



Design of a Scholarship Program for Optimal Impact

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Introduction

The elimination or reduction of the early intervention and academic support programs for low-income and underrepresented minority students coupled with increasing costs, reductions in financial aid, and rising student debt levels constitute serious obstacles to efforts to tap the diversity of the U.S. population¹. Federal scholarship programs can provide resources to open up opportunities for students from underrepresented groups and thus improve diversity in the engineering workforce. However, the scholarship programs must be designed with this objective in mind to make the most effective use of the resources. For example, reducing the award size increases the number of students that receive support, but the level of support may not be sufficient for the students to complete their degrees. On the other hand, using funds to provide very large offers may attract outstanding students who may have otherwise attended other institutions, but changing which institutions the students attend may not increase the number of underrepresented students in the profession. In addition, the scholarship awards need to be complemented with academic support programs so that students persist to graduation.

In this paper, these ideas will be illustrated using results from a National Science Foundation (NSF) Scholarships in Science, Technology, Engineering and Mathematics (S-STEM) project that targets students from underrepresented groups who have financial need, but do not qualify for university-level scholarships. The project provides scholarships of full in-state tuition support for up to four years, so students can complete their degrees. The requirements are designed to set high expectations, but at the same time provide incentives and encouragement for students that may have difficulty in the adjustment from high school to college. The students are also provided with various types of academic support. The design of this scholarship program and lessons learned from its implementation are described in this paper.

Design of Scholarship Program

The scholarship program was designed to support students with financial need, so only applicants with expected family contributions (EFC) as determined by the Free Application for Federal Student Aid (FAFSA) less than \$18,000 were eligible for scholarships. Such support is needed to offset the rising costs of education as tuition has grown more than 500% over the past 25 years. The cost of attendance at a public university today, including room and board, is \$12,000 to \$15,000 per year¹.

In addition, students whose ACT scores and high school grade point averages (GPAs) were high enough to receive a tuition scholarship from the university were considered to not have financial need. There were two levels of scholarships. In-state residents were awarded a scholarship in the amount of tuition plus fees, while out-of-state students were awarded \$10,000, which is the maximum allowed by the program. Tuition from out-of-state residents is three times that for in-state residents, but if a student receives scholarships for the amount of in-state tuition, one-third of the out-of-state tuition is waived, so non-residents receiving the NSF scholarships paid less than the amount of in-state tuition.

The project has an advisory council that consists of representatives from the nine academic programs in the college of engineering. This council evaluates applications and provides input on general procedures. The council decided to set the minimum GPA for a full scholarship to be 3.0, which is consistent with other scholarships at Auburn University. Included with other significant predictors of persistence in science and engineering, Reichert and Absher indicated that having a high early college GPA is a significant predictor of persistence². However, to encourage and enable students who may drop below a 3.0, partial scholarships are awarded to students with GPAs between 2.2 and 3.0 according to the following formula:

$$\text{Scholarship amount} = \{(GPA - 2.2) / (3.0 - 2.2)\} \cdot \{\text{Amount of full scholarship}\}$$

The scholarship can be reinstated and the amount adjusted according to changes in the student's cumulative GPA.

Scholarships were offered to two cohorts of students – one that matriculated in fall 2009 and another that matriculated in fall 2010. Overall about two-thirds of the scholarships offered were accepted. Two notable trends were that matriculation rates for applicants with EFC from \$18,000 to \$40,000 (these students did not qualify for NSF scholarships) were relatively low (52%), which indicates that their income was too high to obtain significant financial need assistance, but low enough that finances significantly affect the decision. Another notable observation regarding acceptance rates was that 75% of the students who received a tuition scholarship from the university accepted that university scholarship, which supports the approach to not award these students NSF scholarships. The acceptance rate for out-of-state applicants (5/9 = 56%) was lower than that for in-state applicants (19/21 = 90%) who were offered scholarships. Both of these rates were higher than the corresponding rates (28% and 78%) for those qualified applicants that were not awarded scholarships, which indicates that the scholarships positively impacted the students decision to attend Auburn University.

