DOCUMENT RESUME

ED 427 590 HE 031 781

AUTHOR	Cabrera, Alberto F.; Colbeck, Carol L.; Terenzini, Patrick T.
TITLE	Teaching for Professional Competence: Instructional Practices That Promote Development of Group, Problem-Solving, and Design Skills. ASHE Annual Meeting Paper.
INSTITUTION	Howard Univ., Washington, DC.; Pennsylvania State Univ., University Park. Center for the Study of Higher Education.
SPONS AGENCY	National Science Foundation, Arlington, VA.
PUB DATE	1998-11-00
NOTE	44p.; Paper presented at the Annual Meeting of the Association for the Study of Higher Education (23rd, Miami, FL, November 5-8, 1998).
CONTRACT	634066D
PUB TYPE	Reports - Evaluative (142) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Classroom Environment; *College Instruction; College Students; *Engineering; Higher Education; *Instructional Effectiveness; Problem Solving; Professional Education; Self Evaluation (Individuals); Skill Development; *Student Development; Teaching Methods; Teamwork; Undergraduate Study
IDENTIFIERS	*ASHE Annual Meeting

ABSTRACT

This study compared the effects of personal characteristics and teaching practices in the development of professional competencies by undergraduate engineering students. A survey completed by 480 engineering students gathered information concerning students' personal, academic, and demographic characteristics; characteristics of their current engineering course; and their self-evaluation of progress made in various areas as a result of their current course. Results indicated that self-evaluated gains in group, problem-solving, and design skills were more the result of current teaching practices than the outcome of students' precollege characteristics. Results suggest that gains in professional competencies can be fostered in the classroom by frequent interaction with and feedback from the instructor, frequent opportunities to work collaboratively with peers, and by clear instructions and structure provided by the instructor. No significant differences were found between male and female students. An appendix lists engineering program accreditation criteria. (Contains 62 references.) (DB)

TEACHING FOR PROFESSIONAL COMPETENCE: INSTRUCTIONAL PRACTICES THAT PROMOTE DEVELOPMENT OF GROUP, PROBLEM-SOLVING, AND DESIGN SKILLS[1]

Alberto F. Cabrera
Associate Professor & Senior Research Associate
Center for the Study of Higher Education
The Pennsylvania State University
403 South Allen St., Suite 104
University Park, PA 16801-5252
Phone: (814) 865-6346
Fax: (814) 865-3638
E-Mail: afc4@psu.edu

Carol L. Colbeck
Assistant Professor & Research Associate
Center for the Study of Higher Education
Phone: (814) 865-6346
Fax: (814) 865-3638
E-Mail: clc15@psu.edu

Patrick T. Terenzini
Professor & Senior Scientist
Center for the Study of Higher Education
Phone: (814) 865-6346
Fax: (814) 865-3638
E-Mail: ptt2@psu.edu

An earlier version of this paper was presented at the 1998 annual meeting of the Association for the Study of Higher Education. Miami, Florida.

[1]This study was supported in part by a grant from the Engineering Education and Center Division of the National Science Foundation to Howard University (Grant No. 634066D) to support the Engineering Coalition of Schools of Excellence in Education and Leadership (ECSEL). The opinions expressed here do not necessarily reflect the opinions or policies of the National Science Foundation, and no official endorsement should be inferred.

ASHE Association for the Study of Higher Education

Headquartered at the University of Missouri-Columbia • College of Education • Department of Educational Leadership and Policy Analysis • 211 Hill Hall, Columbia, MO 65211 • 573-882-9645 • fax 573-884-5714

This paper was presented at the annual meeting of the Association for the Study of Higher Education held in Miami, Florida, November 5-8, 1998. This paper was reviewed by ASHE and was judged to be of high quality and of interest to others concerned with higher education. It has therefore been selected to be included in the ERIC collection of ASHE conference papers.

Teaching for Professional Competence: Instructional Practices that Promote Development of Design and Team-Building Skills

Abstract

Research on teaching and learning in the college classroom suggests that students' gains in subject matter learning are influenced by many factors including students' pre-college characteristics, teaching practices, and students' perceptions of classroom climate for women and minorities. One purpose of this study was to determine whether these same factors (pre-college characteristics, teaching practices, and climate) are reliably related to gains in students' professional competencies. A second purpose was to investigate whether teaching practices and classroom climate have differing impacts on White male and female students' development of professional competencies. Results indicate that the vitality of the classroom experience matters on a student's gains in professional competency. Teaching practices as a group were found to contribute above and beyond personal characteristics do in self-reported gains in group skills, problem solving and design skills among undergraduate engineering students. Findings also lend mixed support for the differential learning styles hypothesis between women and White men.

TEACHING FOR PROFESSIONAL COMPETENCE: INSTRUCTIONAL PRACTICES THAT PROMOTE DEVELOPMENT OF GROUP, PROBLEM-SOLVING, AND DESIGN SKILLS

Higher education leaders from various venues are calling for stronger links between college teaching and the skills students need to develop for use in their post-college careers. Developing students' professional competencies is a major concern of university presidents (Kellogg Commission, 1997), higher education scholars (Stark & Lowther, 1989; Jones, 1996), faculty senates (Janesch, 1996), and regional and specialized accrediting agencies (Lopez, 1996; ABET, 1998). In 1992, for example, the National Educational Goals Panel (1992) emphasized that student developmental outcomes such as critical thinking, problem solving, effective communication and responsible citizenship should be key issues when judging the effectiveness of its institutional affiliates. Industry leaders asset that new graduates must have abilities to work in teams and to design solutions to real world problems (Black, 1994; Augustine, 1996). In addition, regional and specialized accrediting agencies are requiring member institutions to focus on teaching for professional competence. The North Central Accreditation Commission, for example, recently encouraged institutional evaluators to assess measures of students' gains in group interaction skills, initiative, and problem solving skills. The Accreditation Board for Engineering and Technology (ABET), the sole agency responsible for accreditating engineering degrees in the US, recently enacted criteria requiring colleges of engineering by the year 2,001 to demonstrate their graduates have developed eleven competencies, including the abilities "to design systems or component, or process to meet desired needs", "to function on multi-disciplinary teams", and "to communicate effectively" (ABET, 1998).

While there appears to be growing consensus about the competencies that undergraduate students should develop before they graduate, there is less clarity about how faculty can help students develop these competencies. According to Stark and Lowther (1989), few faculty discuss how to teach students for professional competence within or across disciplines. Since there is little information about the relationship between teaching and learning professional skills, we turned to literature on teaching and students' gains in subject matter knowledge. Research on teaching and learning in the college classroom suggests that students' gains in subject matter learning are influenced by many factors including students' pre-college characteristics (Astin, 1993; Pascarella, 1985), teaching practices (Murray, 1991; Pascarella and Terenzini, 1991), and students' perceptions of classroom climate for women and minorities (Hall & Sandler, 1982; Cabrera & Nora, 1994). One purpose of this study was to determine whether these same factors (pre-college characteristics, teaching practices, and climate) are reliably related to gains in students' professional competencies. A second purpose was to investigate whether teaching practices and classroom climate have differing impacts on White male and female students' development of professional competencies.

