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PERSISTENCE OF AFRICAN-AMERICAN MALE COMMUNITY COLLEGE STUDENTS IN ENGINEERING

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OVERVIEW

The twenty-first century will be dominated by technological change as the United States competes in an increasingly interdependent world. If the United States is to maintain its technological leadership, an inclusive engineering education is required. Engineering impacts many important aspects of day-to-day life from the environment to national security and half of our graduate degrees in engineering are granted to foreign nationals. While this influx of creative talent enriches the academic community, the underutilization of domestic talent threatens the engineering enterprise with professional shortages in university classrooms, research facilities, and corporate boardrooms. We are simultaneously challenged with addressing the shrinking pool of African-American males in higher education. The challenge is daunting but not insurmountable. Many African-American students have aspirations for engineering without the preparation and the community college is well suited to provide the bridge between aspiration and accomplishment. Community colleges serve 46% of all African-American

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students in higher education and there are exemplary programs that have tapped the underdeveloped resources in the African-American community. One example is the Emerson Minority Engineering Scholarship Program. By utilizing best practices, this program has helped to increase the pool of African-American engineers by providing opportunities to students who may have made other academic choices. This paper reviews persistence literature and discusses the challenges and strategies in developing a community college-based minority engineering program.

In an increasingly technological and interdependent world, engineering is one of the careers that will fuel the engine of economic growth (Reichert & Absher, 1997). If the United States is to maintain its technological leadership in this interdependent global economy, an inclusive engineering education is required. Unfortunately the number of engineering graduates in the United States is sufficient in neither size nor inclusiveness to maintain technological leadership. Brainard and Carlin (1998) report that undergraduate engineering enrollments declined from 406,000 students in 1983 to 318,000 by 1996. The number rose with some fluctuation to 409,000 by 2005. The number of engineering degrees granted also declined from almost 78,000 in 1985 to just over 65,000 in 1997. The number of degrees has been relatively steady over the last 10 years with 66,000 graduates in 2005 (National Science Board, 2008) and 68,000 in 2006 (NACME, 2008). Stagnant or shrinking engineering enrollments pose a potentially serious problem for American industry and society in general. The ratio of baccalaureate science and engineering graduates to the population of 24 year olds is lower in the United States than in the United Kingdom, France, Japan, Canada, Germany, and Italy (National Science Board, 2008). Although frequently overstated, there is also growing technological pressure from India, China, and South Korea. The United States is facing a knowledge gap with 25% of the science and engineering workforce reaching retirement age by 2010 along with an increasing dependence on foreign students in higher education. Students on temporary visas earned 25% of the science and engineering bachelor's degrees, 28% of the master's degrees, and 36% of all S&E doctorates in 2005. In engineering, foreign nationals earned 46% of master's degrees and 57% of doctoral degrees in 2004 (National Science Board, 2008). Noeth, Cruce, and Harmston (2003) assert:

> The future of engineering in the US may be in jeopardy. We don't have the numbers of prospective students, and many of those students aren't prepared. The science of engineering impacts many important aspects of our day-to-day lives, including our national security, healthcare, and the environment, so these findings should not be taken lightly.

Although the total number of engineering graduates at the baccalaureate level has declined since the mid-1980s, the percentage of engineering degrees awarded to underrepresented (African, Hispanic, and Native American) minorities has increased steadily from 2.9% in 1973 to 9.2% in 1995 (Reichert & Absher, 1997) to 12% in 2006 (NACME, 2008). Even with the increase, the percentage of engineering degrees awarded to minorities is less than half of the combined representation of these minorities in the US population. In the midst of an international financial crisis, there is a new urgency in filling and reinforcing the STEM pipeline. For the United States to remain globally competitive, it must create a workforce that resembles America, especially in the innovative technological careers of the twenty-first century. The National Science Board (2008) recognizes the problem when it asserts:

> The lack of diversity in the engineering workforce and in the engineering-education pipeline, poses significant, and growing, costs and risks for the engineering profession. First and foremost, the extreme under-representation of major segments of American society in engineering poses a moral and social dilemma, and, unless actions are taken to change the situation, the opportunity costs to the engineering enterprise and the nation will increase in the coming decades.

Increasing the representation is challenged by some disturbing trends. Over 1 million US students drop out of high school every year and of those who do graduate only 4% are "engineering eligible" (NACME, 2008). Although 30% of the nation's undergraduate students are underrepresented minorities, only 12% of baccalaureate engineering graduates fit that classification and 92% of current engineering faculty members do not belong to an underrepresented minority group. Persistence to graduation in engineering for underrepresented minorities in the United States is 39% compared to 62% for non-minority students. The NACME National Symposium Report (2008) warns:

> Our national shortage of engineers, coupled with the increasing diversity of our population, has made minority representation in science, technology, engineering, and mathematics (STEM) careers more than a matter of fairness. Full use of all our human resources has become imperative for the success of our businesses, the health of our economy, and our national security.

