing particularly innovative or unusual about the approach presented here." However, we have come to realize that assessing our course subject to Haws's insightful criteria or simply comparing it to other efforts in engineering ethics instruction would omit a key fact that we ourselves almost overlooked: we didn't really set out to create an ethics course—at least, not *just* an ethics course.

We also wanted students to think critically about past, present, and future technologies and the roles they (both the engineers and the technologies) play in modern society. We wanted them to look at technology from different viewpoints and read about it in different genres. We wanted them to apply the course material to their lives, not just their studies. And most importantly, we wanted to foster discussion—real, dynamic, decentered discussion, in which students genuinely speak and listen to each other.

We suspect that some of the programs Haws examined and some of those discussed at last year's conference also had other goals in addition to ethics instruction, and we therefore advocate a more complicated view of how "best" to teach ethics at any particular institution. Thus, while we do not dispute Haws's theoretical prescription of the ideal pedagogical approach to bringing about ethics-related learning outcomes, we wish to present here the design and assessment of a course that *combines* ethics with several other complementary course goals. Such a hybrid approach was the most feasible way to get an ethics-related course off the ground in our department at the particular time we were trying to do so. Herein, we hope to make a case for the power and potential of flexible, interdisciplinary, student-centered courses that leverage individual schools' particular institutional contexts to couple ethics with other non-technical subjects typically given short shrift in engineering curricula.

Motivation: All best practices are local

Like many engineering educators across the country, we are both excited by and somewhat impatient for the promise that imbues efforts such as the reform of the ABET criteria, the ASEE Year of Dialog, and the creation of engineering education departments at Purdue University and Virginia Tech. We are excited because we believe that the more we allow our decisions about curriculum and instruction to be informed by the scholarship of teaching and learning engineering, the better off our students (and probably the nation) will be. On the other hand, we are impatient because we work on a daily basis with students who will graduate before many of the most innovative reforms will gain widespread support, let alone implementation.

For instance, Haws notes the "enormous potential" to teach ethics through service learning[9] experiences, and Shuman, et al. believe that that potential extends to ABET's other "professional skills"[10]. While this seems to be one of those cases where a scholarly consensus is at least beginning to form, we know that implementation of this best practice will take years at many institutions. We're relatively lucky at UW-Madison: At the December 2006 commencement ceremony, our chancellor noted that an unprecedented number of our university's graduates had participated in service learning[11]. However, we are as yet far from making this opportunity available to all students. In a sense, then, the question we try to answer with this course and with this paper is "What might we do in the meanwhile for those students who won't have the chance to do service learning before they graduate?"[12]

Our answer is informed by a metaphor that environmental writer Michael Pollan develops in his *Second Nature: A Gardener's Education*[13]. Searching for an alternative to the high-minded but difficult-to-apply traditional wilderness ethic (i.e., preserve pristine wilderness areas wherever they exist, regardless of context), Pollan points out that an "ethic based on the garden would give local answers," and suggests that we "begin with Alexander Pope's famous advice to landscape designers: 'Consult the Genius of the Place in All.'" Though the analogy doesn't translate perfectly, we believe it is still somewhat instructive. First, somewhat like the wilderness ethic, Haws's and Shuman's academically rigorous and forward-thinking proposals are ultimately excellent goals, but they do not necessarily map very well onto the local peculiarities of our department (Engineering Professional Development), especially as this particular time. As we work toward medium- and long-term goals, we would be wise to look for short-term solutions that better match our institutional circumstances. In fact, we believe such short-term solutions can actually be stepping stones to long-term reform if we can look for ways to combine long-term theoretical goals with short-term practical implementations by building and modifying new programs incrementally.

Moreover, we believe it is empowering to think of our institutional circumstances using Pope's expression about "the genius of the place." While it's easy to blame the status quo on local circumstances ("if only the state would fund us better," "if only the department were set up differently," etc.), we believe it was ultimately more productive for us to look at the specifics of our institutional niche and try to focus on the ways in which our circumstances might help us to do something innovative, rather than always focusing on how they hinder us from doing so.

Thus, throughout this description of our course design and assessment, we will attempt to show the ways in which "the genius of *this* place" influenced our course by making it possible in the first place and by helping us shape and focus it to better meet our students' needs. We will attempt to do so in a way that makes these lessons adaptable to other sets of institutional circumstances.

The early evolution of the course (spring 2005)

In the spring of 2005, a seminar-style class grew out of necessity, circumstance, and a desire to have a reading and discussion course in the Technical Communication Certificate (TCC) program housed in our College of Engineering's Engineering Professional Development Department. An unanticipated and significant shift in our TCC staff that semester demanded that a handful of students, all registered for independent study credits, meet as one class. At the same time, one of this paper's coauthors (Kyle Oliver, then an undergraduate nuclear engineering student) approached our TCC director (Laura Grossenbacher, another coauthor) about doing some independent reading as a follow-up to a history of science course Oliver had recently completed.

The two events converged, so to speak, and thus "Social and Ethical Impacts of Technology" was born, although it was not yet named as such. The students in the resulting small, semi-formal pilot course[14] agreed to take on a reading list (see Appendix A) that included excerpts from Kant, Mill, Poincaré, Hawking, Dawkins, and others, as well as the entirety of Richard Rhodes's *The Making of the Atomic Bomb*, which the group read over winter break before their spring 2005 session.

Before moving on, it's worth pointing out that our diction in the heading for this section was deliberate—the pilot course *evolved* inasmuch as it was largely a product of its institutional environment. Part of "the genius of the place" in our department is that students in our Technical Communication Program often want to design their own independent study projects for their certificate coursework, just as they do in their engineering majors. However, there may be analogous curricular niches in colleges without programs like our TCC. For instance, many schools require engineering students to take a certain number of "technical electives"; most of the departments in our College of Engineering count this course toward that total, and the same might be true at other institutions.

Nonetheless, designed as it was shortly before the beginning of the term by a busy faculty associate and an undergraduate, the course had no formally articulated learning outcomes. However, whatever ambiguity we left about *what* the students would learn, we were quite clear in our expectations about *how* that learning would take place: this was to be a seminar-style reading and discussion course, fitting squarely and unabashedly in Haws's "humanistic readings" model. No tests. No problem sets. Lots of dog-eared photocopies and cups of coffee. As it turned out, our discussions tended to cover issues of ethics, interdisciplinary collaboration, politics, and—more often than not—our students' frustration with the restrictiveness of engineering curricula.

The course had three main components: the reading and discussion itself, posts to the course's online forum, and a final synthesizing paper. The biweekly group discussion was informal, with the agenda being negotiated each week among members of the group who had particular interest in some specific line of inquiry. To help spark and focus the discussion, we required each group member (including the instructor) to post a couple-paragraph response to some issue in the reading and then to read the other members' posts before class. In our opinion, the online forum was one of the most fertile and productive aspects of the class; it allowed everyone to process in advance (and, frequently, to respond to) the various viewpoints and priorities each member developed about a particular set of readings. Finally, the students who were enrolled for two credits completed a formal research paper in which they could explore an issue of interest in greater depth.

Although the pilot course could not be formally assessed, we have some evidence of its positive outcomes because the participants were so moved by their experience that they felt compelled to share their thoughts with others; the instructor and five of the six students presented papers about the course at their regional ASEE section's annual conference in fall 2005. Reflecting on what some of the students wrote, we're glad we chose a flexible, open-ended, egalitarian model because we believe it did help bring about the three goals Haws mentions—what he calls "'enabling' objectives." For instance, one student reached a conclusion that comes reassuringly close to Haws's definition of the ability to perform "divergent thinking." The student wrote as follows: "Educators must provide [students] with the 'equipment for living' that will help students make a real connection to the material they are learning and ultimately, guide and nurture *those thoughts they may not have had the opportunity or even motivation to explore before*" (emphasis added)[15]. Similarly, a student who wrote on the conflicts of interest raised by the increasing entanglement between corporate funding and scientific research[16] showed a reasonable fluency with "the common vocabulary of ethical articulation."

