AC 2011-1272: RECRUITING AND RETENTION OF ENGINEERING STUDENTS: USING A ONE YEAR SCHOLARSHIP AT TWO-YEAR PARTNER SCHOOLS

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Two-Year and Four-Year Partnerships

Abstract

Colleges of Engineering have been trying to tap potential engineering students from the underrepresented minority segment of the population for more than thirty years. As soon as it was realized how few high school minority students were fully qualified to and interested in studying engineering, four-year institutions began seeking and qualifying those students who were "almost" qualified. Summer bridge programs were developed to build needed skills, create academic community and perhaps offer course credit. Extensive first-year programs were created which provided academic assistance, peer or faculty mentoring or perhaps offering first year research with faculty. Follow-on programs were also instituted at some colleges to give academic support and build community among engineering learners. Additional options are dual degree programs and curriculum adjustments making engineering "more relevant". Still other institutions have marshaled student professional organizations to conduct outreach, build community and act as a recruiting and retention hub. This paper describes the development, workings and results of one Four-Year College program, and recommends how such a program could be created by virtually any engineering college interested in tapping the under-prepared population of students attracted to studying engineering. The key elements of principles, process and current best-practices include: recruiting students and parents, selection, orientation, the junior college experience, academic planning and advising, community-building, curriculum development, and institutional selection and alignment.

Introduction

For more than thirty years, engineering colleges and universities have been trying to draw in more students into engineering programs. Recruiting and retention research has investigated academic reasons such as the inability to succeed in calculus[1], accommodating options and curriculum adjustments making engineering "more relevant"[2] or offering dual degree programs[3], and considering conditions which influence students to change major[4]. Institutions began seeking and qualifying those students who were "almost" qualified [5-6]. Numerous programs were developed to enhance persistence, such as common first year programs[7], peer mentoring program[8], supplemental instruction program[9], and high intensity collaborative learning based on the Treisman model[10]. Student professional organizations have been employed to conduct outreach, build community and act as a recruiting and retention hub [11-14]. Studies to define best practices have been conducted[15-16] and the question of commitment to an engineering major *before enrolling* has been investigated[17]. The first-generation college students population has been given additional scrutiny for encouragement to study engineering as colleges and universities have attempted to draw in engineering students through the community or junior colleges [18-20]. More recently, community colleges and baccalaureate institutions have collaborated to deliberately design practices and coursework to optimize the enrollment and retention of women and minorities into engineering degree programs [21-24].

This paper describes the salient features and rationale for the collaborative Two-Year and Four-Year college program developed over ten years which is addressing many of the recruiting and retention issues faced by the Four-Year Engineering College. This model involves a ten month preparatory year at a junior college working with the Four Year. In contrast to traditional models the Four Year defines the partnership and also selects the students who attend the Two Year anticipating that they will matriculate and graduate from the Four Year.

Recruiting Students and Parents

Student search strategies are designed to attract students beginning in the sophomore year of high school. Special emphasis is placed on identifying underrepresented students, largely using traditional means that include direct mail, travel, and outreach through community organizations and technically oriented non-profits with youth development missions. Budget permitting, advertising is also used from time to time. Given the dwindling size of the pool of high school graduates who intend to major in engineering, underprepared students, those whose academic credentials fall somewhat below the normal threshold for admission, are deliberately sought to expand the pool of applicants.

Students who respond to initial contact are invited to visit the Four-Year College early on. A number of specialized one-day programs with extensive college student and faculty contact are offered for High School students likely to benefit most from the Scholarship. These highly-personalized, relatively intimate visit programs of 10-40 participants are crucial in attracting students to the University and introducing them to the Scholarship program. They allow the Admissions staff to address two significant concerns. First, parents are often reluctant to allow their children to consider such a rigorous education. Second, the idea of spending an extra year in college is initially unappealing to many students.

Depending on their entry point into the admissions cycle, students who are admitted to the Scholarship program usually visit several times over a two year period, often with financial support from the University. They participate in overnight "Student for a Day" programs, and ideally, a one week experiential workshop, the College Introduction Program (CIP).