Although the challenge of increasing representation cuts across ethnicity and gender, African-American male participation in higher education is particularly challenging. The dropout rate of African-American males in high school is greater than 50% in the largest urban school districts and the rate is often masked by the greater number and relative success of African-American females. In community colleges, African-American males

are the only ethnic/gender cohort with less than a 50% first-year persistence rate (Freeman, 2003). Poverty, criminality, and incarceration are just some of the dire consequences when students fail to complete high school. There is no shortage of data characterizing the deficiencies and pathologies confronting African-American males. These challenges come in a century that is witness to extraordinary African-American male accomplishment at the highest levels of government, education, technology, and the arts. The twenty-first century conversation on race must address the negative consequences for the resources and competitive edge of the nation when African-American males are not fully represented in the economic opportunities of the twenty-first century.

The challenge is daunting but not insurmountable. Community colleges are an underutilized resource for preparing underrepresented students for engineering careers. The most recent published data from the American Association of Community Colleges (2008) provide a profile of the 1,195 community colleges in the United States. Community colleges serve 6.5 million credit-seeking students nationally. Approximately 46% of all first-time freshmen and 46% of US undergraduates are enrolled in community colleges, and over half a million associate degrees are awarded annually. The student population is 60% female and 41% full time (12 credit hours or more). Community colleges serve 46% of all African-American students, 55% of all Hispanic students, 46% of all Asian/Pacific Islander students, and 55% of all Native American students in undergraduate higher education. The community college is an affordable post-secondary option with an average annual tuition of $2,361 and only one-third of community college students receive any federal financial aid.

Community colleges have already established an indispensable role in the education of engineers in the United States with 20% of degreed engineers beginning their academic careers by earning at least 10 credits at community colleges (Adelman, 1999). In a related study, 40% of the students obtaining engineering bachelor's and master's degrees in 1999 and 2000 took some classes at a community college (Tsapogas, 2004). The challenge is less about attracting students to the community college than keeping them on track once they arrive. This means addressing the specific needs of underrepresented minorities while creating a more user-friendly culture of engineering. Landis (1995) describes the negative impact that the culture of engineering may have when he writes:

> Sometimes it appears that we don't want our students to succeed. We seem to go out of our way to avoid helping our students to learn to be effective. Our view of subjects like professional development, academic success strategies, personal development, and orientation is that they are not "academic." ... We are reluctant to find room for them in our already full curricula ... But it goes even further than that. We sometimes seem pleased by the fact that many of our students don't succeed. We find comfort in the view that "not everyone can be an engineer." Our approach is to put up a difficult challenge and believe that we have done a service to the profession by "weeding out" those who don't measure up. We tend to hold the black-and-white view that "some have it, and some don't." (pp. ix–x)

The resilience of the American economy has consistently depended on innovation and technological development as a key to global leadership. Attracting and retaining underrepresented students to STEM majors and careers is a national interest.

LITERATURE REVIEW

Persistence Theories

Tinto's (1993) multivariate model of student retention in post-secondary institutions explains student departure from college prior to graduation through a comprehensive set of demographic, cognitive, psycho-social, and institutional factors. The model proposes that both student characteristics and student experience with the social and academic environments of the institution are the principal determinants of educational goals and institutional commitment. The combination of attributes and interactions provides the foundation for the student's decision to persist or withdraw from college. Tinto suggests that students may integrate in two distinct arenas: social and academic. Social integration consists of the social ties that result from the day-to-day interactions within the college community. Academic or intellectual integration results from sharing information, perspectives, and values common to other members of the community. A student may be able to achieve one mode of integration without achieving the other. A student who is well integrated socially might still withdraw from the institution because of insufficient integration into the academic domain of the college. Students must secure acceptance in both social and academic circles of the institution to ensure persistence. In Tinto's theory, the more students are integrated into the social and academic fabric of the campus, the more they become committed to the goal of graduation. This integration also enhances loyalty to the individual institution which, in turn, increases the likelihood that students will persist and graduate

(Mutter, 1992). Although Tinto's model suggests that the decision to withdraw is primarily the result of the interaction of the student within the college environment, Tinto also believes that external commitments along with the student's pre-entry skills and attributes contribute significantly to the departure decision. Tinto also states that faculty interaction may be even more important for marginal students attending commuter institutions than for similar students at residential institutions.

Much of the research on student persistence utilizes Tinto's model, even though it was originally developed around one all-male four-year residential college in the northeast region of the United States. The growing population of students who begin their post-secondary academic experience at community colleges has largely been ignored by the body of research attempting to apply Tinto's model. Little is known about the factors that influence persistence behavior on this important group of students.

