Teaching for Social Responsibility: Exploring Engineering Faculty Members' Beliefs and Curricular Decisions

Jennifer Pollard and Lisa R. Lattuca
Center for Higher and Post-Secondary Education
University of Michigan
Ann Arbor, Michigan 48109
Email: jrpollar@umich.edu

Abstract

The accreditation criteria for engineering programs mandate 11 specific learning outcomes for undergraduate engineers across all sub-disciplines. While technical knowledge and skills are foundational, seven of the 11 competencies focus on students' capacity to apply engineering skills within a dynamic social context. In this connection, knowledge of environmental, political, ethical, health-related and sustainability impacts and constraints become important elements of an undergraduate engineering education. To align with ABET's accreditation criteria, educators and industry representatives alike have thus called for greater attention to preparing future engineers for socially responsible practice.

The goal of this study is to explore factors associated with engineering faculty members' inclusion of social responsibility content in their undergraduate courses. The data come from an NSF-sponsored study that surveyed more than 1000 engineering faculty members from 31 U.S. colleges and universities in seven engineering fields.

Consistent with the study's conceptual framework, we examined the relationship between engineers' beliefs about engineering education and their emphasis on professional values relevant to social responsibility in their courses. Multinomial logistic regression analysis allowed the researchers to go beyond correlational analyses to determine odds of an event (a course of action, in this case, an emphasis on particular course content) given the strength of another factor.

Findings from the analysis demonstrate relationships between faculty members' beliefs (e.g., personal responsibility as a teacher for implementing socially responsible topics) and their course planning decisions. Further, relationships exist between faculty members' use of active teaching/learning and an emphasis on socially responsible curriculum content. The findings suggest that if engineering departments are to see the development and implementation of curriculum that stresses socially responsible knowledge and skills, it will be necessary to focus on faculty beliefs as a point of departure for pedagogically-focused faculty development endeavors.

The accreditation criteria for engineering programs mandate 11 specific learning outcomes for all undergraduate engineering students[1]. While technical knowledge and skills are foundational, seven of the 11 competencies focus on students' capacity to apply engineering skills within a dynamic, social context. Such capacity suggests that students should understand the impacts and constraints associated with environmental, political, ethical, health-related, and sustainability factors in engineering. Keeping current on contemporary issues, learning to work in multidisciplinary teams, and commitment to lifelong learning are also required competencies for new engineers. To align undergraduate curricula with ABET's accreditation criteria, educators[2] and industry representatives[3] stress the importance of preparing future engineers for socially responsible practice.

Literature Review

The majority of U.S. colleges and universities identify civic and social responsibility as desired learning outcomes for their graduates. Many further consider an emphasis on diversity necessary to build students' competencies for life and work within "an increasingly diverse democracy[4]".Such initiatives align with the Association of American Colleges and Universities' (AAC&U) exhortation to "unapologetically teach personal and social responsibility[5]".

Many presume that courses in the humanities and social sciences are more able than STEM courses to take up themes of social and civic responsibility as such content forms the substance of these disciplines. College science educators[6, 7], however, assert that because cultivation of social responsibility is a critical part of scientific and technical preparation, it should be included in the curriculum and modeled by instructors. A number of engineering educators have also called for instruction that approximates engineering practice by bringing issues of professional and personal ethics and values into engineering classrooms[8].

Social Responsibility in Engineering Higher Education and in the Workplace

Social responsibility in engineering can be understood as "the ability to identify with and feel part of social groups, or responsibility for other people, solidarity or collective willingness to help others[9]". It can thus include environmental awareness and sustainability, promoting human well-being locally and globally, and taking into account the needs and contributions of diverse persons in workplace as well as understanding how diversity shapes the needs of clients and customers. Socially responsible engineering and ethical engineering practice are linked; Colby and Sullivan[10] observe that "the profession's responsibility to the public is the first provision in virtually all codes of engineering ethics" (p. 328). Bucciarelli[11] and Conlon[12] called on educators to ground the teaching of engineering ethics in organizational, social, and political contextual realities that students will face in practice, thus further supporting the infusion of social responsibility content into the engineering curriculum.

Faculty Role in Preparing New Engineers

Unless engineering faculty members undertake curricular planning that shows exemplary engineering practice to be a strong marriage between technical knowledge and skills *and* social responsibility, many students will enter the workforce underprepared for sound practice.

Understanding the factors that influence engineering faculty's decisions to emphasize content relating to socially responsible engineering practice is thus essential, but there are few studies that offer insights into influences on faculty members' decisions about course content, particularly as it relates to socially responsible practice. Examining the inclusion of diversity-related course content in a single Research I institution, Mayhew and Grunwald[13] found that engineering faculty were more likely to include "content designed to promote sensitivity towards diversity issues" (p. 155) than those in arts, science, business administration and fine arts. Faculty who were more likely to agree that their department needed more diversity were also more likely to incorporate diversity content in their courses, as were those who perceived that their department emphasized the importance of diversity. Faculty of color were also more likely to include diversity-related content in their courses. Such findings suggest that faculty members' curricular decisions are shaped by factors beyond disciplinary knowledge and socialization.

