AC 2009-368: AN EXAMINATION OF STUDENT EXPERIENCES RELATED TO ENGINEERING ETHICS: INITIAL FINDINGS

Janel Sutkus, Carnegie Mellon University

Dr. Janel Sutkus is Director of Institutional Research and Analysis at Carnegie Mellon University in Pittsburgh, Pennsylvania. She received her doctorate from the Center for the Study of Higher and Postsecondary Education at the University of Michigan, and also holds degrees from Cornell College (BA in psychology and music) and the University of Iowa (MA in higher education administration). Prior to earning her Ph.D. she was a college administrator for 15 years at two small, private liberal arts colleges. While at the University of Michigan, she taught non-experimental educational research methods for three semesters, and served as a virtual writing instructor at Marygrove College, working with master's students on quantitative and qualitative research papers for the departments of education and criminal justice. She was the recipient of the Louise Fairman Scholarship, sponsored by the U-M Alumnae Council, in 2006-2007; and was named a Margaret Dow Towsley Scholar for 2007-2008 by the U-M Center for the Education of Women. She and Cynthia Finelli received a grant in fall, 2007 from the University of Michigan Center for Ethics in Public Life for their longitudinal study: Ethical Development of Engineering and Humanities Students at the U of M. She is a member of the Association for Institutional Research, the Association for the Study of Higher Education, and the American College Personnel Association.

Donald Carpenter, Lawrence Technological University

Dr. Donald D. Carpenter is Associate Professor of Civil Engineering at Lawrence Technological University (LTU). In this role, he is an instructor for several engineering courses (from freshman to senior level) that involve ethics instruction. Dr. Carpenter is also Director of Assessment for LTU and recently served as Founding Director for LTU's Center for Teaching and Learning. Dr. Carpenter has conducted funded pedagogical research and development projects, has published numerous educational papers, and conducted several faculty development workshops. He is an active member of the Educational Research and Methods (ERM) Division of the American Society of Engineering Education (ASEE), and he received both the 2001 Apprentice Faculty Grant and the 2002 New Faculty Fellow Award for contributions to engineering education. In 2006, the National Collegiate Inventors and Innovators Alliance (NCIIA) named Dr. Carpenter a Kern Fellow for entrepreneurial education.

Cynthia Finelli, University of Michigan

Dr. Cynthia Finelli is Director of the Center for Research and Learning North and associate research scientist in the College of Engineering at the University of Michigan. She joined the University of Michigan after serving as Founding Director of the Center for Excellence in Teaching and Learning and Richard L. Terrell Professor of Excellence in Teaching at Kettering University. In her current role, she consults with administrators, faculty, staff, and graduate students, offers workshops and seminars on teaching and learning, and supports college-wide initiatives in engineering education. In addition, she actively pursues research in engineering education at the University of and Michigan and assists other faculty in their scholarly projects. She is PI on a multi-university collaborative research study assessing the ethical outcomes associated with the curricular and extra-curricular experiences of engineering undergraduates on a national scale. Further, she leads an evaluation of the effects of different kinds of instructional consultations on teaching, an assessment of the impact of an interactive theater sketch on student teamwork skills, and a study of effects of an applied honors math course. Dr. Finelli also provides national leadership in engineering education research. She is Chair of the Educational Research and Methods Division of American Society of Engineering Education, is a member of the International Planning/Advisory Committee for the 2009 Research in Engineering Education Symposium, and is guest co-editor for a special issue of the International Journal of Engineering Education on applications of engineering education research.

