Assessing Overall Competence of Faculty: EC Criterion 5

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Abstract

ABET self-study directions require engineering departments to discuss the competence of their faculty. This paper describes the structure, content, and measurement characteristics of a Web-based Engineering Faculty Survey that addresses ABET requirements to assess "the overall competence of faculty." The survey can also be used as a diagnostic to assess what individual and organizational factors are associated with teaching methods such as team-based design projects or use of traditional lecture and textbook problem sets. The Engineering Faculty Survey, developed for the NSF-funded ECSEL coalition, gathers information about individual demographic characteristics, industry and academic experience, sources and applications (education or basic research) of funding, publication productivity, teaching goals, self-assessment of skills, perceptions of rewards and resources available for teaching, and teaching methods. Analyses reveal contrasting sets of variables associated with the use of team-based design projects and traditional teaching methods.

Introduction

"The faculty is the heart of any educational program" according to Criterion 5 of ABET's Engineering Criteria 2000 [1]. This criterion stipulates that "the overall competence of faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and registration as Professional Engineers." ABET self-study directions require institutions to discuss the competency of faculty and to describe their involvement with students, in professional development, and interactions with industry.

While faculty may be the "heart" of engineering education programs, most ABET-related activities have focused far more on efforts to demonstrate that graduates of their bachelor's degree programs have achieved the competencies outlined in EC 2000 Criterion 3. Student competencies specified by Criterion 3 include abilities "to design a system, component, or process to meet desired needs," "to function on multi-disciplinary teams," "to apply knowledge of mathematics, science & engineering," and "to identify, formulate, and solve engineering problems." The implicit linkages between "the overall competence of faculty" and the development of student competencies can and should be make explicit.

There are two important links between engineering programs, faculty, and competent engineering graduates. The first is the link between faculty teaching and student learning.

Effective education of engineering undergraduates should include identification and implementation of the teaching practices most likely to promote development of students' creative design and team-building skills as well as students' understanding of math, basic science, and engineering science concepts. The second link is between the context of the engineering program and faculty members' motivation to use the teaching practices that foster desired student learning. Faculty members' use of effective teaching practices is likely to be a result of their training and experiences, research demands, teaching objectives, skills, and their perceptions of the extent to which their departments provide adequate rewards and resources for teaching.

Links between teaching practices and student learning have been identified through educational research. The effectiveness of various teaching methods varies depending on desired learning outcomes. Lecture may be as good or better than other pedagogical methods for fostering immediate factual recall of material[2 3]. Currently, more than three-fourths of faculty rely on lecture as their primary -or even their only- teaching practice[4]. Practicing engineers, however, frequently work in groups or teams on design problems[5]. Students may be more likely to develop interdisciplinary team and design competencies when classroom experiences mimic the work environment. Recent studies have demonstrated that engineering faculty members' use team-based design projects had a positive influence on students' gains in ill-defined problem-solving skills, group skills, and awareness of what it means to be an engineer[6]. In addition, instructors who interacted frequently with students, who gave specific feedback and encouragement, and who provided opportunities for students to work together had a positive impact on gains in students' sense of responsibility for their own learning, and in their confidence and motivation to become engineers[7]. Departments that must demonstrate to ABET review teams how their faculty members' abilities to foster the development of engineering students' professional competencies might wish to show how faculty members' experiences, skills, and teaching objectives are related to the kinds of teaching practices that result in desired learning outcomes.

Links between program contexts and faculty use of alternative teaching practices are less well known, although much has been conjectured about what motivates faculty to teach the way they do. Faculty developers assert that most faculty receive little formal training in teaching; instead they rely on informal training achieved by observing their own professors, reading about teaching, discussions with colleagues, or occasional formal instructional development workshops[8]. Scholars have considered organizational reasons why faculty might change their teaching methods[9 10]. There is little empirical evidence to show what motivates faculty to use traditional or alternative methods of instruction, such as lecture and textbook problem sets or team-based design projects.