Revised course design (spring 2006)

The instructor and students' enthusiasm also convinced the department to revise and rerun the course. The revised class was team-taught and preserved the seminar-style reading and discussion format, but with a larger class size (n = 15). Students in the course had the following responsibilities:

- Do the assigned readings for each week (see Appendix B for reading list).
- Write a short (1-2 paragraph) response to one of the questions posted on the course's online discussion forum or respond to another student's post (see Appendix C for sample discussion forum questions).
- Attend and actively participate in the weekly two-hour class discussion.
- Write a substantial research paper on a topic appropriately related to the course material and themes.

The course was open to students of all majors and publicized through word-of-mouth and e-mail to students in our Technical Communication Certificate program and then to the College of Engineering as a whole. Seven instructors, all members of the Engineering Professional Development Department's technical communication faculty, each facilitated one or two weeks' worth of discussion. This somewhat unusual teaching arrangement came about mostly because

there was so much enthusiasm about the course among department faculty. Six of the seven instructors helped teach this class on top of their normal teaching load; the seventh, (Traci Kelly, another of our coauthors), was the coordinator and instructor of record, and this course was counted as part of her teaching load. Far from showing that the course is untenable (after all, we didn't *need* to have this many instructors involved), the high participation among department faculty actually suggests another overlooked advantage of the "humanistic readings" model: it is rewarding—even sustaining—for the instructors as well as the students[17].

The reading list for the revised course was substantially changed and included readings on the making of the atomic bomb; robotics, cybernetics, and artificial intelligence; neo-Luddite perspectives on technological development; the effects of the internet and social networking; bio- and genetic engineering; and environment protection and resource sustainability. This decision reflects, in part, our acknowledgement that a more formal course needed to more explicitly relate to ABET outcomes and to the concerns of our department's industrial advisory board (see below).

Moreover, it reflects our desire to stimulate engineering students' critical thinking about the direction engineering is heading and especially about some of the controversial emerging technologies they are likely to encounter and perhaps even work on during their careers. This desire is consistent with Lewis Duncan's admonition about the need for engineering students to develop the social, political, economic, and ethical expertise necessary for effective leadership in a twenty-first century engineering landscape dominated by nanotechnology, bioengineering, and other promising but potentially problematic technologies (in his 2006 Liberal Education Division Distinguished Lecture "The Unleashed Human Mind: Liberating Education for the 21st Century"[18]).

We chose the learning outcomes and formal title ("Engineering Professional Development 690: Social and Ethical Impacts of Technology—Literature and Discussion") with an eye toward our experiences with the pilot course, the mission of our department within our College of Engineering, and the ABET "professional skills" criteria. The five learning outcomes we designed for students were

- Outcome 1: Articulate connections among engineering, ethics, community, history, social change, and politics by actively listening and participating in a small discussion setting
- Outcome 2: Recognize and work with the role of uncertainty in engineering and its relationship to social and ethical dimensions
- Outcome 3: Analyze and assess the social and ethical impact of technology on society by critically thinking about the readings and discussion topics
- Outcome 4: Communicate effectively by writing and speaking
- Outcome 5: Identify, formulate, and solve engineering problems related to professional and ethical responsibilities, including interdisciplinary approaches to said problems

Three details are worth noting. First, the emphasis on both listening skills and the idea of uncertainty came in response to feedback from our department's industrial advisory board. Regarding listening skills, Grossenbacher said in her interview that industry representatives are frustrated by some recent graduates' inability to listen for both the explicit content of a speaker's

presentation as well as any unspoken implications—neglecting the latter, they say, can lead to costly mistakes. Our board's similar concern about the challenges of dealing with uncertainty and ambiguity[19] in engineering work came up in Grossenbacher's interview and has also been reported elsewhere[20].

Second, while we wished to focus the course on social and ethical impacts of technology and on past, present, and future professional issues facing engineers and scientists, we still felt the need to include one "general communication skills"-specific learning outcome. This emphasis clarified the relationship of the course not just to the mission of our department (a department concerned with professional development in general), but also to our Technical Communication Certificate program specifically—since, after all, many of the students enrolled in the course counted it as a technical communication elective.

Finally, we wish to address a possible critique of our emphasis on "impacts." Martin notes that Science and Technology Studies (STS) theorists have critiqued the idea of studying "the social impacts of technology" (preferring instead to invert the assumed causality and explore the "social shaping of technology") because inherent to the former is the assumption that "technology development is largely autonomous of society"[21]. However, if one allows that—once developed through social processes—individual technologies do impact society (which seems to us a common-sense stance that does not necessarily conflict with STS theory), we believe that the future engineers who will be part of the "social shaping of technology" should be exposed to the ways in which their work will impact other people. Haws would almost certainly agree with this desire, since it relates very closely with his first two "enabling objectives."

Obviously, our learning objectives make clear that this is a course about more than just ethics, which we believe to be both a strength (in light, for instance, of Dvorak and Fulle's suggestion that ethics instruction is improved when it's placed in larger social contexts[4]) and a necessity (in light of our institution-specific circumstances).

Assessment design

In designing and conducting our assessment of this course, we have come to agree with Shuman et al.'s observations about the challenges of assessing "Professional Skills"-type learning outcomes[9]. With limited funding for this project (in the form of a small, University-awarded student/faculty fellowship for independent research), we were unable to employ some of the more sophisticated assessment techniques Shuman and his colleagues suggest. Nevertheless, we implemented an assessment scheme that attempted to maximize both student and faculty feedback and actual review of the work that went on in the class, within the limits of the project's scope. Thus, our three-pronged assessment scheme measured success of the learning outcomes through (1) interviews with a student focus group and with individual faculty members; (2) written student surveys, including a short mid-semester evaluation and Elaine Seymour's Student Assessment of Learning Gains (SALG) protocol[22] at the end of the semester; and (3) review of the online discussion forum transcripts and the final research projects (the latter being required only for the students enrolled in the course for two credits). Textual analysis was our primary method for interpreting this (mostly qualitative) data set, although we

begin the sections on each learning outcome below by reporting the quantitative data from the SALG protocol.

Focus group

The focus group was conducted during the last week of class by two of our coauthors, Oliver (the recipient of the University research fellowship) and his faculty mentor Sandra Courter (a professor in our department who, as the director of our college's Engineering Learning Center, is also an assessment specialist). The focus group comprised six self-selected students (40.0% of the class) who were assigned a number based on the order in which they sat down around the table. Their majors, years, and genders are given in Table 1, and the focus group interview script is given as Appendix D[23].

Table 1: Focus group demographics

	Major	Year	Gender
Student 1	Mechanical engineering	Senior	Male
Student 2	Engineering mechanics and astronautics	Freshman	Male
Student 3	English literature	Senior	Male
Student 4	Geological engineering	Senior	Male
Student 5	Industrial and systems engineering	Sophomore	Female
Student 6	English literature	Senior	Female

Faculty interviews

The faculty interviews were conducted by Oliver in the first two to four weeks after the term. Subjects were assigned numbers based on the (random) order in which they were interviewed, and their fields of training, number of weeks spent facilitating, and genders are given in Table 2. The faculty interview script is given as Appendix E. Most of the instructors attended the class on the weeks they facilitated and one to three other weeks (in most cases, the first two weeks of the course and the week preceding their facilitation weeks). The course coordinator, Kelly, attended class each week and assigned the grades for the course.