Conceptual Foundations

The conceptual framework for this study is depicted in Figure 1. The Teaching for Professional Competence model was adapted from several models of the impact of college on students including the Learning Outcomes model developed by Terenzini, Springer, Pascarella and Nora (1995). The Learning Outcomes model depicts student learning and development as the product of the interplay between a students' pre-college characteristics and collegiate experiences. Student pre-college characteristics include ability, socio-economic status, educational aspirations, ethnicity and gender. The institutional context is composed of classroom and out-of-classroom activities. Classroom experiences include exposure to teaching methods, the curriculum and interactions among peers and with faculty. Out-of-classroom experiences include extracurricular activities, working on and off campus, and social interaction. Although the model postulates that both classroom and out-of-classroom experiences contribute to student development, classroom experiences appear to have a stronger and more varied effect on student outcomes (Volkwein, 1991; Volkwein & Lorang, 1996). In the revised Model of Student Integration, Tinto (1997) portrayed classroom experiences as the center point where students' academic and social experiences in college converge. Therefore, the Teaching for Professional Competence model focuses on classroom experiences, and posits students' pre-college characteristics, teaching practices, and classroom climate as predictors of gains in students' professional competencies.

Insert Figure 1

Students' Precollege Characteristics

Ability and background: Scholars who have investigated college impact have shown that students' characteristics at time of matriculation influence the ways and the extent to which students change as they progress toward graduation. In particular, students' intellectual ability, their educational aspirations, and the education level attained by their parents influence students' learning in college (Astin, 1993, Pascarella & Terenzini, 1991).

Gender: In addition, research has shown that, under some conditions, gender and race influence what and how students learn (Oakes, 1990). Opinions differ, however, about the reasons for gender and race-related learning differences. For example, scholars have suggested at least three reasons for gender differences in learning. For example, one reason may reside in essential differences in the ways that women and men learn. Belenky and associates (1986) assert that women may be more likely than men to engage in "connected knowing." Connected knowing involves learning though relating with others and focuses on the subjective understanding of experience. In contrast, men (and some women educated in college by men) may be more likely than other women to engage in "separate knowing." When engaged in separate knowing, individuals critically challenge alternatives for the purpose of deducing objective truth. If women are inherently more likely than White men to prefer connected knowing, then women are also more likely than men to prefer collaborative learning with their peers and extensive interaction with their instructors.

The influence of societal factors is second reason given for gender differences in learning (Oakes, 1990). According to this perspective, childhood socialization and differing career opportunities for males and females inhibit the development of women's confidence and restrict women's perceptions of appropriate college majors and jobs (Sax, 1994; Hackett & Betz, 1992). In addition, females' preferences for collaborative learning and humanistic majors and males' preferences for individual learning activities math and science majors are seen as the result of culturally-determined gender roles rather than as inherent sex-related differences in learning styles (Fennema & Sherman, 1977; Ferguson, 1984). Similar to the first reason, this explanation would also suggest that women would be more likely than White men to prefer opportunities to interact with instructors and to engage in collaborative learning with peers.

A third reason given by some scholars for gender differences in learning and persistence is differential treatment of men and women in school and college classrooms. Observational and interview studies that investigated students' experiences in pre-college and college classrooms revealed that many teachers provide more attention and more specific feedback to male than to female students (Seymour & Hewitt, 1997; Sadker & Sadker, 1986; Hall & Sandler, 1982). Moreover, male students in science and engineering fields tend to devalue to contributions of their female peers (Seymour & Hewitt, 1997). As a result, female students may be more likely than males to avoid group work (Rosser, 1998) or to be disappointed with their experiences on mixed-gender collaborative learning projects (Felder, et al., 1995).

Teaching practices

Research on the impact of instructional activities on student learning is somewhat mixed. Kulik and Kulik's (1979) review of research on college teaching effectiveness led them to suggest that learning has more to do with individual motivation to study outside the classroom than with what the instructor does in the classroom. Murray's (1991) research on observable low-inference teaching behaviors led him to reach an opposite conclusion. However, Murray advises that the debate regarding the impact of teaching behaviors on student outcomes can best be informed by further research.

Research design and measurement issues may have prevented researchers' abilities to find conclusive evidence documenting the relationship of instructional activities to student learning (Abrami, 1985; Murray, 1991). Murray (1991) found fewer measurement problems when the studies about teaching focused on concrete and observable "low-inference" teaching practices rather than when the studies rely on "high-inference" descriptors. "Student centered", "Being friendly" are examples of high-inference measures in that they call for a high degree of inference and judgement on the part of the evaluator. A related low-inference teaching behavior is "the instructor encourages students to listen, to evaluate and to learn from the ideas of other students." In comparison to high-inference measures, low-inference behaviors are less prone to interpretation bias and more likely to be reported by more than one observer. According to Murray (1991), however, most research on low-inference teaching behaviors has emphasized the relationship between teaching behaviors and student ratings of instruction. More research is needed to explore the relationship between teaching behaviors and gains in student learning.

Research on college teaching has shown that teaching practices are multidimensional in nature. Moreover, the effectiveness of each dimension appears to vary as a function of the student outcome under consideration (McKeachie, 1990; Murray, 1991; Kulik & Kulik, 1979). Teacher clarity, for instance, has been found to correlate with student achievement (Feldman, 1989), and student motivation to re-enroll in courses (Murray, 1991). Continuous, specific and immediate feedback has been found to improve achievement (Kulik & Kulik, 1979). While both lecturing and class discussion have been found to correlate with students' acquisition of knowledge, class discussion appears to be more effective for enhancing problem solving skills (Kulik & Kulik, 1979). In addition, research indicates that students' critical thinking skills are positively influenced by class discussions, by encouragement from the teacher, and by teachers' articulation of problem-solving procedures (McKeachie, 1988, Pascarella & Terenzini, 1991).

While routine problem solving can be taught, according to Schon (1987), design cannot be taught using traditional lecture or discussion methods. Design is the art of developing creative solutions to open-ended problems and is a skill required in many professions (Schon, 1987). Students can learn design through practice as they are guided through frequent interactions with an experienced and encouraging coach (Dally & Zhang, 1993; Dym, 1994; Schon, 1987). Coaching involves interactive dialog, demonstrations, questioning, listening, clarifying objectives, understanding other's viewpoints, and articulating design specifications (Dym, 1994, Schon, 1987).

Collaborative learning involves collective intellectual effort among groups of students. The practice of collaborative learning in the college classroom is grounded in the assumption that the processes of engaging in social conversation about a specific task or problem enhances participants' reflective thinking, and therefore their acquisition of knowledge (Bruffee, 1984). Students' achievement, positive attitudes toward a subject area and emotional bonding with peers also appear to be positively influenced by cooperative and collaborative learning experiences in the classroom (Johnson, Johnson & Smith, 1991). To prepare college students for the workplace, more and more faculty are assigning students to work together to solve open-ended problems (Gamson, 1994).

