The Urgent Need to Encourage Aspiring Engineers: Effects of College Degree Program Culture on Female and Minority Student STEM Participation

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Abstract - As experts in technology continue to rapidly advance knowledge and technical capabilities in their field, the United States is faced with an increasing need to enhance student interest and retention in technology fields, particularly engineering programs. The first purpose of this paper is to describe the current state of retention in the STEM education and work force, with particular focus on Hispanic and female students. The second purpose of this paper is to establish the need for research that can provide insight as to how to both engage and retain engineering students. A comprehensive description of our research plan and potential implications of this on-going study will be discussed.

Keywords –College Degree, Female Students, Minority Students, Student retention, STEM Education

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La Necesidad Imperiosa de Alentar a los Aspirantes a Ingeniería: Efectos de la Cultura del Programa de Grado sobre la Participación de Mujeres y Estudiantes Minoritarios en STEM

Resumen – A medida que los expertos en tecnología continúan avanzando rápidamente los conocimientos y las capacidades técnicas en sus campos, los Estados Unidos enfrentan una necesidad creciente para aumentar el interés y la retención de los estudiantes en campos tecnológicos, especialmente en los programas de ingeniería. El primer propósito de este trabajo es describir el estado actual de retención en la educación y fuerza de trabajo en Ciencias, Tecnología, Ingeniería, y Matemáticas (STEM), enfocándose en particular en los estudiantes hispanos y mujeres. El segundo propósito es establecer las necesidades de investigación que puedan proveer indicaciones sobre como involucrar y retener estudiantes de ingeniería. Se discuten nuestro plan de investigación y las potenciales implicaciones de este estudio en desarrollo.

Palabras claves – Grado, Estudiantes mujeres, Estudiantes minoritarios, Educación en STEM, Retención de estudiantes

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INTRODUCTION

The landscape of the workforce is changing. Employment in science, technology, engineering and mathematics (STEM) fields is projected to increase three times faster than employment in all other occupations by 2010 (National Science Board, 2002). Additionally, twenty-five percent of U.S. scientists and engineers will reach retirement age by 2010 (BEST Report, 2004). The Bureau of Labor Statistics projects that our greatest needs in the future will be in the computer-related fields that drive innovation.

The changes in occupational opportunities are accompanied by a change in the demographics of the workforce. Women and minorities, particularly individuals of Hispanic descent, are the fastest growing segments of our workforce. By 2010, women will earn more degrees than men at every level of higher education from the associate to the doctoral level. By 2015, the nation's undergraduate population is expected to expand by more than 2.6 million students, 2 million of whom will be students of minority status. In order to produce sufficient numbers of STEM workers to remain competitive in the global economy, the U.S. will need to find

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Note. The manuscript for this paper was submitted for review and possible publication on January 1, 2007; accepted on June 20th, 2007. This paper is part of the *Latin American and Caribbean Journal of Engineering Education*, Vol. 2, No. 1, pp. 57-63, December 2007. © LACCEI, ISSN 1935-0295.

ways to encourage women and minorities to enter these fields (CEOSE Report, 2000, p. 41).

Considerable evidence from the research literature indicates that certain aspects of STEM disciplines' traditional climates and cultures appear to consistently work against the presence of underrepresented groups (Fennema & Peterson, 1985; Brown & Clewell, 1998; Etzkowitz, Kemelgor, & Uzzi, 2000; Herzig, 2004). Orientations such as student rather than institution, collaborative rather than competitive, and collegial rather than bureaucratic have been found to be associated with increased success for all students, and particularly for underrepresented minority members and female students (Smith, et. al., 1997; Berger, 2003; Noel, Levitz, & Saluri, 1985; Braxton, 2002; Tinto, 1975, 1982, 1988, 1993).

In this paper, we describe the projected changes in both the types of occupations that will be available in the future and the education requirements for these positions. Additionally, we review the literature concerning Hispanics and female student retention in STEM fields. Organizational culture and climates, as well as their potential impact on STEM program retention rates are discussed. Finally, we discuss the particular research questions we are addressing in our current study and the methods we are currently using to address these questions.