Table 2: Faculty demographics

	Fields of training	Weeks taught	Gender
Instructor 1†	English	2	Female
Instructor 2	English	2	Male
Instructor 3	Poli. sci., social work, law, graphic arts printing	2	Male
Instructor 4	English, teaching, history, tech. comm. & rhetoric	1	Female
Instructor 5‡	English	1	Female
Instructor 6	Religious studies, journalism	1	Female
Instructor 7	English, comp. lit., curriculum development, composition	2	Male

† Technical Communication Certificate program director (Grossenbacher)
‡ Instructor-of-record/course coordinator (Kelly)

Other sources of assessment data

The mid-semester evaluation (Appendix F) was completed anonymously in class by 15 students (100%), and the end-of-semester SALG protocol was completed anonymously outside of class (online) by 11 self-selected students (73.3%). (Of particular note, the SALG protocol's Q3, "How much has this class added to your skills in each of the following?" prompted the students to rate and reflect on each individual learning outcome.) We reviewed the online forum transcripts for all 11 weeks that the forum was used, and we reviewed the end-of-semester research papers of all seven students (46.7%) who took the course for two credits.

Results

General responses to in-class and online discussion

In a way, we introduced some confusion into the assessment process when we added "by actively listening and participating in a small discussion setting" to the end of Outcome 1; indeed, this phrase really applies to each outcome. Thus, in this section we will provide a general discussion of students' and faculty's feedback about the two aspects of our "small discussion setting": the in-class part and the online part. This section will then inform our assessment of each learning outcome.

Figure 1 shows how students rated both the in-class and online discussion in the SALG. On the protocol's one to five scale, the in-class and online discussion averaged 3.73 and 3.64, respectively, placing them between "moderate help" and "much help."

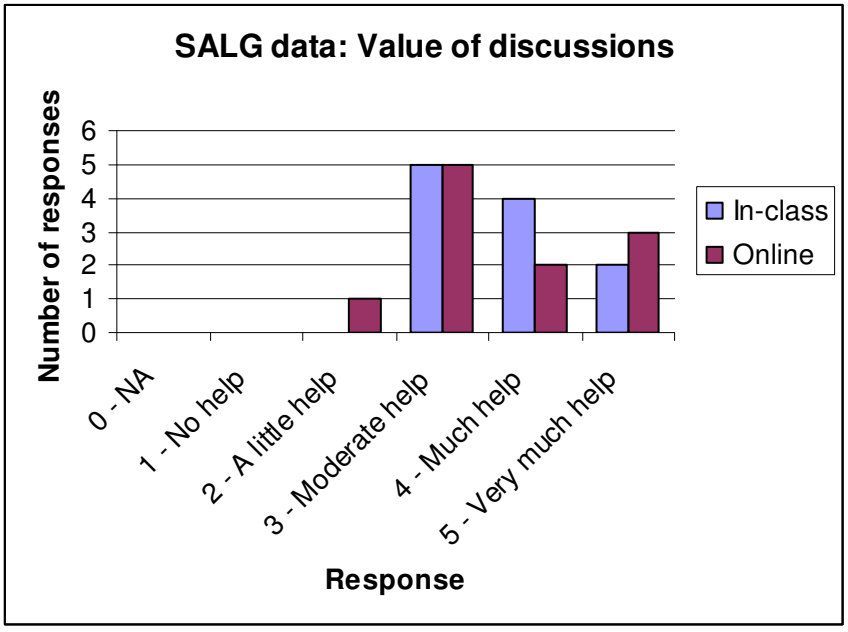

Figure 1: SALG responses to Q1,
"How much did each of the following aspects of the class help your learning?"

Turning our attention first to the in-class discussion, we note that some students were unequivocally positive. One wrote, "I learned how to communicate effectively both through participation and through hearing other people share their thoughts. I hope that I can take a class similar to this in the future," and another wrote "Discussion is the most enriching component of this class."

However, a common theme throughout the assessment was that, while many students enjoyed and felt enriched by the discussion, they thought it would be more valuable if it stayed more consistently focused. This theme received five mentions in the SALG written comments ("[sometimes] unfocused and not as productive," "unorganized," "off subject," "unfocused and distanced from the text," and "less organized and coherent at times"); two mentions in the focus group ("[expected] a more focused discussion," and "[mediator should] demonstrate building off of other people's points"); and six mentions in the mid-semester evaluation (various permutations of "off-topic," but three students noted that this was not necessarily a problem). In his or her SALG response one student cogently expressed what seems to be the majority opinion:

> Some instructors did a great job of mediating discussion and keeping discussion centered around the text that we had read for the class. [One instructor] was exceptional at allowing class discussion to explore different concepts but then kept the class from straying entirely from the class. [He] clearly organized his texts so that students could follow ideas from one text to the next and make connections which [led] to a deep and thoughtful discussion. He was also very open to discussion and encouraged different perspectives of an issue rather than pushing the class to agree with his own personal arguments. I believe the way he led his class should be a model for how all discussions in this course are led.

Many of the instructors themselves were also concerned about this tension between over- and under-facilitating the conversation. One instructor suggested that "The less of an agenda the professors had, the better the class went." Another agreed in principle but pointed out that while an agenda-less approach might work for a class of seven to ten students, it was untenable for a class of 15 and a couple instructors. Expanding on this sort of sentiment, one instructor noted that among she and her colleagues "[t]here were varying abilities for bringing people back [on task]." Interestingly, she cited as a positive example the same instructor the aforementioned student had written about in her SALG response.

Students and faculty seemed to be even more on the same page about the value of the online forum. Both groups were uniformly positive about how the online forums had worked, and many also suggested refinements to improve the system. Even more encouragingly, the two groups offered roughly the same reasoning to support these conclusions. For instance, an instructor reflected, "some of the students offered some very thoughtful and insightful comment in the forums and may have learned as much in simply figuring out what they wanted to say in that context as they learned through any other activity we conducted." Indeed, at least one student felt exactly that way and said the following in the focus group: "I like the forums too, because you got to think about what you were going to say for hours instead of just seconds like what happened in the in-class discussions. And I don't really think quite that fast, so I didn't really add too much to the in-class discussions…I'd like to see more focus on the online forums

where you get to think about it for a long time and digest it really." Several students and instructors also independently offered similar suggestions about improving the level of interaction in the forum, including requiring multiple posts each week, at least one of which would be a response to another person's idea.

Overall, we believe students and instructors responded well to the format of the two major discussion components. As in the pilot course, this format appears to have been a welcome change of pace for both students and instructors, and we plan to preserve the general format of the course in the future. This is not to say, however, that the overall format contributed equally well to bringing about each learning outcome. Thus, we will now discuss our assessment of each of our course's learning outcomes.

Outcome 1: Articulate connections among engineering, ethics, community, history, social change, and politics

According to Haws, the strength of the "humanist readings" approach is in "open[ing] the young engineer to other perspectives that might be less obvious"[1]. Our first learning outcome, with its emphasis on making connections among the diverse perspectives and approaches offered in our wide variety of readings, is most closely aligned with that strength. Our assessment of this outcome suggests his statement is reasonable (which of course is why we find this model so appealing for our department's particular circumstances).