Cohen (1995) describes the community college as an institution that confers the associate degree in arts or science, and also awards certificates of proficiency and specialization to students or employees seeking to advance their careers or improve their marketability. He goes on to note that the community college's multiple functions of offering career, collegiate, developmental, and continuing education to students have been well accepted by the public as well as state and federal funding agencies. Cohen further asserts that a community college can be found within commuting distance of nearly all the people in the United States. Commuter students are less influenced by college experiences to change their aspirations and goal commitments. A 1992 national study conducted by the American College Testing Program indicates that 50% of first-time, full-time students at four-year colleges fail to earn a bachelor's degree within five years of entry (Feldman, 1993). The study also notes that graduation rates at public community colleges are substantially lower with less than 39% of students completing an associate's degree within three years of initial entry. Since the missions and types of students attending community college are, in many cases, substantially different from four-year institutions, it might be expected that factors associated with attrition and retention would operate differently (Feldman, 1993). Many of the theories on student attrition do not account for the external forces that affect student participation and persistence in college. As a result, current theories of student retention are not particularly well suited to the study of non-residential institutions or the departure decisions of community college students (Mohamaddi, 1996).

Persistence in Engineering

Heckel (1996) examines the impact of high-school graduation rates on engineering enrollments and then draws the following conclusions:

> The extreme cycles in engineering enrollments over the past three decades and the insensitivity of these cycles to variations in the number of high school graduates indicates that other factors can exert significant influence over engineering enrollments. The analysis presented here concludes that national economic trends do not correlate with engineering freshman enrollments. (p. 20)

Astin, Tsui, and Avalos (1996) identify the selection of a college major as a factor that influences student persistence. They note that enrollments in fields like business, psychology, or other social sciences generally have higher-than-expected retention rates, while students majoring in engineering have lower-than-anticipated retention. They conclude that persistence in engineering is typically different than persistence in college because of the rigorous demands of the engineering program.

Moller-Wong and Eide (1997) determine that switching is a significant factor in the high attrition in engineering. Seymour and Hewitt (1997) examine the reasons that 40% of undergraduates leave engineering programs, 50% leave physics, and 60% leave mathematics. One of the major findings of their research is that students who switch majors do not differ from those who do in the individual attributes of performance, attitude, and behavior. The authors offer the following conclusion:

> Contrary to the common assumption that most switching is caused by personal inadequacy in the face of academic challenge, one strong finding is the high proportion of factors cited as significant in switching decisions which arise from structural or cultural sources within institutions, or from students' concerns about their career prospects. (p. 32)

The authors suggest that students leave primarily due to a change in their relative interest in science, engineering, or mathematics as a major. Further exploration suggests that the level of student interest changes, in part, because of how the introductory material is presented. The authors report that faculty pedagogy is responsible for over one-third of the decisions to switch while over 90% of the students express concern about classroom teaching. Seymour and Hewitt also note that many students express concern that "faculty conspired to make their learning experiences harder than they needed to be" (p. 103). They go on to suggest that the same problems that encourage students to leave science, mathematics, and engineering make

persistence difficult for those who choose to stay. Landis (1995) also describes a negative impact on students from the "culture of engineering."

LeBold and Ward (1988) find that the best predictors of engineering persistence in college are the first and second semester college grades and cumulative grade point averages. They also assert that the best pre-college engineering predictors are math, science, and English grades as well as high-school rank. Student self-perceptions of math and science problem-solving abilities are also suggested as strong predictors of engineering persistence.

Besterfield-Sacre, Atman, and Shuman (1997) find a difference between the students who leave and the students who stay in engineering. By examining students who left engineering in good standing, they determined that those who left started out liking engineering less, had a lower appreciation of the engineering profession, differed in their mathematics and science interests, differed in their confidence to succeed in engineering, had more confidence in their communication skills, and had been somewhat influenced by family to pursue engineering. Besterfield-Sacre et al. conclude that students who switch may start out with the intention of graduating in engineering, but their general level of commitment is not as high as those who choose to stay.

Takahira, Goodings, and Byrnes (1998) reinforce many of the previous findings when they report some of the reasons students choose to leave engineering:

(1) Other non-scientific majors offered a better and more interesting education.
(2) They rejected scientific careers and their associated lifestyle.
(3) The engineering curriculum was too overwhelming and fast-paced.
(4) Their morale was undermined by the competitive culture of engineering programs.
(5) They experienced poor teaching by math, science, and engineering faculty.
(6) They received inadequate advising and help.
(7) They lacked confidence due to poor grades.

Persistence of Minorities

Although efforts are underway to increase the level of K-12 interest and preparation for science and engineering, there are immediate needs in addressing the persistence of African-American college students. Many African-American students leave college before completing a degree and much of the research on student persistence and retention focuses on a student deficit model where students are characterized as "dropping or stopping out" (Padilla, Trevino, Gonzales, & Trevino, 1997). Padilla et al. focus on retention by building an expertise model. The underlying assumption of their model is that successful college students are experts at achieving success at a specific college. Students arrive on campus with a certain amount of theoretical and practical knowledge that they acquired throughout their academic careers. Once on campus, the successful students acquire the additional practical knowledge that is required to successfully negotiate the challenges of campus life. Typically this heuristic knowledge is not provided in a formal manner.