Trevor Harding, California Polytechnic State University

Dr. Trevor S. Harding is Associate Professor of Materials Engineering at California Polytechnic State University–San Luis Obispo where he teaches courses in service learning, introductory materials engineering, biomedical materials design, and tribology. His research interests include both ethical development in engineering students and in vivo degradation of biomedical materials. Dr. Harding earned B.S. degrees in Aerospace Engineering and Materials Science and Engineering (1995), a M.S. degree in Materials Science and Engineering (1997), and a Ph.D. degree in Materials Science and Engineering (2000) from the University of Michigan. Previously, he was Associate Professor of Industrial and Manufacturing Engineering at Kettering University. He currently serves as Associate Editor of the online journal Advances in Engineering Education, is Materials Division Program Chair for the 2009 ASEE Annual Meeting, and ERM Program Chair for the 2010 ASEE Annual Meeting. Dr. Harding has delivered several invited presentations on ethics in engineering curricula, and was invited to participate in the NSF Project Based Service Learning summit. He recently received the Cal Poly 2008 President's Service Learning Award for innovations in the use of service learning. In 2004 he was named a Templeton Research Fellow by the Center for Academic Integrity.

An Examination of Student Experiences Related to Engineering Ethics: Initial Findings

Key words: engineering ethics, focus groups, interviews, survey development

Introduction

In today's technological society, the ethical behavior of engineers is more important than ever. The need to graduate engineers who are conscious of their ethical and professional responsibilities is evidenced by *The Engineer of 2020* report[7] produced by the National Academy of Engineering (NAE). The report concluded that future engineers would need to "possess a working framework upon which high ethical standards and a strong sense of professionalism can be developed." Another NAE report, *Emerging Technologies and Ethical Issues in Engineering*[6,] concluded that future engineers will be trained to advance technologies, but will not be trained to address the "social and ethical implications" of these technologies. This growing emphasis on producing more ethical engineers is further evidenced in the nationwide engineering accreditation standards (established by ABET, the Accreditation Board for Engineering and Technology). Those standards require engineering graduates to have "an understanding of professional and ethical responsibility[2]," and Lattuca and colleagues report that these standards have resulted in an increase in students' awareness of ethics and professionalism[4]. However, awareness of ethics and professionalism is not enough, as it focuses on students' knowledge of ethics rather than their ability to analyze and resolve ethical dilemmas or, more importantly, their subsequent behavior as ethical professionals.

The importance of graduating more ethical engineers underscores the necessity to assess the current state of engineering undergraduates' ethical development and to identify factors that have a positive impact on this proficiency. Therefore, in order to determine both how engineering programs promote development of ethical decision-making skills and the level of success of those efforts, our research team is undertaking a multi-year study to measure students' participation in curricular and co-curricular activities meant to affect ethical development, their knowledge of engineering ethics, and their moral reasoning ability. The critical objective of this study is to enact educational reform by widely disseminating to the engineering education community the specific curricular and co-curricular activities and experiences that most positively affect students' ethical decision-making skills.

The project described in this paper is the initial stage of the multi-year study in which we visited ten engineering programs and collected data which will inform the development of a national survey to be administered in the spring of 2010. Although the overall study is only in its second year, the data collected in the first year provide us with both a platform upon which to build the national survey and cultural context which will inform analysis of the survey data.