Classroom Climate

While teaching practices affect the attainment of student outcomes, the classroom climate of tolerance towards diversity also appears to play a role. A classroom climate permeated by prejudice on the part of faculty and peers has emerged as an explanatory factor accounting for differences in college adjustment, majoring in hard sciences, and college persistence between White men, women and minority students (Cabrera & Nora, 1994; Hurtado, 1992, 1994; Eimers & Pike, 1997; Fleming, 1984; Seymour & Hewitt, 1997). Women may be more likely than men to leave science and engineering majors because of their perceptions of competitiveness and inferior instruction in technical fields (Strenta, Elliott, Adair, Matier, & Scott, 1994). Members of majority groups may also be negatively affected by a climate of intolerance. Researchers have shown that regardless of students' gender or ethnicity, their perception that some students suffer from discrimination in the classroom has a negative effect on their own academic development and commitment to their institution (Cabrera, Nora, Terenzini, Pascarella, & Hagedorn, forthcoming; Whitt, Pascarella, Edison, Nora & Terenzini, 1998). Thus, the climate for tolerance in a given class may also influence the extent to which students develop professional competencies as a result of taking that class.

Gains in Professional Competencies

Higher education scholars, industry leaders, accrediting agencies, and university presidents agree that four years in college should develop students' communication, critical thinking, problem-solving skills. Whether the skills were learned in liberal education or professional school classes, a student who is competent at communication, critical thinking and problem-solving has much to offer potential employers (Jones, 1996; Stark & Lowther, 1988). Faculty members', administrators', and employers' opinions about the essential skills that college students should develop were explored in studies conducted by Jones and associates (1994, 1997) Results of the Delphi studies revealed areas of consensus among the three groups of stakeholders about the components of critical thinking, problem solving and communication skills (Jones, et al, 1994, Jones, et al., 1997).

Group interpersonal skills: Faculty, administrators, and employers agree that students should develop interpersonal and group skills, including identifying and adapting to the needs of others, motivating others, and managing interpersonal conflict (Jones, 1994). In the workplace, individuals frequently work in groups or teams to solve problems (Bucciarelli, 1988). Effective designs are more likely to result when team members can communicate with one another effectively (Bucciarelli, 1988, Schon, 1987). Research on workplace groups reveals that three types of communication are involved in effective group functioning: discussions about the task, discussions about the process for achieving the task, and communications about personal relationships among group members (Jehn, 1997). Therefore, it seems desirable that faculty foster classroom conditions that enable students to develop task, process and relational communication skills among team members.

Problem solving skills: Solving a problem involves several stages, including identifying the problem and generating, selecting, and implementing a solution (Dougherty & Fantaske, 1996). Problem-solving often involves skills also associated with critical thinking, such as collecting and evaluating evidence, analyzing arguments, developing hypotheses, and drawing conclusions (Jones, et al., 1994).

Design skills: Design involves solving complex and ill-defined problems that may have many solutions (Schon, 1987). In addition to creativity, design usually includes generating and evaluating specifications to achieve objectives and satisfy constraints (Dym, 1994). Design problems are central to science and engineering, architecture, art, music, business, and the health care professions (Dougherty & Fantaske, 1996; Schon, 1987). The new accreditation criteria for engineering colleges requires that graduates with a bachelor's degree demonstrate competence in design (ABET, 1998).

Methodology

Sample and Data Collection

Because engineering is a field in which accreditation criteria are currently changing to reflect the importance of competency development, this study focuses on the relation of teaching practices to gains in professional competencies in engineering classes. In Spring 1997, 480 undergraduate engineering students from six universities in ECSEL, an NSF-funded coalition of engineering schools, completed a pencil-and paper, multiple-choice questionnaire. The Engineering Coalition of Schools of Excellence in Education and Leadership (ECSEL) includes City College of New York (CCNY), Howard University, Morgan State University, the Pennsylvania State University, the University of Maryland, the University of Washington and the Massachusetts Institute of Technology. The two primary goals of the ECSEL are to incorporate design in the undergraduate engineering curriculum and to increase the diversity of engineering graduates. At the participating schools, ECSEL classes are more likely than other undergraduate engineering courses to require students' participation in team-based design projects. The questionnaires were administered in 17 ECSEL classes (N=339) and 6 non-ECSEL classes (N=141).

The survey form gathered information in three categories: 1) students' personal and academic background and demographic characteristics; 2) characteristics of the course in which they were enrolled when completing the questionnaire; and 3) the extent to which they believed they made progress in a variety of learning and skill development areas *as a result of taking that particular course*. The items comprising each of the three sections of the questionnaire were derived from learning theory, research on college students, Delphi studies by Jones and associates (1994) and ABET's new accreditation criteria. (See Appendix A.)

Table 1 displays the descriptive statistics of the scales and variables used in subsequent analyses. Seventy-seven percent of the respondents were males, and 45 percent were Caucasians. On average, the students' parents had undergraduate degrees. The average student in this sample expected to complete a Master's degree. Non-ECSEL students reported somewhat stronger pre-college academic credentials than did the ECSEL-course students. Compared to their ECSEL-peers, non-ECSEL students reported higher SAT scores (by 30 and 35 points on the verbal and math portions of the SATs, respectively) and high school grade-point averages. Each of these differences were statistically significant. No statistically significant differences were identified, however, between the two groups with respect to current engineering GPA or overall GPA. Students were approximately evenly distributed across the class years, with 25-27 percent in each of the freshman, sophomore, and junior classes, although slightly fewer (18%) were seniors. No significant differences in this distribution were identified between ECSEL and non-ECSEL course students. Ratings of classroom climate indicate that most respondents perceived that all students were treated the same regardless of gender or ethnicity.

Insert Table 1

Development of Indicators

Indicators of Teaching Practices and Classroom Climate: Students were asked to report how often they or the instructor engaged in each of 26 classroom activities. The scale ranged from 1 to 4, where 1='never', '2=occasionally', '3=often', and '4=very often/almost always'.

Twenty-four items were drawn from literatures on effective teaching, collaborative learning, and educating for reflective practice. In accordance with Murray's (1991) discussion of low-inference behaviors, items were designed to describe specific teaching behaviors. Two items asked for perceptions of the classroom climate of tolerance for women and minorities.

A principal component factor analysis of the 26 items produced 4 factors. This factor solution accounted for 61% of the variance in the correlation matrix and is presented in Table 2. Three of the four factors reflected teaching practices. Instructor Interaction and Feedback included ten practices that fostered frequent, supportive communication between faculty and students. Collaborative Learning included six practices that fostered interdependence among students working in groups. Clarity and Organization included three practices that involved clear explanations, expectations or integrated course structure. The Instructor Interaction and Feedback practices are consistent with Schon's (1987) description of coaching for reflective practices and similar in factor structure and item composition to the "Interaction" and "Rapport" factor solutions reported in Murray (1991). The fourth factor grouped together perceptions of fairness in the treatment of minorities and women in the classroom and was labeled Classroom Climate (2 items). The internal consistency of the four scales was high, ranging from .81 to .92.