Student Support Programs

In addition to the financial support from the scholarship program, academic support services are provided through the Alabama Power Academic Excellence Program (AE-AEP) to help the students succeed in their academic programs. Proponents of higher education should create programs to support and retain underrepresented minorities as they go through college; programs should make available peer groups, mentors and role models¹. Tinto³ advocated five conditions that support persistence to graduation for new students. The five conditions are settings that expect the students to succeed; settings that provide academic, social, and personal support; settings that provide early and frequent feedback on students' performance; settings that include students as valued members; and settings that foster learning.

One AE-AEP support program is the *Interactive Learning Laboratory*, which incorporates a variety of approaches to learning, including one-on-one tutoring, collaborative (peer) learning and interactive software. The laboratory consists of nine computer workstations where students can use interactive software to enhance classroom learning. The lab also includes resources to help students develop money management skills and financial literacy that are essential for students while in school, as well as after graduation.

Students are also encouraged to participate in *Collaborative Learning Groups*, designed to foster collaborative and peer learning in key mathematics, science, and computer programming courses. A collaborative group enables students to develop a small supportive community of peers, that helps bond them to the broader social communities of the college while engaging them more fully in the academic life of the institute⁴. Freshman engineering students are organized into study groups based on common technical courses. Each group is facilitated by upper-class students proficient in the subject matter, who provide structure to the session and ensure that problem solving progresses at a reasonable pace. Students work in groups solving homework problems and working through course material during the sessions. While facilitators are encouraged to promote critical thinking in the freshman students, they do assist the students when they cannot find solutions to the problems. These collaborative learning groups have broader impact since shared learning can create an inclusive learning environment for minority students⁵, which supports cohort development.

In addition, *Sunday Evening Tutorial and Academic Excellence Workshop* sessions are organized to allow students to receive additional academic help. The tutorial sessions are facilitated by upper-level students. As indicated by Rouche and Rouche⁶ many students lack preparation and study strategies necessary for success in higher education. In addition to the tutorial sessions, a segment of the time allocated on Sunday evening is devoted to academic excellence workshops, which are presented by volunteer corporate sponsors, alumni, and upper-level students. The topics include study strategies, time management, dealing with diversity, financial management and success strategies for transitioning into the work place. The purpose of having the tutorials on Sunday evening is that oftentimes students go home for the weekend and fail to return to campus until a weekday morning. The weekend tutoring program brings the students back to campus at a reasonable time and assists them in preparing for the upcoming week's exams and assignments. Good, Halpin and Halpin⁷ stated that administrators in higher education have initiated numerous academic support programs to encourage students to continue to excel in sciences and mathematics in hopes of retaining them in these quantitative majors. Also, as noted by Besterfield-Sacre, Atman, and Shuman⁸, freshman engineering courses and seminars could attempt to introduce more 'real world' applications to the classrooms.

A *Mentoring Program* has been established, since students have indicated that networking with upper-class mentors eases the transition of freshman students into the university environment⁹. The program enlists upper-class students who have successfully moved into their major to serve as mentors to assist incoming freshman students and sophomore students in managing their academic schedule, sharing study strategies, participating in proactive mentoring and helping students navigate through the campus milieu. Because of a lack of understanding of the engineering culture, many minorities use ineffective approaches to and hold unrealistic expectations about studying engineering. Mentors are vital because they not only inspire, but also assist students in setting and reaching realistic goals. They broaden students' horizons, assist students in locating university resources and combat student isolation¹⁰.

This approach has been expanded in the *Mentoring Beyond the Classroom* program, which is designed for alumni to give back to the program that was such a benefit to them. Many students in the program begin internships during their sophomore year and cooperative work during their

junior year. When students are in the preparation stage of their intern or cooperative work assignment, an alumnus that lives and works in the city where the student will be located is notified. A match is made with this person who graduated from the university, was a participant in the program, and works at the company where the student will be employed. The alumnus becomes a mentor and helps the student acclimate to the city. The mentor initiates a reception to make sure the student has an opportunity to meet other alumni who graduated from the university. The purpose of the *Mentorship Beyond the Classroom* program is to lessen the feeling of isolation a young person feels when in a large, unfamiliar city for the first time. As Stromei¹¹ noted, providing students with a mentor at both school and work increases the likelihood of success at both locations and contributes to a smooth transition to the postsecondary environment and eventually to the workplace.