First, Outcome 1 was tied with Outcome 2 for second in the students' numerical self-assessment of the success of all the learning objectives (average score: 3.82). These data are shown in Figure 2, and they support the textual evidence gathered for this outcome. For instance, of those students who wrote responses to the SALG's "resources" question and addressed the entirety of the readings, both responses were positive (two other responses to the readings focused on one or two single texts). More importantly, though, one of the themes we identified in our textual analysis was that students made connections among these assorted readings by identifying what they usually called "common themes" or simply "connections" between the approaches and perspectives of our many authors. Two students' written SALG responses noted these connections in a qualified way (one said they didn't happen every week, the other that we should have spent a bit more time deliberately fleshing them out). Student 5 mentioned in the focus group that she appreciated the chance to forge connections between readings that "on the surface…seemed to not relate to each other," and Student 4 pointed out that "the broader themes we've just been talking about weren't in the readings at all, so that would never have gotten brought up without discussion."

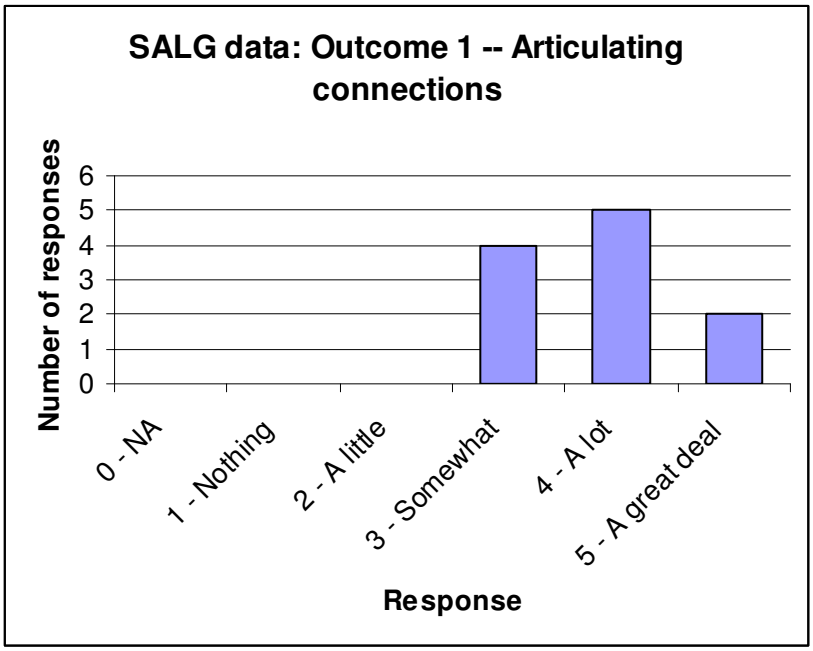

Figure 2: SALG responses to Q3,
"How much has this class added to your skills in each of the following?"

As we leafed through the piles of interview and online forum transcripts, it was difficult to decide which sets of "connections among engineering, ethics, community, history, social change, and politics" to discuss. After just the first three weeks (which together composed the first "unit" of related readings: Rhodes's *The Making of the Atomic Bomb*, Frayn's *Copenhagen*, and Lightman's *Einstein's Dreams*), students writing in the online forum had made an impressive array of connections between disparate perspectives and discourse communities. The first four we identified were (1) analyzing the competing roles of ethical and moral duty versus civic and patriotic duty in deciding whether to research gas warfare, (2) noting the importance of international and interdisciplinary collaboration to scientific research, (3) questioning the possible scientific effects of the emotional and philosophical background of Niels Bohr, and (4) exploring the difficulties of explaining scientific concepts to laypersons (and the effects of failing to do so)—these connections barely got us into the second week.

To be sure, some of these connections were more significant, insightful, and clearly expressed than others, but the point is that a multi-genre "humanistic readings" approach coupled with an online discussion forum that gets everyone involved seems to be an especially effective way to help students explore fruitful connections between the readings.

Outcome 2: Recognize and work with the role of uncertainty in engineering and its relationship to social and ethical dimensions

As we mentioned above, we wanted to articulate a course outcome about uncertainty and ambiguity because of very specific feedback our department has received from its industrial advisory board. The goal here was to get students to grapple with problems in which, say, an economic optimization equation or an empirical feasibility study were not the sole determinants of the right answer. Indeed, "grapple with" would probably have been better word choice than

"work with"—in this outcome we're talking identifying and discussing, rather than solving, problems that involve such uncertainties (see Outcome 5 below for our assessment of students' ability to "solve" ethics problems).

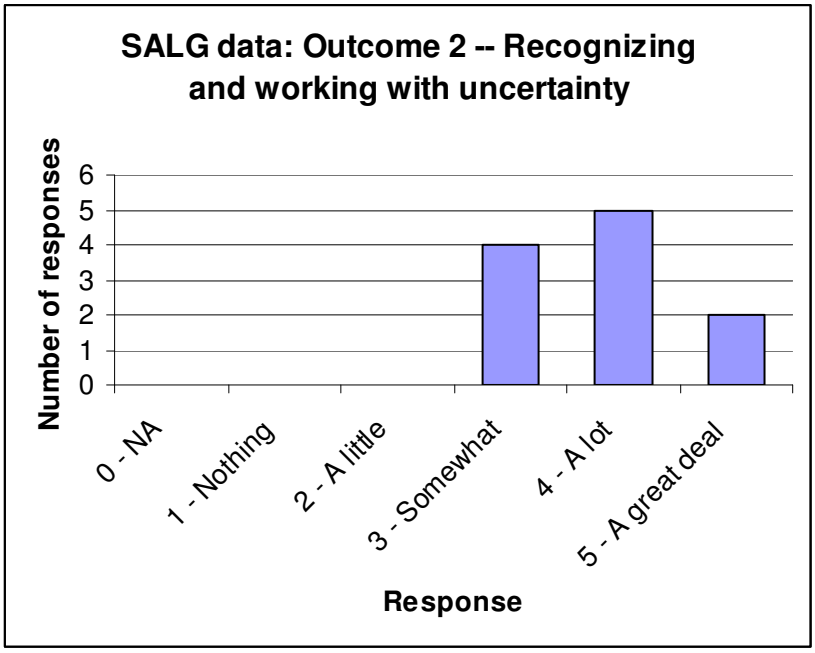

Figure 3: SALG responses to Q3,
"How much has this class added to your skills in each of the following?"

The numerical self-assessment data for this outcome are shown in Figure 3. Given that this outcome is in some ways a subset of Outcome 1, it is not too surprising that students rated their abilities in this area with the same distribution. At least one student also highly *valued* this skill. When asked the most important thing he had learned in the class, he responded,

> Probably the biggest thing I learned was…that things that I thought that I knew to be fact maybe weren't the case. And also, kind of going along with that, I tend to think of things as more like black and white, while now the issues are so complicated that a lot of times there is no black and white answer, it's gray. Those are probably the two things I learned most.

A similar comment surfaced in the mid-semester evaluations as well. This student noted there are "no clear cut answers" in the problems we looked at and that he or she "walk[ed] away from class with more questions than I came with (which I suppose is a good thing)." This outcome did have the lowest "mention frequency" among the various student self-assessment mechanisms, with no mentions in the SALG written responses at all and only the two mentioned above in the focus group and mid-semester evaluations. This learning outcome also seemed to be mostly off the faculty radar during the post-semester interviews. Only two instructors (not for nothing, they were Grossenbacher and Kelly) chose to discuss this learning outcome at any length, though they both believed that students were successful in this area and that it was among the more valuable outcomes of the course.

However, one possible explanation for this omission is that we made our "big push" to explicitly address uncertainties and ambiguities during the second week of the class, when we read Michael Frayn's *Copenhagen*, so this particular theme of the course, though it came up often, may not have been on students' minds as its own discreet outcome of the course by the end of the semeseter. Still, three of the ten students who posted to the online forum that week (we were still working out some technical kinks, so not everyone was participating yet) explicitly addressed uncertainty. One of these was a meta-critique of how uncertain we must be about the helpfulness of Frayn's analogy between uncertainty in physics and uncertainty in history.