Hypothesis

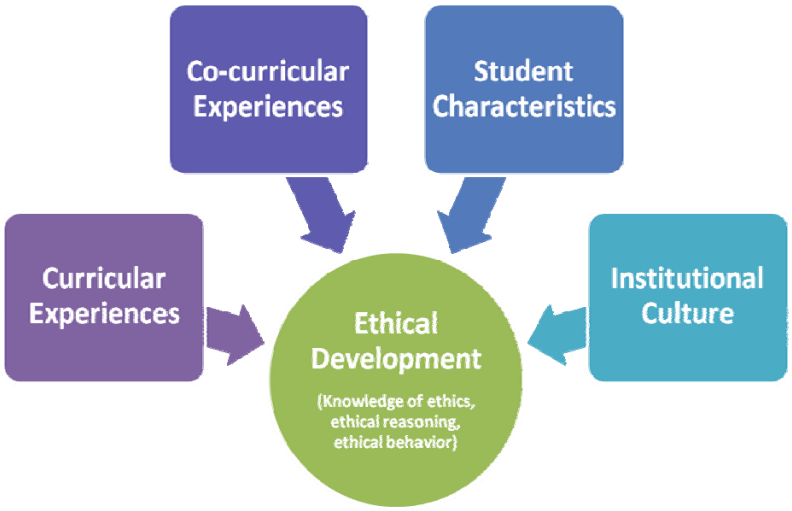

Figure 1: The Determinants of Ethical Development

As shown in Figure 1, we hypothesized a student's ethical development is influenced by multiple dimensions within four major domains: curricular experiences, co-curricular experiences, student characteristics, and institutional culture. Curricular experiences are defined as those within a formal academic program that are intentionally provided by the institution with the goal of affecting students' ethical development. Co-curricular experiences are defined as those outside of the formal curriculum that may or may not be intended to influence students' ethical development. Student characteristics are those individual qualities or traits that have been shown to be related to students' moral reasoning and ethical development. Institutional culture is the collection of shared knowledge, values, practices, symbols, traditions, social norms, and ideals that are unique to a certain institution. The specific dimensions we predetermined within each domain are described in the methodology section.

The outcome variable of ethical development is comprised of three constructs: knowledge of ethics, ethical reasoning, and ethical behavior. Knowledge of ethics is a student's familiarity with professional codes of conduct and, to a limited degree, the engineer's role in ethical dilemmas. Ethical reasoning is a student's ability to apply reason and identify the right decision when faced with a moral dilemma in a professional context. Ethical behavior is the extent to which the student takes action that is consistent with her identification of the right decision.

We will test our hypothesis by analyzing the results of the survey, which will measure three of our four hypothesized determinants of ethical development and the three components comprising ethical development. The mapping between individual survey items and the determinants and constructs they are intended to measure is shown in Table 1.

Table 1: Determinants and Outcome Constructs Mapped to Survey Items

Determinant	Survey Items
Curricular experiences	list of items distilled from analysis of focus groups and interviews at first ten partner visits
Co-curricular experiences	list of items distilled from analysis of focus groups and interviews at first ten partner visits
Student characteristics	demographic questions, such as race, gender, class year, citizenship status, grade point average, etc.

Outcome Construct	Survey Items
Knowledge of ethics	questions taken from the Fundamentals of Engineering exam[8]
Ethical reasoning	the Defining Issues Test[10], a nationally-normed instrument that provides a measure of ethical reasoning ability
Ethical behavior	questions about both pro- and anti-social behavior (for example, community service and cheating on tests)

In addition, institutional culture will be assessed using the individual institutional cultural dimensions distilled from analysis of focus groups and interviews at all nineteen partner visits. These dimensions will not be included in the survey but will be used in survey data analysis for both individual institutions and institutions grouped by type.

Methodology

An initial set of potential partner institutions was created by categorizing all four-year degree-granting engineering programs by their Carnegie Classification programs into four lists. Each list was then ranked by the combined number of students majoring in civil, mechanical, or computer and electrical engineering. The final set of institutions was created by taking the largest programs from each of the four lists, making adjustments to maximize both geographical diversity and diversity of institutional type. Each institution designated an on-campus liaison who was responsible for assisting with subject recruitment and visit logistics. In addition, each institution gave permission to publish its name as part of the study, with the condition that survey results will not be reported for individual institutions but rather in the aggregate or by category. Table 2 displays the nineteen institutions that agreed to serve as partner sites, as well as their institutional type and related project category. Because there are structural and cultural differences across institutional types, final survey results will be reported both in the aggregate and by category to allow readers to focus on the results for institutions most like their own. A twentieth institution – Purdue University – will serve as the testing site for the online survey instrument, but the collected data will not be included in the final results and analysis.

Table 2: Partner Institutions by Carnegie Classification and Project Category

Partner Institution	2005 Carnegie Classification	Category
Iowa State University	RU/Very High Research	1
Pennsylvania State University	RU/Very High Research	1
University of California at San Diego	RU/Very High Research	1
University of Michigan	RU/Very High Research	1
University of Texas at Austin	RU/Very High Research	1
Michigan Technological University	RU/High Research	2
Missouri University of Science and Technology	RU/High Research	2
North Carolina A & T University	RU/High Research	2
North Dakota State University	RU/High Research	2
San Diego State University	RU/High Research	2
University of North Carolina at Charlotte	Doctoral/Research University	2
California Polytechnic State University	Master's Larger	3
Lawrence Technological University	Master's Larger	3
Tennessee Technological University	Master's Larger	3
University of Wisconsin at Platteville	Master's Medium	3
Bucknell University	Bac/A&S	4
The Cooper Union for the Advancement of Science and Art	Bac/Diverse	4
Ohio Northern University	Bac/Diverse	4
Rose-Hulman Institute of Technology	Specialty Engineering	4