Faculty members' beliefs about teaching and educational goals may also affect their decisions about what to include in their courses. Analyzing data from a multi-institutional study, Reason, Cox, Quaye, and Terenzini[14] found that individual factors accounted for the "vast majority" (p. 409) of the variance in faculty members' promotion of encounters with difference in first-year courses. This construct included items indicating whether faculty provided students with opportunities to learn about others who differed from them across a variety of background characteristics, attitudes and values and how often faculty asked students to examine and "wrestle with" (p.389) differing perspectives. Notably, faculty members emphasizing active teaching, learning and assessment were more likely to promote student encounters with difference. In contrast to the findings of Mayhew and Grunwald[13], in this study individual demographic variables accounted for very little variance in the outcome: gender and time at institution represented less than 3% of the variance in faculty members' efforts to encourage students to think about diversity and difference. Faculty members' teaching practices were three to 20 times more powerful than demographic characteristics. At the institutional level, perceiving an organizational emphasis on active teaching and assessment were the most powerful predictors while Carnegie classification (i.e., institutional type) and institutional location were the least powerful.

In this study, we explore factors associated with engineering faculty members' inclusion of social responsibility content within their courses. Specifically, we examine the relationships among a variety of individual and organizational factors and faculty members' emphasis on social responsibility in undergraduate courses that they regularly teach.

Conceptual Framework

The contextual filters model proposed by Stark, Lowther, Ryan, Bomotti, Genthon, & Martens[15] guided our analysis (Figure 1). The model builds on the assumption that a curriculum is "an intentional design for learning negotiated by faculty in light of their specialized knowledge and in the context of social expectations and students' needs" (p. 183)[16]. The model also reflects Toombs and Tierney's assertion that there are three essential parts of a curriculum design process: *content,* the *context* in which the curricular choices are made, and the *form* that results from these design decisions. In two studies of course planning, Stark and her colleagues confirmed Toomb's hypothesis that *content* and *context* interact to shape faculty members' course design (*form*)[15,17].

As shown in Figure 1, Toombs identified three influences on faculty members' choices of course content: their background and characteristics, their views of their academic fields, and their beliefs about the purposes of education. Although depicted separately in Figure 1, these influences are hard to separate in reality[18]. In the course planning studies, Stark and her colleagues found a strong relationship between the subject-matter arrangements that instructors reported, their beliefs about educational purposes, and their views of their academic fields.

The model also includes empirically derived *context* influences representing instructors' perceptions of what influences them as they plan courses. Each "contextual filter" mediates or modifies instructors' views of their field and educational purposes. Finally, the model portrays faculty member's course decisions as the *form* of the course, which includes choices of course content (subject matter), identification of course goals and objectives, selection of instructional activities and materials, and sequencing of subject matter.

Methods

Data were collected from faculty as part of a larger, 31-institution study sponsored by the National Science Foundation that focused on the organizational factors and student experiences supporting the development of a variety of student learning outcomes (see table 1 for institutional sample). The sample was drawn using the following strata: six engineering disciplines , three levels of highest degree offered (bachelor's, master's, and doctorate), and two levels of institutional control The distribution of institutions is representative of the engineering education population with respect to type, mission, and highest degree offered. A university survey research center collected data through a web-based questionnaire. Of 2,942 survey invitations, we received usable responses from 1,119 faculty members (response rate= 38%). We report on responses from 531tenure-track or tenured faculty who indicated that an emphasis on socially responsible engineering was applicable to their course. For the multivariate analyses, we adjusted the data so the sample was representative of the population of engineering faculty members at participating institutions.

The Expectation-Maximization (EM) algorithm of the Statistical Package for the Social Sciences (SPSS) software (v.18) was used to impute missing data. To reduce data into fewer scales, we conducted principal axis analysis (Oblimin with Kaiser Normalization rotation). Scales were formed by taking the sum of respondents' scores on the items on a factor and dividing by the number of items in the scale as prescribed by Armor[19].

Variables

As per the contextual filters model, we explore the impact of a number of *content* and *context* variables on the *form* of undergraduate courses. Content variables are faculty characteristics, including gender, race/ethnicity (white or underrepresented minority), work experience, and beliefs about education. Context variables are course- and institutional-level variables that are potential influences on course planning, including course and institutional type. Our dependent variable – the form of the course – is the emphasis on social responsibility (abbreviated as SR) in the faculty members' own undergraduate course. Each of these variables is discussed in detail below.

Dependent Variable. The dependent variable is the Professional Values scale (alpha = .81) that measures the extent to which faculty members emphasize values reflective of social responsibility in an undergraduate engineering course that they regularly teach (table 2). Faculty responded on a 5-point scale (1=Little/no emphasis, 2=Slight, 3=Moderate, 4=Strong, 5=Very strong) to four survey items asking respondents to indicate how much they emphasize the following in a focal course: Beliefs and values and how they affect ethical decisions; the value of gender, racial/ethnic, or cultural diversity; ethical issues in engineering practice; and the importance of life-long learning. The "strong" and "very strong" categories were collapsed because of the small n in the latter category.