Thus, though the evidence is not so resounding as in the first case, we do believe our students were satisfactorily successful in achieving Outcome 2, based on their numerical self-assessment, the confidence in the comments from students and faculty who did discuss this outcome, and the close connection between it and Outcome 1.

Outcome 3: Analyze and assess the social and ethical impact of technology on society by critically thinking about the readings and discussion topics

Outcome 3 is the third and final outcome that mapped directly onto the actual direction of our in-class and online discussion almost every single week. What's more, because "social and ethical impacts of technology" was in the actual name of the course, we suspect that students more deliberately focused their attention on this outcome. Either way, they rated it as the outcome they most effectively achieved (average: 3.91), with the distribution shown in Figure 4.

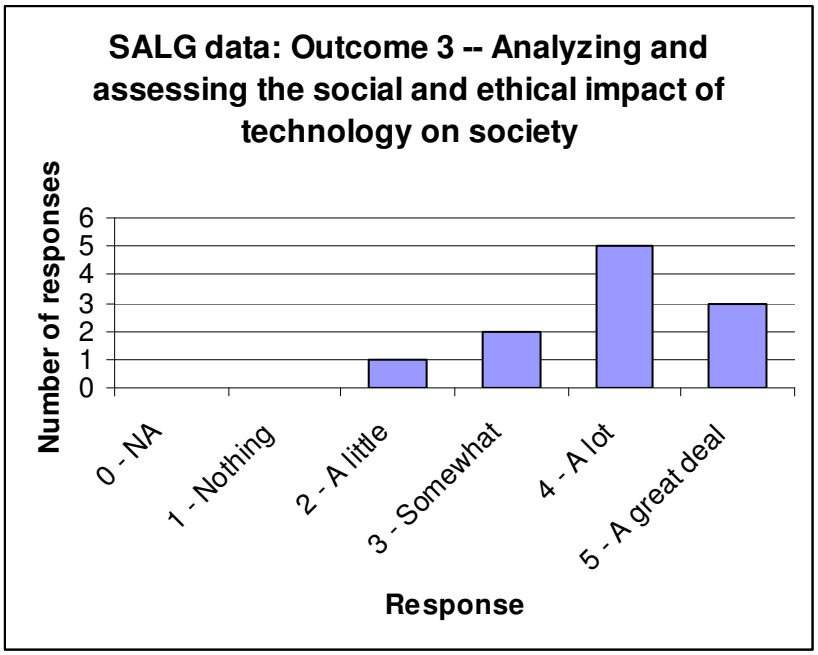

Figure 4: SALG responses to Q3,
"How much has this class added to your skills in each of the following?"

Obviously, this outcome overlaps somewhat with Outcomes 1 and 2, and indeed at some times we had difficulties differentiating between these outcomes when coding our data. Nevertheless, some students did speak very specifically to their understanding of the effects of technology, with answers ranging from the generic ("The discussion and forum posts will help with future strategies for discussing social and ethical implications of engineering work," on the SALG) to one comment on the final week's forum (in a post about who shares responsibility for environmental degradation) that also essentially summarizes why this learning outcome is important to us: "Engineers and scientists typically analyze many aspects of a problem before they solve it. Once they come up with a solution, they have a responsibility to assess the short-term and long-term impact of their proposed solution. This assessment should include environmental impact including the use of limited resources."

As with Outcome 1, analyzing and assessing the social and ethical effects of technology was a task that happened in a very large number of forum posts. Sometimes, the effects posted on were rather obvious, and the students simply expanded on or clarified major themes in the text (such as the dehumanizing effects of cybernetics, various types of weapons technology, and genetic and bioengineering). At other times, students drew from their own experience, especially in a series of energetic in-class and online debates about how social networking software and other pieces of consumer technology are changing campus climate and American culture in general.

From our perspective, one of the more rewarding student responses to the course had to do with critically examining the effects individuals' actions—both inside the lab and out:

> I guess what I'm going to take from this class is that you've just gotta pay attention to what you're doing and why you're doing it, even down to day-to-day activities like going to the grocery store. It all makes a difference, and if you're not paying attention to what you're doing, you might be doing something that you wouldn't even agree with if you thought about it for a short amount of time. Not to avoid deep thought is really good, even if it's not very fun or pleasurable.

As for the instructors, one mentioned in her interview that she regretted not returning the in-class discussion to a particularly insightful forum post that analyzed the subtle but far-reaching effects of search engine algorithms, specifically the way they allow huge companies to control, as the student put it, "what I know, and what I don't know." Another instructor did not dismiss the success of Outcome 3 but qualified it somewhat, pointing out "the part about how all this stuff impacts society as a whole—it's nice to bring in a bunch of white middle class kids from Wisconsin to talk about that, but there's a whole other world out there, and they're also affected by these things." While there were isolated posts and papers on, for instance, global issues—including one impassioned post about the exporting of American garbage to the Philippines and a thorough end-of-semester paper titled "The Ethical and Social Impacts of Global Outsourcing"—this is a valid criticism of our reading list, one that we plan to remedy in future semesters.

Still, reflecting more generally on this learning outcome—and after expressing misgivings about how well we helped students achieve Outcomes 4 and 5—the Grossenbacher said, "I would certainly hang my hat on the idea that people thought more about the impacts of technology on society." Indeed, along with Outcome 1, Outcome 3 was really the bread and butter of the day-

to-day discussions in this class, so it's not especially surprising that students and faculty agreed on the overall success of this course goal.

Outcome 4: Communicate effectively by writing and speaking

When attempting to discern whether students' written and oral communication skills improved as a result of this course, we must rely heavily on faculty- and self-assessment of this outcome; our assessment scheme includes no direct records of students speaking in class, and the amount of writing each student did each week in the forum is neither of sufficient length nor of an appropriate genre (being, as it was, mostly an informal way to get the cognitive juices flowing) for accurately judging improvements in writing skills like clarity, organization, argumentation, sentence structure, etc., although the student papers were an appropriate means of assessing this outcome.

Data from the SALG protocol show that, in general, students believe their oral communication was improved more by the course than their written communication was. Figure 4 shows the distribution of student responses when asked about this outcome.

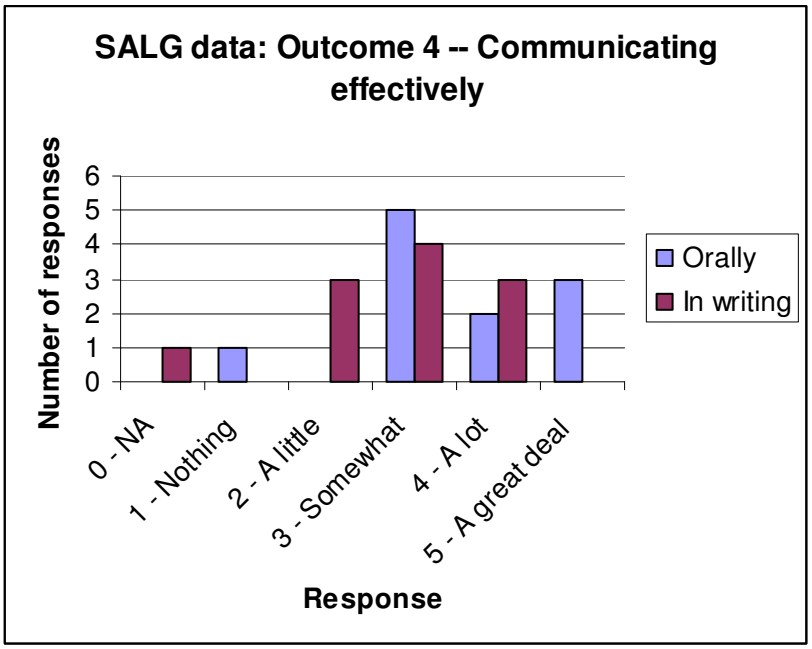

Figure 5: SALG responses to Q3,
"How much has this class added to your skills in each of the following?"