The CIP is a college student-led, faculty-supported, reality-based journey into life as a Four-Year College student, designed for rising high school seniors. This special week, offered three times each July, is built around a robotics project which serves not only as an introduction to engineering, but also as a laboratory to explore leadership and team building. The schedule is high-intensity, deliberately designed to challenge students in several developmental domains. Activities are structured to replicate the Four-Year College student experience. In 2009 a four hour college planning component was added, receiving very favorable reviews. One day during each session includes a full-on program for parents, who watch their children compete for honors in the robotics competition, meet staff and faculty, learn about the admissions process and careers in engineering.

Overall, the week is transformational for participants, 85% of whom go on to apply to the Four-Year College. Realizing that underrepresented students were less inclined to participate in CIP without having first visited the campus, the specialized day long programs referenced above were established, partly to increase participation in CIP, and hence, develop a more diverse applicant pool. As a result, the number of underrepresented students participating in CIP doubled in 2004 when the robotics curriculum was added to CIP.

Four-Year College students are a crucial resource in recruiting; the most active college students are those who graduated from the Scholars program, testament to the success of cohort-building and their opinions about their prep year. These Four-Year College students often stay in touch with high school students who visit using social media and email. Admissions staff is highly engaged with both students and parents as well. Their duties include advising on high school courses, especially math, during their junior and senior years in high school.

Importantly, these conversations are always oriented around admission to the Four-Year College, the successful completion of a technically oriented curriculum, and choosing a technical major. The Scholarship is noted as a pathway to admission, but serious conversation about a scholarship school does not occur until after the Admissions Committee makes a recommendation based on each student's complete record.

In summary, factors that drive a successful recruitment strategy include:

- Early outreach to capture attention and influence curricular choices in high school
- Sustained contact, socialization, and visitation, allowing high school students to see themselves as future Four-Year College students
- Parental engagement to influence decision making and reinforce expectations for support that are crucial later in the program
- Four-Year College student engagement and role modeling to foster identification and aspiration

Selection

In addition to the resource requirements for the program, a second challenging aspect of this approach is student selection. Rather than allowing the process of attrition to determine who will have the opportunity to progress towards a Baccalaureate degree , this model puts the onus on the Four Year institution to learn to identify and support students who show promise - immediately after high school.

Even so, Scholars have just ten months to close educational gaps. Consequently, choosing students who are most likely to succeed requires informed knowledge of the capabilities of each junior college partner, the student's individual strengths and weaknesses, and the nature of expectations at the Four Year College (academic, physical, and emotional). Also required is the fortitude to deny admission to deserving students whose needs are too great to succeed given the limitations of the program and the expectations of the College.

Scholars are selected from the applicant pool as a whole. All applicants are screened for the Scholarship Program by the College student Selection Board and the Admission staff. A second selection board is constituted to review records of Scholarship prospects. The Scholarship Selection Board consists of the Academic Advisors who support the Scholars, a tenured member of the Athletic Department, and the Director of Admissions. All Board members visit junior college partners, most maintaining on-going contact with faculty and administrators at each institution.

The conceptual model used to assess student records is holistic. All factors relevant to a student's educational potential are considered by the Board. The criteria for admission of every college student and Scholar relate to the following factors [25] :

- Leadership potential
- Academic and intellectual potential
- Ability to recognize and use available resources in pursuit of personal growth
- Motivation to excel
- Capacity to contribute to the campus community and future professional career

In addition, Scholar prospects are evaluated for their ability to persevere and achieve long term goals. Reviewers look for evidence of sustained commitment in an academic or

extracurricular domain; or evidence that a student successfully confronted a significant obstacle in life[26].

Evidence is collected from student essays, transcripts, interviews, teacher/counselor recommendations and to a limited extent, standardized test scores. Interviews are conducted in nearly all instances, typically by the Scholarship Program Coordinator.