An *Academic Resource Library*, which includes a collection of books, video tapes, textbooks, software, and periodicals, is available for students' use during their academic career. The library also accommodates a computer bank of old test files to aid students in preparing for exams. Students often use the resource materials in areas where software programs, tutorials, or learning groups are deficient. Another facet of the library is the textbook loan program. At the beginning of each semester, textbooks are loaned to students with the greatest financial need.

Recently a *Summer Engineering Enrichment Program* has been implemented. This program is a comprehensive three-week residential program for highly motivated underrepresented engineering students who want a head start in their engineering career. The program emphasizes academic preparedness, development and enhancement of study strategies, establishment of social support networks, and exposure to valuable campus resources. The program is staffed by engineering faculty, counselors, graduate teaching assistants, and upper level engineering students. Campus climate involves the sum total of the daily campus living experiences of students and is pivotal to their perception of the level of comfort that exists in the college environment¹¹. At the same time outreach programs focused on preparing students to study engineering in college should be academically rigorous¹².

Student Performance

The performances of the scholarship recipients in high school are summarized in Table I. The high school GPA and ACT test scores of the 2010 cohort of scholarship awardees are higher than those of the 2009 cohort. Although differences between high school GPAs are not statistically significant, the differences between the ACT scores are different to greater than 90% confidence (according to the student t-test).

The average cumulative college GPAs of scholarship recipients are shown in Figure 1. Consistent with the higher ACT scores, the 2010 cohort has performed better in college than the 2009 cohort. Although the average GPA is useful for comparison and showing trends, the GPA relative to the critical values for scholarship eligibility are more important and these are summarized in Table II for the scholarship recipients after their fifth semester (fall 2011 for the 2009 cohort and fall 2012 for the 2010 cohort). Overall, the students are approximately evenly distributed between full/partial/no scholarship with most ($15/24 = 63\%$) students qualifying for scholarship (8 full, 7 partial) and nine not receiving scholarships either because of a low GPA (8)

or because they are no longer in engineering (1). As with the trend in average GPA, the number of students from the 2009 cohort that are not receiving scholarships (6) is larger than that in the 2010 cohort (3), which is consistent with the average GPAs of scholarship recipients summarized in Figure 1.

Evaluation of students' performances in college relative to their performances in high school is helpful to gain understanding that would be useful in identifying promising students for recruitment. The cumulative GPAs of NSF scholars after five semesters in college show a positive correlation with high school GPA (see Figure 2). An even stronger correlation is observed relative to ACT-Math scores as shown in Figure 3. All of the students with an ACT-Math score of a least 29 have a GPA of greater than 3.0 while only four out of the 18 students with ACT-Math scores less than 29 have a GPA of greater than 3.0. The line in Figure 3 represents a linear trend line fit for those with ACT-Math scores less than 29 and indicates essentially no dependence among those with scores less than 29.

One common attribute of the students with ACT-Math scores less than 29 and GPAs greater than 3.0 was that all had strong participation (40 hours or more) in academic support programs. Figure 4 shows how the GPAs of scholarship applicants (those awarded and those not awarded) are related to the number of hours spent in academic support program activities. Although there is considerable scatter in the data, the GPAs of students who spent more than 30 hours / semester in academic support activities are on average a half a grade point higher (>99.9% confidence from the student t-test) than those who spent less than 30 hours in academic support program activities in their first year. The trend even continues into the second and third years (data not shown). As mentioned above, the critical parameter for a student maintaining his or her scholarship is the GPA relative to the critical values of 2.2 and 3.0. Approximately half (46-50%) of students who spent less than 30 hours in support activities had a GPA of 2.2 or less while only 12-27% of students who spent more than 30 hours had a GPA of 2.2 or less, so a majority (73-88%) of those students with significant participation in support activities did, or

Table I. Pre-College Performance of Scholarship Recipients

Cohort	Residency	#	HS-GPA	ACT	
				Math	Composite
2009 Cohort	In state	11	3.85	24.2	23.5
	Out of state	2	3.49	26.0	23.5
	All	13	3.79	24.5	23.5
2010 Cohort	In state	8	3.96	26.3	25.3
	Out of state	3	3.78	31.5	27.7
	All	11	3.91	27.3	25.9
All	In state	19	3.88	25.6	24.7
	Out of state	5	3.67	28.8	26.0
	All	24	3.85	25.7	24.6

Table II. Performance of Scholarship Recipients after 5th Semester

Categories	Scholarship	Number of Students		
		Cohort		Total
		2009	2010	
GPA \geq 3.0	Full	4	4	8
2.2 < GPA < 3.0	Partial	3	4	7
GPA \leq 2.2	None	5	3	8
Transferred	None	1	0	1
Total		13	11	24

would have, received a full or partial scholarship. Thus, participation in the support activities is beneficial to success in engineering curricula.

