Integrating Sustainability Within Ethics Discourse: A Freshmen Perspective

Seetha V. Veeraghanta, Janice W. Frost
University of Utah, Undergraduate Studies Program

Abstract

Recently, engineering academia has recognized the importance of including ethics and the concept of sustainability into the curriculum. This development is evidenced in the ABET guidelines, viz., “…engineering standards and realistic constraints - economic, environmental, sustainability, ethical, health and safety, social and economic” [1].

In this paper, we present the argument that incorporating theories and concepts of global resource sustainability into a discussion of ethics enables a first-year student to comprehend ethics as an engineering goal. In addition, we argue that this incorporation at the first-year level ensures that the students continue to engage in the discourse of ethics throughout their engineering education.

We draw our inferences based on our five years of teaching “UGS 1101 - Ethics in Engineering” to freshmen engineering students in University of Utah. In this course, the students examine how the world of social sciences studies human institutions, cultures, and behaviors, and, in particular, apply the concepts to engineering ethics and decision-making processes. This course prepares students to recognize ethical issues within engineering contexts with the help of case studies drawn from national and international contexts. To understand the impact of engineering solutions in global and societal contexts, we introduce the concepts of local and global sustainability. We examine the notion of sustainable development from the practicing engineer’s perspective. This encompasses a discussion of ethical implications of issues such as globalization and the rapid growth of information technology.

In the course, an understanding of professional and ethical responsibility is drawn from the exploration of the scope and definition of “ethics” and “ethical responsibilities” via discussions focused on the code of ethics statements from discipline specific professional (both national and international) organizations and societies. Case study analyses of engineering failures help integrate concepts of risk analysis into the discussion of ethics and professional responsibilities, especially as they relate to public health, safety and whistle blowing. Such an integration allows students to realize that ethics form the core of the engineering profession. The students explore their discipline specific discourse on sustainability and ultimately present their findings as a culmination of the semester-long learning.

Introduction

The pedagogical framework of engineering ethics education has predominantly used case studies examined through the application of codes of ethics drawn from professional engineering societies or through moral theories. We believe that these tools represent one way to teach ethics to first-year engineering students. However, based on our five years of teaching about 250 freshmen
engineering students in the nationally recognized LEAP Program [2] about the importance of ethics in this discipline, we argue that linking the concept of sustainability to a discussion of ethics promotes a higher level of learning and comprehension for students who are engaged in general science and introductory engineering courses, rather than in upper division engineering courses.

As these students have limited education in engineering and little work experience in this area, they are unable to comprehend specific ethical dilemmas that an engineer might face. By exploring this concept of sustainability and linking it to the research published in major science and engineering databases, our students have replaced a theoretical notion of ethics applied to cases outside their domain with an understanding of the ethical dimension of sustainability as it relates to their respective engineering majors. The result is that this connection operationalizes the concept of ethics for our students. Students perceive that sustainability, grounded in the reality of resource management, is crucial to engineering practice.

Rationale for Linking Sustainability and Ethics

There are good grounds for making this connection between sustainability and ethics although engineering academia has only recently recognized the importance of focusing on this link in the general education and technical parts of the curriculum. As evidence of this, Herkert argues that despite ABET’s requirement that engineering schools address “sustainability” and “ethics”, only “17% of institutions and 8% of graduates do have one or more required courses with ethics-related content, these courses are usually not courses in engineering per se, but rather courses in such areas as philosophy or religion”[3]. In these courses, sustainability is not generally paired with ethics.

Twenty-first century engineering demands a paradigm shift in the way engineering is conceived. Calling for “renaissance engineers,” Splitt argues for a redefinition of the role of engineering which includes a search for the solution of problems involving issues of resource management and the corresponding issues of social equity and social justice. He states that “The new paradigm for engineering education is keyed to the fact that current and future demands will be for the solution of problems involving human values, attitudes and behavior, as well as the interrelationships and dynamics of social, political, environmental, and economic systems on a global basis”[4]. Often sustainability is seen as a balancing act between economic development and resource management operating within the framework of cost-benefit analysis. Herkert [5] argues that framing sustainability in economic or effective management terms excludes and ignores the ramifications of the social aspects of resource allocation and distribution. Questions pertaining to equity and just distribution call for ethical frameworks. Therefore linking sustainability to the ethics discourse acknowledges that ultimately the notions of economic progress, and equitable and just distribution of resource management rest on a world view that is a “value judgement and [based on] consensual knowledge systems” [6].

Contrary to the argument that sustainability and value judgements are not in the purview of engineers, and that engineers are best suited for objective technological solutions, Kotari [7] claims that:

- The shift to sustainable development is primarily an ethical shift. It is not a technological fix, nor a matter of financial investment. It is a shift in values such that nature is valued in itself and for its life support function, not merely for how it can be converted into resources and commodities to feed the engine of economic growth. Respect for nature’s diversity, and the responsibility to conserve that diversity, define sustainable development as an ethical ideal. Out of an ethics of respect for nature’s diversity flows a respect for the diversity of cultures and
livelihoods, the basis not only for sustainability, but also of justice and equity. Thus we make the argument that in order to better understand the public role of engineers in the pursuit of “solutions for problems involving human values, ..as well as the interrelationships.. of social, political... economic systems on a global basis” [8], engineering ethics discourse provides a space and an outlet for the students to interrogate the relationship between ethics and sustainability.