CHANGES IN OCCUPATIONAL OPPORTUNITIES AND EDUCATIONAL REQUIREMENTS

The changing occupational arena is reflected in the latest projections by Bureau of Labor Statistics data (Hecker, 2005), reporting professional occupations (one of 10 major occupations groups) as the fastest increasing, overall adding the most new jobs by 2014 (6 million). Among professional and related occupations, computer and mathematical science occupations are projected to grow the most rapidly, adding approximately 967,000 jobs. These increases can be attributed to the growing complexity and sophistication of technologies adopted by organizations, such as networking, information sharing, internet and server security, electronic commerce, and the stabilization of computer hardware and software prices. Computer and mathematical science are expected to account for almost 75% of the new jobs in the professional occupations category (Table 1). These trends in job growth highlight the need for an ever-increasing number of STEM workers to enter the work force.

Table 1. Projected Fastest Growing Professional Occupation Groups

Occupational group	Numeric change (in thousands)	Percent change
Computer and mathematical science	967	30.7
Health care practitioner and technical	1756	25.8
Education, training and library	1740	20.8
Community and social services	483	20.0
Life, physical and social science	216	16.4
Legal	194	15.9
Arts, design, entertainment, sports, and media	375	14.9
Architecture and engineering	315	12.5

However, growth in computer and mathematical science occupations is slower than in recent decades due to widespread outsourcing of computer and technical jobs overseas. U.S. high schools and universities do not produce sufficient numbers of students who pursue and persist in these programs to meet the needs of our expanding job market (NSF, 1999). Additionally, U.S. students have also shown a declining interest in mathematics and science coursework and related careers (Adleman, 2004; US DOE, 2000). It is no longer possible to keep up with the growing demand for STEM workers without a renewed focus on engineering, science and mathematics in our educational system, particularly in the postsecondary stages.

Advances made in computer technology, such as voice recognition, and the rapid growth of business conducted electronically contribute to job declines among administrative support personnel. These technological changes lessen the demand for office staff, such as word processors and file clerks. Consequently, the technological advances that contribute to the rapid loss of such jobs also form the foundation for growth of other occupations, such as computer and network administrators.

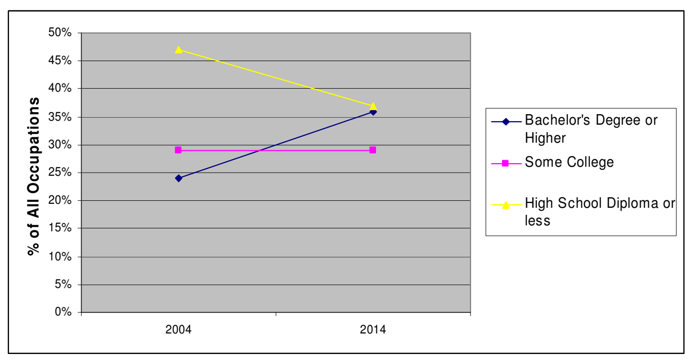

Figure 1. Projected changes in educational requirements for jobs by 2014.

Trends in educational requirements for the work force can be identified by examining changes in educational requirements for occupations. To examine the distribution of educational attainment across occupations, the Bureau of Labor Statistics (BLS) divided educational attainments into three categories: high school graduate or less, some college (including associate's degree) and bachelor's degree or higher. Of the 750 occupations included by in BLS analysis, the occupations that require a bachelor's degree or higher are expected to increase from 24 to 36% between 2004 and 2014. Jobs that require a high school diploma or less are predicted to drop from 47% of jobs held in 2004 to 36% of the jobs available in 2014 (See figure 2). There is a clear trend predicted which indicates an increase in the need for college-educated workers and a decrease in the need for workers with only a high school degree who receive on-the-job training. Additionally, there is increasing need for college-educated workers that the current labor market cannot fill. These examples underscore the need for higher educational institutions to engage and retain STEM students. This need particularly pertains to Hispanic and female students, who constitute the most rapidly growing groups in the U.S. university system, as well as the workforce.