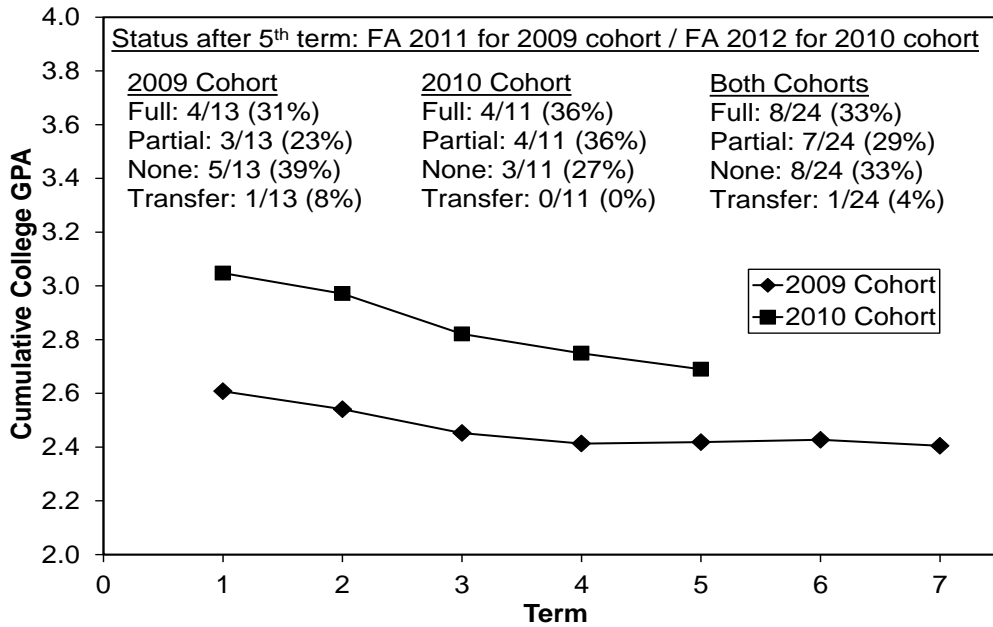


Figure 1. Cumulative GPA and scholarships status of NSF scholarship recipients.

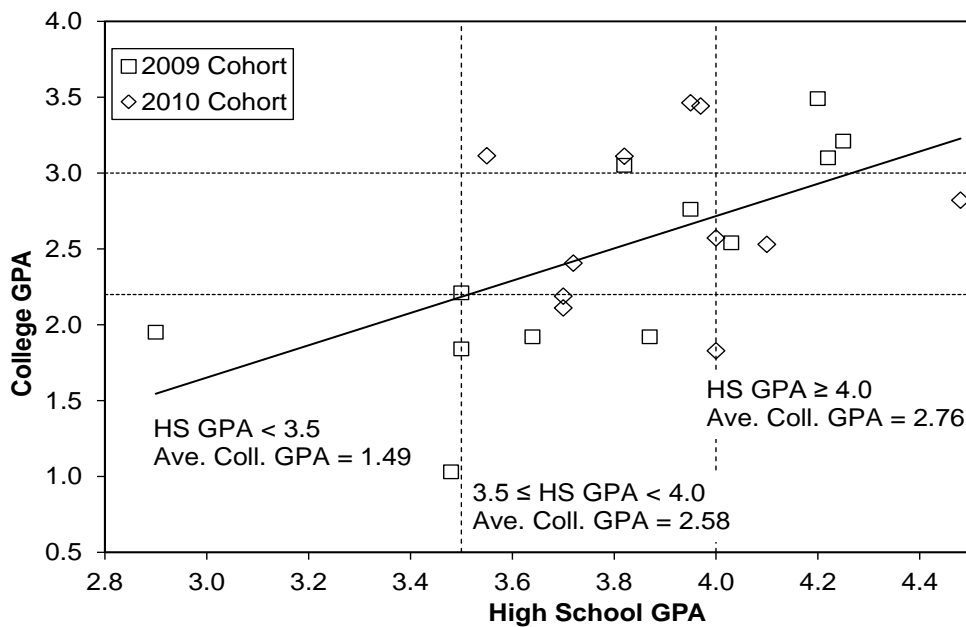


Figure 2. College and high-school GPAs of NSF scholarship recipients.