The research described in this paper had three purposes. The first was to develop an instrument, the Engineering Faculty Survey, to measure ABET-relevant faculty characteristics. Second, in the process, effort was made to develop a set of items that would capture the experiences, skills, teaching goals, and organizational factors that might influence faculty members' use of the teaching methods associated with the development of ABET-relevant student competencies. This paper reports the psychometric properties of the survey. The third purpose was to examine the extent to which faculty characteristics and organizational factors were associated with use of either traditional or project-based teaching methods.

Methods

The conceptual framework adopted for this study is depicted in Figure 1 and hypothesizes that faculty members' use of certain teaching practices is a function of their demographic characteristics, experience, and motivation. Motivation, as defined by Ford[11], involves personal goals (in this case, for teaching), capability beliefs (perceptions of one's own skills), and context beliefs (perceptions of whether or not one's environment provides needed support.)

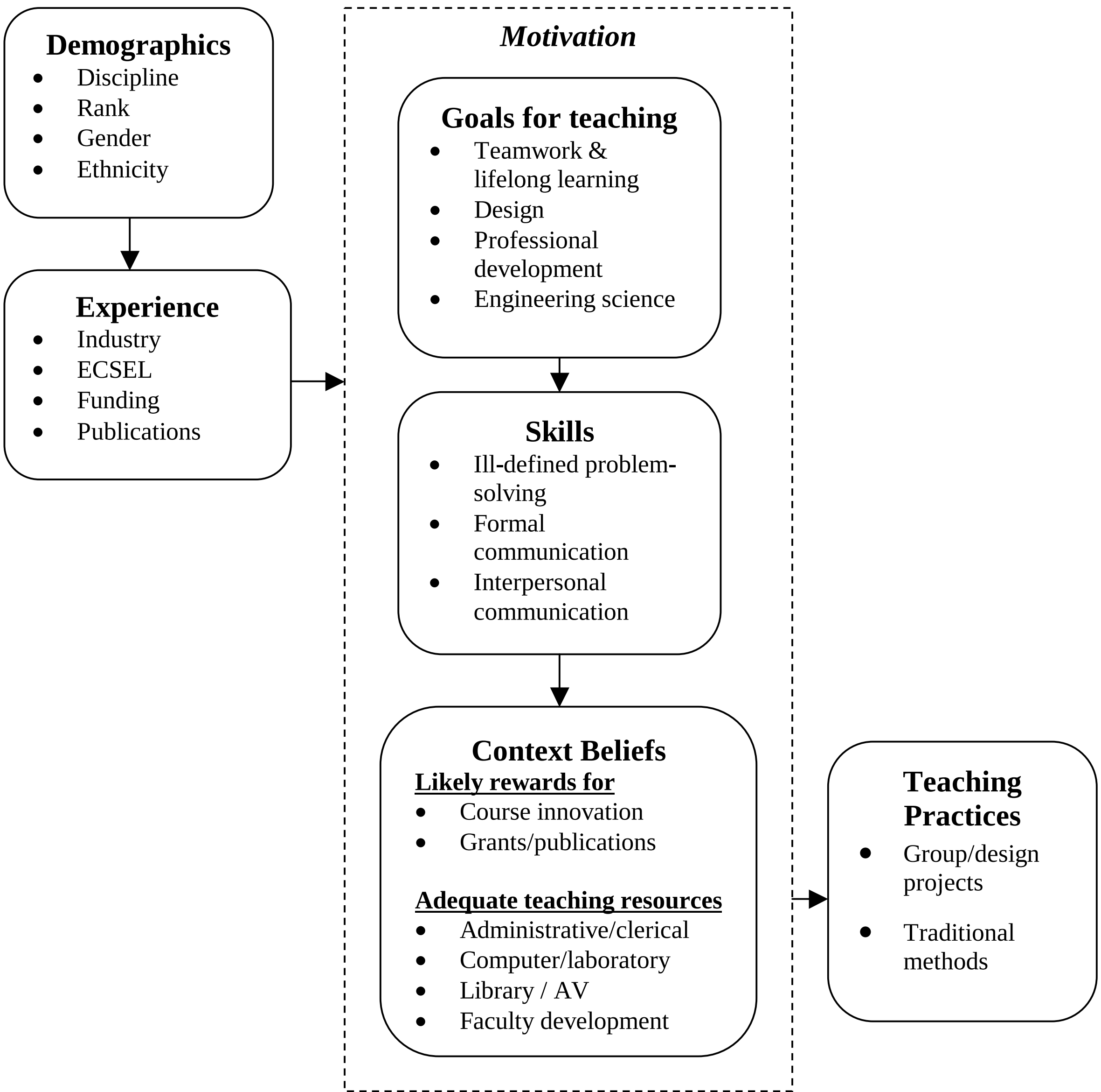

Figure 1: Faculty Motivation to Use Alternative Teaching Practices

The instrument was administered to tenured and tenure-track faculty at the seven schools participating in the NSF-funded Engineering Coalition of Schools for Excellence in Education and Leadership (ECSEL) in Spring, 2000. A total of 898 surveys were delivered either by campus or email. All of the faculty at five schools (City College of New York, Morgan State University, Pennsylvania State University, University of Maryland and University of Washington) received an email invitation to participate that was linked to a password-protected WEB-based survey. All of the faculty at Howard University and only ECSEL participants at MIT received a hard copy invitation and paper version of the survey with a stamped return envelope. A total of 544 completed surveys were returned, for a response rate of 60.6%. Of those, 75 were not used either because they did not have a tenure-track appointment (3), or because the responding faculty members reported that they did not teach an undergraduate class during