Insert Table 2

Indicators of Gains in Professional Competencies: Students were asked to report the progress they believe they made in 27 areas as a result of the course they were taking. Progress was reported on a 1 to 4 scale, where '1=none', '2=slight', '3=moderate', and '4=a great deal'.

These items were drawn primarily (but not exclusively) from Jones and associates (1994) research about the essential skills college students should acquire before they graduate. The items were also developed to reflect, as closely as possible, 7 of the 11 learning outcomes articulated in ABET's (1998) *Engineering Criteria 2,000.* (See Appendix A.)

Several considerations guided the decision of using self-reported gains to measure learning outcomes instead of objective cognitive tests. Many competencies, such as ability to work in groups, cannot be measured by objective tests. Furthermore, locally developed or standardized tests for profession-specific competencies are expensive and difficult to design. Finally, Pike (1995) found self-reported measures of educational gains to be as valid as objective measures, to the extent that the measures reflect the content of the learning outcome under consideration.

Table 3 presents the results of the factor analysis of the 27 gains items. The factor analysis yielded three factors: Gains in Design Skills (5 items), Gains in Problem Solving Skills (7 items), and Gains in Group Skills (7 items). This three factor solution explained 66% of the variance in the correlation matrix. The internal consistency of the three scales was also high, ranging from .87 to .92.

Insert Table 3

Findings

Relationship between Teaching Practices and Gains in Professional Competencies

Multiple regression analyses were performed to assess the significant predictors of self-reported gains in group, problem-solving, and design skills. Mean substitution was used to replace missing values in the predictors. To examine whether variation in student development of professional skills had more to do with pre-college characteristics than with teaching practices, factors were grouped in two blocks and sequentially entered. The first block included measures of academic ability (SAT verbal and math scores), high school achievement (GPA), educational aspirations (highest degree expected), socioeconomic status (highest parental education), gender, ethnicity, class year (freshman to senior), and perceptions of classroom climate. The second block included the three measures of teaching practices (Instructor Interaction and Feedback, Collaborative Learning, and Clarity and Organization).

The regression models explained 39.7 percent, 32.2 percent and 39.6 percent of the variance in group, communication and design competencies (see Table 4). Teaching practices explained considerably more of the variance in self-reported gains in professional competencies than did student pre-college characteristics (see Table 4). Teaching practices accounted for 29.9 %, 26.3 % and 31.1% of the variance of gains in group, problem-solving, and design skills, respectively, whereas students' pre-college characteristics, class year and classroom climate explained less than 10 percent of the variance.

Insert Table 4

Instructional Interaction and Feedback and Collaborative Learning were associated with gains in all three professional competencies (see Table 5). The relative importance of the teaching practice as determined by standardized betas varied with the learning outcome under consideration. Instructional Interaction and Feedback had strong, significant, and positive relationships with gains in group, problem-solving and design competencies. Not surprisingly, Collaborative Learning was the teaching practice that had the strongest positive relationship with self-reported gains in group skills. Collaborative Learning, however, was also related significantly and positively to gains in problem-solving and design skills. Clarity and Organization showed no significant effect on gains in group skills, this teaching practice was positively and significantly related to gains in problem-solving and design competencies.

Students' characteristics had less effect on competencies than did teaching practices. Gains in group skills were negatively affected by students' aspirations for advanced degrees, high SAT verbal scores, and by higher levels of parental education. The magnitude of these negative effects, however, were minimal. African Americans and Asian Americans reported significantly greater gains in communication and design skills than did their Caucasian counterparts.[1] Again, the magnitude of the effects of ethnicity on gains in professional competencies was much smaller than the effects of teaching practices.

Insert Table 5

---

[1]The researchers will explore the relation of ethnicity to gains in professional competencies in more depth in a future paper.

Impact of Gender on Relationship between Teaching Practices and Professional Competencies

Because retention rates continue to be lower for women than for men in engineering and science majors (Suter, 1996), there is particular concern that traditional lecture-style teaching practice used in these fields alienates women (NSF, 1996). Because of ECSEL's goals to teach design and to improve diversity, we had reason to believe that at least some faculty in ECSEL surveyed for this study incorporated other teaching practices in their classrooms. Therefore, even though gender did not emerge as significant in the initial regression analysis, we conducted additional analyses to determine conclusively if there were any gender differences in perceptions of teaching practices, classroom climate, or gains in professional competencies . A series of t-test comparisond of males' and females' mean perceived gains in competencies and classroom climate revealed only one significant difference: females reported greater gains in design skills than their White male counterparts. No significant differences were observed in terms of gains in group or problem skills. Both groups reported similar levels of tolerance in the classroom towards women and minorities (see Table 6).

Insert Table 6

Additional multiple regression analyses, reported in Table 7, were performed to compare the significant predictors of self-reported gains in group, and problem-solving, and design skills for White males and for females. Mean substitution was used to replace missing values in the predictors. The models explained more variance in gains in proficiencies among females than they did among White males. Among females, the regression models accounted for 36.8 percent, 36.0 percent and 44.7 percent of the variance in self-reported professional gains in group, problem-solving and design skills. The regression models explained 41.2 percent, 24.6 percent and 27.2 percent of the variance in group, problem-solving, and design skills among White males.

Insert Table 7

The relationship of teaching practices with gains in group skills were similar for White males and for females. For both genders, Instructor Interaction and Feedback and Collaborative Learning had significant and positive associations with gains in group skills. Instructor Interaction and Feedback also had a strong and positive relationship with gains in problem-solving skills for both genders. Comparison of the regression models for White males and females, however, indicates that females' gains in problem-solving were enhanced by Collaborative Learning and by Clarity and Organization. White males' gains in problem-solving skills were not significantly related to those two teaching practices. There was a positive, significant and strong relationship between Instructor Interaction and Feedback and gains in design skills for both female and White male students. In addition for females--although not for White males--Collaborative Learning was significantly and positively associated with gains in design skills. No pre-college characteristics emerged as significant in these regression models. Classroom Climate emerged as significant in one very interesting case. White males' perceptions of gains in group skills were negatively associated with their perceptions of the way women and minorities were treated in their class.

Discussion

The findings indicate that faculty efforts in the classroom indeed have important influences on students' career preparation. After all, gains in group, problem-solving, and design skills were more the result of teaching practices than the outcome of students' pre-college characteristics. The results reported here suggest that both male and female undergraduate students' gains in professional competencies can be fostered in the classroom by frequent interaction with and feedback from the instructor, opportunities to work collaboratively with peers, and by clear instructions and structure from the instructor.

It is perhaps no surprise that students associate experiences collaborating with peers in the classroom with improvements in their interpersonal and group skills. Interview studies indicate that many students believe that the best way to learn group skills is to be forced to work in teams, then to learn how to cooperate by trial and error (Campbell, Bjorklund, & Colbeck, 1998). Another result of this study, however, is noteworthy. This study provides evidence that the instructor also has an important influence on improvement in students' ability to work together effectively in groups. An instructor who interacts with students frequently, who guides rather than lectures, and who gives specific feedback and encouragement, undoubtedly provides students with an important model for appropriate and positive collaborative behavior.