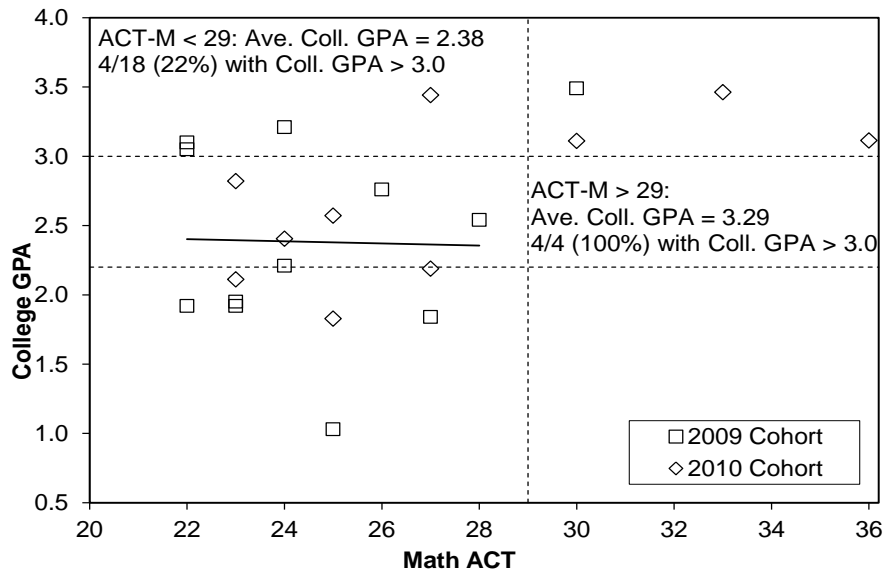


Figure 3. College GPA and Math-ACT scores of NSF scholarship

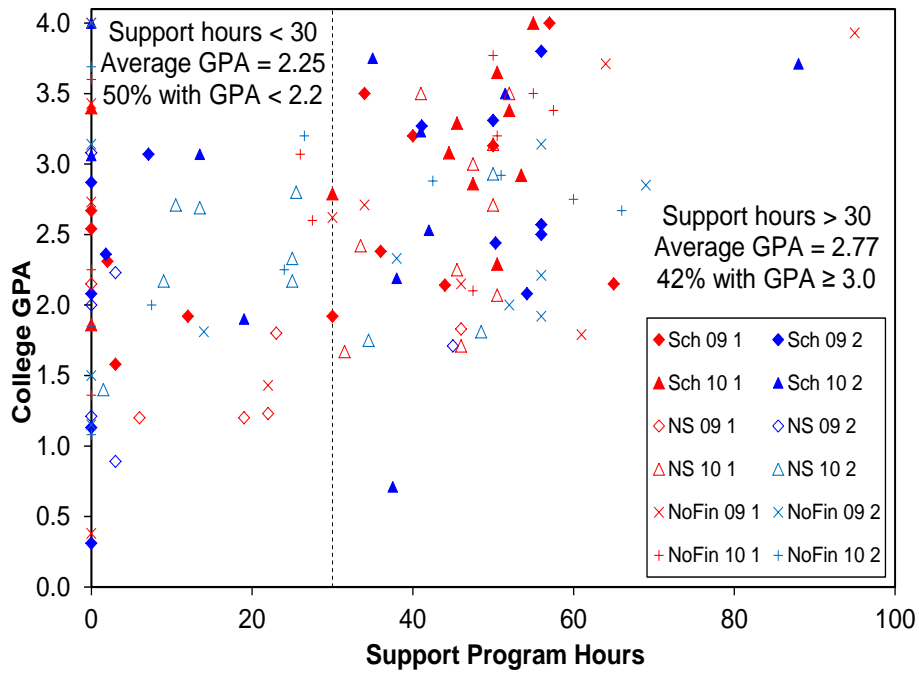


Figure 4. GPA and support program participation of NSF scholarship applicants include those awarded scholarships (Sch), those not eligible due to lack of financial needed (NoFin) and those eligible but not selected (NS). “09” or “10” indicates matriculation year and “1” or “2” indicated first or second semester.