the academic year 1999-2000 (72). Therefore, the total sample for this analysis is 470. The instrument includes seven sections which ask about (1) faculty members' demographic characteristics, (2) experiences in industry and academe, (3) teaching goals, (4) own skills, (5) perceptions of departmental rewards for teaching, (6) beliefs about the adequacy of resources for teaching, and (7) the teaching practices used in undergraduate classes during the 1999-2000 academic year.

Demographic characteristics taken into account for this study included discipline, rank, gender, and ethnicity. (See Table 1). Most of the respondents were from the three large, public research universities. Nearly one-half hold the rank of full professor. An overwhelming majority are white and male, although it is interesting to note that several respondents did not mark their gender (4 percent) or race (8.3 percent).

The respondents had rich and varied experiences in industry, curricular reform, funding, and publication. Half the respondents had worked full time as practicing engineers, nearly 60 percent have consulted for corporations or public works projects, and nearly 43 percent had participated in ECSEL in some way. Nearly 70 percent said they had received funding from at least one source in the prior five years for curricular development, teaching innovation, or engineering education research. For many respondents, however, the amount received was so small, that they did not include it at all when considering what percentage of their total funding was for education purposes. Nearly 60 percent said that the total amount of funding they had received for curricular development, teaching innovation, or education research was 5 percent or less of the total funding they had received since 1995. In contrast, nearly 90 percent of respondents had received funding from one or more sources in the prior five years for basic or applied engineering research. Not surprisingly then, the respondents had also published far more about engineering research than about engineering education. Less than 23 percent had published at all about engineering education in the prior two years, while nearly 63 percent had three or more basic or applied engineering research publications during the same time period.