Content Variables. The first two content variables were gender and underrepresented minority status and both were coded dichotomously (see table 3 for descriptives). For the purposes of the analysis male served as the reference group given the possibility that there might be gender differences in the representation of human factors engineering issues within the curriculum, and that women faculty might place greater emphases on these factors than men. Race/ethnicity was a dichotomous variable due to the small numbers of historically underrepresented minority faculty in the sample. Race/ethnicity was coded as White or Underrepresented Minority (comprised of African Americans, Hispanic and Native Americans). Asian Pacific Islanders were excluded as they are not typically considered as underrepresented minorities in research, as their achievement profiles overall (without disaggregation) more closely approximate those of White participants[20]. The Multiracial and Other categories were also excluded because the racial combinations represented in these groups were unknown. Additionally, faculty choosing the designations of foreign national, naturalized citizen, and Middle-Eastern were omitted because of concerns regarding the possible confounding impact of having been educated in higher education systems that are culturally distinct from those in the U.S. For analytic purposes, White served as the reference group as consideration was given to the possibility that underrepresented minorities (URMs) may be more likely than White faculty to place high importance on SR content. Indeed, in a large scale national study, it was found that URM faculty placed greater emphasis than Whites on "the affective, moral, and civic development of students[21]". Further, research has revealed particularly strong beliefs among URM faculty that "an ethic of service[22]" should be instilled in students and that community service be made a graduation requirement.

Descriptives for the remaining content variables are presented in table 3. The primary department affiliation of the faculty member was categorized as Civil, Electrical, Mechanical, Chemical, or Interdisciplinary (combining faculty in General, Bio-Engineering, Biomedical Engineering and Industrial Engineering). Chemical engineering was assigned as the reference group.

Work experience was represented by two continuous variables. The first was years of work experience while a faculty member and the second was years of work experience before becoming a faculty member. These variables were included as it was expected that faculty work experience might have some bearing on the extent to which real world applications such as socially responsible practice[23] might be viewed as important curricular emphases.

Tenure status was coded dichotomously to reflect whether the faculty member had already achieved tenure or was tenure-eligible. "Tenured" served as the reference group for analytical purposes.

Faculty use of active learning pedagogical approaches was also included in the present analysis. This variable was coded dichotomously: the first level of the variable represented the extent to which faculty employed these approaches "often to very often" and the second level, "never to sometimes." This variable was included since one of the typical features of active learning is the application of material to real world situations[24] of which a likely component, in the case of engineering, would be socially responsible practice. "Never to sometimes" served as the reference group.

The final content variables were the independent variables of interest concerning faculty beliefs about socially responsible curricular content and teaching (see table 4 for component items and descriptives). The Socially Responsible (SR) Curriculum Beliefs scale (alpha = .82) reflects the degree to which faculty members believe that socially responsible content should be included in the engineering curriculum (e.g. preparation of students to work globally and take on community leadership). The Socially Responsible (SR) Teaching Beliefs scale (alpha= .84) reflects the degree to which faculty members believe it is their *personal* responsibility as teachers to include such content (e.g. prepare students for citizenship roles and help them understand diversity). In each case, the reference group was "neither agree nor disagree" and the other levels of each of these variables were "strongly disagree and disagree" (grouped together because of the small n for "strongly disagree"), "agree" and "strongly agree." The SR Curriculum Beliefs and SR Teaching Beliefs scales are distinct from each other in that the first focuses on whether the faculty member believes that engineering curricula in general should include an emphasis on socially responsible professional values and the second on whether the faculty member feels personally responsible for such curricular content in his/her courses.

Context Variables. Descriptives for context variables are presented in table 3. The institutional type variable was comprised of three levels indicating whether the college/university in which the faculty member was employed was a bachelor's, master's or research institution. It was expected that institutional type might have an influence on the emphasis placed on SR content in the curriculum, with the more teaching- and student-oriented bachelor's and master's institutions assumed to focus more strongly on students' preparation for the world of work. The latter was therefore designated as the reference group.

We also distinguished between upper division courses and lower division courses because course level might affect faculty curricular emphases. For example, faculty teaching upper division courses might be more likely to include SR professional values due to a focus on preparing students for practice in an engineering subfield than those teaching lower division courses, who might focus more on the fundamentals of engineering. For this reason, lower division courses served as the reference group.

Courses were grouped into five types – Fundamental Science and Math courses, First-Year Design courses, Required Engineering courses, Engineering Electives, and Capstone Design courses. Fundamental Science and Math courses was chosen as the reference group because course content in such courses is typically focused on fundamental science and engineering principles. Other types of courses might include varying levels of practical engineering content. Further, it was deemed likely that capstone design courses might include more socially responsible content because capstone projects require students to apply their knowledge and skills to authentic, real-world engineering problems or projects[25,26]. As such, it would be likely for SR content to be a component of such courses and the associated guidance provided to students on their projects.

Analyses

The analytical method applied in this study was the multinomial logistic regression. In this model, binary logits for each pair of outcome categories are estimated simultaneously. This analytical method is appropriate for analyzing data in which the dependent variable has more than two outcome categories, where the assumption of ordered categories can be questioned, and where the assumption of parallel regression assumptions had been rejected[27].