Students admitted to the Scholars program share the following attributes:

- Completed four years of math with strong foundation in Algebra; at least three years of lab science; and four years of English
- Graduated in the top third of their high school class with standardized test scores between 1050 and 1180 on the two part SAT or ACT equivalent
- Open to the idea of pursuing a technical major; strong commitment to own education
- Strong moral character
- Sustained commitment to an academic or extracurricular pursuit which the student intends to continue at the College; or have overcome an adversity leading to personal growth and insight
- Strong support network that includes parent or guardian approval

Orientation

A second mention of Summer Orientation is warranted given its crucial role helping students make the transition to college, form identity, and accept the norms and expectations of the institution as their own.

Scholars are required by contract to attend this eight day program in August. It is organized and supervised by Admissions staff and Academic Advisors, but led by a cadre of 20 college students, themselves products of the Scholars program. Like CIP, the pace and demands of the week are designed to simulate the college student experience. Importantly, college students (juniors and seniors) are the "face of the institution." Drawing as well on their own experience, these college students train for a week prior to the start of the program. They bring an extraordinary sense of pride, commitment, authenticity and excellence to the Summer Orientation experience.

The relationship between Scholars and their college student leaders is actually supportive. College students understand that their role is to prepare the new class for college and the expectations of the Four-Year College. They are evaluated based on relationships they forge with the Scholars and the extent to which they maintain these relationships during the scholar's year.

At Orientation, the transition to college is marked by a ceremony attended by parents and family members. This ceremony serves an important purpose: to drive home the idea that the Scholars now represent something bigger than themselves, a link in a long chain of graduates not only from the program but from the institution and the profession its graduates go on to serve and lead. Senior administrators normally officiate. In addition, expectations are once again reviewed, in the presence of parents, who are seen as partners in the education of their children.

In addition to briefings on scheduling, transportation and medical coverage, parents are also advised on institutional points of contact, resources available to them, and support programs for their children. They are encouraged to call on the Ombudsmen, Four-Year College counselors, Admissions staff and Chaplains as they see fit. Parents are encouraged to join the Facebook

account and Parents Association listserv as well. In practice, parents usually go to the Ombudsmen and Admissions staff first when concerns arise.

Besides completing administrative requirements during the week, students complete their placement testing and meet informally with their college student cadre to prepare for their arrival at their two-year institution. Teamwork is continually reinforced; Scholars are expected to assist and support each other for the good of the group as a whole.

By the end of Orientation, the Scholars have developed a strong group identity and powerful sense of community, which allows them to stand out as role models the moment they arrive at their new campus. Thanks to the outstanding support and commitment of junior college partners, expectations for teamwork and excellence are reinforced during the year.

The Director of Admissions retains oversight until Scholars matriculate to the Four-Year College. The Program Coordinator and senior staff are personally aware of the status, needs, and progress of each Scholar, despite their distance from the Four-Year College. Importantly, Scholars must check in each week with their Four-Year College Advisor, who in turn, maintains contact with teachers and Admissions. In addition to advising, we hope that students establish a habit of consulting their teachers and advisors regularly by the time they report to the Four-Year College.

The Scholars College Experience

Students undergo another orientation when they arrive at the two-year school. There is additional academic placement testing to confirm or question four-year placement recommendations. Most courses are specified and the student will have only one elective course during the year. This is by design. The Scholars year needs to stretch the student and to match the difficulty as closely as possible to what is expected in a four-year engineering program. This means calculus, physics, and English are expected.

Students are required to email their four-year school academic advisor each week. They also meet weekly (individually or in small groups) with their Scholars school academic advisor. The two academic advisors confer frequently, ensuring the students end up with an academic relationship (often a close one) with a Four Year college faculty. These academic advisors follow the progress of Scholars until they graduate with their BS degree. Each mid- and end-semester the faculty advisor reviews grades and progress of all current and former Scholars.

First Year Persistence and Matriculation

Admission to the Four-Year College is not guaranteed. This is a powerful incentive for students to do their best, one of the fundamental expectations of the program. Maintaining a consistent standard is essential not only for the benefit of instructional staff at the junior colleges, but in order to maintain institutional credibility and a strong pipeline of future applicants.