Such an instructor, according to the results of this study, also provides students with the support and information necessary to learn how to solve both simple problems and complex design problems. These findings support Schon's (1987) descriptions of ways to educate reflective practitioners. Schon asserts that design skills cannot be imparted by lecturing. Instead, as was found in this study, students develop the ability to understand and reframe problems, imagine, explore, and test alternative solutions in a classroom where the instructor guides students, giving them chances to practice relating concepts to real problems, and encouraging them to question assumptions.

Improvement in students' abilities to solve problems and do design are also positively influenced by instructors who explain assignments and activities clearly, state their expectations of students explicitly, and relate assignments to content of the class. These findings that organization and clarity are positively associated with gains in professional competencies are consistent with prior research that shows that organization and clarity are consistently among the teaching practices associated with positive evaluations of teaching (Feldman, 1976; Murray, 1991) and with gains in subject matter knowledge (Pascarella & Terenzini, 1991).

Gender had little significant impact on the relationship between teaching practices and gain in professional competencies. In fact, in the original analysis, the effect of gender was not only non-significant, it was very weak. Subsequent regressions conducted separately for White males and females provide, at best, only minimal support premises that women are more likely than men to learn effectively from collaborative work, whether because of inherent learning style differences or as a consequence of gender role socialization. For both male and female students, collaborative learning fostered gains in group skills. Results indicate that gains in problem-solving and design skills were also significantly associated with collaborative learning female students, but not for White males. These findings, however, may be confounded with ethnicity, since the regressions for females included female students of color, and the regressions for males included only Whites. Moreover, the findings fail to support the premise that hostile treatment from male peers would make women less likely to learn effectively in small group situations.

Thus, it appears that collaborative learning practices are associated with gains in professional competencies for both genders. These findings corroborate recent research evidence from Tinto (1997), that collaborative learning is effective in promoting college persistence, regardless of student's gender or ethnicity.

Since most students perceived that female and minority students were treated the same as White male students, classroom climate had no impact on self-reported gains in professional competencies except in one interesting case. Perceptions that all students were treated fairly was negatively but significantly associated with White male students' gains in group skills. One possible explanation for this finding is that females and minorities are more accustomed to dealing with discrimination, and are therefore less surprised or more resilient than White males when they perceive prejudice directed at themselves or others (Cabrera & Nora, 1994). Another possible explanations is that some White males, accustomed to receiving more favorable treatment than their peers, felt some loss when females and minorities also benefitted from frequent interactions with instructors.

Implications for the Practice and Assessment of Teaching

The results of this study corroborate evidence from other research that active and collaborative learning activities enhance student learning (Tinto, 1997). Nevertheless, more than three-fourths of new and senior faculty continue to rely on lecture as their primary — or even their only — teaching practice (Finkelstein, Seal & Schuster, 1998). Thus, faculty persist in giving traditional lectures despite evidence that more faculty/student and student/student interaction in the classroom promotes the learning of content knowledge and professional competencies. Perhaps this is because faculty perceive that structuring classes for active and collaborative learning is complex and time consuming. Many colleges and universities create and maintain centers for excellence in teaching that provide faculty with in-service training about how to teach actively, collaboratively, and effectively. However, faculty often neglect to take advantage of such opportunities because they believe their institutions' reward systems only pays lip service to good teaching. An assistant or associate professor confronting the competing demands for research and service is likely to be hesitant to demanding instructional techniques if these activities are neglected in promotion and salary decisions. So what can be done to encourage faculty to teach in ways that foster students' development of professional competencies?

Expectations on the part of accrediting agencies such as ABET that institutions be accountable for developing students' professional competencies may encourage more widespread use of teaching practices such as instruction interaction and feedback, collaborative learning, and organization and clarity. The intrinsic satisfaction of contributing student development will no doubt continue to inspire some faculty to adopt such practices. On the other hand, departments and institutions should implement rewards--including sufficient time to implement changes— for faculty who are willing to make extra effort to help students develop competencies essential for their professional success.

The assessment literature suggests at least three conditions necessary when developing successful performance indicators (Bordern & Banta, 1994; Gaff, Ratcliff and associates, 1996). To begin, the data yielded by a performance indicator are meaningful when defined by the user. This implies the data the performance indicator conveys should inform the user something of importance about what it is taking place at the institution (Ewell, 1997). Second, performance indicators are best when used as a group. The information they provide should portray a comprehensive picture of an institutional strategic area if they are to support strategic decisions (Ewell, 1997). Third, data should inform about the input and processes associated with a particular outcome such as student learning. The indicators of teaching practice used in this study meet several of the conditions recommended by the assessment literature. They evolved from theory, research and consultation with the users. They are meaningful to the user in that their content is consistent with the objectives of ECSEL's curricular reform objectives. The indicators are reliable and valid; each of the scales has reliabilities that fall in the high range. The indicators portray a comprehensive picture of the classroom practices to which engineering students are exposed. They also index gains in competencies deemed essential by the coalition of engineering schools. Moreover, classroom practices indicators are valid in that they predict self-reported gains in competencies. The indicators are also consistent with recommendations from the literature on teaching effectiveness (e.g. Murray, 1991); they index observable behaviors (e.g. instructor gives frequent feedback) rather than subjective impressions (e.g. the instructor is caring)

Appendix A:

ACCREDITATION BOARD FOR ENGINEERING AND TECHNOLOGY (ABET) ENGINEERING CRITERIA 2000

Criteria for Accrediting Programs in Engineering in the United States

Criterion 3: Program Outcomes and Assessment: Engineering programs must demonstrate that their graduates have:

a) an ability to apply knowledge of mathematics, science, and engineering

b) an ability to design and conduct experiments as well as to analyze and interpret data

c) an ability to design a system, component, or process to meet desired needs

d) an ability to function on multi-disciplinary teams

e) an ability to identify, formulate, and solve engineering problems

f) an understanding of professional and ethical responsibility

g) an ability to communicate effectively

h) the broad education necessary to understand the impact of engineering solutions in a global/ societal context

I) a recognition of the need for and an ability to engage in lifelong learning

j) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

References

Abrami, P.C. (1985). *Dimensions of effective college instruction*. Review of Higher Education, 8(3), 211-228.

Accreditation Board for Engineering and Technology (1998). *ABET 2000: Criteria for accrediting programs in engineering in the United States*. Baltimore, Maryland: ABET.

Astin, A. W. (1993). *What matters in college? Four critical years revisited*. San Francisco: Jossey-Bass.

Augustine, N. R. (1996). Rebuilding engineering education. *Chronicle of higher education,* May 24, 1996, B1-B2.

Belenky, M.F., Clinchy, B.M., Goldberger, N. & Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice, and mind.* New York: Basic Books.

Black, K. M. (1994). An industry view of engineering education. *Journal of engineering education, 83* (1), 26-28.

Borden, V.M.H. & Banta, T. W. (1994). *Using performance indicators to guide strategic decision making*. San Francisco: Jossey-Bass.