HISPANICS IN EDUCATION AND ENGINEERING

Enrollment and graduation trends parallel population trends, with increasing percentages of Hispanic and female students. Between the years 1996 and 2003, the Florida State University system (FL SUS) has seen the number of entering undergraduate students in each year increased from approximately 54,000 to more than 72,000 students during this period. All non-white groups increased in representation at entry during this time, with increases of 2% for Hispanic students, from 15 to 17% of total FL SUS enrollment (Micceri, 2006). Over the past two decades, the presence of Hispanic students in secondary educational institutions has tripled (NCES, 2001), with the largest increases of Hispanic student enrollment at community colleges. This increase in enrollment has led to a surge in research and political interest in Hispanic college students.

In 1996, African Americans, Hispanics, and Native Americans made up 23% of the 18 to 29 year-old age group (US DOE, 2000), but these minority groups combined account for only 17% of the associate's degree recipients and only 14% of the Bachelor's degree recipients in science and engineering in the same time period. Hispanics are underrepresented in both mathematics and physical sciences; only 9% of graduates in mathematics and physical sciences are Hispanic while Hispanics make up 14% of the population (Micceri, 2006). Over the past 10 years, Hispanic students have shown consistent growth in a number of college majors including mass communication, education, biological sciences, mathematics and business and management. Hispanic students have historically been overrepresented is architecture and foreign language disciplines; however, the over representation of Hispanic students in these fields has diminished as they presence become increasingly prevalent in other fields (Micceri, 2006).

In the late 1990's, the percentage of Hispanic freshmen intending to pursue a science and engineering degree was significantly higher than that of Caucasian freshmen (US DOE, 2000). The percentage of Hispanic students intending to pursue a science and engineering degree was so high that the number of overall minorities intending to pursue science and engineering careers was equivalent to or higher to that of Caucasians during the first years of college. There is an immense difference between the number of minority students intending to major in STEM fields and the much smaller number who actually obtain a STEM degree. This indicates that there is a high attrition rate for Hispanic students in STEM degree programs, and that their attrition rate is much higher than that of their Caucasian counterparts.

WOMEN IN EDUCATION AND ENGINEERING

The field of education has been changed dramatically by women over the past 50 years. While historically women were significantly less likely to complete high school than their male counterparts, women today are more likely complete not only high school but also to attain bachelor's degrees than men. Women of all racial and ethnic backgrounds are more likely to complete college than men, with Hispanic women demonstrating a 2% advantage in graduation rates than Hispanic men in higher education institution within the United States (Coley, 2001).

When women are overrepresented in specific disciplines, they tend to dominate the disciplines by making up 80% or more of all graduates from that discipline (Micceri, 2006). This pattern can be seen in the graduation rates for women in the disciplines of education, human sciences, psychology, public administration and services, and health professions and related sciences. Over the past 10 years, women have shown steady increases in representation and higher graduation rates in several broad disciplines, including architecture, engineering, engineering technology, interdisciplinary sciences, and physical and related sciences over the past ten years. Female representation and graduation rates have shown comparatively steady decreases in computer and information sciences and human sciences.

Despite women's overwhelming growth in enrollment and graduation rates, women are still less likely to major and attain degrees in the traditionally defined "hard" sciences and engineering (Astin, Korn, Sax, & Mahoney, 1994). This finding is consistent across all racial/ethnic groups. Women are most notably underrepresented in engineering. In general, women earn 51% of bachelor degree annually. However, women earned only 18% of engineering bachelor's degrees awarded in 1996 (US DOE, 2000). The discrepancy between female representation in higher education and female representation in engineering degree programs is demonstrably massive.