Tinto (1993) suggests that four clusters of factors lead to attrition: adjustment, difficulty, incongruence, and isolation. Padilla et al. (1997) identify four broad categories of barriers that successful minority students have to overcome. They label them as follows: discontinuity barriers which include obstacles to a student's smooth transition from high school to college, lack-of-nurturing barriers which stem from the absence of supportive resources to facilitate the development and adjustment of minority students, lack-of-presence barriers which occur when there is an absence of minorities in the college population or program, and resource barriers related to insufficient financial aid. Nora, Cabrera, Hagedorn, and Pascarella (1996) identify institutional experiences, academic achievement, and environmental pull as the most significant factors contributing to persistence. They further argue that these factors have different effects on persistence for different ethnic and gender groups. Their study concurs with St. John (1994) in suggesting that minority status has a positive effect on persistence of minority males but not for minority females. Nora et al. (1996) also find that interaction with peers is positively associated with persistence for males and females, but interaction is not significant when just considering minority students. They also conclude that family responsibilities and off-campus employment are negatively associated with persistence.

Reichert and Absher (1997) identify related barriers to African-American success in engineering such as inadequate academic preparation, substandard educational resources, mismatched social and academic expectations, lack of encouragement, psychological intimidation, unstable familial and financial circumstances, inadequate peer support, lack of role models and mentoring, low expectations by faculty, racism, and poor instruction/advising.

Minority students bring different personal and social histories to their college and engineering experience; they may require different persistence strategies.

Persistence by Gender

The majority of undergraduate students are women and they are more likely to complete a degree than men. This appears to hold true for both White and African-American students (Astin et al., 1996). Stoecker, Pascarella, and Wolfle (1988) find that for African-American males, socioeconomic status, high-school achievement, college experience, academic integration, and social integration have direct effects on persistence behavior while academic achievement has a direct effect on persistence for African-American females. Nora et al. (1996) find that non-classroom relationships with faculty are positively associated with persistence for females only. Morgan (1996) complicates the analysis when he observes that expectations of high-school students have been changing over time and the extent of the change varies with gender and race. This may have consequential impact on the persistence of students as they enter post-secondary education.

For community colleges, some research finds no significant relationship between gender and persistence (Cofer & Somers, 2000) while others find that women are less likely to persist (Bonham & Luckie, 1993; Lewallen, 1993). Still other research on community colleges suggests that the significance of gender may change with ethnicity (Somers, Cofer, Hall, & Vander Putten, 2000). Wolfle (1985) suggests that racial effects may be confounded by gender differences and that further study is merited. Freeman (2003) finds that for beginning first-time community college students, Asian males have the highest year-to-year persistence rate of any of the gender/ethnicity cohorts at 77.4% followed by Asian females at 71.1%. Both Asian cohorts persist at substantially higher rates than the other cohorts, although in other cohorts females have higher persistence rates than males. Hispanic females persist 62.8% of the time and Hispanic males persist at a rate of 58%. White males and females perform comparably in persistence at 57.9% and 58.5%, respectively. African-American females persist 53.4% of the time and outperform their male counterparts who make up the only cohort where the majority of students do not persist (48.8%). The performance of African-American students on the measure of persistence is consistent with other research on persistence and attainment (Astin et al., 1996; Cofer & Somers, 2000).

Although there are similarities among different gender and ethnicity cohorts, they are different with respect to persistence outcomes and the variables that are significantly related to persistence (Freeman, 2003). Aggregate figures can obscure smaller group distinctions by assuming the trend of a statistically dominant group, balancing conflicting correlations, or picking trends that are found only in the aggregate. The distinctions are why it is important to study separate cohorts.

Freeman (2003) finds significant differences in the factors that influence persistence at community colleges for different ethnic and gender cohorts. African-American males and females do better when they participate in purposeful activities beyond the classroom experience and simple socializing with friends. Although research suggests that academic and social integration are important contributing factors for persistence, those factors do not work the same way in different ethnic and gender cohorts. For African-American males, the three most significant factors were having degree aspirations, attending full time, and talking to faculty outside of class. The significant factors for African-American females included having degree aspirations, participating in clubs and activities, and financial assistance. The strategies that promote persistence are not automatically interchangeable across gender and ethnicity.