A series of multinomial logistic regressions was carried out as follows:

> Model 1: Faculty characteristics: Gender, Race, Primary Departmental Unit, Tenure Status, and Teaching Practices
>
> Model 2: Same variables as in Model 1, with the addition of faculty beliefs (the Socially Responsible Curriculum Beliefs and Socially Responsible Teaching Beliefs scales)
>
> Model 3: As in model 2, with the addition of institutional variables (institutional type) and course variables – course level (upper division versus lower division courses) and course type (Fundamental Science and Mathematics versus First-Year Design courses, Required Engineering courses, Engineering electives, and Capstone Design course.

As is customary for such analyses, AIC and BIC scores were generated to assess model fit[27]. In this regard, the decreasing AIC figures (table 6) across the models suggest that there was an increasingly better fit to the data from model 1 to model 3. With regard to the BIC criteria, the results suggest that model 2 was the best fit for the data as at model 3, the BIC score increased rather than decreased.

Findings

The goal of our study was to understand the relationship between engineering faculty members' beliefs about socially responsible (SR) teaching and curriculum and their emphasis on SR professional values in their courses. Faculty beliefs were assessed using two variables – first, the extent to which faculty members believed that engineering curriculum in general should include socially responsible content and second, the extent to which faculty members believed that they had personal responsibility for including such content in their courses. In the results presented below all other variables in the model were held constant.

In general, our results indicate a significant relationship between faculty members' beliefs about the importance of socially responsible and their emphasis on such content in their courses. We first report on the "content" variables identified by our conceptual framework. See table 5 for results.

Relative to faculty who were neutral on the issue, the odds that faculty who disagreed or strongly disagreed that the engineering curriculum should include SR values would place a strong or very strong emphasis on SR content in their courses decreased by a factor of 1.21 ($p<.001$) in model 2 and 1.31 ($p<.001$) in model 3. Conversely, the odds that faculty who strongly agreed that engineering curriculum should include SR values would place a strong or very strong emphasis on such content in their courses increased by a factor of 6.89 ($p<.01$) in model 2 and 7.08 ($p<.01$) in model 3. While increased odds were noted for the agreed category (by a factor of 2.16 in model 2 and 3.02 in model 3), these findings were not statistically significant.

We also found several significant relationships between faculty members' sense of personal responsibility for SR curricular inclusions and emphasis on SR in courses. Relative to faculty who were neutral in their beliefs, the odds that faculty who agreed that they held personal responsibility for SR curricular inclusions would moderately emphasize these areas in their classes increased by a factor of 2.48($p<.01$) in model 1 and 2.43($p<.05$) in model 3. As expected, decreased odds (by a factor of .4 in both models 2 and 3) were noted for those who disagreed or strongly disagreed and increased odds were noted for those who strongly agreed (by a factor of 3.05 in model 1 and 2.55 in model 2); these findings, however, were not statistically significant. Relative to faculty who were neutral in their beliefs, the odds that faculty who disagreed or strongly disagreed that they had personal responsibility for SR content would place strong to very strong emphasis on such aspects in courses, decreased by a factor of 1.26 ($p<.001$) in model 2 and 1.98 ($p<.001$) in model 3. The pattern of results for those who strongly agreed on personal responsibility relative to those who were neutral on the issue was also in the expected direction. The odds that faculty who expressed strong agreement regarding personal responsibility for SR curricular content would place strong or very strong emphases on these areas within their classes, increased by a factor of 16.16 ($p<.001$) in model 2 and 15.28 ($p<.001$) in model 3. Finally, increased odds were noted for the agreed category (by a factor of 2.46 in model 2 and a factor of 1.79 in model 3), but these findings were not statistically significant.

Faculty members' use of active teaching approaches, as well as their years of work experience (both before and while engaged as a faculty member), were also significantly related to an emphasis on SR course content. Recall that the active learning variable is dichotomous. Relative to faculty who used active teaching and learning approaches "never to sometimes," the odds that those who employed such strategies "often to very often" would place "moderate emphasis" on SR content, increased by a factor of 5.27 ($p<.001$) in model 1 and 5.09 ($p<.001$) in both models 2 and 3. Further, the odds that those who used active teaching strategies "often to very often" would place a "strong to very strong emphasis) on SR content, increased by a factor of 16.19 ($p<.001$) in model 1, 11.83 ($p<.001$) in model 2 and 8.49 ($p<.001$) in model 3.

The significant yet modest results for work experience all resided within the "moderate emphasis" outcome category. For every one year increase in work experience *before* becoming a faculty member, the odds that an engineering faculty member would include moderate SR emphases in his/her curriculum increased by a factor of 1.05 ($p<.05$) in model 1 and 1.06 ($p<.05$) in model 3. For every additional year of engineering work experience *while* a faculty member, the odds increased by a factor of 1.05 ($p<.05$) in model 2 and 1.06 ($p<.05$) in model 3 that such a faculty member would include moderate SR curricular emphases.

In terms of context variables, institutional type (bachelor's, master's and research) and course level (upper division versus lower division) had no significant impact on the odds that a faculty member would make “strong to very strong” SR curricular emphases in his/her teaching relative to making a “slight emphasis”. However, significant results were observed in the outcome category of “none to little emphasis” Relative to teaching a fundamental science or math course, the odds decreased by a factor of 9.59 ($p<.001$) that faculty who taught first year design courses would place “none to little” emphasis on SR content relative to those who slightly emphasized SR content. Further, teaching capstone design (relative to teaching fundamental science or math) decreased the odds by a factor of .02 ($p<.01$) that faculty would place “none to little” emphasis on SR content. A similar pattern occurred for teaching an engineering elective such that the odds decreased by a factor of .14 ($p<.05$).