Researchers have found that the underrepresentation of women in STEM majors, particularly engineering, increases throughout the undergraduate years, indicating that the attrition rate of women from STEM degree programs is higher than the attrition rate of men from those same programs (Astin & Astin, 1993). Several reasons for the difference in attrition rates have been identified and substantiated by researchers. STEM faculty have been found to create an academic atmosphere that is unwelcoming to women, while not directly discriminating against female students (Seymour & Hewitt, 1997). Female STEM students have been found to feel less comfortable asking questions and have lower confidence about completing their degrees than male STEM students (Henes, Bland, & McDonald, 1995). Women in STEM program also report feelings of alienation and depression, which led the student to leave the program (Arnold, 1987). All of these explanations for higher attrition rates for women in

STEM fields related to the overall academic culture we will be examining in this study.

PROGRAM CULTURE AND CLIMATE

There is a substantial body of research and theory regarding organizational culture that cuts across a variety organizations, including academic environments. Both climate and culture focus on understanding psychological phenomena in organizations, and both assume that organization members have a shared understanding of certain aspects of the organizational context. These two constructs overlap one another; however, it is worthwhile to make a distinction. Organizational culture is made up of organization members' fundamental ideologies and assumptions, their espoused values, and the organization's symbols and other observable artifacts. Climate involves organization members' perceptions of the organization or situation, that is, their perceptions of what it is like in terms of practices, policies, procedures, routines and rewards. Ostroff, Kinicki, and Tamkins (2003) suggest that climate can be viewed as experiential descriptions or perceptions of what happens in organizations, whereas culture helps define why these things happen.

Climate and culture have emerged from different research traditions. Research on organizational culture has its roots in anthropology and relies heavily on qualitative methods, such as participant observation and interviews. Climate focuses on organization members' perceptions, and as such is typically assessed quantitatively through surveys. Culture can be viewed as existing in layers or levels that vary along a continuum of accessibility and subjectivity. The examination of culture often includes studying observable artifacts, espoused values, and basic underlying assumptions (ideologies). Artifacts are relatively accessible, but often difficult to interpret. At the other end of the spectrum, organization members are sometimes not even aware of their underlying assumptions and these can be very difficult to measure.

Climate can be measured in terms of a few global dimensions, such as structure, support, or innovation. This approach assumes that people develop a global or summary perception of their organizations. It has been suggested that climate might be better conceptualized and studied as a more specific construct that has a strategic focus related to the organization's goals (Schneider, Bowen, Ehrhart, & Holcombe, 2000), that is, a "climate for" something, such as a climate for service. Along these lines, we could hypothesize that college programs and/or departments can have a "climate for student retention." This climate might be related to some more global dimensions (e.g., support, cooperation) or it could involve more specific practices and perceptions.

Research has also demonstrated that cultures and climates can exist at different organizational levels of analysis. Culture researchers, for example, have documented the existence of subcultures (e.g., Hofstede, 1998), and climate researchers propose that functions, departments, or groups within an organization may develop different climates (e.g., Schneider & Bowen, 1985). That is, the content of the culture and climate can vary across groups within the organization. This supports the premise in our proposed research that particular programs and/or college departments will have cultures and climates that are, at least on some ways, distinct from that of the entire college or university.

Organizational culture is expected to impact organizational structure, practices, policies and routines, which in turn provide the context for members' climate perceptions (Tesluk, Farr, & Klein, 1997). Finally, the collective attitudes and behaviors of members are shaped by climate and in turn impact organizational effectiveness and efficiency. A well-developed, business-specific culture is thought to underpin stronger organizational commitment, higher morale, more efficient performance, and generally higher productivity (Peters & Waterman, 1982). However, reviews of research on the link between culture and financial performance have found the evidence for this to be weak (Siehl & Martin, 1990). Little research has been conducted on relationships between culture and other types of criteria. In one notable exception, Sheridan (1992) found that organizations that emphasized interpersonal relationship values as opposed to task values were more likely to retain newly graduated accounting employees. Climate measured at the individual, unit, and organization level has been found to be related to a variety of important organizational outcomes including performance, satisfaction, stress, commitment, helping behavior, turnover intentions, absenteeism, and involvement (see Ostroff et al., 2003 for a review). This has clear implications for the effects of climate/culture on students in STEM programs.