Before creating our focus group and interview protocols, it was important we first understood the use, purposes, benefits, and risks of those qualitative methods commonly used in survey development. This was necessary to ensure our survey would accurately measure the determinants of ethical development.

The first purpose of a focus group is to capture all domains (the broadest category being investigated) to be measured in the survey[5,9]. For our study, the predetermined domains are curricular experiences, co-curricular experiences; student characteristics; and institutional culture. The benefit of using focus groups is the ability to gather a wide range of perspectives in a short amount of time and therefore gain a complete picture of participants' thinking. This is critical for survey development as it reduces potential for omitting relevant variables which can result in unfounded conclusions. Although it is possible that researchers can determine all domains in advance, it is important to be open to the possibility of emergent domains.

The second purpose of a focus group is to determine all of the dimensions comprising each domain[5,9]. The predetermined dimensions within the co-curricular domain, for example, were service learning, Greek life, athletics, volunteerism, and professional student engineering organizations. Here the benefits are the reduction of invalid survey data by ensuring questions fully cover the domain content. Again, it is possible to predetermine all dimensions. The third purpose of a focus group is to develop item wordings that effectively convey intent to the respondents[5,9]. This improves survey validity by finding wordings appropriate to the widest range of participants and by minimizing differences in how participants interpret questions.

The risk in using focus groups can occur during analysis if the responses are used to determine the research rather than to guide it by letting isolated focus group remarks push the research into a direction not supported by the broader data[5]. The dimensions we predetermined for each domain hypothesized to affect ethical development are shown in Table 3.

Table 3: Predetermined Domains and Dimensions

Domains	Dimensions
Curricular experiences	Independent ethics course Integrated ethics module Integrated curricular threads *Potential emergent dimensions*
Co-curricular experiences	Service learning Greek life Volunteerism Professional engineering student organizations Athletics *Potential emergent dimensions*
Student characteristics	Gender Ethnicity and race Political disposition Religious commitment Socio-economic status Age Educational level *Potential emergent dimensions*
Institutional culture	Presence of honor code Acceptance of honor code Faculty cohesiveness Research/teaching emphasis Institutional mission coherence Residential/commuter focus *Potential emergent dimensions*
Potential emergent domains	*Potential emergent dimensions*

Creating and Testing the Protocols

In order to gain both teacher and learner perspectives on the determinants of ethical development, we conducted focus groups with engineering students and faculty and interviewed academic affairs and student affairs administrators at each partner institution. The interviewees were chosen based on their knowledge of ethics and ethics instruction within the engineering program. Although they were often members of the college of engineering, several were not, particularly student affairs professionals. Student, faculty, and administrator protocols included prompts for curricular and co-curricular experiences and general institutional culture. The administrator protocols were adjusted to fit the participant's role, as we asked more questions about co-curricular activities of student affairs professionals and more questions about curricular activities of academic affairs administrators.

In the fall of 2007, following Institutional Review Board approval at our home institutions and all partner institutions, we tested our protocols at two sites. Each site visit was conducted by two researchers – the team's research assistant who moderated the focus groups and one of the three principal investigators who conducted the interviews. All participants signed a consent form agreeing to be audio-recorded and to allow their comments to be published anonymously and without identifying information.

We made no changes to the interview protocols and two changes to the student and faculty protocols following the protocol testing. First, when asked about the activities affecting ethical development, participants related them only to ethical knowledge and ethical behavior, omitting ethical reasoning ability. Therefore, we subsequently asked participants to comment specifically on activities affecting ethical reasoning ability. Second, although we informed participants that our definition of ethical development focused on professional engineering ethics, their responses centered on academic ethics, such as cheating and plagiarism. As a result, we added a statement to the protocols informing participants we would speak about engineering ethics and academic ethics, asking them to speak first about engineering ethics, and then asking them to speak about academic ethics. This ensured our data were not limited to information about academic dishonesty.