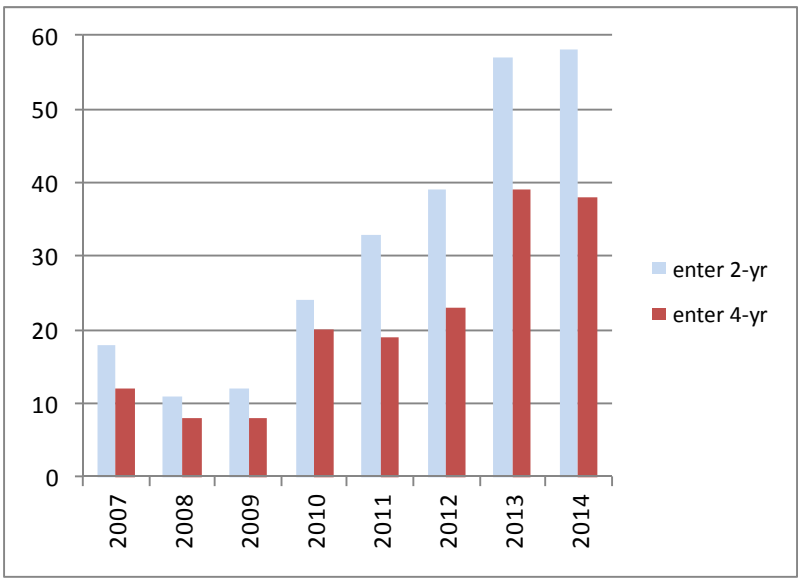

Figure 1: Comparison by class year, number of students who enter two-year school and students who enter the four-year school.

The Scholarship Selection Board convenes (December and May), conducting a holistic review using college student selection criteria. In addition to the student's admission file, college transcripts, curriculum, and the recommendations of junior college and Four-Year College Advisors are heavily weighted. Barring exceptional circumstances, students who are unable to meet academic or disciplinary expectations by the end of the first semester are separated from the program. Considerable assistance is offered to place the student in another program of their choice; some chose to continue at the junior college at their own expense. An amicable "soft landing" is an ethical priority, out of respect for the relationship with each family and underlying commitment to student success. Junior college partners are invaluable colleagues in the out-placement process, conferring early with Four-Year College administrators and students.

In the measurement of success, the results are mixed. There are many opportunities for students to choose to leave, as well as many opportunities for students to be forced to leave. First, as shown in Figure 1, consider the number who complete the Scholars year and transition successfully to the Four-Year College.

The reasons why students do not matriculate are as varied and numerous as the students. Although both the Four-Year College and the Scholars school provide their best support, the success of each student is dependent primarily on his or her personal determination. It is likely that the range of "leavers" for these eight year groups (25%-42%) reveals the range that could be expected over a much longer period (decades), however, the goal remains for both the two-year and the four-year school to see every student enrolled complete a B.S. degree.

Measuring Success

Consider the prep-program students who enter the Four-Year College who graduate with a B.S. degree. As shown in Figure 2, the comparison of students who enter to those who graduate (dashed bars are estimated based on individual performance to date) shows a record of increasing persistence until class year 2014. This group has shown a slow start during their first semester. Only time will reveal the rest of the story. More confidence is attributed to class years 2011-12 since many engineering schools have shown that once students proceed to the upper class level, their likelihood of graduating is very good.

Overall, it may be tempting to conclude that having as few as half of the Scholars persist to graduation constitutes minimal success; many engineering colleges obtain results of this magnitude by doing virtually nothing "extra." The philosophy of this Four-Year College includes a commitment toward reaching out to under-prepared high school communities over the long term. It is our hope that those who don't graduate from our Four-Year College will graduate from another BS institution and persist in engineering as a career choice. Further, we endeavor to inspire former applicants to lofty goals and we hope that our institutional reputation is enhanced as a result of the Scholars experience.