**Table 1: Demographics and Experience Variables:
Frequencies and Percent of Total (N = 470)**

Variable	N	%	Variable	N	%
Institution			**Discipline**		
CCNY	21	4.5	Electrical	87	18.5
Howard	13	2.8	Mechanical	74	15.7
MIT	8	1.7	Civil/Environmental	68	14.5
Morgan State	2	0.4	Computer Science	44	9.4
Penn State	193	41.1	Engineering Technology	49	10.4
University of Maryland	114	24.3	Materials Science	25	5.3
University of Washington	119	25.3	Industrial	20	4.3
			Aero / Astro	23	4.9
			Chemical	33	7.0
			Other disciplines	47	10.0
Rank			**Gender**		
Assistant professor	106	22.6	Male	424	90.2
Associate professor	136	28.9	Female	25	5.3
Full professor	228	48.5	Did not answer	21	4.5
Ethnicity			**Consulted for corporations or public works projects**		
White	336	71.5			
Non-white	95	20.2	No	190	40.4
Did not answer	39	8.3	Yes	280	59.6
Worked full time as engineer			**Participated in ECSEL**		
No	239	50.9	No	270	57.4
Yes	231	49.1	Yes	200	42.6
# funding sources for curricular development/teaching innovation			**# funding sources for basic or applied engineering research**		
no sources	147	31.3	no sources	50	10.5
1 source	139	29.6	1 source	115	24.5
2 sources	109	23.2	2 sources	114	24.3
3 sources	55	11.7	3 sources	131	27.9
4 or more sources	20	4.2	4 or more sources	60	12.8
Publications about engineering education			**Publications about basic or applied engineering research**		
No publications	364	77.4			
1 or more publications	106	22.6	No publications	99	21.1
% total funding for curricular or teaching innovation			1-2 publications	88	18.7
			3-4 publications	64	13.6
None	185	39.4	5-6 publications	86	18.3
0.1 - 5% funding	98	20.9	7-9 publications	49	10.4
10 - 20% funding	105	22.3	10 or more publications	84	17.9
25 - 75% funding	31	6.6			
80 - 100% funding	51	10.8			

A third section of the Engineering Faculty Survey focuses on teaching goals. The section asks faculty to consider how important it is that undergraduate engineering students learn any of 18 concepts, values, or skills from courses the respondent taught during the 1999-2000 academic year. The scale ranged from 1 to 4, where 1 = "not important," 2 = "somewhat important," 3 = "very important," and 4 = "extremely important." The list of concepts, values, and skills includes all of the competencies listed in EC 2000 Criterion 3 and items concerned with communication and sensitivity to the needs of diverse students. A principal components factor analysis of these 18 items produced four factors. The factor solution, accounting for 65.3 percent of the variance in the correlation matrix, is shown in Table 2.

Table 2. Teaching Goals and Skills Scales, with Values, Items, and Factor Loadings (λ) for Each Item in Scale

Scale	Values	Items	λ
Teaching Goals		*Importance that undergraduate students learn from you:*	
Teamwork & lifelong learning	Range = 1-4[a] Mean = 2.65 Std Dev. = .72 Alpha = .88	how to function of multidisciplinary teams how to resolve conflicts in groups sensitivity to needs, viewpoints of students from different ethnic backgrounds sensitivity to needs & viewpoints of students from other gender importance of lifelong learning broad understanding of contemporary issues	.55 .76 .89 .89 .56 .59
Design	Range = 1-4[a] Mean = 2.82 Std.Dev. = .60 Alpha = .80	how to conduct and design experiments how to design a process, system, or component how to identify and formulate open-ended engineering problems how to solve open-ended engineering problems how to analyze and interpret data	.65 .72 .80 .77 .68
Professional development	Range = 1-4[a] Mean = 2.88 Std. Dev. = .75 Alpha = .83	to understand engineers' professional responsibilities to understand engineers' ethical responsibilities to understand the impact of engineering solutions in societal & global contexts	.84 .81 .74
Engineering science fundamentals	Range = 1-4[a] Mean = 3.21 Std. Dev. = .61 Alpha = .75	to understand and apply mathematics concepts to understand and apply basic science concepts to understand and apply engineering science	.81 .91 .74
Own Skills			
Ill-defined problem solving	Range = 1-4[b] Mean = 2.89 Std Dev. = .54 Alpha = .65	I am good at identifying and redefining ill-defined problems I design effective solutions to ill-defined engineering problems I am good at creating models, prototypes, or graphic representations of engineering problems	.78 .85 .59
Formal communication	Range = 1-4[b] Mean = 3.13 Std. Dev. = .51 Alpha = .57	I explain abstract concepts and principles effectively I write well I give well-organized, informative conference presentations	.57 .84 .64
Interpersonal communication	Range = 1-4[b] Mean = 2.99 Std. Dev. = .58 Alpha = .73	I have strong interpersonal communication skills I work well in a group	.72 .86