Discussion

Findings from the analysis demonstrate relationships between faculty members’ beliefs about socially responsible curriculum and teaching and their course content decisions. Faculty who believe the undergraduate engineering curriculum should teach students about intercultural communication, to work across national and cultural boundaries, and focus on ethics and the many non-technical factors that affect engineering solutions are more likely to include such content in their courses. Similarly, beliefs about teaching, specifically that it is one’s responsibility to help students reflect on their values, to see the world from multiple perspectives, to understand the value of diversity in its many forms, and to prepare for their roles as citizens as well as engineers, are more likely to include socially responsible content in their courses. Our use of a multinomial logistic analysis indicates that these relationships not only vary in the expected directions, but that they are more or less likely based on faculty characteristics; this suggests a causal relationship rather than a simple association. Practically, these findings suggest that if engineering schools are to develop and implement curricula that stress socially responsible knowledge and skills, it will be necessary to focus on building support among faculty for the kinds of attitudes about social responsibility described above. In short, faculty beliefs must become a point of departure for pedagogically focused faculty development efforts.

Further, relationships exist between faculty members’ use of active learning strategies and their emphasis on socially responsible curriculum content. This finding seems to suggest that there may be a common factor (possibly teaching beliefs) that increases the odds both that faculty members will frequently use active learning approaches and that they will also emphasize socially responsible professional values in their courses. It is also conceivable that since a component of active learning is making real-world linkages and applications, faculty who frequently use active teaching and learning approaches view socially responsible content as a critically important real-world application.

Although one might suspect that work experience in industry might lead to greater emphasis on real-world examples, and thus more options for discussion of socially responsible topics, we found only modest relationships between work experiences and curricular emphasis on SR. This may reflect the nature of the work in which faculty engaged before and during their academic tenure, or alternatively, their hesitancy to bring personal work experiences into their courses. This finding lends support to the idea that faculty development efforts must begin by creating a set of faculty beliefs about the importance of social responsibility as relevant to engineering practice.

Our analysis revealed that teaching first-year and capstone design courses yielded decreased odds that faculty would place little to no emphasis versus slight emphasis on SR topics in their courses. This finding may be attributed to the observation that design courses carry much of the weight when it comes to teaching about engineering practice[28]. A similar trend for elective courses may be attributed to the greater freedom that faculty may enjoy in determining course content.

The absence of relationships between the personal characteristics and an emphasis on SR content may reflect the standardization of graduate training programs and the strength of the focus on technical knowledge and skills in those programs. Alternatively, characteristics such as gender and race/ethnicity may simply be too broad; individual beliefs, as we have noted, are more influential in promoting an emphasis on socially responsibility course content. The lack of a significant relationship between institutional type and curricular emphases is more likely to be a reflection of curricular standardization. Future research should explore the role of other contextual influences (e.g., engineering sub-discipline, department culture), which may be more influential than institutional type on curricular decisions.

The study from which this data were drawn includes measures on selected student experiences and learning outcomes. In other analyses, the research team has explored curricular and instructional choices that faculty have made in particular courses in relation to some student outcomes such as design and problem-solving or interdisciplinary competence.

Unfortunately, the present study did not include a learning outcome scale that corresponds to the faculty SR professional values' scale; consequently, we cannot examine how faculty beliefs and behaviors regarding SR curricular emphases shape students' SR-related learning outcomes. This is a question that should be tackled in future research given the SR learning imperatives inherent to the ABET criteria, the professional requirements and demands of modern, global engineering practice, as well as those of good corporate and individual citizenship. Further, the building of evidence regarding students' learning outcomes may ultimately lead to the identification of the kinds of SR content inclusions and pedagogical practices that effectively promote student achievement of SR outcomes.

Bibliography

1. ABET (2011). Criteria for accrediting engineering programs. Retrieved from http://www.abet.org/uploadedFiles/Accreditation/Accreditation_Process/Accreditation_Documents/Current/eac-criteria-2012-2013.pdf
2. Pritchard, J. & Baillie, C. (2006). How can engineering education contribute to a sustainable future? European Journal of Engineering Education, 31(5), 555-565.
3. Douglas, D., Papadopoulos, G., & Boutelle, J. (2010). Citizen Engineer: A handbook for socially responsible engineering. NJ: Prentice Hall.
4. Umbach, P. D. & Kuh, G. D. (2006). Student experiences with diversity at liberal arts colleges: Another claim for distinctiveness. Journal of Higher Education, 77(1), 169-192.