Conducting the Focus Groups and Interviews

We visited ten institutions during the 2007-2008 academic year which resulted in focus groups with 66 students and 59 faculty members and interviews with 20 academic and student affairs administrators. We employed a random recruitment process for the students and asked the campus liaison to select faculty and administrators either involved in ethics education or with knowledge of how ethics was included within the curriculum. Each participant completed a brief anonymous questionnaire which allowed us to aggregate their demographic characteristics. Student participants reflected the demographics of engineering students nationwide, with two-thirds of the participants being male, seventy-five percent studying civil, mechanical, or electrical and computer engineering, and two-thirds being white[3]. In addition, the participants were distributed almost evenly across freshman, sophomore, junior, and senior/fifth-year classes. Nearly sixty percent were members of a professional engineering student organization and forty percent had participated in an off-campus professional internship or co-op position.

Eighty percent of the faculty participants were males, eighty-nine percent were white, and fifty-nine percent were tenured. Nearly sixty percent had been teaching at least seven years and seventy percent indicated they had non-teaching responsibilities within the engineering school such as research, administrative responsibilities, or appointments as program directors, chairs, or department heads. Furthermore, nineteen percent reported teaching appointments outside of the engineering school and one-third reported non-teaching expectations outside of the engineering school.

Analyzing and Summarizing the Data

Our data analysis differed from traditional qualitative methodology as we did not focus on discovering broad themes or drawing parallels or distinctions across institutional types. Rather, we coded four types of transcript data:

1) the types of activities affecting ethical development, for example, *ethical case studies*
2) the setting in which those activities were conducted, for example, *within a capstone engineering course*
3) the pedagogical method by which those activities were conducted, for example, *a case study presented by an actual participant in the case who asked students to reflect upon it and create their own ethically defensible solution*
4) cultural aspects of the institution, for example, *a mandatory service-learning program*

The first set of data was compared to the list of existing domains and dimensions to determine whether new ones had emerged. We found no new domains, but several emergent dimensions within the curricular and co-curricular domains as shown in Table 4. In addition, leadership was discussed within many dimensions, as students made a very clear distinction between the ethical situations faced by group members and those faced by appointed or elected leaders. Therefore, survey respondents will be asked whether they had an official leadership role for each of the co-curricular dimensions listed.

Table 4: Predetermined Domains and Emergent Dimensions

Predetermined Domain	Emergent Dimension
Curricular experiences	Engineering design teams required within coursework Engineering case studies
Co-curricular experiences	Engineering design teams outside of coursework Student government Environmental awareness or action group Student judicial board Political organization or campaign On-campus religious organization Work as a tutor or supplemental instructor ROTC (Reserve Officers' Training Corp) *(Each dimension will be measured on both membership AND leadership.)*
Student characteristics	No emergent dimensions

The second set and third sets of data, shown in Table 5, add specific details to the list of curricular dimensions. For example, the second set, as shown in Figure 2, will be cross-tabulated with the curricular dimensions, such that students will describe the setting in which the particular activity occurred.

In which situations have you ever been presented with information about professional engineering ethics? Please mark all that apply to you.								
	Summer pre-college bridge program	New student orientation	Intro engineering course	Advanced engineering course	Engineering capstone course	Course outside of engineering department	Required workshop or seminar	Voluntary workshop or seminar
Case study presented by an engineer or other guest speaker	o	o	o	o	o	o	o	o

Figure 2: Snapshot of survey instrument

We will explore the cognitive depth of each of these curricular activities by using concepts from Bloom's taxonomy of educational objectives[1]. Bloom's taxonomy is frequently referenced in the creation of educational objectives and is widely recognized within the education community. The taxonomy is a list of six progressively complex and abstract intellectual behaviors, beginning with knowledge, in which the student simply recalls information, and ending with evaluation, in which the student must make judgments about the value of particular ideas or arguments.