CURRENT RESEARCH AND IMPLICATIONS

The research being undertaken will result in a much needed, comprehensive understanding of the complex relationship that exists between the environment of the program and its' students' persistence and success in that program. Specifically, the examination of the culture and climate of STEM programs that succeed in encouraging student enrollment and retention that our study is undertaking holds promise for identifying strategies that will lead to increased student engagement and retention. There is explicit attention paid to programs that recruit and retain members of underrepresented groups, including Hispanic students and women, in part because they are the fastest growing sectors of the U.S. workforce. It is imperative to attract and maintain their interest in STEM education and careers; it is in these fields that there are the fastest growing employment opportunities. This outcome will promote a healthy economy by ensuring a diverse and well-qualified STEM workforce.

The knowledge gained during this investigation of program culture and climate has implications for higher education policy throughout the U.S. There is an opportunity to develop interventions and recommend best practices to STEM programs that focus on creating a culture that fosters support for a diverse population of students. An additional focus of these recommendations can be strategies to increase undergraduate students' interests in and ability to obtain degrees in STEM fields.

With the partnership of several state universities, we have the opportunity to investigate a) how the climate and culture of certain STEM degree programs facilitate or inhibit the recruitment, retention, and matriculation of students, especially from underrepresented groups and b) determine the extent of alignment between the STEM program culture and the current practices and climate of the program. Civil and Electrical Engineering and Chemistry were chosen as a sample of the vast number of possible STEM undergraduate programs. These programs were highlighted because of their uniform existence across all public Florida universities as well as their large enrollment numbers and distribution of gender and ethnicities. In addition, engineering was emphasized because: (1) the need for U.S. engineers is growing; (2) engineering comprises a major area where women are underrepresented; and (3) engineering has a larger number of graduates compared to other STEM programs. Four public institutions of higher education have participated in this research, and another four institutions are slated to participate in the coming months. They vary by size and scope of undergraduate programs and relative success in graduating women and minority students as well as all students in STEM majors.

We have developed a research plan that employs a mixed methods approach, assessing program culture, climate, and context at multiple levels and using both qualitative and quantitative techniques. This is a multi-phasic plan for which includes two targeted site visits to each program at each institution over a two year period.

The first phase of data collection includes a qualitative investigation of Electrical and Civil Engineering program culture at four large, state universities. The qualitative assessment of academic program culture will be accomplished through department observations, interviews and focus groups that describe program-related experiences, and an assessment of culture-related structural characteristics and practice. The second phase of data collection complements the first by quantitatively assessing the culture and climate of the Civil and Electrical Engineering programs. The quantitative assessment of program culture and climate involves the use of previously published surveys as well as the development and implementation of a new measure of climate designed specifically for this project. The third and fourth phases of the research mirror the first two, but will be conducted with Chemistry programs instead of Engineering at the same universities.

METHODS TO STUDY CULTURE

There are a number of ways to study the culture of a group, such as an academic program, and this project drew heavily from ethnographic methodology to accomplish this goal. Observations of the physical environment and the social interactions between members of each department were conducted. These observations provided insight into the structural characteristics that may impact students, such as class size (Hancock, 1996) and available resources (Wimshurst, Wortley, Bates & Allard, 2006). They also allow a first-hand look at the types of interactions that occur among students and between other members of the department. A structured protocol was developed to ensure that all of the culture relevant information was captured and that we collect comparable information across all of the programs.

One-on-one interviews provide a rich source of information about a program's values and practices. Semi-structured (Bernard, 1995) interviews were developed in order to gather information from key program representatives. Participants included department chairs, professors, and other program staff such as secretaries and/or office managers who are deemed knowledgeable about program culture due to their years of experience in the department. Additionally, many students were interviewed about their educational and social experiences in the program.