5. Ardaiolo, F. P., Neilson, S., & Daugherty, T. K. (2011). Teaching students personal and social responsibility with measurable learning outcomes. Journal of College and Character, 12(2), 9. Retrieved from http://search.proquest.com.proxy.lib.umich.edu/docview/1037909680?accountid=14667
6. Avard, M. (2006). Civic Engagement in the Science Classroom. Journal of College Science Teaching, 36(3), 60-61.
7. Chamany, K., Allen, D., & Tanner, K. (2008). Making biology learning relevant to students: Integrating people, history, and context into college biology teaching. CBE - Life Sciences Education, 7(3), 267-278.
8. Finelli, C., Holsapple, M., Ra, E., Bielby, R. M., Burt, B. A., Carpenter, D. D., Harding, T. S., & Sutkus, J. A. (2012). An Assessment of Engineering Students' Curricular and Co-Curricular Experiences and Their Ethical Development. Journal of Engineering Education, 101 (3), 469-494.
9. Lappalainen, P. (2011). Development cooperation as methodology for teaching social responsibility to engineers. European Journal of Engineering Education, 36(6), 513-519.
10. Colby, A., & Sullivan, W. M. (2008). Ethics teaching in undergraduate engineering education. Journal of Engineering Education, 97(3), 327-338.
11. Bucciarelli, L. L. (2008). Ethics and engineering education. European Journal of Engineering Education, 33(2), 141-149.
12. Conlon, E. (2008). The new engineer: Between employability and social responsibility. European Journal of Engineering Education, 33(2), 151-159.
13. Mayhew, M. J., & Grunwald, H. E. (2006). Factors contributing to faculty incorporation of diversity-related course content. Journal of Higher Education, 77(1), 148-168.
14. Reason, R. D., Cox, B. E., Quaye, B. R., & Terenzini, P. T. (2010). Faculty and institutional factors that promote student encounters with difference in first-year courses. Review of Higher Education, 33(3), 391-414.
15. Stark, J. S., Lowther, M. A., Ryan, M. P., Bomotti, S. S., Genthon, M. L., Martens, G. (1988). Reflections on course planning: Faculty and students consider influences and goals. Ann Arbor, MI: University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning. (ERIC Document Reproduction Service No. ED316067).
16. Toombs, W. & Tierney, W. G. (1991). Meeting the mandate: Renewing the college and departmental curriculum. (ASHE-ERIC Higher Education Reports, No. 6). Washington, DC: The George Washington University.
17. Stark, J. S. (2002). Testing a model of program curriculum leadership. Research in Higher Education, 43(1), 59-82.
18. Lattuca, L. R. & Stark, J. S. (2009). Shaping the college curriculum: Academic plans in context (2nd ed.). San Francisco, CA: Jossey-Bass.
19. Armor, D.J. (1974). Theta Reliability and Factor Scaling, in H. Costner, ed., Sociological Methodology:1973-1974. Jossey-Bass, San Francisco.
20. Kao, G. & Thompson, J. S. (2003). Racial and ethnic stratification in educational achievement and attainment. Annual Review of Sociology, 29, 417-442.
21. Antonio, A. L. (2002). Faculty of color reconsidered: Reassessing contributions to scholarship. Journal of Higher Education, 582-602.
22. Antonio, A. L., Astin, H. S., & Cress, C. M. (2000). Community service in higher education: A look at the nation's faculty. The Review of Higher Education, 23(4), 373-397.
23. Richter, D. & Loendorf, W. (2007). Faculty with Industrial Experience Bring a Real World Perspective to Engineering Education. In ASEE Annual Conference & Exposition.
24. Beichner, R. J., Saul, J. M., Abbott, D. S., Morse, J., Deardorff, D., Allain, R. J., ... & Risley, J. S. (2007). The student-centered activities for large enrollment undergraduate programs (SCALE-UP) project. Research-based reform of university physics, 1(1), 2-39.
25. Todd, R. H., Magleby, S. P., Sorensen, C. D., Swan, B. R., & Anthony, D. K. (1995). A survey of capstone engineering courses in North America. Journal of Engineering Education, 84(2), 165-174.
26. Padmanabhan, G., & Katti, D. (2002). Using community-based projects in civil engineering capstone courses. Journal of Professional Issues in Engineering Education and Practice, 128(1), 12-18.
27. Long, J. S., & Freese, J. (2006). Regression models for categorical dependent variables using Stata. College Station, TX: Stata Press.
28. Lattuca, L. R., Terenzini, P. T., Knight, D. B., & Ro, H. K. (2014). 2020 Vision: Progress toward Preparing the Engineer of the Future. Ann Arbor, MI:Authors.

Figure 1. Contextual Filters Model (Stark, Lowther, Ryan, Bomotti, Genthon, and Martens (1988)