[a] 1 = Not important, 2 = Somewhat important, 3 = Very important, 4 = extremely important
[b] 1 = Not at all characteristic, 2 = Somewhat characteristic, 3 = Very characteristic, 4 = Extremely characteristic

The internal consistency reliabilities (alpha) of the four factors, "teamwork and lifelong learning, "design," "professional development,' and "engineering science fundamentals," were quite high, ranging from .75 to .88. Cronbach's alpha ranges from 0 to 1, reflects the homogeneity of items comprising a scale, and indicates the extent to which the component items are measuring the same underlying construct. When the alpha value is close to 1, a factor's items are highly consistent with each other. Similarly, the factor loadings (λ), determined through varimax rotation are also quite high. The higher the loadings, measured on a scale of -1 to 1, the more each individual item is correlated -- shares something in common -- with the other items. The factor, "teamwork and lifelong learning" is composed of six items that reflect the goal of teaching effective group communication and sensitivity as well as understanding of the place of engineering education over in a lifetime of learning and within the context of contemporary issues. "Design" consists of 5 items that involve teaching the identification and solution of open-ended engineering problems. The three-item "professional development" factor reflects a goal of teaching for understanding engineers' professional, ethical and global responsibilities. The final factor, "engineering science fundamentals" reflects the goal of teaching students basic math, science, and engineering concepts. On average, respondents to this survey placed more importance on teaching engineering science fundamentals (mean = 3.21) than on professional development (mean = 2.88), design (mean = 2.82), and teamwork and lifelong learning (mean = 2.65).

Individuals may have goals, but see them as unattainable if they do not have the personal ability to achieve them. Another section of the Engineering Faculty Survey, therefore, considers faculty members' capability beliefs, their assessment of their own skills. (See Table 2). Respondents were asked to rate the extent to which eight skills or attributes were characteristic of them. The scale ranged from 1 to 4, where 1 = "not at all characteristic," 2 = "somewhat characteristic," 3 = "very characteristic," and 4 = extremely characteristic. A principal components factor analysis of the eight skills resulted in three factors: "ill-defined problem solving," (three items) "formal communication," (three items) and "informal communication" (two items). This factor solution explained 62.2 percent of the variance and produced factors with alpha reliabilities ranging from .57 to .73. Factor loadings ranged from .59 to .86. On average, the respondents perceive them selves as quite skillful, with formal communication (mean = 3.13), interpersonal communication (mean = 2.99), and ill-defined problem solving skills (mean = 2.89) all "very characteristic" of them.

Even if one has the necessary skills, it may be difficult to attain one's goals if the environmental context is not supportive or has inadequate resources. The Engineering Faculty Survey includes two sections to ascertain faculty members' context beliefs: one asks about likely rewards for teaching, and the second asks about the adequacy of resources for teaching. The characteristics of the rewards and resources scales are reported in Table 3. Faculty were asked to rate the likely effect on their professional rewards if they accomplished any of seven different activities. The scale ranged from 1 to 5, where 1 = "very negative," 2 = "negative," 3 = "not applicable," 4 = "positive," and 5 = "very positive." Two factors resulted from the principal components analysis with varimax rotation: "course innovation" (three items) and "grants and publications" (four items). This solution explained 68 percent of the variance, produced factors with high reliabilities (.80 and .81), and items with high factor loadings (from .71 to .88). On average, respondents believed that securing grants and publishing articles in leading journals -- whether for education or research -- would be more likely to earn them professional rewards than designing or redesigning a course or including group or design projects in their undergraduate courses. The mean for course innovation was only 3.24, while the mean for grants and publications was 4.15.