Institutional Environment

Awareness of student background characteristics does not address the efforts that the colleges and universities make to improve persistence. Research reports a number of factors that influence retention at an institution above and beyond the student's personal characteristics (Astin et al., 1996). Carter (1999) concludes that institutional characteristics and experiences have as much impact on student aspirations as SES or individual achievement. Tinto (1993) outlines three principles of institutional commitment in developing effective retention programs. He suggests that retention programs should be committed to: the students they serve; the education of all, not just some, students; and the development of supportive social and educational communities. Tinto goes on to offer the following caution about institutional retention programs:

> Although retention programs can be most helpful, they cannot replace the absence of a high quality, caring, and concerned faculty and staff. Institutions should therefore not be misled by the use of modern technology or marketing strategies ... The road to institutional commitment and thus to student commitment does not require very

> elaborate or high-cost interventions ... rather, effective retention calls for sustained effort on the part of all institutional members to give to each and every student serious and honest attention on a daily basis. It requires, if you will, a continuing commitment to the education of students. No technology, however sophisticated, can replace that sort of commitment. (p. 201)

Hermond (1995) acknowledges the important role that colleges can play in improving student retention. He identifies seven institutional initiatives that are focused on improving the persistence of minorities in engineering programs:

- matriculation, which is defined as the activities done with students between the time they are admitted and their first semester of enrollment;
- orientation, which consists of a course, program, or activity which directs students towards setting and evaluating goals;
- academic advising, which involves providing students with adequate information about available course options;
- student organizations, which are designed to help fulfill the social and personal needs of students;
- tutoring and academic workshops, which help students to achieve greater levels of self-reliance, self-confidence, and academic achievement;
- personal counseling, which may be critical to the management of academic stress or the feeling of isolation that minority students may experience in an engineering program;
- financial aid, which is critical to a population 30% of whom leave college due to a lack of funds.

Reichert and Absher (1997) also identify seven characteristics of schools that do well in retaining minorities in engineering. The institutional attributes that they list are: sincere commitment, academic support, minority engineering societies, bridge programs and workshops, minority scholarships, outreach and clustering, and participation criteria. There is clear overlap in the two lists, but Reichert and Absher also make the point that the participation criteria of retention efforts for minority students should not be established and presented in ways that stigmatize participating students. They also make the point that minority students who participate in outreach efforts are more likely to persist.

Attitudes and motivation may be critical retention factors, but they are difficult to quantify. Measures like self-confidence, sense of development, and individual stress experienced in the college environment influence the decision to stay or leave. Motivation is critical to maintaining the desire and drive necessary to complete a rigorous engineering program (Moller-Wong & Eide, 1997).

Seymour and Hewitt (1997) note that those who leave engineering, mathematics, or science have the same array of abilities, motivations, and behaviors as those who remain. They find that only 10% of the exiting students leave because they find a non-science major that is more suited to their abilities. They find that those who remain cite intrinsic interest in their major twice as often as those who switch. Those who persist develop a set of attitudes and coping strategies that position them to take advantage of serendipity. They cite the following attitudes and coping strategies as helpful in persistence in engineering: competence, confidence, persistence, assertiveness, strong interest in the discipline, and strong interest in the career.

Blumner and Richards (1997) examine the role that study habits play in the persistence of engineering students by measuring the importance of distractibility, inquisitiveness, and compulsiveness. Distractibility is a measure of the degree to which students find it difficult to concentrate on their work. Inquisitiveness is a measure of the degree to which a student attempts to make sense of the subject matter (deep-level processing). Compulsiveness is a measure of the extent to which students try to accommodate details when they read or study (surface-level processing). The authors find that the engineering students who receive the highest grades tend to demonstrate lower levels of distractibility and higher levels of inquisitiveness. The students who score high on the compulsiveness scale generally try to memorize information in order to reproduce it, while the students who scored high on inquisitiveness try to develop insights about how the material might be used. High amounts of compulsive study do not correlate with better academic performance in engineering.

Transfer Seamlessness

Pascarella, Smart, and Ethington (1986) recognize the commitment most two-year colleges have to the transfer function. Their research indicates that studies conducted at single institutions tend to identify students who transfer to four-year institutions as dropouts who have withdrawn from college. Many of these students leave a specific institution, but do not necessarily withdraw from higher education. Pascarella et al. (1986) use Tinto's model to study the long-term persistence of students who began their post-secondary education in two-year community colleges and persisted to four-year baccalaureate degree completion. The results indicate that while

much of the influence of student pre-college traits is indirect, the two variables with the most consistent patterns of significant positive effects on degree completion are academic and social integration at the last college attended. The authors conclude that Tinto's model is reasonably useful in accounting for the long-term persistence behavior of students who begin their post-secondary education careers in two-year institutions.

Research documents that the "baccalaureate gap" between students who start at community colleges and those who start at senior institutions is not totally explained by reported differences in socioeconomic status, race, academic ability/preparation, ambition, or part-time status (Dougherty, 1992; Grubb, 1991). Carter (1999) suggests that the chief reason for this difference appears to be a lower level of academic and social integration. She concludes that community colleges tend to lower student aspirations. Nora and Rendon (1990) conclude that "encouragement by others" is the only major factor associated with transfer and commitment. In their findings, commitment includes academic and social integration. They conclude that students with high levels of academic and social integration are inclined to transfer, but high levels of commitment without academic and social integration do not increase the inclination to transfer. The research suggests clear differences between two- and four-year colleges in the measure of baccalaureate completion. The question remains as to whether the distinction is created by the community college or by other social forces that affect the completion rate.