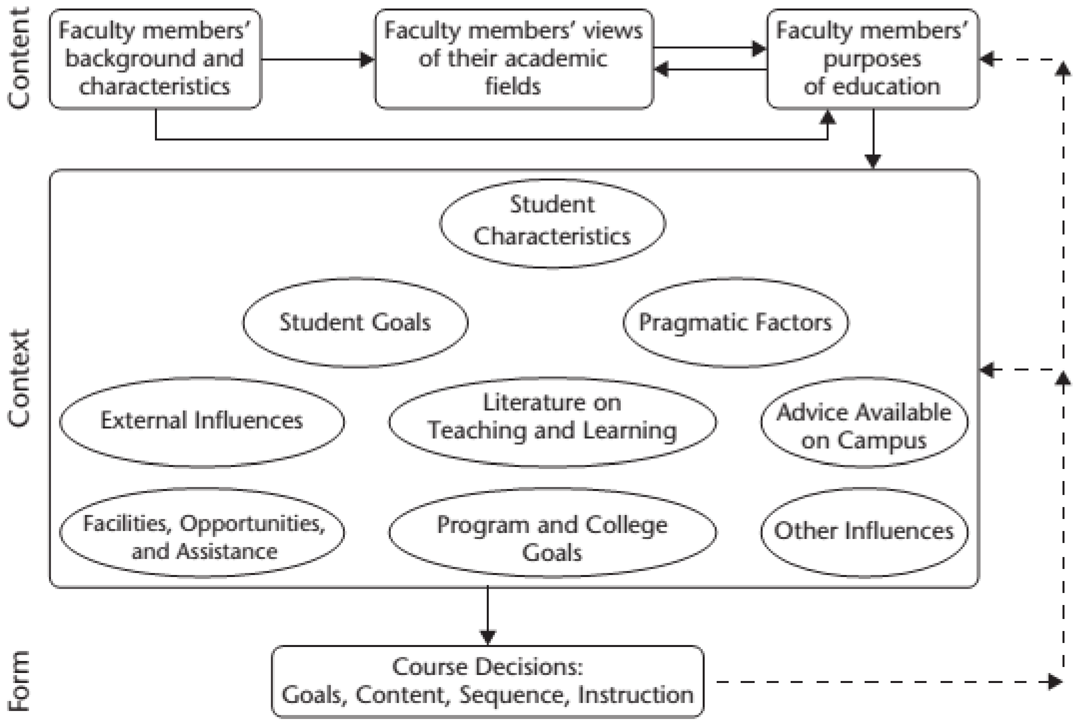

Table 1. Institutional sample

Research Institutions:	**Master's/Special Institutions:**
Arizona State University (Main & Polytechnic)[a]	California Polytechnic State University[c]
Brigham Young University	California State University, Long Beach
Case Western Reserve University	Manhattan College
Colorado School of Mines	Mercer University
Dartmouth College	Rose-Hulman Institute of Technology
Johns Hopkins University	University of South Alabama
Massachusetts Institute of Technology[a]	
Morgan State University[b]	
New Jersey Institute of Technology	**Baccalaureate Institutions:**
North Carolina A&T[b]	Harvey Mudd College[a]
Purdue University	Lafayette College
Stony Brook University	Milwaukee School of Engineering
University of Illinois at Urbana-Champaign	Ohio Northern University
University of Michigan[a]	Penn State Erie, The Behrend College
University of New Mexico[c]	West Virginia University Institute of Technology
University of Texas, El Paso[c]	
University of Toledo	
Virginia Polytechnic Institute and State University[a]	

[a] Institution participating in the companion qualitative study
[b] Historically Black College or University
[c] Hispanic-Serving Institution

Table 2. Descriptive Statistics for Professional Values Scale (Outcome Scale). Means are shown for each variable with standard deviations in parentheses.

Professional Values Scale (alpha = .81)	
Stem: In this course how much do you emphasize:	
Examining beliefs and values and how they affect ethical decisions.	1.99 (1.14)
The value of gender, racial/ethnic, or cultural diversity in engineering.	1.73 (.97)
Ethical issues in engineering practice.	2.33 (1.16)
The importance of life-long learning	3.09 (1.22)
Overall Professional Values Scale Score	2.35 (.93)

Scale: 1=Little to no emphasis, 2=Slight, 3=Moderate, 4=Strong, 5= Very Strong
Note: for analytical purposes Strong and Very Strong were combined because of small ns in the latter category.

Table 3. Content and Context Variables (n=531)

Variable	N (%)	M (SD)
Content Variables		
Gender		
Man	466 (87.76)	
Woman	65 (12.24)	
Race/Ethnicity		
White	426 (80.23)	
Underrepresented Minorities	105 (19.77)	
Primary Academic Department		
Chemical Engineering (employed as reference group in the analysis)	67 (12.62)	
Civil Engineering	93 (17.1)	
Electrical Engineering	238 (44.82)	
Mechanical Engineering	41 (7.72)	
Interdisciplinary (Bio-medical/Bio-engineering; General Engin/Engin Science & Industrial Engin).	92 (17.33)	
Employment Outside of Higher Education		
Number of years worked while Full-time Faculty Member		3.37 (6.46)
Number of years worked before working Full-time Faculty Member		3.62 (4.95)
Tenure Status		
Tenured	402 (75.71)	
Tenure-Eligible	121 (24.29)	
Engagement in Active Teaching/Learning Practices		
Never to Sometimes	243 (45.75)	
Often to Very Often	288 (54.24)	
Context Variables		
Institutional Type (Carnegie Classification)		
Bachelors	36 (6.68)	
Masters	56 (10.55)	
Research	439 (82.55)	
Course Type		
Fundamental Science or Math Course	12(2.6)	
First-year design course	15(2.82)	
Required engineering course	331(58.57)	
Engineering Elective	142 (26.74)	
Capstone Design Course	51 (9.6)	
Division in which Identified Course is Taught		
Lower Division	117 (22.03)	
Upper Division	414 (77.97)	

Table 4. Descriptive statistics for Socially Responsible Curriculum Beliefs and Socially Responsible Teaching Beliefs scales. Means are shown for each variable with standard deviations in parentheses.