Table 3. Likely Rewards & Adequate Resources Scales, with Values, Items, and Factor Loadings (λ) for Each Item in Scale

Scale	Values	Items	λ
Likely Rewards		*Likely effect of activity on your professional rewards if you:*	
Course innovation	Range = 1-5[c] Mean = 3.24 Std Dev = .67 Alpha = .80	designed or redesigned a course used group projects in my undergraduate classes used design projects in my undergraduate classes	.75 .88 .86
Grants & publications	Range = 1-5[c] Mean = 4.15 Std.Dev. = .62 Alpha = .81	received $100,000 in external funding for curriculum development, teaching innovation or education research received $100,000 in external funding for basic or applied engineering research published an article in a leading engineering research journal published an article in a leading engineering education journal	.77 .86 .83 .71
Adequate Resources		*Adequacy of the following resources in your college of engineering for teaching undergraduate classes:*	
Administrative & clerical support	Range = 0-4[d] Mean = 1.90 Std Dev. = .91 Alpha = .74	clerical support release time travel money industry contacts	.66 .83 .78 .70
Computer & laboratory support	Range = 0-4[d] Mean = 2.56 Std. Dev. = .71 Alpha = .74	computer hardware computer software laboratory facilities	.83 .75 .73
Library & AV support	Range = 0-4[d] Mean = 2.73 Std. Dev. = .63 Alpha = .55	library resources audio/visual equipment	.82 .79
Faculty development	Range = 0-4[d] Mean = 2.10 Std. Dev. = .87 Alpha = .68	faculty development professional support	.79 .87

[c] 1 = Very negative, 2 = Negative, 3 = Not applicable, 4 = Positive, 5 = Very positive
[d] 0 = Not available, 1 = Inadequate, 2 = Barely adequate, 3 = Adequate, 4 = Outstanding

The survey asked faculty to rate the adequacy of several resources in their own college of engineering for teaching undergraduate classes on a scale of 0 to 4. In this scale, 0 = “not available,” 1 = “inadequate,” 2 = barely adequate,’ 3 = “adequate,” and 4 = “outstanding.” Four factors resulted from a principal components factor analysis: “administrative and clerical support,” (four items), “computer and library support” (three items), “library and AV support” (two items), and “faculty development” (two items). The factor solution explained 66.4 percent of the variance in the correlation matrix. Internal consistency reliabilities (Cronbach’s alphas) of the factors ranged from .55 to .74, and the loadings of individual items ranged from .66 to .87. In general, respondents perceived that resources available for undergraduate teaching were less than adequate. They perceived, however, that library and AV support (mean = 2.73) and computer and library support (mean = 2.56) were more adequate than either faculty development (mean = 2.10) or administrative and clerical support (mean = 1.90).

Finally, the Engineering Faculty Survey asked respondents to rank how often they used any of several teaching practices when teaching their undergraduate courses during the academic year 1999-2000. The scale ranged from 1 to 4, where 1 = “rarely”, 2 = “sometimes,” 3 = “often,” and 4 = “almost always.” A factor analysis yielded five factors: “group/design projects” (three items), “traditional methods” (two items), “coaching” (three items), “fostering tolerance” (two items), and “teaching/research integration” (four items), and explained 72.2 percent of the variance. This paper compares two of the teaching practice factors: group/design projects (alpha = .85) and traditional teaching methods (alpha = .56). Factor loadings of individual items for these scales ranged from .74 to .83. The faculty who responded to this survey were more likely to use traditional methods more often (mean = 3.11) than group/design projects (mean = 2.44) when teaching their undergraduates in 1999-2000. See Table 4.

Ordinary least squares multiple regression was used to estimate the relative contributions to their teaching practices of faculty members’ demographic characteristics, experiences, and motivation. The variables were entered in three steps, with demographics first, experiences second, and motivation variables entered last. The motivation variable set was comprised of the teaching goals, capability beliefs (skills), and context beliefs (likely rewards and adequate resources) factors. Two OLS regressions were run, one for each teaching practice (group/design projects and traditional methods.)