That the average scores for student self-assessment of this outcome were lower than for the previous ones (oral: 3.55, written: 3.00) is perhaps unsurprising, since communication skills did receive less explicit emphasis from the course facilitators, especially in comparison to other courses in our department, most of which have an essentially monolithic emphasis on communication skills (basic communication, technical writing, technical presentations, technical editing, etc.).

It is interesting that the question about oral communication showed the lowest student *agreement* (i.e., it has the highest standard deviation and a distribution that is not at all symmetric about the mode), though we were not able to posit a supportable explanation for this disparity. One possible explanation is the aforementioned student frustration with the occasional inability of the class to remain focused and on-topic. Perhaps if the discussions had been more consistently effective in students' eyes, they would have thought that they accomplished more as speakers. This is of course pure conjecture, but it would be worth comparing changes in student self-assessment of this learning outcome to any future changes in how they rate the value of the discussion.

The instructors' overall assessment of the students' success in the writing and speaking learning outcome also varied. Kelly, who evaluated the papers, noted a wide spectrum of topics (from sustainable food-production practices to the training of soldiers to kill efficiently to the black-boxes now routinely installed in automobiles), which reflected not only the students' individual interests but the span to which they were willing to apply concepts gleaned from the course. The quality of those investigations, however, also swayed from one end of the spectrum to the other. Some appeared as nothing more than book reports, while other written reports were truly a fusion of research and introspection—which was what, in fact, the instructors and course designers were hoping for.

Of those who talked about the quality of writing on the online forum, one instructor said, "Their writing, as I was looking over the forum…I thought that many of them raised excellent questions, brought in some good examples, and communicated what they were saying fairly well. So I was happy with what I was seeing in the forum." The Grossenbacher was more critical of the quality of the writing but noted that students are likely to struggle with this kind of writing task:

> I wouldn't say that the writing produced in this class was particularly clear. Although people really tried to be clear. I think they realized, "Oh, it gets very tricky. You can't be very clear when you're discussing ideas and you're trying to sort it out." I think there's some interesting writing challenges at that level that people need to be exposed to, because I think they will face that as leaders.

In total, four of the seven instructors said that the value of the course for the writing and speaking learning outcome was an indirect (and difficult to measure) benefit—the knowledge that writing, like learning about the social and ethical impacts of technology, is a highly contextualized and highly social process in which there are no discreet, clearly defined correct answers about how best to proceed. Perhaps more than any other, it is this synergy that leads us to believe that this is a course that does belong in our technical communication program and that we shouldn't completely write off the idea of incorporating communication-specific learning objectives into the course.

Outcome 5: Identify, formulate, and solve engineering problems related to professional and ethical responsibilities, including interdisciplinary approaches to said problems

As unequivocally as our assessment told us we had succeeded in helping students articulate connections between disparate viewpoints, it told us that we had been significantly less successful in helping students complete the trifecta of identifying, formulating, and *solving* engineering problems related to professional and ethical responsibilities. There's no doubt that part of the cause here was our own reluctance about this learning outcome. In her interview Kelly summarized our attitude thusly: "We told them 'we're not going to give you the code of ethics from NSPE and say match it up…it's not fourth grade where you match A to number 1.'" To us, the final verb in this learning outcome smacked of formulaic thinking, decision matrices, and—worst of all—certainty. We were skeptical of this outcome, and our teaching probably reflected that.

As an important and relevant aside, we note that our thinking on this point was, in part, based on a stance similar to that of engineering ethics scholar Sarah Pfatteicher in her "Teaching vs. Preaching: EC2000 and the Engineering Ethics Dilemma." She notes, "I do not want to indoctrinate my students. Rather, I want to inculcate in my students a belief in the value of critical thinking, careful exploration, and thoughtful questioning—values of education (or 'lifelong learning') rather than of ethics"[24]. We believed that by explicitly introducing the theoretical stances of particular ethicists—or especially by "resorting" to the common "codes of ethics" approach—we would undermine the students' ability to think critically and independently about the issues we discussed and their acknowledgment of the ambiguous and uncertain nature of ethical decision making.

However, we had overlooked two important points in Pfatteicher's article. First, Pfatteicher claims we need not couple "understanding" with "commitment"; in introducing students to techniques for ethical problem solving, we need only require that they understand these techniques, not that they uncritically accept and embrace them. Second, Pfatteicher notes that there is still a large degree of ambiguity inherent in applying many standard ethical problem solving techniques and that as long as we don't "teach a specific set of beliefs to our students,"[25] we do not remove the inherent value of grappling with that ambiguity. Both these points suggest that we needn't have been so worried about introducing some readings and activities that dealt with ethical theories and frameworks directly.

In any event, it was clear from the first day of class—and most certainly from the mid-semester evaluation—that many students were somewhat frustrated with both the lack of concrete ethics instruction, such as examining the NSPE Code of Ethics, and the sometimes tenuous link between the topics we discussed and the students' future professional engineering work, both of which are important to Outcome 5.

Sometimes, this frustration was the result of individuals' incomplete understanding of what we actually *had done* in the class; we noted this learning gap at mid-semester and attempted to address it in the second half of the course. For instance, one student pointedly wrote at mid-semester, "I have yet to learn a <u>single thing</u> about <u>Ethics</u>" (emphasis original). Now, while we had admittedly refrained from introducing prescriptive ethical problem solving methods, we had indeed by this point had a great deal of discussion about why the effects of various technologies may or may not have made their development ethical. Indeed, though no one used the word

"Kant," several students' forum posts articulated principles of his person-centered ethics (for instance, in two posts on gas warfare and one on environmental racism).

Similarly, three students expressed concern at mid-semester that the issues we were discussing were irrelevant to their careers. Again, though we may not have spent much time discussing specific applications of some technologies, it seems somewhat shortsighted to think that in a room of a dozen or so engineers, none of them would go on to work in at least one of the areas of technology we discussed.

However, these students' comments do suggest a failure on our part to help them understand a larger point: that even if they don't themselves do work in one of the developing fields we discussed, as technological leaders it will be part of all engineers' *professional responsibility* to be a part of the public discussion about these technologies. This is just one instance where student suggestions and complaints indicate we need to make adjustments to how we approach Outcome 5—and, indeed, tells us that they want us to approach it. This conclusion is also supported by the students' numerical assessment of their success with this outcome, which, as can be seen in Figure 6, had the lowest score of all the outcomes (average: 3.00).

