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Making Ethics Explicit: Relocating Ethics to the Core of Engineering Education

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Making Ethics Explicit:
Relocating Ethics to the Core of Engineering Education

Abstract

Our project is motivated by the expanding and at times controversial literature that emphasizes the centrality of emotion to moral choice. In this paper we present the preliminary results of our project funded by the National Science Foundation Ethics Education in Science and Engineering program. Our project aims to develop effective pedagogical practices that incorporate the emotions into engineering ethics curricula. We synthesize findings from the philosophy of emotion, science and engineering ethics, engineering studies, and education research to argue that emotions offer an entry point to ethics that engages students' preconceptions. Pedagogical research across the curricula shows the necessity of addressing the preconceptions that students hold. We argue that ethics instruction should begin by engaging students' preconceptions and existing ethical frameworks, which may be expressed emotively. Rather than portraying emotion as a threat to rationality, we outline pedagogical strategies that encourage students to explore the relationship between emotions and feelings, logic and reason, and values and ethics. The pedagogical strategies presented here are being piloted in an advanced (upper-division) undergraduate seminar course, "Ethics, Engineering, and Society." This seminar, which was first taught during the 2011/12 Academic Year at the University of California, Berkeley, also informed the development of our funded project. This paper describes early student responses to the new curriculum. Our results suggest that engaging students' emotions encourages and enables them to reflect on their preconceptions about engineering and about engineering ethics. While many students initially perceive ethics as tangential to their larger education, engaging their emotions about this assumption allows for the possibility to reframe ethics as a core part of their curriculum.

Introduction

Engineering students have identified ethics as central to engineering[1] but it often remains at the periphery of a curriculum that is focused on technical knowledge.[2] The challenge is to make ethics explicit and central, especially to advanced students who are in the process of defining their societal roles.[3] To do this, our approach embraces the interdependency of emotions, values, and ethics and builds on recent research that shows emotions are indispensable to risk and decision analysis and to ethical reasoning.[4] Here we report the preliminary results of our two-year, National Science Foundation-funded project that aims to develop effective, sustainable, and pedagogically sound approaches to ethics education that start from the important role of emotion in moral choice. We are designing programs that are being piloted at the University of California, Berkeley, College of Engineering (COE) to reach both undergraduate and graduate students. Here we describe a variety of problem-based learning (PBL) activities that have been employed in an undergraduate course to engage students' emotions in ethical learning. Our approach is rooted in student-engagement approaches to curriculum design.[5] Our early results suggest that involving students in the process of curriculum development creates a gateway to additional ethics-oriented opportunities.[6]

Our project team includes two nuclear engineers and two historians of science and technology.

The core group of co-PIs is located at the University of California, Berkeley (UCB) and is collaborating with teams from the University of California, Los Angeles (UCLA) Henry Samueli School of Engineering and Applied Science, as well as the Centre for Ethics and Technology at Delft University of Technology. The UCLA collaboration is designed to allow us to test the transferability and sustainability of the project's curricular innovations in a different American institutional setting. The Delft collaboration is organized to facilitate the development of an international learning forum. The Delft collaboration also brings philosophical expertise to our project through scholars who work at the intersection of the philosophy of emotion and the philosophy of technology.

Despite the abundance of literature that emphasizes the centrality of emotion to moral reasoning, there is a dearth of scholarship on how to integrate emotion into ethics curricula.[7] A few pedagogical approaches that target emotions have been suggested, such as reading stories, role-playing, and listening to music.[8] These approaches, however, have not been rigorously implemented or tested in ethics curricula. Furthermore, it is not clear how these pedagogical activities map onto recent conceptual advances in the interdisciplinary emotion scholarship. Some philosophers of education are seeking ways to bridge this divide, but there is a practical need to: 1) develop effective pedagogical practices that engage the emotions, and 2) study the effects of engaging emotion in the learning process. We draw on scholarship from the learning sciences to suggest strategies for engaging the emotions in engineering ethics curricula. We argue that incorporating and emphasizing the emotions in the engineering ethics classroom offers a new starting point to meet engineers and scientists where they are. Learning science shows that learning is always driven by preconceptions; the power of preconceptions applies equally to both infants and adults. In fact, if preconceptions are ignored in the classroom, students tend to adopt a learning strategy that centers on memorizing content (*e.g.*, normative rules). Although this strategy may allow students to perform well on assignments or exams, they typically resort to using their preconceptions once they leave the classroom.