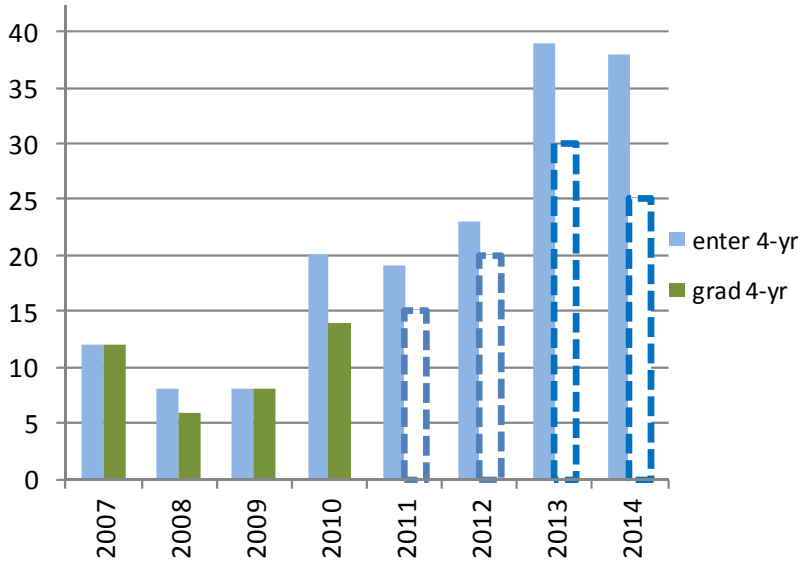

Figure 2: Comparison by class year, number of students who enter and number who graduate (2011-2014 estimated).

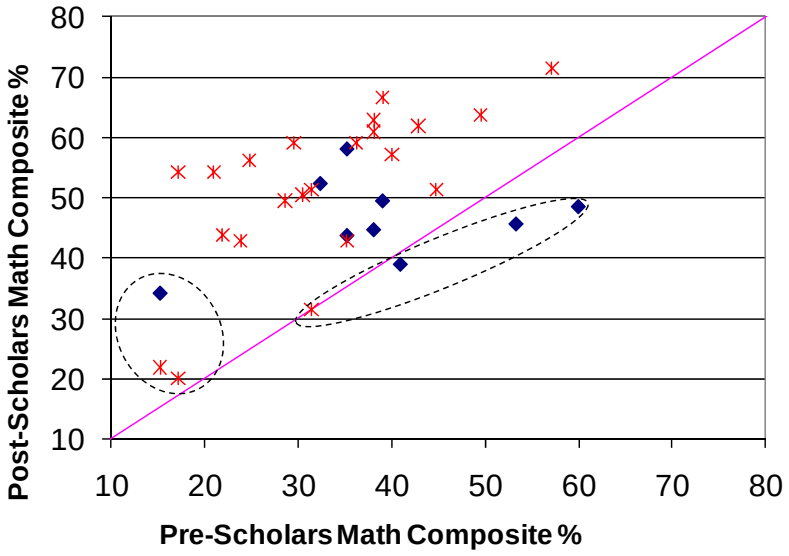

Figure 3: Comparison of pre-calculus skills before and after the Scholars year.

It is worth noting that assessment is valuable at each step in the process. For example the pre-Scholars year math and reading placement exams are repeated as post-Scholars year measurements to gauge evidence of academic skill development. In the example shown here (Figure 3) we have two schools represented in a cross-plot of pre-and post-scholars math skills test where the pre-test value is plotted on the abscissa and the post-test on the ordinate. The diagonal line represents the equality of pre- and post-test scores, so that points lying below (right of) the diagonal show little or no improvement (dotted ellipse) and those in the lowest pre-test range, while improved, are still of concern (left circle). This is a useful tool to communicate to students, faculty and administrators how seriously the objectives are assessed. Showing such a plot to the Scholars during Orientation sets appropriate

expectations for the upcoming year, and reviewing their progress when they matriculate helps to define their accomplishment as well as to help place them, visually, among their peers.

One other such cross-plot (Figure 4) revealed a lack of reading improvement that caused faculty and staff to take corrective measures. Again, we show two different Scholars schools (two markers) and the diagonal line is the equality designation.