Bruffee, K. A. (1984). Collaborative learning and the "conversation of mankind." *College English, 46,* 635-652.

Bucciarelli, L. L. (1988). An ethnographic perspective on engineering design. *Design studies, 9*(3), 159-168.

Cabrera, A. F., Nora, A., Terenzini, P. T., Pascarella, E., & Hagedorn, L. S., (forthcoming). College racial climate and the adjustment of students to college: A comparison between White and African-American students. *Journal of higher education.*

Cabrera, A. F. & Nora, A. (1994). College students' perceptions of prejudice and discrimination and their feelings of alienation: A construct validation approach. *Review of Education/Pedagogy/Cultural Studies, 16*(3-4), 387-409.

Campbell, S. E., Bjorklund, S., & Colbeck, C.L. (1998). Grouping in the dark: What college students learn about communication from participating in group problem solving projects. Paper presented at the annual meeting of the American Educational Research Association, San Diego, CA., April, 1998.

Crockett, L. J. & Peterson, A. C. (1984). Biology: Its role in gender-related educational experiences. In E. Fenneman & M. J. Ayers, (Eds.), *Women and education: Equity or equality?* Berkeley, CA: McCutchan.

Dally, J. W., & Zhang, G. M. (1993). A freshman engineering design course. *Journal of Engineering Education, 82(2)*, 83-91.

Dougherty, C. & Fantaske, P. (1996). Defining expectations for problem-solving skills. In E. A. Jones (Ed.), *Preparing competent college graduates: Setting new and higher expectations for student learning* (pp. 55-66) New Directions for Higher Education, Vol. 96. San Francisco: Jossey Bass.

Drew, D. (1996). *Aptitude revisited: Rethinking math and science education for America's next century*. Baltimore, MD.: Johns Hopkins University Press.

Dym, C. L. (1994). Teaching design to freshman: Style and content. *Journal of Engineering Education, 83*(4), 303-310.

Eimers, M.T. & Pike, G. R. (1997). Minority and nonminority adjustment to college: Differences or similarities. *Research in Higher Education*, 38(1), 77-98.

Ewell, P. (1996). Identifying indicators of curriculum quality (pp. 608-632). In J.G. Gaff, J.L. Ratcliff and associates, *Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, practices, and change*. San Francisco: Jossey-Bass.

Ewell, P. T. (1987). *Assessment, accountability and improvement*. Washington, DC: American Association for Higher Education.

Fennema, E. & Sherman, J. A. (1977). Sex-related differences in mathematics achievement, spatial visualization, and affective factors. *American educational research journal, 4,* 51-72.

Ferguson, K. E. (1984). *The feminist case against bureaucracy*. Philadephia, PA: Temple University Press.

Finkelstein, M. J., Seal, R. K., & Schüster, J. H. (1998). *The new academic generation: A profession in transformation*. Baltimore, MD: The Johns Hopkins University Press.

Fleming, J. (1984). *Blacks in college: A comparative study of students' success in Black and in White institutions*. San Francisco: CA.: Jossey-Bass.

Gaff, J. G., Ratcliff, J.L. & Associates (1996). *Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, practices, and change*. San Francisco: Jossey-Bass.

Gamson, Z. F. (1994). Collaborative learning comes of age. In S. Kadel and J. A. Keehner (Eds.) *Collaborative learning: A source book for higher education, volume II,* pp. 5-17. State College, PA: National Center for Teaching, Learning, and Assessment.

Hackett, G. & Betz, N. E. (1992). Self-efficacy perceptions and the career-related choices of college students. In D. H. Schunk & J. L. Meece (Eds.) *Student perceptions in the classroom,* pp. 229-246.

Hall, R. M. & Sandler, B. (1982). *The classroom climate: A chilly one for women?* Project on the Status and Education of Women. Washington, D. C.: Association of American Colleges.

Hurtado, S. (1994). The institutional climate for talented Latino students. *Research in Higher Education*, 35, 21-41.

Hurtado, S. (1992). The campus racial climate: Contexts of conflict. *Journal of Higher Education*, 63, 539-569.

Janesch, A. (1996). General education objectives under review. *Penn State Intercom,* September 19, 1996, 3.

Jehn, K. A. (1997). A qualitative analysis of conflict types and dimensions in organizational groups. *Administrative science quarterly, 42*, 530-557.

Johnson, D. W., Johnson, R. T., & Smith, K.A. (1991). *Cooperative learning: Increasing college faculty instructional productivity.* ASHE-ERIC Higher Education Report No 4. Washington D. C.: The George Washington University, School of Education and Human Development.

Jones, E. A., Dougherty, C., & Fantaske, P. (1997). *Defining essential critical reading and problem-solving outcomes; Perspectives of faculty, employers and policy makers.* National Center on Postsecondary Teaching, Learning and Assessment, Center for the Study of Higher Education. Pennsylvania: State College: The Pennsylvania State University.

Jones, E. A., Hoffman, S., Moore, L., Ratcliff, J., Tibbetts, S. & Click, B. (1994). *Essential skills in writing, speech and listening, and critical thinking: Perspectives of faculty, employers and policy makers*. National Center on Postsecondary Teaching, Learning and Assessment, Center for the Study of Higher Education. Pennsylvania: State College: The Pennsylvania State University.

Jones, E. A. (1996). *Preparing competent college graduates: Setting new and higher expectations for student learning* (New Directions for Higher Education, No. 96). San Francisco: Jossey-Bass.

Jones, E. A. (1994). *Goals inventories*. National Center on Postsecondary Teaching, Learning and Assessment, Center for the Study of Higher Education. Pennsylvania: State College: The

Pennsylvania State University.

Kellogg Commission on the Future of State and Land-Grant Universities. (1997). *Returning to our roots: The student experience.* Washington D.C.: National Association of State Universities and Land-Grant Colleges.

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.

Lopez, C. L. (1996). *Opportunities for improvement: Advice from consultant-evaluators on programs to assess student learning.* Chicago, IL: North Central Accreditation Commission on Institutions of Higher Education.

Mckeachie, W. (1990). Research on college teaching: The historical background. *Journal of educational psychcology, 82* (2), 189-200.

McKeachie, W. (1988). Teaching thinking. *Update, 2*(1), 1.

Murray, H. G. (1991). Effective teaching behaviors in the college classroom. In J.C. Smart (Ed.) *Higher education: Handbook of theory and research, Vol. VII* (pp. 135-172). New York: Agathon Press.

National Education Goals Panel (1992). *The National Education Goals Report: Building a Nation of Learners.* Washington, DC: U.S. Government Printing Office.

National Science Foundation, Directorate for Education and Human Resources (1996). *Shaping the future: New expectations for undergraduate education in science, mathematics, engineering, and technology.* (NSF-96-139).

Nedwek, B. P. & Neal, J. E. (1994). Performance indicators and regional management tools: A comparative assessment of projects in North American and Europe. *Research in Higher Education, 35(1),* 75-104.