The pedagogical strategies that we describe are rooted in the idea that it is necessary to critically engage students' emotions in ethical learning in order to address their preconceptions. Although acknowledging emotions in the context of ethics is not novel, many introductory ethics textbooks discourage students from critically considering their emotional reactions. In ethics curricula, students are often warned that their emotions will impede their ability to conduct a rational analysis. Students are advised to check their emotions at the door. However, most introductory ethics texts also recognize that ethics and values are often expressed emotively, especially by those who have not formally studied ethics. This framing of ethics as a form of analysis that is completely distinct from the emotions dissuades students from engaging their ethical preconceptions, which are sometimes most readily expressed emotively.

The role of emotions in ethical reasoning and decision-making remains controversial. Some scholars argue that elevating the role of emotion could lead to ethical relativism, while others argue that the emotions are at the very center of moral life.[9] Our approach builds on the position that emotions fundamentally influence how we see and make sense of the world.[10] We argue that the emotions are a necessary entry point to ethics. Explicitly engaging students' emotional responses in the classroom offers an effective way to elicit students' existing value systems. We put this strategy to work in engineering ethics education by framing an open conversation around

students' existing value systems as the basis for engagement with larger questions of engineering ethics.

This paper provides an introduction to the place of emotion in engineering ethics and then describes different problem based learning (PBL) activities that have been piloted at the University of California, Berkeley in the upper division engineering course, "Ethics, Engineering, and Society" (E125).

Bringing Emotion into Engineering Ethics

In engineering, being rational usually implies removing emotions that might bias analyses. However, there is a growing scholarship across many disciplines that shows emotions are necessary for effective analyses and decision-making. Developments in psychology, neurology, evolutionary biology, and economics have motivated a range of interdisciplinary collaborations.[11] Although far from pervasive, emotion is beginning to establish a presence in engineering ethics. Analyses of engineering ethics case studies demonstrate that even seemingly unemotional events elicit emotional attention as they unfold.[12] More recently, studies have demonstrated the effectiveness of incorporating emotional content into engineering ethics case studies.[13] Within the engineering ethics community, there are references to the emotions from a virtue ethics perspective.[14] Virtue ethicists emphasize the importance of cultivating the character and emotions that enable a more intuitive response to ethical problems.[15] It remains unclear, however, how these emotions might be effectively engaged in an engineering ethics classroom.[16]

Feminist approaches to engineering ethics offer strategies for considering emotional factors with analytical rigor. Whereas traditional ethical approaches emphasize culturally masculine traits, such as autonomy, intellect, and will, feminist approaches draw attention to the importance of emotion, relationships, and community.[17] There is a growing group of scholars who work at the intersection of feminist epistemology and engineering ethics.[18] These new feminist perspectives reframe discussions of women in engineering by directing the focus away from traditional issues of underrepresentation. Instead, recent feminist scholarship draws attention to the power relations, social structures, and concepts that have shaped and continue to shape engineering.[19] Earlier work by engineers helped to make space for feminist approaches within engineering ethics by arguing for the application of the ethic of care framework to the engineering design process. The ethic of care approach is recognized as an important departure from and alternative to the traditionally paternalistic style of ethical reasoning, and was developed as an analytical approach that emphasized the importance of relationships during ethical decision-making.[20] Marina Pantazidou and Indira Nair argue that employing an ethic of care approach, especially during problem identification, fosters a community-based perspective. Emphasizing community and connectedness enables a reimagination of the design process.[21]