In addition to the individual interviews, focus groups were assembled for a more informal, group discussion. In order to encourage openness and participation, separate focus groups were conducted for important demographic subgroups, such as women or Hispanic students (Bernard, 1995). The discussion topics for focus groups included sources of support both in and outside of the program, educational opportunities and barriers, and other student-relevant issues.

To compliment the detail-rich data collected using these qualitative methods, a number of quantitative measures will also be distributed. Surveys have been professionally developed to measure espoused organizational values, and many have been found to have adequate reliability and validity (Cooke & Lafferty, 1987). Other constructs will also be measured via paper-and-pencil survey, including socialization into the program (Ostroff & Kozlowski, 1992), commitment to the program (Allen & Meyer, 1990), and satisfaction with the program (Awal & Stumpf, 1981). We will administer these measures to students and program representatives who are in a position to define and interpret the culture of the program.

In addition to the instruments discussed above, a new scale has been developed specifically for the purposes of this research, but has wide-spread appeal for future use. The objective of this scale is to identify the factors likely to define a "climate for student retention" based on global dimensions as well as specific practices and perceptions. This instrument will provide valuable information about how members of the department perceive the culture of their program and help determine how well the culture and the practices of the program fit together.

This multi-dimensional retention climate scale was created using a number of resources. Primarily, the results of the qualitative culture assessments were used to develop the scale. Prevalent themes from the interviews and focus groups provided the base of knowledge needed to generate dimensions and items for the scale. For example, many student interviews echoed the importance of participating in academically-oriented student groups, especially ones that also bring together students from similar ethnic or racial backgrounds. Another common theme among student interviews and focus groups stressed the importance of creating strong peer networks for both academic and social support. In addition, existing scales of educational climate were referenced to ensure that a wide range of relevant dimensions were represented. For example, the College Senior Survey (CSS) measures a variety of student experiences, such as satisfaction, involvement, academic achievement, and career plans. The Cooperative Institutional Research Program (CIRP) provides predictive data for student retention (Astin and Oseguera, 2005) by focusing on individual student characteristics upon entering an academic program. Both the CSS and the CIRP were developed by the Higher Education Research Institute at UCLA. Finally, one climate survey measures the interaction between gender and classroom experiences as they relate to STEM retention in college (Wyer, 2003).

CONCLUSION

Our primary objective in the proposed project is to understand the culture and other organizational conditions that promote successful completion of undergraduate degrees in STEM by all students, with particular emphasis on the women and minority students enrolled in these programs. Our results will also allow us to determine the extent of alignment between the STEM program culture and the climate experienced by undergraduate students. The culture factors found unique to the successful STEM programs can serve as benchmarks to provide best practices and specific recommendations concerning more effective, efficient interventions to modify the climate and culture in order to improve retention, especially among the underrepresented populations.

ACKNOWLEDGMENT

Support for this work was provided by the National Science Foundation's Research on Learning and Education Program under Award No. 0337543. The authors wish to thank two anonymous reviewers for their comments on an earlier version of this article.

REFERENCES

Adleman, C. (2004). Principal indicators of academic histories in postsecondary education: 1972-2000. Washington, D.C.: U.S. Department of Education.

Allen, N. J., and Meyer, J. P. (1990). The Measurement and Antecedents of affective, continuance and normative commitment to the organization. *Journal of Occupational Psychology*, 63(1), 1-18

Arnold, K.D. (1987). Values and vocations: The career aspirations of academically gifted females in the first five years after high school. Paper presented at the Annual Meeting of the American Educational Research Association, Washington, D.C.

Astin, A.W., & Astin, H.S. (1993). Undergraduate Science Education: *The Impact of Different College Environments on the Educational Pipeline in the Sciences.* Los Angeles, CA: Higher Education Research Institute, U.C.L.A.