Oakes, J. (1990). Opportunities, achievement, and choice: Women and minority students in science and mathematics. In C. B. Cazden, (Ed.) *Review of research in education, Vol. 16* (pp. 153-222).

Pascarella, E. & Terenzini, P. T. (1991). *How college affects students.* San Francisco: Jossey-Bass.

Pascarella, E. (1985). College environmental influences on learning and cognitive development: A critical review and synthesis. In J. C. Smart, (Ed.), *Higher education: Handbook of theory and research, Vol. 1* (pp. 1-61). New York: Agathon.

Pike, G. R. (1995). The relationship between self reports of college experiences and achievement test scores, *Research in Higher Education, 36(1)*, 1-22.

Sadker, M. & Sadker, D. (1986). Sexism in the classroom: From grade school to graduate school. *Phi Delta Kappan, 67* (7), 512-515.

Sax, L. J. (1994). Retaining tomorrow's scientists: Exploring the factors that keep minority and female college students interested in science careers. *Journal of women and minorities in science and engineering, 1,* 45-61

Schon, D. A. (1987). *Educating the reflective practitioner.* San Francisco: Jossey-Bass.

Seymour, E. & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences.* Colorado, Boulder: Westview Press.

Stark, J. S., & Lowther, M. A. (1989). Exploring common ground in liberal and professional education. In R. A. Armour & B. Fuhrmann (Eds.) *Integrating liberal learning and professional education* (New Directions for Teaching and Learning, No. 40, pp. 7-20). San Francisco: Jossey-Bass.

Strenta, A. C., Elliott, R., Adair, R. Matier, M, & Scott, J. (1994). Choosing and learning sciences in highly selective institutions. *Research in higher education, 35*(5), 513-548.

Suter, L. E. (Ed.) (1996). *The learning curve: What we are discovering about U.S. science and mathematics education.* Washington DCL National Science Foundation. (NSF-96-53)

Tinto, V. (1997). Classrooms as communities: Exploring the educational character of student persistence. *Journal of Higher Education, 68*(6), 599-623.

Volkwein, J. F. & Cabrera, A.F. (1998). *Student measures associated with favorable classroom experiences.* Paper presented at the Association of Institutional Researchers Forum. Minneapolis: MN.

Volkwein, J. F. & Lorang, W. (1996). Characteristics of extenders: Full-time students who take light credit loads and graduate in more than four years. *Research in higher education, 37* (1).

Volkwein, J. F. (1991). Improved measures of academic and social integration and their association with measures of student growth. Paper presented at the annual meeting of the Association for the Study of Higher Education, Boston, MA, November, 1991.

Whitt, E. J., Edison, M. I., Nora, A. & Terenzini, P. T. (1998). *Perceptions of a "Chilly Climate" and cognitive outcomes during college.* Paper presented before the annual meeting of the Association of Educational Researchers. California, San Diego.

Table 1. Descriptive statistics

Variable	N	% Cell	Mean	S.D.	Reliabilty
Gender					
Male	359	77.2			
Female	106	22.8			
Ethnicity					
African-American	69	14.4			
Asian-American	108	22.5			
Hispanic	32	6.7			
Native-American	5	1.0			
White	216	45.0			
Highest parental education	456		5.10	1.76	
Ability					
Sat Math	280		644.59	87.34	
Sat Verbal	279		546.11	101.28	
High School GPA	372		3.59	.40	
Highest degree expected	470		2.03	.62	
Class year	461		2.39	1.07	
Teaching practices:					
Instructor Interaction & Feedback	426		2.59	.65	.92
Collaborative Learning	444		2.93	.77	.83
Clarity & Organization	459		3.17	.67	.81
Gains in:					
Group Skills	420		2.69	.84	.92
Problem Solving	432		2.85	.68	.90
Design Skills	439		2.70	.74	.87
Classroom Climate	437		3.68	.57	.89