Sabine Roeser, our collaborator, explicitly argues that engineers need to be more emotional to perceive the full range and depth of the ethical issues that are associated with emerging technologies.[22] Her approach frames emotions as a valuable source of moral wisdom. According to Roeser, emotions are an essential normative guide, especially when considering novel and potentially high-risk technologies.[23] Our project builds on Roeser's work. Rather than portraying emotion as a threat to rationality, we encourage students to explore the relationship between

emotions, reason, values, and ethics. By emphasizing important sources of values, particularly from each student's family of origin, we are developing curricula that enable students to explore the interconnectedness of emotion and rational reasoning. The following sections describe pedagogical strategies that encourage students to identify and reflect upon their own emotions and values. Developing the capacity for personal reflection is meant to build a student community that embraces a diversity of cultural and personal values. Students learn to appreciate that values do not stand apart in a timeless, objective realm, but are shaped by each individual's experiences and background.[24] Grounding reflective exercises in relevant literature communicates two important ideas: first, that engineering ethics is a legitimate scholarly field, and, second, that it is possible and necessary to include the rigorous analyses of ethical issues in engineering research.

A Pedagogical Shift: Toward Problem-Based Learning

Our project is targeted at engineering students at both the advanced undergraduate and graduate levels. Although different curricula have been developed to reach these distinctive audiences, each shares an underlying pedagogical commitment to problem-based learning (PBL). There is widespread support and significant empirical evidence that shows the superior effectiveness of collaborative and active learning environments. In fact, it has been suggested that no further research is needed to demonstrate this well-established finding.[25] Engineering students, however, continue to spend an exceedingly high number of credit hours in lecture courses, especially at the undergraduate level.[26] Lecture-style courses require students to quickly intake and apply packaged information from lectures, but students are often left with little time to critically engage ideas or identify the big-picture relevance of course content.[27] In engineering curricula, ethics is a casualty of this style of course delivery. Our curriculum development activities contribute to the larger movement within the engineering education community that is working toward a pedagogical shift away from lecture-style learning and toward more self-directed, project-based, or problem-based learning (PBL).[28]

PBL was pioneered in medical schools as both a method and a philosophy that would allow students to integrate and acquire new knowledge while developing problem-solving skills. Since its success in the medical school context, PBL has been adopted in a variety of fields ranging from architecture to business, but it is not as prevalent in ethics education, which is usually more oriented toward case studies. Although both case-based learning and PBL are inductive instructional methods, a case-based approach relies on cases rather than problems to provide the context for learning.[29] In PBL broad, ill-structured problems are used to motivate and structure learning.[30] The strategy of introducing problems before any specific knowledge acquisition has occurred contrasts sharply with the prominent deductive approach in engineering education. In the deductive approach theory is introduced first and problems are assigned later. Research suggests that students benefit from studying complex problems rather than organized cases in which the information has already been packaged.[31] A PBL approach to engineering ethics enables students to develop the skills and confidence that will enable them to question the different perspectives that they encounter, including their own and their teachers'. The PBL approach described here also draws on the student engagement scholarship, which argues that students should play an active role in shaping their curriculum.

Ethics, Engineering, and Society (E125): Testing New Pedagogical Strategies

We are currently assessing a variety of inquiry-based pedagogical approaches in a new advanced (upper-division) undergraduate seminar course, "Ethics, Engineering, and Society" (E125) that was developed, approved, and implemented during our preliminary research with support from UC Berkeley's COE. The seminar-style course was taught for the first time during the spring 2012 semester and again during the 2012 summer session. The course was taught for the third time during the spring 2013 semester and will be offered in a larger "lecture" size format during the fall 2014 semester. During the spring 2013 offering we implemented a number of new innovations that were made possible by the fact that the course is taught in one of UC Berkeley's new active learning classrooms, which is equipped with technologies (both high- and low-tech) that have been specifically designed to facilitate active learning. During the fall 2014 offering we are planning modifications to accommodate the larger number of students, but we are committed to maintaining an active learning environment with minimal lecturing. The active learning classroom is being used to test a variety of new PBL activities that we are planning to scale-up.