External Environment

Four-year residential colleges are relatively self-contained environments. Much has been made about the importance of social integration at the residential campus and the relative lack of importance at the community college, unless students are planning to transfer. The community college presents an environment where work, family, relationships with non-attending students, and visibility/availability of competing interests can exist at levels unmatched by any residential campus (Adelman, 1992; Bean, 1982; Vorhees, 1987). Compared to students at four-year residential campuses, community college students work more off-campus hours, have more family responsibilities, and have more modest financial resources (Baird, 1990). When the local economy improves, community college enrollment tends to fall because many students find employment more attractive than the alternative of remaining in school (Vorhees, 1987). Community college students also spend less time interacting with other students and faculty outside of the classroom. As a result of these external forces, community college students are less influenced by college experiences to change their aspirations and goal commitments.

Many of the theories on student attrition do not account for the external forces that affect student participation and persistence in college. Even some of Tinto's later work shows some limitation on explaining the impact of external community forces. As a result, current theories of student retention are not particularly well suited to the study of non-residential institutions or the departure decisions of community college students (Mohamaddi, 1996).

Freeman (2003) summarized nine examined factors and associated variables that potentially influence persistence at the community college. Those factors are presented in the conceptual framework in Fig. 1.

THE EMERSON MINORITY ENGINEERING SCHOLARSHIP PROGRAM

The Emerson Minority Engineering Scholarship Program is an example of an effective partnership designed to increase the number and success rate of students pursuing an engineering degree by starting at a community college. This cooperative program was established in 1988 by Emerson, a diversified global manufacturing and technology company headquartered in St. Louis, Missouri, in partnership with St. Louis Community College (STLCC) and Missouri University of Science and Technology (formerly University of Missouri at Rolla). Emerson has provided eight scholarships annually for students to complete an associate's degree at the community college. The Emerson scholarship covers the cost of tuition, books, and fees for up to six semesters. Students who achieve a minimum grade point average of 2.5 are eligible to transfer to Missouri S&T as juniors under a second scholarship program which covers the costs of tuition and fees for up to three years. To increase the number of underrepresented students in the engineering pipeline, high-school students could apply for the scholarship with a 2.5 GPA in mathematics and science classes and minimum ACT math and science scores of 18. With an average ACT of 20, most of the Emerson scholarship students starting at STLCC would not be accepted directly out of high school at Missouri S&T. Students must withdraw from the scholarship program if they switch from engineering, decide not to go to Missouri S&T, or if their GPA drops below 2.5.