For each situation a students marks, we will ask a series of follow-up questions using the objectives from the taxonomy. For example, when a student indicates she has received information about professional engineering ethics in a "case study presented by a guest speaker in an intro engineering course," she will be asked the following:

> For the guest speaker in the introductory class, which of the following applied to you? (indicate all that applied):
>
> 1. Learn the facts related to professional engineering ethics.
> 2. Recognize ethical concerns faced by professional engineers.
> 3. Apply information learned about ethics to new ethical situations.
> 4. Identify the relevant information necessary to make an ethical decision in a given situation.
> 5. Critically evaluate the ethical decisions made by other engineers.
> 6. Justify the decision you would make if faced with the same ethical situation.

In sum, the first, second, and third sets of data we collected and analyzed will allow us to fully measure the activities colleges and universities undertake to affect students' ethical development. We will be able to determine with great specificity the most influential experiences, including what they are, in what setting they occur, the pedagogical method used, and the cognitive depth to which students experienced them.

Table 5: Educational Settings and Pedagogical Methods within the Curricular Domain

Educational Setting	
	summer pre-college "bridge" program new student orientation introductory engineering course advanced engineering course engineering capstone course course outside of engineering department required workshop or seminar voluntary workshop or seminar
Pedagogical Method	
	information presented by professor information presented by an engineer or other speaker information presented in movie format information presented in skit format information presented in game format information presented through use of online modules students asked to role play different sides of case study students asked to suggest alternate solutions students asked to discuss with each other

The fourth set of data was related to institutional culture and was used to develop a cultural synopsis of each institution. We separated the data into categories such as "institutional focus on ethics," "barriers to ethical behavior," "student/faculty relationships," and "student demographics." As these summaries will be further synthesized in order to create context when reporting survey results to each institution, we did not limit the analysis to only those cultural aspects which affect ethical development, but coded any comments related to institutional culture.

There were several themes within the cultural data; here we will provide examples of the most prevalent theme. It is important to note that this theme is based upon the first ten partner visits, and the team will visit the remaining partner institutions between September 2009 and May 2010. As those visits may generate data that are counter to the themes found in the first ten visits, final project reports may include analysis and interpretation different from what is written here.

Within the partial dataset created from the first ten visits, there is a good deal of evidence that despite the many activities designed to inculcate students with a sense of professional ethics, the students are not internalizing those experiences. For example, several faculty at a high research institution spoke with pride about a ceremonial experience specifically designed to introduce new freshmen to codified institutional values,

> "they're told that this is to be a sign that, as they go through this and then when they leave, throughout the rest of their careers, that this is, you know, these are our statement of values. So, they get this actually before they even start classes and I think that helps to impress upon them that this is something we hold valuable and that it is important. Showing them from the first day that it is important, you know, that the chancellor and the vice-provosts and

> the faculty that are attending convocation are all standing there stating the same values, I think that starts them on the right foot."

When the researcher asked the student focus group later that day to reflect upon that value-sharing experience, their responses revealed disinterest both at the time of the experience and one year later. One student stated,

> "they give us a little folder with a . . .maybe certificate in it with a short paragraph. I mean, when I read it, I was like, 'this is kinda like middle school or something.' I mean, I didn't think much of it, but. . .yeah, it's just a little ethic code but I have never thought about that until you said something right now."

This is an extreme example, as this particular student actually denigrated the experience as being "like middle school," but there are other instances in which faculty and administrators believe their efforts are being recognized by students, yet the students display little recognition. From a professor at a very high research institution,

> "our Dean has a slide that he puts up at every talk he gives. Ethics, teamwork, excellence, and the first word is ethics. So I think you know, from the management for the last 12 years and probably goes back much further than that, I do think there is a top-down cultural emphasis on ethics, professional ethics. Um, I think that's the history of the University, I don't know how formalized it is, it's maybe just sort of ingrained."