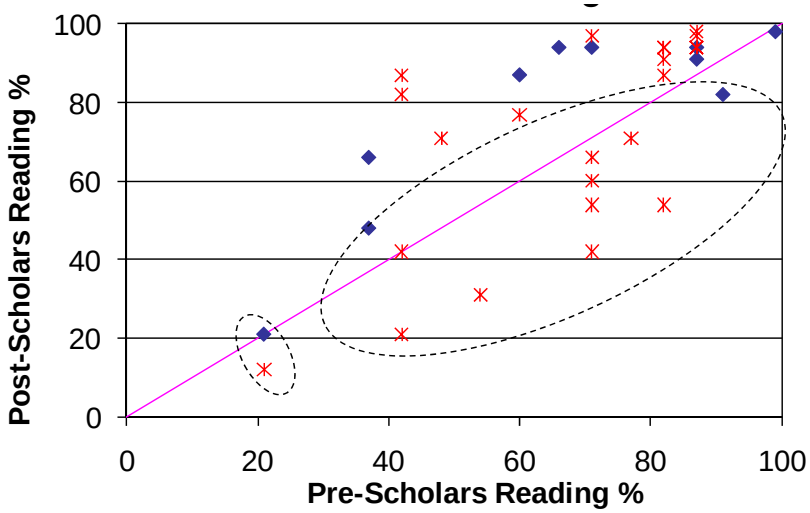

Figure 4: Comparison of reading skills before and after the Scholars year

One additional consideration for this Four-Year College is the proportion of "technical majors" at graduation. The goal is 70% of the graduates to major in Science, Engineering or Math (SEM). The comparison of "technical" and non-technical Scholars by class year is shown in Figure 5. This could become the pivotal characteristic for this program and ultimately determine whether or not the efforts continue.

Defining the Partnership

Traditional articulation agreements rely exclusively on the "push" afforded by Two Year colleges to propel students forward.

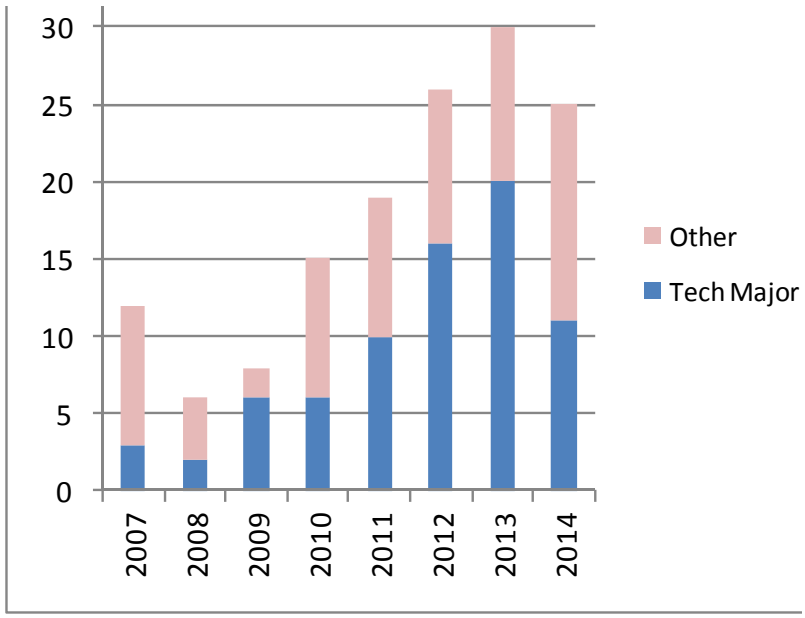

Figure 5: Comparison by class year, SEM vs. non-technical major (years 2011-2014 are estimates).

The Four-Year College Scholarship is different because it relies on both "push" and "pull." Achieving "pull" requires that the Four Year (not the Two Year) institution take primary ownership for student success. This equation has played a crucial role helping the Four-Year College diversify its student body and increase the number of SEM graduates, both key enrollment goals. It is a model that can be used elsewhere with equal success.

