

Experiences of African American Students and Women and Minority Engineering Faculty in Attaining their Educational Goals

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Colleges and universities across the United States are turning their attention to the retention of undergraduate engineering students, especially women and underrepresented minority students. What motivates students to become engineers, and what influences contribute to successful completion of educational goals? This paper summarizes two separate studies designed to provide insights into the experiences of a group of African American students majoring in engineering and a group of women and minority engineering faculty.

The first study identifies cognitive, non-cognitive and situational variables which influence the academic success of African American engineering students attending a select private research institution. The second study describes the perceptions of current engineering faculty as they report the incidents that impacted their education and career choices, including the factors related to achieving career goals.

The findings of the two studies yielded similar information in a number of areas that might be pertinent to current retention efforts in engineering. Understanding the factors related to success as reported by a group of engineering students and faculty sheds some light on the issues and obstacles faced by current students in making career decisions and successfully completing engineering degrees.

Both studies were conducted through guided interviews; one with current engineering students enrolled at Carnegie Mellon University, and the second with assistant professors of engineering at Carnegie Mellon University, Howard, and the University of Pittsburgh. Open-ended questions asked students to reflect on their preparation and commitment to engineering, and on the nature of their academic and social experience. Faculty open-ended questions focused on the timing of education and career decisions, who acted as an influence, and what support system existed to carry out the decisions.

In both studies, the motivation to major in engineering was surprisingly consistent and fell into three main categories. Enjoyment and academic success in high school math and science courses, encouragement to pursue engineering by a significant individual, and a passion for "tinkering". The findings suggest that students' exposure and success with math and science in high school, opportunities to apply it to real world problems, and the

encouragement of significant others were the foundation for the commitment to engineering that sustained them during their years at the university.

In both studies some of the respondents reported on the influence of being singled out in high school for their abilities in math or science, or of participating in special programs for science math or engineering. Some respondents had engineering related summer internships during high school, or had participated in a pre-college program.

Encouragement to pursue engineering by a significant individual was also noted frequently by most of the respondents. High school teachers, especially in math and science were pivotal figures, serving as role models for the pursuit of careers in technical or science related fields such as engineering.

A number of respondents in both studies reported on the early influences on their career through attention of their father or other family member. To the extent that previous studies (Weidman 1984, Tinto 1975) have indicated student choice of major is heavily influenced by parental occupation, it is no surprise that engineering faculty often responded that one of their parents was an engineer. Other research (Baum 1989, Nair & Bechtel 1990) has similarly outlined the importance of father's occupation of engineer as an influence on women engineering student's choice of major. Having a father who is an engineer may not be a unique gender-related characteristic, but may in fact be more generally characteristic of high achieving, successful engineering students.

The third category of motivation was characterized by a passion for "building things", "application of math and science" and "hands-on experience." A number of male faculty identified their fascination with electronics and dismantling radios and televisions as learning experiences that later influenced their education and research careers. One male respondent mentioned that he didn't consider himself to be a good engineer because he is not a "natural tinkerer."

Male faculty were reporting active involvement or use of tools such as building, repairing, or fixing objects, especially electronic apparatus such as science kits, old television sets or radios as being important in helping to choose a career as an engineer. Female faculty did not report similar experiences.

A female faculty member said that she believed that female students were much more likely to accept male leadership in the lab, in effect limiting their own opportunities and experience. Another female faculty respondent observed that female engineering students were less prepared than their male peers.

Students identified factors related to success, including spending the required time on task, getting help as soon as possible, being tenacious, staying focused, seeking help from faculty or teaching assistants, studying in groups and high expectations of self.

In both studies respondents related student environment fit to their self esteem. Engineering students questioned their fit to the university or the engineering program relative to their disappointment over academic performance that is different from that experience in high school. Students who excelled in high school, for example equate average performance with failure. Findings indicate that well prepared students become less confident about their commitment to engineering and their ability to succeed academically after they begin matriculating rather than before, and that redefinition of what it means to be academically successful is an effective coping mechanism to sustain the effort required to master courses

In addition many women and African American respondents have had to deal with the perception that their admission as being based less on ability and more on affirmative action.

Isolation increases as an issue when academic achievement is tied to study groups and group projects. Many of the African American students noted the difficulty involved in participating or being invited to participate to join a study group. When they do participate in group exercises their expertise is often challenged.

In contrast, the educational experience described by a few foreign born black faculty respondents is worth noting. The experience is characterized by systematic attempts to provide students with supportive environments. They were guided through education and career choices by faculty and peers and were supported financially, academically and socially.

While students did receive financial support for their studies, there is an issue of maintaining the financial support package. At the undergraduate level, concern was often expressed about the distraction that finances became for most of the respondents. Students might receive financial aid based on high school academic performance that is difficult to maintain at the undergraduate level. Some students who were accumulating large amounts of loan debt wondered if the education was worth it and others expressed concern that they were running out of options for meeting additional debt such as yearly increasing tuition, or the cost of an unanticipated fifth year.

At the graduate level, women and minority faculty reported that they were granted financial awards, especially those who graduated from programs in universities known for the quality of their engineering programs. The nature of those awards were reported differently by gender and race. While many majority males were attached to one research group for their whole graduate experience, women and minority respondents reported on a wider variety of assistantships. Women and minority respondents reported having experienced more complicated financial awards that were pieced together, sometimes spending time as a teaching assistant, sometimes as a research assistant.

Recommendations:

Enhance the engineering curriculum to accommodate hands on experiences, but also mindful to provide for varying levels of experience with this approach. By providing opportunities for faculty to explore more fully teaching and learning styles, as well as communication styles and their impact. Methods of constructing study or lab groups and the leadership/group dynamics involved, as well as curriculum issues related to study group involvement; hands on opportunities.

A faculty development program would provide an opportunity for faculty to learn about their personal teaching style and its power to determine student access to learning. Exposure to learning styles will help make the faculty member aware of how people process and absorb information, might encourage faculty to expand teaching and evaluation modalities so that students are provided with a variety of ways within the context of a course to demonstrate competence.

The educational community has given considerable attention to developing strategies and programs to address issues of transition and adjustment during the first year. At many institutions, relatively small numbers of African American and women are split into even smaller groupings when the choice of major is declared and they move into the department

in their second year. This second transition can be particularly unsettling. This is a critical transition point where institutional attention might yield more positive performance outcomes.

A Sophomore orientation might concentrate on the importance of study groups and study partners to master large volumes of material, capitalize on one another's strengths and provide social and emotional support that studying in isolation cannot. It might also include an introduction to the implicit conventions of the discipline or the department.

A closer scrutiny of the types of awards being made to women and minority students at the undergraduate and graduate level may also be warranted. Institutions might have to pay closer attention to the types of awards offered and the psychological and emotional energy needed to maintain those awards. At the undergraduate level, institutions may want to consider requiring only satisfactory progress toward a degree, rather than a specific QPA. At the graduate level, making awards with reasonable chances of continuity for the duration of the program would allow students more time to focus on their program.

These represent a few pragmatic solutions that might make a difference in retention of minority and women engineering students. Through these types of efforts universities could create an ever expanding circle of success for women and minority engineering students.

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