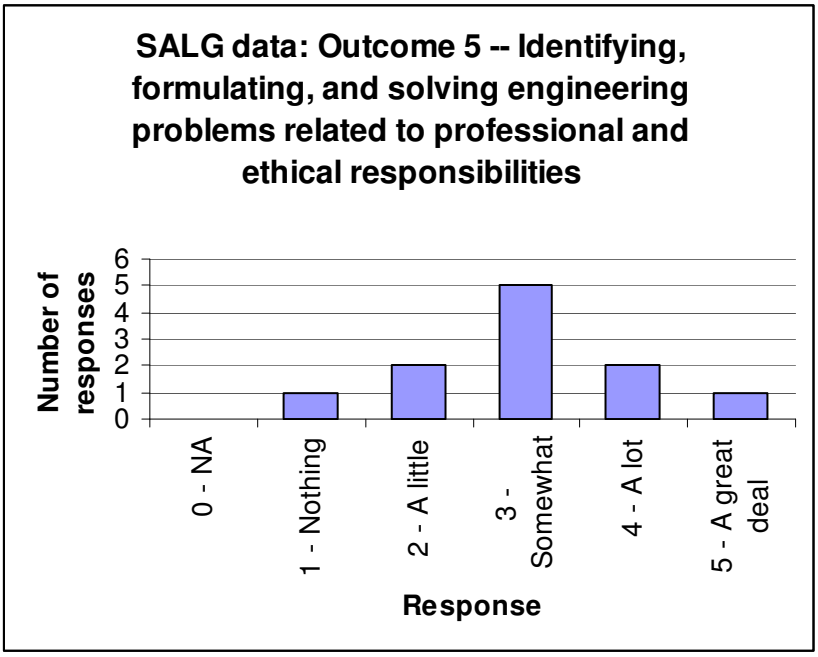

Figure 6: SALG responses to Q3,
"How much has this class added to your skills in each of the following?"

The most favored adjustment among the students (two mentions in the mid-semester evaluations, two in the SALG, and one in the focus group) was that we incorporate (but not necessarily put primary emphasis on) codes of ethics, theoretical grounding, or case studies at some point in the course. Student 4 in the focus group also clearly understood Pfatteicher's point about why doing so need not conflict with our other desired learning outcomes:

> Something I really got out of the class, which I had presented to me in a different course but manifested itself a lot better here, is that, especially the more broad and the more large the topic, there can be right and wrong answers, *but only within a given set of values*. And it's really important to realize that your set of values is not the [only] set of values, and if you're going to have a discussion or a debate with somebody about anything, you really need to decide right away that you're both actually talking about the same thing. I can debate the merits of sustainable development all day, but if the person sitting across the table from me is saying "I live my life by economics, the preachings of Adam Smith," and that's not how I see it, we're going to continuously butt heads about what's right, what's wrong, what's a solution, what isn't. So we can end up talking about an issue but not really talking about the real issue, which is that we're coming from different perspectives. (Emphasis added)

As we discuss in the conclusion, we have come to agree with Pfatteicher and Student 4 (and by extension Haws, on this particular point), and we plan to take the students' suggestion to *supplement* what we've done in the past with a more explicit emphasis on professional and ethical problem solving skills and the "access to the common vocabulary of ethical articulation" necessary to develop those skills.

Conclusions

Our findings suggest that our course design was effective in bringing about the first three of our five learning outcomes but that we need to make some adjustments to improve students' ability to hone their communication and ethical problem solving skills in "Social and Ethical Impacts of Technology."

These findings suggests that many of Haws's conclusions about our particular approach to ethics instruction are correct. Indeed, our students expressed frustration with what Haws would call their lack of "access to the common vocabulary of ethical articulation." However, instead of flat-out replacing our humanist readings model, we have two reasons for appealing to the Pollan-Pope approach and allowing "the genius of the place" to determine how we proceed in future semesters.

First, the students and faculty in both the pilot and revised course were passionate in their support of the course and its value. Furthermore, we believe the aspects of the course that didn't necessarily support formal discussion of ethics problem solving in a professional engineering setting did support some of our other learning goals, and these aspects also allowed us to take advantage of the (inter)disciplinary expertise of the faculty in our department. We believe it would be shortsighted to abandon our approach to a class about which students wrote the following:

- "I did not expect this level of introspection in this course."
- "The level of interaction all around was really excellent. This class was a very communal learning experience."
- "My own sense of personal growth is what I consider most rewarding."

Second, we believe we can construct an adapted best practice that doesn't necessarily accept Haws's formula[26] (theoretical grounding + case studies + service learning = 3 successful enabling objectives) but does accept his premises. After all, if we're already meeting two of his three enabling objectives, we should focus on his advice about meeting the third. To that end, rather than a complete redesign of the course, we planned in the next semester to provide an early theoretical grounding in ethics. We believe this solution strikes a balance between our desire both to base our course on sound educational theory and to remember that best practices can and should adapt to institutional context.

So beyond the particulars of our approach, what general, exportable suggestions do we have to offer about our experiences with ethics and beyond? We believe three points are especially important:

(1) We were eager to start small, with a flexible solution that was right for our department at the time—which meant designing a class about more than just ethics. If it hadn't been for this approach, we probably would not have launched a course at all.
(2) We were willing, with the help of the literature, to examine the theoretical drawbacks of an approach that we knew was not perfect. We learned that even a modest assessment effort could pay dividends for improving the course; in fact, the most valuable feedback we gathered was on our three-question mid-semester evaluation, which took only ten minutes of class time to administer and only a couple hours of outside work to compile and report.
(3) We let the literature and our local circumstances guide our actions with roughly equal weight.

We believe these points allow the engineering education community to view Haws's meta-analysis and our own brief observations of last year's ASEE conference papers on ethics in a new light. Viewed through the Pollan-Pope lens, the lack of convergence of instructional models in ethics courses does not necessarily mean that we have made no progress in this area or that certain schools are not teaching ethics "the right way"; it may instead suggest the early stages of a movement to couple ethics instruction with the teaching of other professional skills and, even more importantly, to "Consult the Genius of the Place in All."

Acknowledgements

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Appendix A – Reading list for pilot course

Richard Rhodes, *The Making of the Atomic Bomb*

Michael Frayn, *Copenhagen*

H.G. Wells, *The World Set Free* (excerpts)

Immanuel Kant, *Critique of Pure Reason* (excerpts)

John Stuart Mill, "Mathematics and Experience" (excerpts)

Henri Poincaré, *Science and Hypothesis* (excerpts)

Charles Darwin, *The Origin of Species* (excerpts)

Richard Dawkins, *The Blind Watchmaker* (excerpts)

H.G. Wells, *The Time Machine* (excerpts)

Steven Hawking, *A Brief History of Time*

Douglas Adams, *The Salmon of Doubt* (excerpts)

Richard Feynman, *The Pleasure of Finding Things Out* (excerpts)

Appendix B – Reading list for revised course

Richard Rhodes, *The Making of the Atomic Bomb* (excerpts)

Michael Frayn, *Copenhagen*

Alan Lightman, *Einstein's Dreams*

Alan Turing, "Can a Machine Think?"

Ellen Ullman, "Dining with Robots"

Charles T. Rubin, "Conquering Mind and the End of Humanity: Prospects for a Robotic Future"

Bill Joy, "Hope is a Lousy Defense" and "Why the Future Doesn't Need Us"

Langdon Winner, *Autonomous Technology* (excerpts)

Douglas Adams, *The Salmon of Doubt* (excerpts)

Cory Doctorow, "Wikipedia: A Genuine H2G2 – Minus the Editors"

Arlene Weintraub, "My How You've Grown"

Scott Gilbert, Ann Tyler, and Emily Zackin, *Bioethics and the New Embryology*

Charles Alexander, "Code Blue for Conservation"

Ronald Heifetz, *Leadership Without Easy Answers* (excerpts)

Jared Diamond, *Collapse* (excerpts)

Richard Manning, "The Oil We Eat: Following the Food Chain Back to Iraq"

Appendix C – Sample Online Discussion Forum Questions

From week 6:

Readings
Bill Joy, "The Future Doesn't Need Us" and "Hope is a Lousy Defense"
Langdon Winner, *Autonomous Technology* (excerpts)

Questions

- Lots happened between the publication of Joy's "The Future Doesn't Need Us" in Wired, and the interview that he gave them in "Hope is a Lousy Defense." What changes did you note in Joy's views and his rhetoric? How have the changes that took place in the intervening years between Joy's two pieces impacted discussions about the limits of technology – or the imposed limits on technology in society?