Learning Proposals

To empower students to become self-directed learners, especially in the field of ethics, they are required to write a "learning proposal" at the beginning of the semester, which includes an explanation of why they are taking the course, an outline of what they hope to gain from the experience, a list of objectives, and a list of ethical questions or topics that they hope to learn more about. Throughout the course, students learn to take responsibility for their own learning and are given opportunities to select readings (with guidance from the instructor) that address issues of interest from their learning proposals.

Ethics as an Active Research Field

In E125 students are introduced to ethics as an active research field with many open-ended problems. Even at the undergraduate level, students are required to read recent peer-reviewed ethics articles. Framing ethics as a relevant research field allows students to develop a different perspective about what ethics is and what kinds of questions and problems ethicists are thinking about. Our approach begins with the premise that it is fundamentally important to engage students' preconceptions about ethics, in particular, the preconception that many engineering students' seem to share: the notion that ethics is a list of rules and laws that they need to memorize.[32] Framing ethics as an active research field allows students to identify ethics questions, consider possible resources that are available to answer these questions, and ultimately participate in the design of new ethics resources.

Designing New Ethics Resources

The course is organized around a final group project that requires students to work together to develop a proposal for a new ethics resource. This assignment focuses students on the following problem: Why do so many engineering students find engineering ethics courses to be boring and/or irrelevant with respect to the larger engineering curriculum? Students are challenged to reflect about why ethics might be relevant and are asked to consider strategies for making it more relevant. This process invites students to be partners in curriculum design and reform.[33] This approach draws on the student engagement scholarship that explores how students can become active participants in the design and implementation of their education. Throughout the course,

students read about past and ongoing efforts to revise the engineering curriculum to meet the needs of the future, including sections of *The Engineer of 2020* report issued by the National Academy of Engineering. Students are asked to contribute to this reform movement by designing effective ways to engage their peers in ethical reflection and action.

Our experiences with the spring 2012 and summer 2012 E125 classes suggest that this curriculum-design assignment is very effective. It allows students to be creative while also empowering them to see their voices as important. It facilitates interdisciplinary group work and encourages reflective thinking about why ethics might be relevant. Students have presented a variety of potentially transformative strategies for ethics educators. They have, for example, analyzed the importance of marketing ethics as relevant and suggested a variety of strategies that might attract their peers' attention to ethical issues, including a wide range of media campaigns. Interestingly, students also suggested the development of a new peer-taught engineering ethics course. These "DeCal" courses are common at UC Berkeley. The DeCal program allows undergraduate students to design and teach a course under the supervision of a faculty member or instructor. Some students from E125 took the initiative to design a new engineering ethics DeCal course that is being offered during the spring 2013 semester. We interpret this student-taught ethics course as evidence that the curriculum-design assignment allows students to become emotionally engaged in the learning process to the point that they are willing and eager to continue ethics activities beyond the classroom.

Ethics in the News

The second PBL assignment that orients E125 is an ethics in the news activity. It is very common that engineering ethics courses make reference to stories from the news. In E125 we have used a PBL philosophy to put students at the center of this activity. Preliminary student feedback suggests that undergraduate students find this to be the most rewarding and useful component of the course. Each class a student is required to share an engineering ethics story from the news. There is no shortage of technology-oriented stories in the news. Indeed, most newspapers have entire technology sections. It is much more rare, however, that these stories make any explicit references to ethics. The problem, therefore, is for students to locate ethical issues in seemingly innocuous technology news stories. Of course, they are also invited to select stories where the ethical aspects are made evident by the author. Students post the article for the class to read and then spend five minutes introducing the story and approximately twenty minutes guiding a class discussion about the ethical issues. During the discussion, students are encouraged to name their emotive responses as such. Being explicit about emotive responses allows students to find a language that allows them to communicate their personal values and also opens up a dialog about how these values may or may not be shared by the larger engineering profession.[34]