Shifting the Paradigm for Teaching Ethics in the Engineering-LEAP [E-LEAP] Program

In 1994, the University of Utah initiated a year-long program for first-year students, an integrated learning community, to address the University’s concerns about transitioning students from high school to college and retaining freshmen. The program provides small classes (not more than 35 per section) in which students can interact with professors, other LEAP students, and the campus community while completing certain General Education requirements and moving into their majors. The initial student population of this cohort program did not generally include science and engineering students.

In 1999, however, the College of Engineering and the LEAP Program initiated a specific course dedicated to engineering students, Engineering LEAP [E-LEAP], to connect the students to others in engineering or science classes and to activities and departments in the college itself. The first semester of E-LEAP followed the curriculum of the rest of the LEAP sections in looking at the concept of community through a humanities perspective and fulfilling the University’s diversity requirement. But the second semester focused on the engineer’s ethical role in the community on a national and international level by engaging students in identifying the codes of ethics of professional societies and applying these codes to case studies. This proved useful but not specific enough since the cases the students could clearly understand were generally based in business rather than in engineering contexts due to the limited engineering education of these students.

Based on our experience in teaching freshmen in the LEAP Program, we designed an engineering ethics course that would provide an appropriate environment to nurture the students in their initial exploration of ethics. Because the Program is based on identifying the learning styles of freshmen, locating resources appropriate for learning by first-year students, and building communication and research skills, we were able to modify the paradigm for instruction in engineering ethics in the second semester of E-LEAP, UGS 1101, and include the new link between sustainability and ethics.

The engineering ethics course that we teach is specifically designed for first-year engineering students. We incorporate issues, cases and concerns that are directly related to engineers. When we began designing this course, we asked ourselves this question: How do we make our students aware that what they do as engineers has a direct impact on the community to which they belong? Research on engineering ethics has pointed to the lacunae between practice and philosophy. Incorporating sustainability into the ethics course bridges that gap and makes ethics a practicing philosophy.

Our ethics course is taught under a broader rubric of social science, thus incorporating the social and ethical responsibilities of practicing engineers. It makes them aware of their civic participation in their own communities and thus their responsibilities as citizens to a wider society.

Normally ethics is taught under “humanities”; however, we look at ethics as a social science concept that lends itself, when integrated with sustainability, to the rigors of science and research.
methodology. It yields itself to the notions of shifting paradigms - especially in terms of resource definitions in the last half century. Resource as a concept has had a major paradigm shift from being “infinite” to “finite.” Embedding sustainability in the ethics curriculum grounds the discourse of civic responsibilities and the service component of engineering occupations within the ethics realm. According to a general understanding of social science methodology, claiming ethics under social science allows room for students to critically examine the consumption behavior of societies [aggregates] and the relationship between engineering design, innovation, and ethics. Ultimately it is an analysis and an understanding of the “collective social responsibility of the profession” that deals with societal context of engineering [9].

Associating sustainability, from a social science perspective, with the ethics curriculum has brought flexibility into our teaching methods. Traditional materials such as case studies promote good learning at the introductory level in preparing the students for more complex analysis. Team work empowers students to become active learners who explore, question and resolve complex ethical concerns by delving into research using advanced library searching tools. This approach has enabled us to use a myriad of pedagogical methods that rely on teaching team building, library research, and communication skills. In addition, as Figure 1 shows, our syllabus frames the discussion of ethical and sustainability issues through a series of questions that tie to the final project.

Figure - 1: Course Objectives

<table>
<thead>
<tr>
<th>In order to understand the role of the engineer in local, national, and global settings, you will begin by asking:</th>
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<tr>
<td>♦ What is a society or community? How do engineers define a professional society? What is the purpose of professional engineering societies?</td>
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<tr>
<td>♦ How can engineers determine what is ethical in making decisions within different communities? Are traditional philosophical concepts about ethics applicable to engineering codes of ethics, or are there other ways to think about engineering ethics?</td>
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<tr>
<td>♦ What are some of the major questions and problems about communities studied by social scientists? What can engineers learn from social scientists and implement in dealing with other engineers, with corporations or government agencies, and with the public?</td>
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<tr>
<td>♦ How do social scientists study human behavior and institutions? What should engineers know about social and organizational theory?</td>
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<tr>
<td>♦ What role do social scientists play in our society in influencing public debate and public policy? How does this relate to the role of engineers as citizens and as technical advisors in shaping progress or changes in technology?</td>
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<tr>
<td>♦ How do social scientists and engineers analyze and respond to issues of globalization?</td>
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To understand the impact of engineering solutions in global and societal contexts, we will introduce concepts of local and global sustainability. We will examine the notion of sustainable development from the practicing engineer’s perspective and ethical implications of issues such as globalization and rapid growth of information technology. You will explore your discipline specific discourse on sustainability and ultimately present your findings as a culmination of the semester-long learning. You will receive detailed instruction and guidance on how to present professionally.
Team Building

Students are put into discipline-specific teams and assigned a research question related to their discipline and linked to the issue of sustainability and its ethical dimensions. Effective team work is promoted by placing the students in two contexts: participation in face-to-face meetings in and out of class, and through discussion online using WebCT. The students receive intensive training about functioning as members of a team as Figure 2 indicates.