Table 4. Teaching Practices Scales,
with Values, Items, and Factor Loadings (λ) for Each Item in Scale

Scale	Values	Items	λ
		Teaching practices I used in undergraduate courses in 1999-2000	
Group/design projects	Range = 1-4[e] Mean = 2.44 Std Dev. = .91 Alpha = .85	used design projects used group projects used student presentations	.79 .83 .79
Traditional methods	Range = 1-4[e] Mean = 3.11 Std.Dev. = .71 Alpha = .56	used lecture used textbook-based problem sets	.83 .74

[e] 1 = Rarely, 2 = Sometimes, 3 = Often, 4 = Almost always

Results

The regression models explained 31.7 percent and 31.0 percent, respectively, of the variance in faculty members' use of group/design projects or traditional teaching methods. Particularly noteworthy is the fact that motivational variables accounted for about half of variance. Teaching goals, capability beliefs, and context beliefs contributed to 18.6 percent and 14.9 percent of the variance of gains in use of group/design projects and traditional teaching methods. The rest of the explained variance in use of group/design projects was contributed by faculty members' demographic characteristics (6.2 percent) and experience (6.9 percent.) Similarly demographic characteristics (6.3 percent) and experience (9.8 percent) contributed to the balance of the explained variance in faculty members' use of traditional teaching methods. All regression equations were significant at the $p < .001$ level.

Variables that contributed significantly and positively to faculty members' use of group/design projects included rank, participation in ECSEL, recent publication about engineering education, the goal of teaching teamwork and lifelong learning, confidence in one's own strong interpersonal communication skills, and perceived adequacy of computer and laboratory resources. On the other hand, consulting work and perceived adequacy of administrative and clerical resources were negatively and significantly associated with the use of group/design projects when teaching undergraduates. Discipline, gender, ethnicity, funding, and perceived rewards had no significant impact.

Faculty members' use of traditional teaching methods was positively and significantly related with experience working full time as a practicing engineer, recent publications about engineering research, the goal of teaching engineering science fundamentals, confidence in one's own formal communication skills, and -- surprisingly -- the perception that course innovation is rewarded. Faculty in the disciplines of civil/environmental engineering, aero/astro engineering, and other disciplines such as acoustics and fire protection engineering were less likely than faculty in most other departments to use traditional teaching methods. Faculty of color were more likely than white faculty, and faculty who had a larger percent of funding for teaching innovation than research were also less likely to use traditional methods. In addition, the use of traditional methods was negatively and significantly associated with the goal of teaching teamwork and lifelong learning, and confidence in one's own ill-defined problem solving skills.

Summary and Conclusions

The Engineering Faculty Survey described in this paper was developed as part of the evaluation of the Engineering Coalition of Schools for Excellence in Education and Leadership (ECSEL), a coalition of seven engineering schools supported from 1990-2000 by the National Science Foundation. This study evaluated the psychometric characteristics of the survey. Analyses are based on self-reported data from 470 faculty who taught undergraduate classes at the seven ECSEL schools in 1999-2000. Respondents included more than half (52.3 percent) of the total population of full-time tenured and tenure-track faculty at six of the seven ECSEL schools. (Surveys were sent only to ECSEL participants at MIT.) Principal components factor analysis of individual survey items yielded five sets of extremely clean factors corresponding with Ford's motivation theory[11] (motivation = goals x capability beliefs x context beliefs). The factor sets include teaching goals (four factors), capability beliefs about faculty members' own skills (three factors, context beliefs about likely rewards for teaching (two factors) and adequacy of resources for teaching (four factors).