ePortfolios

We are currently working on a new overarching assignment that allows students to tie all of their work together in the form of an ePortfolio. There is a long history of using portfolios to document student learning, especially in architecture, fine art, and creative writing. Although these paper portfolios effectively illustrate student work, they are difficult to share, update, or edit for different audiences. A variety of ePortfolio intitiatives began in the early 2000s with the mandate of developing electronic tools that would allow students to document what they know,

reflect on that knowledge, and present it to different audiences. The aim of ePortfolios is to facilitate deep learning – the kind of learning that occurs when students take the initiative to achieve a level of mastery rather than just learning how to perform specific tasks. Ultimately, ePortfolios are a pedagogical tool that enable students to acquire agency in their learning process and in doing so, develop an understanding of themselves and their capabilities. ePortfolios allow students to show the connections between their lived experiences and their curricular activities by providing a virtual space where they document and reflect on their learning.[35]

Although still in the early stages of development, ePortfolios are being piloted in the spring 2013 active learning classroom. Instead of a final exam, students submit a final ePortfolio, a sort of blog that ties together their work in E125 while also communicating and reflecting upon their unique ethical perspective. The act of systematic reflection in which students question what they know and how they know it, enables them to define a coherent belief system and understand how it coordinates with others Throughout the semester students work on building the ePortfolio as a digital repository for their E125 work, but also as a resource that will enable each student to reflect on his/her learning. Most importantly, the ePortfolio is designed to help students to imagine and represent their future role as an engineer in society. We look forward to sharing the preliminary results from the spring 2013 ePortfolio assignment at the ASEE conference.

Curriculum Research Assistants

During the course of the NSF grant, E125 will serve as an incubator and testing ground for innovative pedagogical approaches to engineering ethics. As indicated by developments currently underway, such as the new ePortfolio assignment, E125 will be steadily revised in response to student contributions. During the spring 2013 semester we are including two undergraduate students as curriculum research assistants. Our methodology builds on an approach piloted through the Bryn Mawr College Teaching and Learning Initiative.[36] The E125 instructor is working with curriculum research assistants to conduct a midcourse and final evaluation of E125. The evaluation process involves student researchers and instructors working together to develop questions for the enrolled students. The researchers conduct informal interviews with students, organize the feedback, and then share it with the instructor. Sample questions include: What is working well in the class? What is not working well? What could the instructor do to improve learning? What could the students do to improve learning?

Student curriculum researchers have been and will continue to be recruited from the COE. Initial involvement as researchers is not overly time consuming, only requiring approximately ten hours/semester (or more, if assistants opt to attend the class). One goal of the curriculum research program is to generate deeper interest in ethics among the student researchers, with some of them potentially becoming more involved in the larger research project. We aim for participation in E125 to become a “low-cost” doorway into ethics research opportunities for students who might not otherwise consider making space for ethics in their busy schedules. Graduate students are also participating in curriculum evaluation and design. During the spring 2013 semester a graduate student instructor is working alongside the E125 instructor to evaluate how activities could best be scaled up for delivery to a larger number of students.

Conclusions

Emotions are beginning to establish a presence in the engineering ethics literature, but the role of emotion in ethical reasoning and decision-making remains controversial. Our approach builds on the growing interdisciplinary scholarship that shows emotions play an indispensable role during ethical reasoning and decision-making. Ignoring or downplaying the role of emotions prevents students from critically reflecting on and discussing the important role that emotions play in their moral lives. We have designed a variety of PBL assignments that intend to make room for students to engage their emotions and consider how they might shape their reactions to engineering ethics. We want students to consider how emotions influence how we see and make sense of the world. Our results suggest that adopting a PBL approach to ethics provides an effective strategy to engage students' emotions. The PBL-based assignments outlined here offer an accessible entry point to ethics and at the same time foster a dialog about the role of ethics in the larger engineering curricula. Including students in the process of curriculum design creates an incentive for further reflection about the objectives that motivate the general engineering curriculum and provides a framework for students to conceptualize the overarching relevance of ethics.

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