Figure - 2 - Team Goals

<table>
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<tr>
<th>Guidelines for Being an Effective Team Member</th>
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<tr>
<td>As a part of the Research Panel Presentation this semester, you are required to work in teams to make your presentations on the topics assigned at the beginning of the semester. At the end of each presentation, you and your team members will be evaluated on your presentation skills and as a member of a team. Grades for each member will be adjusted up or down according to the evaluation of the other team members.</td>
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<td>Here are some criteria for peer evaluations. Your ratings should reflect the following:</td>
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<td>• Level of participation by each member of the team</td>
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<td>• Effort invested by each member of the team to ensure that it is a team presentation, not a series of individual presentations rolled into one.</td>
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<td>• Sense of responsibility to the team’s goal</td>
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<td>Here are some specific responsibilities you should consider:</td>
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<tr>
<td>• Attend scheduled meetings</td>
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<tr>
<td>• Prepare for meetings</td>
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<tr>
<td>• Contribute to the discussions constructively by providing [feasible] ideas for the team presentation</td>
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<tr>
<td>• Communicate clearly and with civility</td>
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<tr>
<td>• Listen effectively</td>
</tr>
<tr>
<td>• Show respect for different opinions</td>
</tr>
<tr>
<td>• Accept criticism gracefully</td>
</tr>
<tr>
<td>• Be a reliable member of the team</td>
</tr>
<tr>
<td>• Cooperate with the other members of the team</td>
</tr>
<tr>
<td>• Carry your share of the load</td>
</tr>
<tr>
<td>Your ratings may be as follows:</td>
</tr>
<tr>
<td>• Excellent - A [10 pts]</td>
</tr>
<tr>
<td>• Very good - B [8-9]</td>
</tr>
<tr>
<td>• Satisfactory - C [7]</td>
</tr>
<tr>
<td>• Marginal - D [6]</td>
</tr>
<tr>
<td>• No show/Deficient - E, Fail [5 and below]</td>
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Library Research

Over the years, the LEAP Program has developed a close working relationship with the Marriott Library Instructional staff at the University of Utah to provide a sequence of 5 increasingly advanced library instruction and assignments. At the end of the year, the students move into their majors fully able to research databases connected to those majors.
and to employ sophisticated search strategies in locating appropriate information. For the purposes of the E-LEAP class, we focus on social science, science, and engineering databases as indicated in Figure 3.

Figure - 3: Library Databases

Students use the following social science and engineering-related databases:
- Social Science Abstracts
- General Science Abstracts
- Applied Science & Technology Abstracts
- Web of Knowledge/Web of Science,
- Compendex
- Inspec, and
- Scifinder Scholar (Chemical abstracts)

- Sustainability and Ethics Project

The final assignment for the semester is a professional quality oral presentation in PowerPoint and a written report prepared by each team based on their presentation. The quality of the final oral presentation and the written report are evidence of the effectiveness of this pedagogy. Figure 4 below spells out the details of the final assignment.

Figure - 4: Final Oral Presentation

**Exploring Sustainability Or Sustainable Development in Industry**

**Sustainability in Your Engineering Discipline**

Questions to be considered in the presentation:
- When did the concept of sustainability become a part of the conversation in your engineering discipline?
- How is sustainability defined in your discipline?
- Has the definition of this concept evolved or remained static in your discipline?
- What are the current research topics and practical applications of sustainability in your discipline?
- How do at least two specific corporations or businesses in industries related to your discipline explain sustainability in their corporate policies or statements?
- How is the concept related to engineering ethics and technological innovations in these corporations or businesses?

Our Reflections

Although this paper is not based on a formal assessment, we offer our findings and reflections:

- Integrating sustainability and ethics provides a context or a basis for linking both resource management and engineering tools for freshmen engineering students to comprehend that practicing ethics is an engineering goal.
- This linkage between engineering ethics and sustainability discourse provides opportunities for the students to conduct meaningful research in specific engineering disciplines at the
freshmen level.

- Linking sustainability to ethics allows the students to take charge of constructing a knowledge base about sustainability and its ethical ramifications through sophisticated research in science and engineering databases.
- This course provides a first step into integrating ethics in the engineering curriculum, thus forming a credible basis for a continuing discussion of ethics in their specific engineering disciplines.
- Embedding sustainability in engineering ethics promotes a higher level of learning for freshmen engineering students which is evidenced by the quality of their final oral presentations and written reports.

Bringing the discourse of sustainability into the engineering ethics curriculum bridges the gap between the students’ perceptions of engineering practices and grounds the discussions of ethics in the classroom.

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