- The term "Neo Luddite" is quite a provocative label to attach to this discussion, and I'd like us to discuss whether it's even useful/appropriate as a way to talk about our fears, concerns, or issues surrounding technology's use today…I'd like to hear your thoughts on what it means to try to force this term into use for the points that Joy and Winner raise in our readings. Is it appropriate? Is there an alternative?

- Winner and Joy are two very different people, speaking from two very different perspectives on technology in society. As you read them each this week, did you get a sense that either one has a more credible perspective? Does either one seem to have a better chance of being heard by those who might care to act upon the authors' ideas? Does venue, position, class status, or education make a difference in who is heard on this topic? Can anyone be? In this forum, I'd like us to discuss who has the right to question technological innovation and evolution, and who has the best chance of being heard on these topics as well.

- Please post any thoughts, questions, or ideas you'd like us to touch on in class next week.

Appendix D – Focus group interview script

Introductions and Informed Consent Form

Review important points from consent form: 1) students will not be identified by name, 2) students must give permission to be directly quoted, 3) recordings will be destroyed after transcription, 4) nothing said in focus group will affect students' grades. Evaluators are here to help improve course by listening to honest discussion among students.

Discussion of Discussion Procedures

Explain how discussion will work: 1) for each question, all students who wish to give an answer will be given the opportunity, 2) investigators will wait to ask substantial follow up questions until everyone who wants to answer a question has done so, 3) respectful discussion among group members is encouraged, but investigators will keep discussion on topic.

Background

- What is your major?
- What is your year in school?
- How did you find out about the class?

Expectations

- Why did you decide to take this course?
- Did the course meet your expectations? Why or why not?

Format

First, review the different aspects of the course: in-class discussion, online discussion, written assignment, in-class activities, etc.

- Did you find the reading and discussion format effective for the course material?
- What aspects of the course did you find particularly effective or ineffective?
- How comfortable did you feel sharing your ideas and opinions? What would have made you feel more comfortable?

Learning Outcomes

- Overall, what is the most important thing you learned this semester?
- What aspects of the course best helped you learn?
- Which of the topics covered did you find the most useful, interesting, or important?

Miscellaneous

- Is there anything else we should know?

Thank You

Remind students that they can contact the investigators with any questions and thank them for their time.

Appendix E – Faculty interview script

Introductions and Informed Consent Form

Review important points from consent form: 1) faculty will not be identified by name, 2) faculty must give permission to be directly quoted, 3) recordings will be destroyed after transcription.

Discussion of Discussion Procedures

Explain how interview will work: 1) need to cover all of the basic questions for consistency's sake, however, 2) both people free to follow up on interesting or important points.

Background

- What is your educational background?
- How long have you been teaching? At UW-Madison?
- What courses have you taught?
- Do you have experience teaching seminar-style courses?
- In addition to the week(s) you taught, how many classes did you attend?

Expectations

- Why did you want to be involved in teaching this course?
- Did the course meet your expectations? Why or why not?

Format

First, review the different aspects of the course: in-class discussion, online discussion, written assignment, in-class activities, etc.

- Did you find the reading and discussion format effective for the course material?
- What aspects of the course did you enjoy teaching
- How comfortable do you think the students felt about sharing their ideas and opinions?

Student Learning

First, review course goals and desired learning outcomes.

- How well do you think students met the course goals and learning outcomes? Please give specific examples as appropriate (names will be withheld).
- What aspects of the course do you think were particularly effective at helping students learn?
- How does this group compare to one of your typical classes? Do you believe a wide variety of students would benefit from taking this course?

Teaching Challenges

- What aspects of this course particularly challenged you as a teacher?
- How would you change this course in the future to make it more effective?

Thank You

Remind faculty that they can contact the investigators with any questions and thank them for their time.

Appendix F – Mid-semester evaluation

Please take a few minutes to answer the following questions about how our reading and discussion course has been working. Be as specific as possible, since your answers will help instructors make adjustments this semester and in the future. This survey is for course evaluation purposes only and will in no way influence your grade.

What aspects of this course, particularly of the in-class discussion component, are working well? Which of your experiences so far has been the most rewarding?

What aspects of this course, particularly of the in-class discussion component, need to be improved? Which of your experiences so far has been the most frustrating?

Are you learning what you expected to learn in this class? Has this learning taken place in the ways you expected it to? Please explain.

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[11] Wiley, J. D. Commencement address. Kohl Center: University of Wisconsin-Madison, (2006, December 17).
[12] Of course, we might substitute any potential reform for service learning. The point is that we're concerned about the effects of short-term curricular deficiencies on students who won't be around to benefit from the long-term improvements promised by innovations in engineering education theory and practice.
[13] Pollan, M. *Second Nature: A Gardener's Education*. New York: Dell Publishing, 1991.
[14] The term "pilot course" perhaps connotes a greater amount of planning and foresight than actually went in to this somewhat last-minute endeavor. Nevertheless, we'll use this term for simplicity's sake to differentiate the original effort from the more deliberate follow-up course that is the focus of this assessment project.
[15] Fitzpatrick, G. Learning How to Think. *ASEE North Midwest Regional Conference Proceedings, 2005*.
[16] Ringstrom, M. The Undermining of Academic Freedom: Corporate and Government Influence on University Science. *ASEE North Midwest Regional Conference Proceedings, 2005*.
[17] This is particularly true in our institutional context, since most of our technical communication faculty's original training is in the humanities and social sciences; thus, the reading and discussion format was a familiar and welcome format. To wit: "We come from disciplines that are more generalist in orientation, and most of us probably came through classrooms that were more discussion-oriented than those that we sometimes find ourselves teaching. We enjoy that format, we miss that format, and we want to take advantages to return to that kind of teaching and that kind of classroom." [From an interview with one of the course instructors]
[18] Duncan, L. The Unleashed Human Mind: Liberating Education for the 21st Century. Distinguished Lecture to the Liberal Education Division at the 2006 ASEE Annual Conference.
[19] We chose "uncertainty" over "ambiguity" to emphasize the link between this learning outcome and one of the readings that most explicitly addresses it: Michael Frayn's play *Copenhagen*, which deals with physical (i.e., Heisenbergian), historical, and ethical uncertainty as it explores the famous meeting of Niels Bohr and Werner Heisenberg in 1941.
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[21] Martin, B. Conclusion. In Martin, B. (ed.), *Technology and Public Participation*. Wollongong, Australia: Science and Technology Studies, University of Wollongong, 1999, 249-263.
[22] Seymour, E. Student Assessment of Learning Gains. Survey available at http://www.wcer.wisc.edu/salgains/instructor/default.asp
[23] You'll note that this script and the one for the faculty interviews were not especially "learning outcomes-centric." Obviously, we were also interested in getting feedback from students and teachers about a wider range of topics—

including classroom climate issues, course administration and mechanics, etc.—many of which are beyond the scope of this paper.

[24] Pfatteicher, S. Teaching vs. Preaching: EC2000 and the Engineering Ethics Dilemma. *Journal of Engineering Education*, **90** (1), 137-142 (2001).

[25] She earlier notes the extreme difficulty in even identifying such a belief system.

[26] In fairness, we should note that he doesn't *call* it a formula, but we believe that's really what this prescription amounts to when it comes time to try to apply it.