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Recruiting and Retention Effectiveness

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Introduction

The twenty-first century will be dominated by technological change as the United States economy becomes increasingly dependent on a technically literate workforce. Engineering is one of the careers that will help fuel the engine of economic growth\(^1\). If the United States is to maintain its technological leadership in this interdependent global economy an inclusive engineering education is a must.

Brainard and Carlin (1998) report that undergraduate engineering enrollments reached a peak of just over 406,000 students in 1983 and that this figure dipped to 318,000 by 1996\(^2\). They continue by reporting that the number of engineering degrees granted also declined from almost 78,000 in 1985 to just over 65,000 in 1997. Shrinking engineering enrollments pose a potentially serious problem for American industry and society in general. While the annual graduation rate of engineering students has declined there has been an increase of over 25% in the demand for engineering jobs in the last decade\(^3\). 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 1972-73 to 9.2% in 1994-95\(^1\). Even with the increase, Reichert & Absher report that the degrees awarded are still less than half of the combined representation of these minorities in the U.S. population.

Almost thirty years ago a national effort was launched to increase the number of minorities in the field of engineering\(^1\). The effort has met with some success and participation by minorities in science and engineering is at an all time high. Many major corporations now support the thesis that diversity makes good business sense. Hispanic, and Native Americans, however, still remain significantly underrepresented in science and engineering with roughly half of the science and engineering degrees awarded to minority citizens going to Asian Americans\(^1\).

Student success has received considerable attention during this time\(^4\). Administrators and researchers in colleges and universities have increasingly focused their attention on retention and attrition rates in higher education\(^5,6,7,8\). The difficulty of meeting the engineering needs of the U.S. economy is exacerbated by a disturbing trend. Over the past twenty years there has been an increase in attrition of engineering students. In 1975, the attrition rate for engineering freshmen was 12% and by 1990 it had grown to 24%\(^9\). Less than half of the students who start college as engineering majors actually graduate with an engineering degree. The attrition for minority students is approximately 70%\(^10\). This decline in engineering interest and persistence while the demand for engineers continues to rise is a major concern for industry and society.

The American Association of Community Colleges (AACC) provides statistics that demonstrate why the community college may be an important participant in meeting the postsecondary
engineering challenge\textsuperscript{11}. The most recent published data from AACC (1996-97) reports that 1132 community colleges serve 5.4 million credit seeking students nationally\textsuperscript{12} approximately 46\% of all first-time freshmen and 44\% of U.S. undergraduates are enrolled in community colleges, and nearly half a million associate degrees are awarded annually. The student population is 58\% female and 36\% 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 higher education. The community college is an affordable postsecondary option with an average annual tuition of $1,518 and only a third of community college students receive any financial aid. The National Center for Education Statistics (NCES) reports that there are currently over 40,000 community college students graduating annually with associate degrees in engineering and related engineering technologies and over 90\% of these degrees are awarded in engineering technology\textsuperscript{13}. According to NCES, the absolute number of 18-year olds in the United States will reach 4 million by 2004 and 75\% of that cohort will graduate from high school. If current trends continue, 80\% of those graduates will pursue postsecondary education immediately after high school graduation. Almost half of that population will attend a community college\textsuperscript{14}.

The major concern about community college participation in meeting the engineering and engineering technology demand is the question of persistence. More than forty percent of community college freshmen choose to withdraw during their freshmen year or fail to return for their sophomore year\textsuperscript{15,16}. This has driven many institutions to increase their efforts to identify potential dropouts early enough to provide some form of successful intervention\textsuperscript{8}. The problem appears to intensify when transfer is considered. Nora and Rendon (1990) report baccalaureate intentions of community college students as high as 74\%\textsuperscript{17} but the transfer rates to four-year colleges may range from 5\%\textsuperscript{18} to 15\%\textsuperscript{19}.

Given the challenges that minorities encounter in engineering attrition, or pursuing a bachelor’s degree by way of the community college, it may seem that the odds are clearly against achieving an engineering degree by starting at the community college. Community colleges, however, continue to be the starting point for millions of Americans, many of whom are minorities, and engineering and related technologies are offered to thousands of community college students throughout the country\textsuperscript{13}.

**Persistence in Community Colleges and the Engineering Discipline**

The mission of the community college is to meet the needs of the communities they serve by helping students to learn and reach their educational objectives\textsuperscript{20}, but community college students are a multifaceted group with diverse needs. The profile of community college students is quite different than the profile of four-year college students\textsuperscript{21,22,23}.

Chickering (1974) reports that commuter students differ from residential students in three ways: (1) At the time of enrollment, commuter students engage in fewer college activities and experiences; (2) commuter students, throughout their college experience, engage in few non-required activities and interact less often with faculty and other students; and (3) commuter students are less influenced by college experiences to change their aspirations and goal commitments\textsuperscript{24}.

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The open admission policies and community-needs orientation of community colleges, especially those in urban environments, attract students who are less likely to complete degree programs than those students who enroll at four-year colleges. A national study conducted by the American College Testing Program (1992) indicates that fifty percent of first-time, full-time students at four-year colleges fail to earn a bachelor’s degree within five years of entry. The 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 mission 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.

Many students transfer before completing degrees, while others receive the desired training or course work and leave. Social integration and institutional commitment are not generally priorities for these students. In fact, social integration is a concept that is not substantiated for community college students. 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.

Astin, Tsui, & 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 & 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 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 & 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.

**Persistence of Minorities and Women**

Success in engineering programs are frequently measured using two criteria: (1) retention through graduation rates, and (2) undergraduate GPA at the time of graduation. Lam et al.