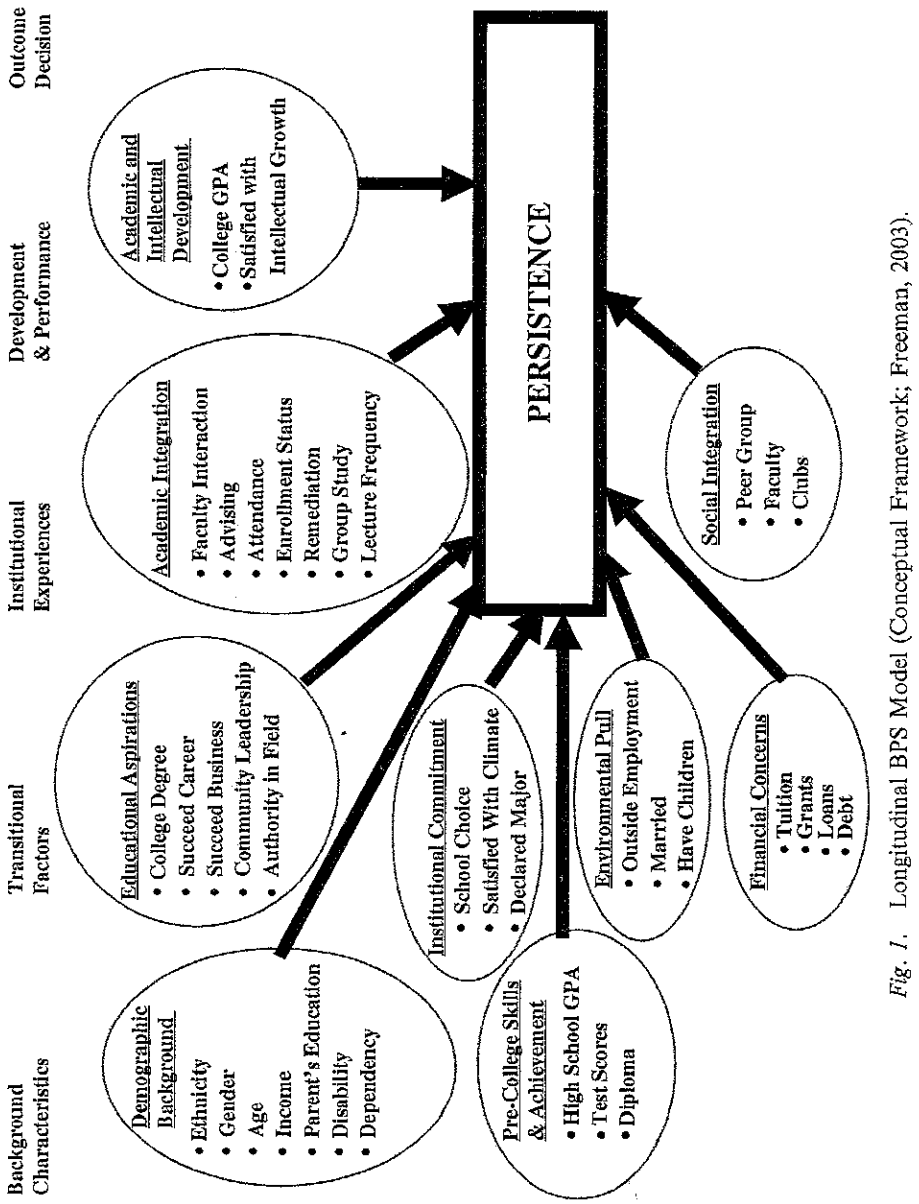

Fig. 1. Longitudinal BPS Model (Conceptual Framework; Freeman, 2003).

Table 1. Comparison of Emerson Minority Engineering Scholarship Program Graduation Rates.

Student Performance 1988–2005	SLCC Graduation Rate	Transfer to Missouri S&T	Transfer to Other Universities	Missouri S&T Graduation Rate
Male (121)	57.0% (69)	92.8% (64/69)	7.2% (5/69)	93.8% (60/64)
Female (64)	53.1% (34)	79.4% (27/34)	20.6% (7/34)	96.3% (26/27)
Total (185)	55.7% (103)	88.3% (91/103)	11.7% (12/103)	94.5% (86/91)

Since the program's inception, 217 students have participated. From 1988 to 2005, 185 students participated and 103 (55.1%) graduated or successfully prepared for transfer to Missouri S&T within three years (see Table 1). Twelve students (11.7%) chose to transfer to other universities. Only four (2.2%) students timed out of the scholarship (took longer than three years). The remaining students switched majors from engineering, stopped out of school, or lost the scholarship for poor academic performance. Not continuing in this program is not an indicator that students were not successful overall in their academic pursuits. Of the students who transferred to Missouri S&T, 94.5% graduated. The graduation rate of the Emerson scholars after transfer is higher than the average graduation rate of STLCC students from Missouri S&T (80%) as well as other transfer students (75%).

Of the 185 students participating from 1988 to 2005, 121 were male and 64 were female. For the male students, 57.0% graduated from STLCC. The graduation rate for those male students who transferred to Missouri S&T was 93.8%. For the female students, 53.1% graduated from STLCC and the graduation rate for those who transferred to Missouri S&T was 96.3%. There is little difference in the performance of male and female students with the exception of the transfer decision. The percentage of male students who transferred to Missouri S&T (92.8%) was much higher than percentage of female students (79.4%) who chose to do so.

The program has experienced phenomenal success based on its on-going commitment to preparing the whole student for academic and career success through well-established best practices:

- The students are recognized as Emerson scholars and no stigma is attached to the program or their participation.
- The program coordinator is a counselor who meets regularly with the students and establishes high expectations for academic performance and

campus participation. New students meet with faculty, administrators, and current students as part of an orientation to the campus. This addresses any sense of isolation students may experience.

- The scholarship removes most of the financial obstacles associated with attending the College as long as students maintain their grades. Family obligations and transportation costs are still potential issues for students attending a commuter campus but those obstacles are more easily addressed because of the scholarship.
- Students participate in tutoring, supplemental instruction, study groups, academic advising, and instructional laboratories as necessary. Orientation introduces them to the resources and they are encouraged formally through counseling and informally through social networks. Social networks are diverse and not restricted to Emerson scholars or African-American students.
- In addition to counseling and academic advising, the students have had faculty champions who spend time with the students in a variety of academic and social settings outside of the classroom. Research suggests that talking to faculty outside of class is particularly beneficial to retaining African-American male students.
- The faculty is encouraged to participate in instructional skills workshops to increase awareness and implementation of effective andragogical learning strategies.
- The students are encouraged to participate in the Student Government Association and Phi Theta Kappa Honor International Society. Emerson scholars have frequently been officers in each group. They have also been recognized by the administration of STLCC and the Student Government Association for their contributions to the campus.
- In the early 1990s, Emerson scholars were among the first community college students to receive engineering internships through INROADS, an organization that develops talented minority youth for leadership in business and industry. Students are encouraged to pursue internships and services are provided to facilitate that process.
- In 1998, Emerson scholars became the first community college to achieve chapter status in the National Society of Black Engineers (NSBE). NSBE is the largest student-run organization in the country with over 20,000 members. This accomplishment expanded the academic and social network of the students. At least 10 students have attended each of the National Conventions since then. In addition, the Gateway Alumni chapter of NSBE meets and runs its pre-college program at STLCC. Emerson scholars as part of NSBE participate in outreach and have the opportunity to work with established African-American engineers.
- Emerson scholars are also encouraged to participate in community service projects through their association with student government, NSBE, and Phi Theta Kappa. Although academic success is the primary focus, it is critically important to develop a holistic approach to success.
- Missouri University of Science and Technology provides a Transfer Assistance Program that makes transfer virtually seamless. Students are invited annually to Missouri S&T campus as part of a Diversity Showcase and transfer coordinators also visit STLCC annually. The social network established at STLCC also provides a familiar critical mass of students at Missouri S&T after transfer.