We did not interview the Dean being referenced, but this comment was echoed several times – without prompting from the researchers – by other faculty and administrators at the institution. One faculty member suggested that whenever their Dean gave a talk to students – described to us as a frequent occurrence – the words ethics, teamwork, and excellence were always included. This Dean interacted with student leaders on a regular basis, and it was reported to us that those three words were prominently posted on several engineering web pages. In sum, these comments portray a college of engineering in which the Dean has championed ethics as one of three core values and college of engineering administrators and faculty try to pass those values on to their students. The students, however, never mentioned the Dean or the three core values he espoused.

There is a positive side, however, as students in general were not vocally resistant to the inclusion of ethics within the curriculum. Embedded within several comments in which students report ethics is not addressed at their institution is the awareness they need to develop a sense of professional engineering ethics,

> "it's really not addressed very much, ethics in general, and so it's easy for engineers to just be in like a little bubble, 'okay, I'm doing this formula, solving this equation,' but they don't really talk about like, engineers' influence on society and like, corporate social responsibility and things like that, which are important for all engineers."

On a related note, students recalled instruction in academic ethics far more frequently than they recalled discussing professional engineering ethics, and several expressed a desire for faculty to speak less about life in the classroom and more about what they might encounter in the workforce. From a student at a very high research institution,

> "I think that the University should or could talk about ethics more on a bigger scale than just like, cheating on your homework because I think it would be better for them to emphasize ethics in terms of, like your responsibilities as an engineer, what role you have occurring there."

A student from a baccalaureate institution agrees,

> "it does seem to an extent that they want us to take what we know about academic ethics and then try to apply it to engineering in the future. Besides that, there's not so much real engineering ethics being taught."

Our data collection and analysis suggests there is "much real engineering ethics being taught," but it is not always internalized by engineering undergraduates. We expect our survey results to significantly contribute to the engineering education community by revealing the types of experiences – at a high level of specificity – that are influencing students' ethical development.

Next Steps

We are visiting four additional partner institutions during the 2008-09 academic year. Survey content will be tested in May 2009 and online administration will be tested in late fall of 2009. We will visit the final five partner institutions between September 2009 and May 2010, and survey administration at the nineteen partner institutions will take place in the spring of 2010. The information gained during the final two sets of visits will be used along with the cultural data collected in the first set of visits to create context for the survey analysis. Dissemination of survey results and their implications for practice will happen through regional workshops for partner institutions, through submissions to national engineering and education journals, and through postings to the team website.

Bibliography

1. Bloom, B., Englehart, M. Furst, E., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain*. New York: Longmans, Green.

2. Engineering Accreditation Commission (2007). *Criteria for accrediting engineering programs: Effective for evaluations during the 2008-2009 accreditation cycle*. Retrieved January, 23, 2009, from Accreditation Board for Engineering and Technology website: http://www.abet.org/forms.shtml#For_Engineering_Programs_Only

3. Gibbons, M. (2007). "Engineering by the numbers." *American Society for Engineering Education.*

4. Lattuca, L.R., Terenzini, P. T., Volkwein, J. F., & Peterson, G. D. (2006). The changing face of engineering education. *The Bridge*, 36(2), 5–13.

5. Morgan, D. (1997) Focus *groups as qualitative research.* Thousand Oaks, CA: Sage Publications.

6. National Academy of Engineering (2003). *Emerging technologies and ethical issues in engineering*. Washington, DC: National Academy Press.

7. National Academy of Engineering (2004). *The engineer of 2020: Visions of engineering in the new century*. Washington, DC: National Academy Press.

8. National Council of Examiners for Engineering and Surveying (2009). Fundamentals of Engineering (FE) Examination Specifications Retrieved January, 24, 2009, from National Council of Examiners for Engineering and Surveying website: http://www.ncees.org/exams/fundamentals/fe_exam_specs.pdf

9. O'Brien, K. (1993). "Improving survey questionnaires through focus groups," pp. 105-117 in Morgan, D. *Successful focus groups: Advancing the state of the art.* Thousand Oaks, CA: Sage Publications.

10. Rest, J. (1979) *Defining Issues Test (DIT).*