Astin, A. W., Korn, W. S., Sax, L. J., & Mahoney, K. M. (1994). National Norms for Fall 1994. *The American Freshman*. Los Angeles: Higher Education Research Institute, UCLA.

Astin, A., & Oseguera, L. (2005). Degree Attainment Rates at American Colleges & Universities. Los Angeles: Higher Education Research Institute, UCLA.

Awal, D., and Stumpf, S. (1981). Differentiating between perceived organization and work group climates. *Journal of Management,* 7(1), 33-42.

Bernard, H. Russell (1995). Research Methods in Anthropology: Qualitative and Quantitative Approaches. Walnut Creek, CA: AltaMira Press.

Berger, J.B. (1998). The impact of organizational behavior at colleges on student satisfaction. Paper presented at the annual meeting of the Association for the Study of Higher Education (ASHE), Miami, FL.

BEST (Building Engineering & Science Talent) Report. 2004. "A bridge for all: Higher education design principles to broaden participation in Science, Technology, Engineering, and Mathematics." San Diego, CA.

Braxton, J.M. (2002). The fostering of social integration and retention through institutional practice. Journal of Student Retention, 3:1, pp. 57-71.

Brown, Shirley V. & Clewell, Beatriz Chu. (1998, January). Project talent flow: The non-SEM field choices of Black and Latino undergraduates with the aptitude for science, engineering and mathematics careers. Report presented to the Alfred P. Sloan Foundation.

Cammann, C., Fichman, M., Jenkins, D., & Klesh, J. (1979). The Michigan Organizational Assessment Questionnaire. Unpublished manuscript, University of Michigan, Ann Arbor.

Coley, R. J. (2001). Differences in the Gender Gap: Comparisons across Racial/Ethnic Groups in Education and Work. Policy Information Report. Educational Testing Service: Princeton, NJ.

Committee on Equal Opportunities in Science and Engineering-CEOSE. (2000). *2000 Biennial Report to the US Congress.* Technical report. Downloaded from the WWW on February 3, 2005: http://www.nsf.gov/pubs/2001/ceose2000rpt/start.htm

Cooke, R. A., and Lafferty, J. C. (1983) Level V: Organizational Cultural Inventory-form I. Plymouth, MI: Human Synergistics.

Etzkowitz, H., Kemelgor, C. & Uzzi, B. (2000). Athena unbound: The advancement of women in science and technology (Vol. 19). Cambridge, England: Cambridge University Press.

Fennema, E. & Peterson, P. (1985). Autonomous learning behavior: A possible explanation of gender-related differences in mathematics. In L.C. Wilkinson & C.B. Marrett (Eds.). Gender influences in classroom interaction (pp. 17-35). Madison: University of Wisconsin Press.

Hancock, T. (1996). Effects of class size on college student achievement. *College Student Journal,* 30(4), 479-481.

Hecker, D. (2005). Occupational employment projections to 2014. *Monthly Labor Review,* Nov, 70-102.

Henes, R., Bland, M., Darby, & McDonald, K. (1995). Improving the academic environment for women engineering students through faculty workshops. *Journal of Engineering Education,* 84(1), 59-67.

Herzig, A.H. (2004). Becoming mathematicians: Women and students of Color choosing and leaving doctoral mathematics. *Review of Educational Research*, 74:2, pp. 171-214.

Hofstede, G. (1998). Attitudes, values and organizational culture: Disentangling the concepts. *Organization Studies, 19,* 477-492.

Micceri, T., Borman, K., Nixon, A., Hesborn, W., Hanson, M.A. (2006). Recent Enrollment and Graduation Trends in Florida State University System Institutions. *Under Review*.

National Science Board (2002). *Science and engineering indicators – 2002.* Arlington, VA: National Science Foundation (NSB-02-1).

National Center for Education Statistics. (2001). *Digest of education statistics, 2001.* Washington, DC: Author. (NCES No. 2002130).