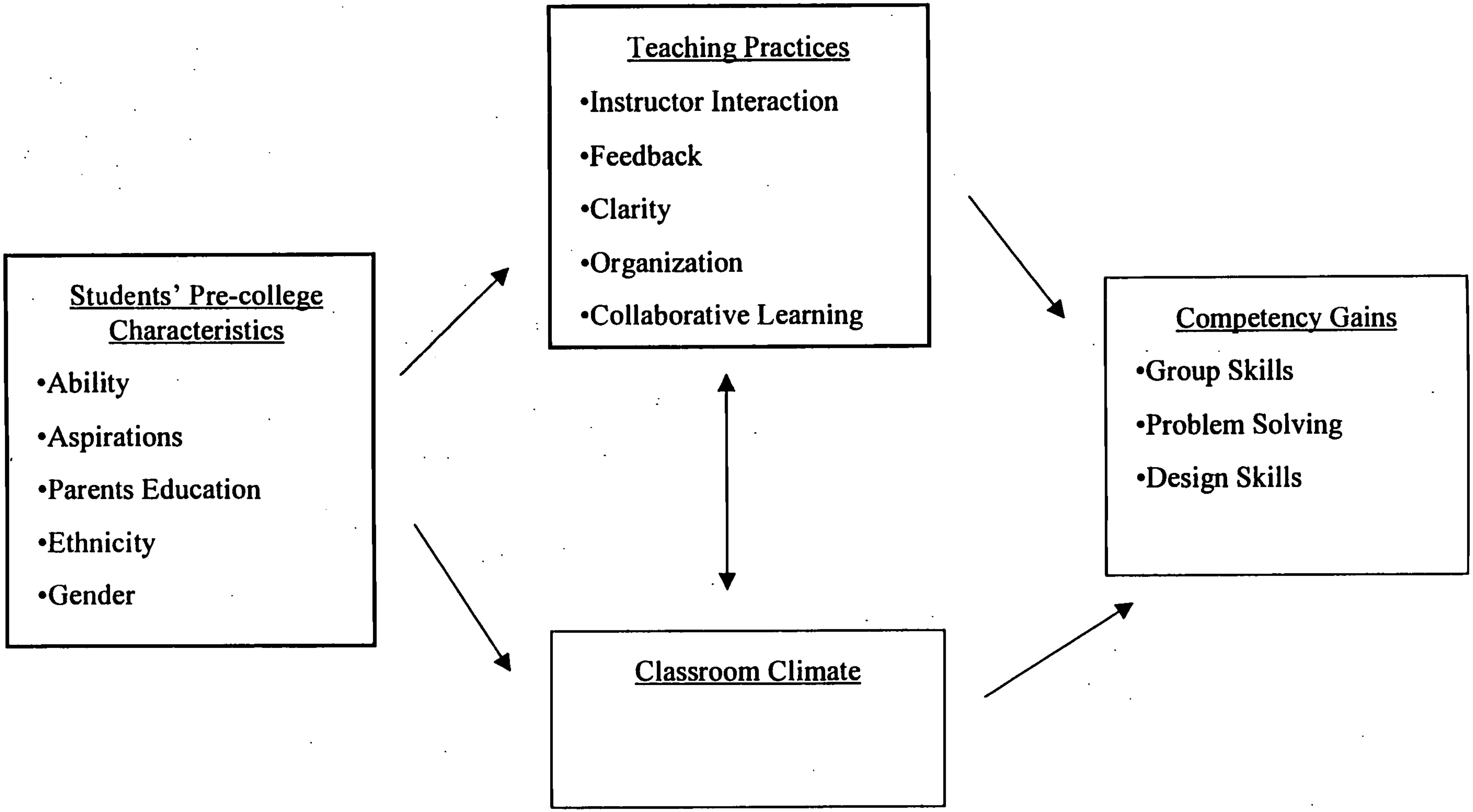

Figure 1. Teaching for Professional Competence Model

Table 1. Descriptive statistics

Variable	N	% Cell	Mean	S.D.	Reliabilty
Gender					
Male	359	77.2			
Female	106	22.8			
Ethnicity					
African-American	69	14.4			
Asian-American	108	22.5			
Hispanic	32	6.7			
Native-American	5	1.0			
White	216	45.0			
Highest parental education	456		5.10	1.76	
Ability					
Sat Math	280		644.59	87.34	
Sat Verbal	279		546.11	101.28	
High School GPA	372		3.59	.40	
Highest degree expected	470		2.03	.62	
Class year	461		2.39	1.07	
Teaching practices:					
Instructor Interaction & Feedback	426		2.59	.65	.92
Collaborative Learning	444		2.93	.77	.83
Clarity & Organization	459		3.17	.67	.81
Gains in:					
Group Skills	420		2.69	.84	.92
Problem Solving	432		2.85	.68	.90
Design Skills	439		2.70	.74	.87
Classroom Climate	437		3.68	.57	.89

Table 2. Classroom Practices: Factor Analysis

Item	Factor Loadings			
	Instructor Interaction & Feedback	Collaborative Learning	Clarity & Organization	Classroom Climate
Encouraged to learn from others	.82			
Instructor guides learning, rather than lecturing	.81			
Interact with instructor as part of the course	.78			
Instructor emphasizes design process	.73			
Instructor gives detailed feedback on work	.67			
Encouraged to challenge instructor/student ideas	.63			
Instructor gives frequent feedback on work	.62			
Opportunities to practice skills learned in class	.53			
Interact with instructor outside class	.53			
Encouraged to apply concepts to problems	.51			
Collaborate with other students on assignments		.80		
Discuss ideas with classmates		.78		
Get feedback from classmates		.71		
Interact with students in course outside class		.70		
Students teach and learn from one another		.69		
Opportunities to work in groups		.67		
Assignments & class activities clearly explained			.86	
Instructor makes clear expectations of activities			.79	
Assignments & class activities are interrelated			.76	
Students are treated the same regardless of gender				.94
Students are treated the same regardless of race				.91
Internal Consistency Reliability (Alpha)	.92	.83	.81	.89

Table 3. Learning Outcomes: Factor Analysis

Item	Factor Loadings		
	Group Skills	Problem-Solving Skills	Design Skills
Progress made in:			
Being aware of feelings of members in group	.85		
Listening to ideas of others with open mind	.85		
Working on collaborative projects as member of a team	.83		
Developing ways to resolve conflict & reach agreement	.82		
Asking probing questions that clarify facts, concepts	.68		
Organizing information to aid comprehension	.67		
Evaluating alternatives that build upon previous work	.63		
Dividing problems into manageable components		.80	
Developing several methods to solve problems		.72	
Ability to clearly describe a problem orally		.71	
Ability to clearly describe a problem in writing		.70	
Ability to identify information needed to solve problem		.68	
Ability to use criteria to evaluate & prioritize problems		.66	
Ability to apply abstract concepts to real problems		.66	
Understanding of the process of design in engineering			.78
Understanding language of design in engineering			.72
Understanding what engineers do			.68
Understanding engineering has a non-technical side			.67
Ability to do design			.67
Internal Consistency Reliability (Alpha)	.92	.90	.87

Table 4. Contribution of Teaching Practices to Variance in Professional Competencies

Outcome	R^2 Baseline Model[1]	R^2 Adding Teaching Practices	R^2 Change
Gains in:			
Group Skills	.098	.397	.299*
Problem Solving	.059	.322	.263*
Design Skills	.085	.396	.311*

[1] Baseline model controls for pre-college characteristics, academic ability, motivation, class year and classroom climate.

*** $p < .05$**

Table 5. Regression results (Standardized Betas)

Variable	Group Skills	Problem Solving Skills	Design Skills
Male	.004	-060	-.070
Ethnicity			
African-American	.101	.124**	.092**
Asian-American	.085	.094*	.090**
Hispanic	.070	.016	.057
Highest parental education	-.079*	-.006	-.010
Ability			
Sat Math	-.076	.031	-.037
Sat Verbal	-091*	-.019	-.067
High School GPA	.007	.026	-.011
Highest degree expected	-.082*	-.017	-.030
Class year	.004	-.013	.041
Teaching practices:			
Instructor Interaction & Feedback	.264**	.253**	.304**
Collaborative Learning	.394**	.212**	.220**
Clarity & Organization	-.040	.199**	.190**
Classroom Climate	-.065	.038	.024
R^2	.397	.322	.396
R^2 adjusted	.378	.302	.378
***F* test**	21.83**	15.78**	21.80**

*** $p < .05$; ** $p < .01$**

Table 6. Group Differences in Gains in Professional Competencies and perceptions of Classroom Climate

	Means		*t*-test of means	***p-value***
	White Male	Female		
A. Gains				
Group Skills	2.55	2.71	-1.33	.184
Problem-Solving Skills	2.73	2.90	-1.88	.062
Design Skills	2.58	2.78	-2.05	.042
B. Classroom Climate	3.74	3.63	1.44	.151

Table 7. Regression results for females and White males (Standardized Betas)

	Group Skills		Problem Solving		DesignSkills	
Variable	**White Male**	**Female**	**White Male**	**Female**	**White Male**	**Female**
Highest parental education	.064	-.154	-.026	.017	-.067	-.029
Ability						
Sat Math	-.087	-.133	.062	.117	-.061	.036
Sat Verbal	-.002	-.090	-.044	-.021	.005	-.093
High School GPA	-.004	-.007	.083	-.027	.020	-.001
Highest degree expected	-.048	-.108	-.063	.018	.006	-.023
Class year	.053	-.019	-.033	.026	.044	-.042
Teaching practices:						
Instructor Interaction & Feedback	.338**	.369*	.391**	.355*	.414**	.373**
Collaborative Learning	.388**	.337*	.098	.207*	.092	.282*
Clarity & Organization	-.015	-.105	.143	.203*	.131	.157
Classroom Climate	-.146*	.016	.024	.050	-.053	.086
R^2	.451	.428	.293	.421	.318	.499
R^2 **adjusted**	.414	.368	.246	.360	.272	.447
***F* test**	12.39**	7.12**	6.25**	6.92**	7.03**	9.48**

BEST COPY AVAILABLE

NOTICE

REPRODUCTION BASIS

- [x] This document is covered by a signed "Reproduction Release (Blanket) form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

- [ ] This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").