Socially Responsible Curriculum (alpha = .82)	
Stem: To what extent do you agree or disagree that the engineering curriculum should:	
Teach students about intercultural communication	3.16 (1.00)
Teach students to consider all relevant factors in (e.g. social cultural, environmental) in designing solutions.	3.92 (.79)
Prepare students to assume community leadership roles.	3.49 (.94)
Prepare students effectively to work across national and cultural boundaries.	3.75 (.84)
Address ethical issues in multiple courses.	3.79 (.84)
Socially Responsible Teaching (alpha = .84)	
Stem: Do you agree or disagree that as a teacher, it's your responsibility to:	
Encourage students to reflect on their values and how these might influence their work as engineers.	3.77 (.89)
Help students consider the world from multiple perspectives.	3.77 (.88)
Prepare students for their role as citizen.	3.50 (.94)
Understand the value of diversity in its many forms (e.g. ideas, cultures, gender).	3.36 (1.03)
Help students understand the value of a liberal education.	3.40 (.95)

Scale: 1=Strongly disagree, 2=Disagree, 3=Neither agree nor disagree, 4=Agree/Strongly agree, 5=Strongly agree
Note: for analytical purposes, "Strongly disagree" and "Disagree" were combined because of the small "n" for "Strongly Disagree"

Table 5. Likelihood of Engineering Faculty Emphasizing Socially Responsible Course Content (compared to reference category, "*slight emphasis*")

	None to Litte Emphasis			Moderate Emphasis			Strong/V. Strong Emph.		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Demographic Variables									
Female (ref grp:Male)	2.18	2.44	2.13	1.03	0.92	1.03	1.24	1.16	1.42
Minority (ref grp: White)	0.76	0.72	0.73	1.47	1.62	1.6	1.37	1.25	1.35
Faculty Characteristics									
Primary Department (ref grp : Chemical)									
Civil Engineering	0.68	0.7	0.8	0.78	0.7	0.56	2.46	1.51	1.15
Electrical Engineering	2.49	2.56	2.85*	0.95	0.9	0.83	2.01	1.79	1.4
Mechanical Engineering	0.08*	0.08	.07*	0.66	0.67	0.64	1.93	1.96	2.13
General, Bio-Engin./BioMed., Industrial	1.43	1.41	1.39	1.36	1.16	1.02	2.51	1.7	1.53
Years of Teaching Experience	1.01	1.01	1.01	1.01	1.01	1.01	1	1.01	1.01
Years of work While a Faculty Member	0.96	0.96	0.96	1.04	1.05*	1.06*	1.03	1.05	1.06
Years of Work Before Becoming Faculty	1	1	1.01	1.05*	1.05	1.06*	0.99	1	1
Tenure Track (ref grp : Tenured)	0.94	1.06	0.91	0.77	0.85	0.97	1.19	1.44	1.95
Faculty Use of Active Teaching/Learning									
Often to Very Often (ref grp: never to s'times)	0.39**	.43**	0.5	5.27***	5.09***	5.09***	16.19***	11.83***	8.49***
Faculty Beliefs About Engin. Curriculum									
Social Resp. (SR) Themes Should be Included									
(ref grp: Neither Agree/Disagree)									
Strongly Disagree and Disagree		0.74	0.63		0.16	0.16		(1.21***)	(1.13***)
Agree		0.8	0.77		1.04	1.14		2.16	3.02
Strongly Agree		1.3	1.01		2.44	2.97		6.89**	7.08**
Personal Resp. as a Teacher for SR Topics									
(ref grp: Neither Agree/Disagree)									
Strongly Disagree and Disagree		1.52	1.62		0.4	0.41		(1.26***)	(1.98***)
Agree		0.81	0.77		2.48**	2.43*		2.46	1.79
Strongly Agree		1.81	1.96		3.05	2.55		16.16***	15.28***
Features of Institutional Context									
Institutional Type (ref. Research)									
Bachelor's Level			1.12			1.07			0.37
Master's Level			1.34			0.56			0.4
Course Level-Upper Div. (ref grp: Lower Div.)			1.25			1.56			0.82
Course Type (Ref grp: Fundamental Sci/Math									
First Year Design Course			(9.59***)			5.19			2.73
Required Engineering Course			0.28			2.24			0.46
Engineering Elective			.14*			3.16			0.86
Capstone Design Course			.02**			1.89			2.09
n	531	531	531	531	531	531	531	531	531
Pseudo R-squared	0.16	0.24	0.27	0.16	0.24	0.27	0.16	0.24	0.27
McFadden's Adjusted R-squared	0.12	0.18	0.19	0.12	0.18	0.19	0.12	0.18	0.19
AIC	1607.7	1502.35	1487.36	1607.71	1502.35	1487.36	1607.71	1502.35	1487.36
BIC	1761.6	1733.18	1808.36	1761.6	1733.18	1808.36	1761.6	1733.18	1808.36
Chi-square	110	1906.48	4318.55	110	1906.48	4318.55	110	1906.48	4318.55

*p < .05 **p < .01 ***p < .001

Numbers in parentheses are inverse odds ratios