Emerson scholars are also encouraged to pursue graduate degrees and develop career plans. Their presence on campus has a positive effect on those African-American engineering students who are not on scholarship. Their presence helps to attract new students and many of the scholars make presentations to high-school students about engineering as a major. The focus of these practices is to eliminate any sense of isolation, instill confidence, improve focus and study skills, and minimize external pull. Every attempt is made to provide relevant academic and social integration that encourages students to succeed. Part of the success of the program is also helping students to follow their career passion. Not every student withdrawn from the scholarship did so because of a deficit in performance. On any college campus growth is part of the experience and as students grow they will hopefully make better decisions about their career path. Sometimes losing a student to a better personal choice is also a successful outcome.

CONCLUSION

Beyond pre-college background and preparation, students leave engineering and technology for various reasons. Many students are lost before entering the core of an engineering or technology program as a result of the isolation they experience. This early isolation from other engineering students combined with the attractiveness of less overwhelming majors can lead to early switching. Others may experience cultural or gender isolation as a result of the relatively low numbers of peers or role models in their particular demographic group. The failure of some students to achieve

academic and social integration also contributes to the loss of engineering students. Many students are discouraged by poor faculty pedagogy and some are overwhelmed by the pace and competitive nature of engineering and technology programs. Successful retention requires sincere commitment on the part of the institution to implement policies that will have a positive effect on persistence. This does not eliminate student responsibility for persistence, but it does raise the question of what institutions and departments are willing to do to retain students even when background characteristics of the students present a challenge.

Institutions should develop matriculation activities designed to encourage and ease the transition to the college environment. Institutions might also consider activities that take place prior to application. These activities might include outreach, seminars, dual enrollment, bridge programs, articulation efforts, and electronic newsletters. Rather than recruiting, the purpose of these activities is to increase the comfort level and expectation of success that the student brings to campus. These activities also serve to build the expertise of the student.

Orientation activities should be designed with the focus of increasing the social and academic integration of students. These activities should be designed to raise the awareness and skill level of students as they strive for success. They should also increase the sense of connection that students have with faculty, staff, and each other. Where possible, students should be connected to departments, role models, and other students with similar majors to help them minimize isolation and maintain the intensity of their interest.

Student organizations should be encouraged and supported at an institutional level. These organizations present a strong source of support, encouragement, and continuity for students, and they should not be left to student initiative alone. There should be a particular focus on the needs that minorities may have for affinity-based organizations that can reinforce expertise and encourage success through mutual support.

Tutoring, academic workshops, and supplemental instruction should be geared to providing on-going support for students. All too frequently, students who need these services do not take advantage of them even when they are available. These services should be more tightly woven into the academic experience. In addition to content, these services should address study skills and test taking in ways that change the culture of learning for these students. It is important to continually reinforce the informal network that exists on the campus.

Faculty pedagogy should be continually addressed beyond minimal evaluation and assessment. If instruction continues to be a source of

discouragement for students in engineering and technology, then the need for instructional skills workshops and activities cannot be ignored. Students change as society changes, and if the faculty fails to address their changing needs, retention will continue to be a problem. Faculty connection and encouragement is a source of persistence for many students and efforts should be made to facilitate that connection.

The ability of students to cope with the sometimes overwhelming pace of the college experience should not be left solely to the student. Attitude, intention, commitment, and coping skills are just some of the elements of resilience that students need to develop. The institution should be focused on helping the whole student to achieve success rather than merely selecting the students who already have a strong foundation of success.

Increasing the amount of financial aid available for students may not always be a viable option for an institution; however, when students are focused on success and committed to the institution, the potential negative impact of financial aid is somewhat mitigated.

Retention is a continuous process of "closing the sale." Zig Ziglar reinforces the notion that everybody sells and everything is selling. Just as selling is more successful when it is perceived as a win–win transaction, retention efforts are more likely to succeed when they are perceived as win–win propositions. It is not enough for institutions to list features and programs; they also have to sell the benefits of completing a degree program. Large expenditures on retention services may be helpful, but closing the deal means that faculty, advisors, administrators, and staff attend to the little things that foster the desire, trust, self-confidence, and resilience of the students attending the institution.

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