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suggest that for minority students in engineering high school GPA is a significant predictor of college success as measured by GPA and persistence to graduation. The authors conclude from their research that this is true even when adjustments are made for the type of high school (from private college preparatory to inner city) that students attend. They also assert that the ACT test score is a significant predictor of undergraduate GPA but not of eventual graduation.

Tinto (1993) suggests that four clusters of factors lead to attrition: adjustment, difficulty, incongruence, and isolation. Bean (1986) proposes a longitudinal model using factors affecting attrition, which include background, academic integration, social integration, environmental pull, attitudes and grade point average. Padilla et al. (1997) identify four broad categories of barriers that successful minority students have to overcome. They label them as follows: (1) discontinuity barriers which include obstacles to a student’s smooth transition from high school to college, (2) lack-of-nurturing barriers which stem from the absence of supportive resources to facilitate the development and adjustment of minority students, (3) lack-of-presence barriers which occur when there is an absence of minorities in the college population or program, and (4) resource barriers related to insufficient financial aid. 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.

Henes, Bland, Darby, and McDonald (1995) confirm that women are less likely to enter and persist in undergraduate engineering programs. They also present five major reasons why women become discouraged with engineering. The first reason involves a sense of isolation that occurs in several ways. Prior to college women are isolated from the engineering and technical professions to a much greater extent than their male counterparts. If they persist they find that engineering students are isolated from each other in their early coursework. This isolation is exacerbated for women because of their relatively small numbers. A second reason for discouragement is a failure to see the relevance of theoretical material to the applied problem solving discipline of engineers. Many women may turn to other majors where the relevance is clearer. There is a similar pressure on men but there is less isolation. A third reason for lower persistence by women is the increased intimidation that stems from lower rates of hands-on experience with mechanical and electrical devices, and less familiarity with the associated jargon. Although many men have similar experience levels, they are less likely to see their lack of experience as a weakness. The fourth reason cited for discouragement is the competitive environment of the classroom. Research indicates that women are less likely to ask questions and participate in class discussions than their male counterparts. The final reason cited in their research was the lack of role models whose very presence offers greater optimism about the likelihood of success.

Brainard and Carlin (1998) identify a number of factors that influence a woman’s decision to persist in engineering or science, to switch to another major or to drop out of school altogether. They list the primary reasons for switching out of engineering as losing interest in the program, being attracted by another program, discouragement by academic difficulties, and perception of
low grades. They suggest that some of the factors that increase persistence prior to a student being accepted in a department are positive relationships with an advisor, the influence of math and science classes, working, and gaining acceptance in a department. They also find that after students have been accepted into a department the persistence factors shift to the positive influence of a mentor, math and science classes, and participation in conferences and events. Brainard and Carlin (1998) also report that self-confidence is a factor in persistence and, to some extent, may operate independently from GPA. Students with higher levels of self-confidence are likely to have had it initially. Self-confidence tends to correlate with other positive indicators of persistence such as higher levels of interest in coursework, positive relationships with faculty, involvement in student societies, seminars, conferences and events, and participating in internships.

Institutional Environment

Research reports a number of factors that influence retention at an institution above and beyond the student’s personal characteristics. Carter (1999) concludes that institutional characteristics and experiences have as much impact on student aspirations as SES or individual achievement. Herndon (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:

1) Matriculation, which is defined as the activities done with students between the time they are admitted and their first semester of enrollment.
2) Orientation, which consists of a course, program, or activity that directs students towards setting and evaluating goals.
3) Academic advising, which involves providing students with adequate information about available course options.
4) Student organizations, which are designed to help fulfill the social and personal needs of students
5) Tutoring and academic workshops, which help students to achieve greater levels of self-reliance, self-confidence and academic achievement.
6) 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.
7) 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: (1) sincere commitment; (2) academic support; (3) minority engineering societies; (4) bridge programs and workshops (5) minority scholarships; (6) outreach and clustering; and (7) 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.
Student Resilience

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. Goal commitment or educational goal attainment represents the degree to which the individual is committed, or motivated, to earn a college degree. The students’ initial commitment to completing college is often the most influential in determining persistence.

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:

1) Competence - knowing the material
2) Confidence - knowing that you know the material
3) Persistence - stick with it
4) Assertiveness
5) Strong interest in the discipline
6) 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.

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 in their particular demographic group. In addition, the small number of minority and female role models can exacerbate the sense of isolation. The failure of some
students to achieve academic and social integration also contributes to the loss of engineering and technology students. Research indicates that many students are discouraged by poor faculty pedagogy, preparation, and accessibility. Students also report being overwhelmed by the pace and competitive nature of engineering and technology programs.

Successful retention requires sincere commitment on the part of the institution. 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. Colleges cannot alter the background characteristics of students, but they can make a concerted effort to address persistence. Research in this area provides several recommendations for addressing the retention issue:

Institutions should develop matriculation activities designed to encourage and ease the transition to the college environment. These activities are designed to take place between the time students are admitted and their first semester of enrollment. Institutions might also consider activities that take place prior to application. These activities might include outreach, seminars, dual enrollment, bridge programs, articulation efforts, and 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.

1) 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.

2) Student organizations should be encouraged and supported at an institutional level. These organizations are present a strong source of support, encouragement, and continuity for students, and they should not be left to student initiative alone. You should be a particular focus on the needs that women and minorities may have for affinity-based organizations.

3) Tutoring, academic workshops, and supplemental instruction should be geared to providing ongoing 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 engineering and technology academic experience. In addition to content, these services should address study skills, test taking, and lifelong learning.

4) 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 faculty fail 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.

5) The ability of students to cope with the sometimes overwhelming pace of an engineering or technology program 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.

6) 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\(^{37}\) 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 an engineering or engineering technology 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.

Bibliography

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