Two OLS regression analyses analyzed the effects of faculty members' demographic characteristics, experience, teaching goals, skills, and context beliefs on their use of traditional teaching methods and group/design projects. Significant contributors to faculty members' use of the two different teaching practices present an interesting contrast. Among the respondents from the ECSEL schools, discipline made no difference in the use of group/design projects, but was associated with less use of traditional methods in a few disciplines. Senior faculty were more likely than junior faculty to use group/design projects, but rank made no difference in the use of traditional methods. Ethnicity was not associated with the use of group/design projects, but non-white faculty were more likely than white faculty to use traditional methods. Experience as a practicing engineer positively affected use of traditional methods and work as a consultant negatively affected the use of group/design projects. Faculty who had participated in ECSEL were more likely than those who had not to use group/design projects, and receiving funding for curricular development or teaching innovation was related to less use of lecture and textbook problem sets. The more faculty published about engineering education, the more they used group/design projects. Similarly, the more they published about engineering research, the more they used traditional teaching methods. The teaching goal of teamwork and lifelong learning was positively related to using group/design projects, and negatively related to using traditional methods, while the goal of teaching engineering science fundamentals is positively associated with the use of traditional methods. Faculty who were more confident of their interpersonal skills used group/design projects more, while faculty who were more confident of their formal communication skills and less confident of their ill-defined problem solving skills were more likely to use traditional methods. Interestingly, the faculty who used traditional methods more, were also more likely to perceive that course innovation was rewarded. Perhaps that is because they have less experience trying to achieve such rewards. Finally, perceived adequacy of computer and laboratory resources and perceived inadequacy of administrative and clerical resources were associated with greater use of group/design projects. Perceived adequacy of resources had no effect on faculty members' use of traditional teaching methods.

The results suggest that the Engineering Faculty Survey may be useful for at least two purposes. The instrument can use used as a tool to document engineering departments' and colleges' compliance with EC 2000 Criterion 5 by documenting the overall competence of engineering faculty. As an important additional analytic step, however, the instrument could enable engineering colleges to show the extent to which their own faculty's collective characteristics, experience, and motivation are associated with the various teaching practices most likely to result in ABET-required gains in student competencies.

Bibliography
[1]URL: http://www.abet.org/downloads/2000-01_Engineering_Criteria.pdf

[2] Kulik, J. & Kulik, C. L. (1979). College teaching. In P. Peterson & H. Walberg, (Eds.) *Research on teaching: Concepts, findings and implications*, pp. 70-93. Berkeley, CA: McCutcheon.
[3] McKeachie, W. (1990). Research on college teaching: The historical background. *Journal of Educational Psychcology, 82* (2), 189-200.
[4] Finkelstein, M. J., Seal, R. K., & Schuster, J. H. (1998). *The new academic generation: A profession in transformation.* Baltimore, MD: The Johns Hopkins University Press.
[5] Bucciarelli, L. L. (1988). An ethnographic perspective on engineering design. *Design studies*, *9*(3), 159-168.
[6] Cabrera, A. F., Colbeck, C. L., & Terenzini, P. T. (2001). Developing performance indicators for assessing classroom teaching practices and student learning: The case for engineering. *Research in Higher Education*, *42*(3).
[7] Colbeck, C. L., Cabrera, A. F., & Terenzini, P. T. (2001). Learning professional confidence: Linking teaching practices to gains in college students' academic and career self-perceptions. *Review of Higher Education*, *24*(3), 173-191.
[8] Weimer, M. & Lenze, L. F. (1991). Instructional interventions: A review of the literature on efforts to improve instruction. In J. C. Smart, (ed.) *Higher Education: Handbook of theory and research, Vol. VII*, pp. 295-333. New York: Agathon Press.
[9] Blackburn, R. T. & Lawrence, J. JH. (1995). *Faculty at work: Motivation, expectation, satisfaction.* Baltimore: Johns Hopkins Press.
[10] Bess, J. L. (1997). *Teaching well and liking it.* Baltimore: Johns Hopkins Press.
[11] Ford, M.E. (1992). *Motivating humans: Goals, emotions, and personal agency beliefs.* Newbury Park, CA: Sage Publications.

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