There are two fundamental agreements; one between the Four-Year College and its

junior college partners, and the other between the Four-Year College and the students it admits to the Scholars Program. This arrangement is in contrast to more typical articulation arrangements, which rely on agreements between the two and Four Year institutions alone, often leaving students to negotiate the transition to the Four-Year institution on their own.

In return for tuition and a well prepared cohort of students each year, the junior college waives its own admission process, assigns a dedicated program coordinator and student advisor, and delivers an exceptional education aligned with the Four-Year College's first year experience; in this case, emphasis on math, science, and writing skills. The relationship between the Four-Year College and each Scholar is contractual in nature and delineated in writing. Scholars agree to enroll in the Four-Year College, if accepted. The contract includes a number of unique requirements designed to promote student success. For instance, students are not permitted to own or operate vehicles or accept employment during their Scholars year; the penalties for underage drinking and illegal drug use are spelled out and include expulsion.

The Four-Year College agrees to pay each student's tuition, travel and medical expenses. Costs were managed in collaboration with junior college partners. For instance, the Board of Regents of one partner elected to offer in-state tuition to Scholars in return for 30 or more college student candidates per year, thus cutting this expense in half. Traditional colleges or universities can do the same thing more simply and perhaps less expensively by using means tested scholarships, endowed funding, and other resources at their disposal which are not available to this Four-Year College.

Faculty and Staff Teamwork is Critical

The Four-Year College faculty who volunteer their time and expertise run the academic oversight and the weekly advisor contact with students. These faculty meet with the Scholars institution faculty regularly to guarantee subject matter coordination for courses such as math, chemistry and physics. The goal is to know specifically what skills students should be able to demonstrate by passing a given course at the Scholars institute and to convey these skills to the students so they can succeed.

One final thought regarding these pivotal people is poignantly expressed by DuMaine and McGuffin: "…the careful selection of a nurturing staff person to serve as counselor and mentor to the students" is an important component of the two-year college collaboration plan[24].

Model for Other Universities

A key component of the process is selecting students from among the applicant pool to the four-year college. This gives a starting point for the student who may not initially be prepared to enter an engineering program but who has a desire to study engineering. The four-year school orients and educates both the applicant and their family to direct a beginning point at the two-year partner institution, then hands-off the student to enroll in the two-year school while keeping in close touch throughout the community college work.

The two institutions partner closely and frequently, matching teacher-to-teacher and staff-to-staff individuals to guarantee skill development is accomplished by the student. Partnering institutions match course content by selecting common texts and sharing course objectives (e.g. skills students should have by the time they complete this course). One fundamental concept is that the two-year school needs to have as one of its mission the goal to guide and prepare students to "complete" their degrees at the four-year partner school.

The four-year school gets to know (by recruiting) the students (and by extension and marketing their parents) before they enter college and stays in touch with students while they are at the two-year school. For minorities (first generation college students and some women), this two-year to four-year track is a pathway that can eventually become "paved" into the home communities of these students, thus providing a road for future under-tapped student populations to follow.

Cost (in dollars) can be a little or a lot. Two-year schools are known for being affordable, but for students living at home, distractions and family expectations can be problematic[20]. Four-year schools may financially supplement students attending the two-year school (as described here) and/or choose to fully provide the non-monetary items (e.g. orientation, academic advising, supplemental instruction, faculty connections and encouragement). The non-monetary costs to administer, coordinate and advise are considerable in terms of work hours, but cannot be reduced without also reducing the potential success of students.

Conclusion

We have described a recruiting and retention model which has developed over more than a decade and which involves a novel philosophy wherein the Four-Year College "owns" the program. The articulation agreements are formal between the Four-Year and the Two-Year institutions and the agreements between the Four-Year College and the students are formal and written. The importance of involving faculty and staff is also described. The key elements are: recruiting students and parents, selection, orientation, the junior college experience, academic planning and advising, community-building, curriculum development, and institutional selection and alignment. A fundamental difference of this program is the number of expectations placed on the student during the Scholars year, spelled out in the written contract and reinforced during orientation. Some methods of assessment have been presented.

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