National Science Foundation (1999). Women, minorities, and persons with disabilities in science and engineering: 1998. Arlington, VA (NSF 99-338).

Noel, L., Levitz, R., Saluri, D. & Associates (1985). Increasing student retention: Effective program practices for reducing the dropout rate. Jossey-Bass, San Francisco, CA.

Ostroff, C. & Bowen, D. E. (2000). Moving HR to a higher level: HR practices and organizational effectiveness. In K.J. Klein & S. W. J. Kozlowski (Eds.), *Multilevel theory, research and methods in organizations* (pp. 211-266). San Francisco: Jossey-Bass.

Ostroff, C., Kinicki, A. J., & Tamkins, M. M. (2003). Organizational culture and climate. In I. B. Weiner (Series Ed.) & W. C. Borman, D. R. Ilgen, & R. J. Klimoski (Vol. Eds.) *Handbook of Psychology: Vol. 12. Industrial and Organizational Psychology* (pp. 565- 594). Hoboken, NJ: John Wiley & Sons.

Ostroff, C. & Kozlowski, S.W.J. (1992). Organizational socialization as a learning process: The role of information acquisition. Personnel Psychology, 45, 849-874.

Peters, T. J., & Waterman, R. (1982). In Search of Excellence. New York: Harper & Row.

Seymour, E. & Hewitt, N.M. (1997). *Talking about leaving: Why undergraduates leave the science*s. Boulder, CO: Westview.

Schneider, B. & Bowen, D. E. (1985). Employee and customer perceptions of service in banks: Replication and extension. *Journal of Applied Psychology, 70,* 423-433.

Schneider, B., Bowen, D.E., Ehrhart, M.G., & Holcombe, K.M. (2000). The climate for service: Evolution of a construct. In N.M. Ashkanasy, C.P.M. Wilderom, M.F. Peterson (Eds.), *Handbook of organizational culture and climate* (pp. 21-36). Thousand Oaks, CA: Sage.

Siehl, C., & Martin, J. (1990). Organizational culture: A key to financial performance? In B. Schneider (Ed.), *Organizational Climate and Culture* (pp.241-281). San Francisco, CA: Jossey-Bass.

Sheridan, J. E. (1992). Organizational culture and employee retention. *Academy of Management Journal, 35,* 1036-1056.

Smith, Daryl G., Gerbick, Guy L., and Figueroa, Mark A. (1997). *Diversity Works: The Emerging Picture of How Students Benefit.* Washington, DC: Association of American Colleges and Universities.

Tesluk, P.E., Farr, J.L., & Klein, S.R. (1997). Influences of organizational culture and climate on individual creativity. *Journal of Creative Behavior, 31,* 27-41.

Tinto, V. (1975). Dropout from Higher Education: A Theoretical Synthesis of Recent Research. *Review of Educational Research*, 65 (Winter): 89-125.

Tinto, V. (1982). Limits of Theory and Practice in Student Attrition. *Journal of Higher Education*, 53, 687-700.

Tinto, V. (1988). Stages of Student Departure: Reflections on the Longitudinal Character of Student Leaving. *Journal of Higher Education,* 59: 438-455.

Tinto, V. (1993). *Leaving College: Rethinking the Causes of Student Attrition* (2nd Edition). Chicago, The University of Chicago Press.

U.S. Department of Education (US DOE; 2000). National Center for Education Statistics. *Entry and Persistence of Women and Minorities in College Science and Engineering Education.* NCES 2000-601, Washington, DC.

Wimshurst, K., Wortley, R., Bates, M., and Allard, T. (2006). The impact of institutional factors on student academic results: Implications for 'quality' in universities. *Higher Education Research & Development,* 25(2), 131-145.

Wyer, M. (2003). Intending to stay: Images of scientists, attitudes toward women, and gender as influences on persistence among science and engineering majors. *Journal of Women and Minorities in Science and Engineering*, 9(1), 1-16.