As noted above, students who received tuition scholarships from Auburn University were not awarded an NSF scholarship. The NSF scholarships could be used to supplement the university scholarships which might attract students to attend Auburn University rather than another institution. While this would be good for Auburn University, it would not increase the number of engineering students – only where they study. To illustrate the impact of this approach, the performance of the scholarship recipients of the current project are compared in Figure 5 with those of the students that would have been selected if applicants with university tuition scholarships were awarded NSF scholarships. Eight applicants (5 in 2009 and 3 in 2010) were awarded university scholarships and six of these applicants matriculated at Auburn University. If these six students replace the bottom eight ranked students (i.e. those that would not have received scholarships) then the average GPA after 4 semesters would be 2.88 rather than 2.56. Similarly, the proportion of students receiving full scholarships would nearly double (increase from 25% to 45%). Although, the performance of this alternate group is better, the impact is less. Most (5/6) of the students with university tuition scholarships earned GPAs of greater than 3.0 and thus succeeded without the scholarship. However, three of the eight students that would not have received scholarships earned GPAs of 2.7 or greater (indicated in Figure 5). While some of these lower ranked students are not doing as well as those that received university scholarships, the success of these three students represent a positive impact, because they may not have succeeded without the financial and academic support associated with the scholarship.

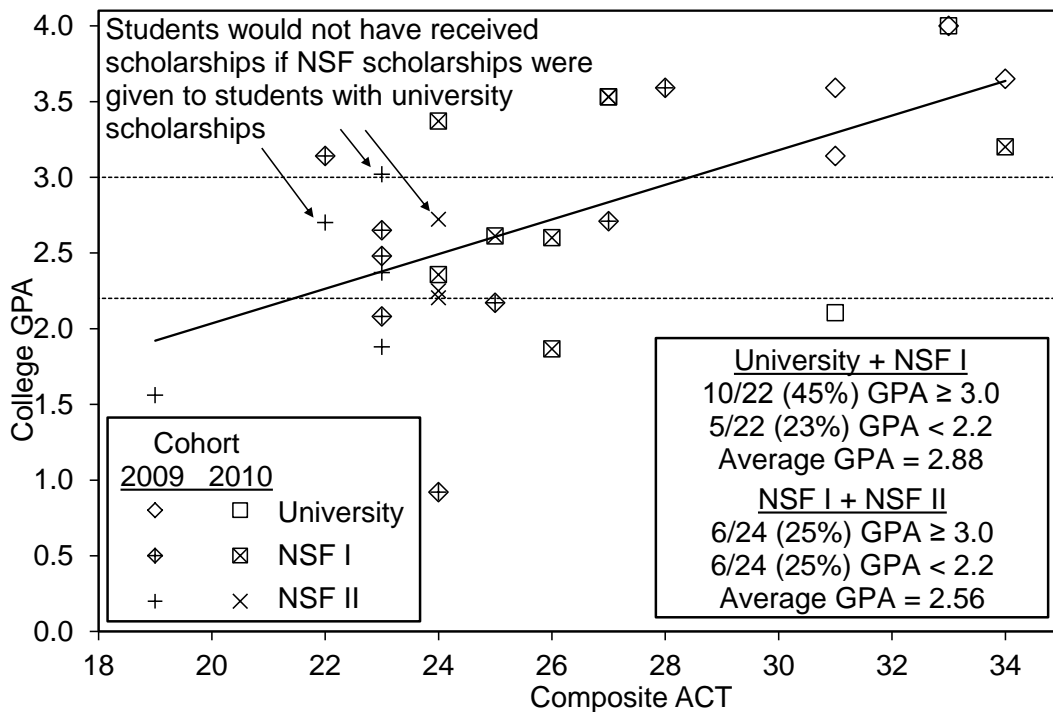


Figure 5. Cumulative GPA scholarship recipients (NSF I and NSF II) and applicants that were not awarded scholarships because they received a university scholarship (University). Students in the NSF II would not have received scholarships if those receiving university scholarships had been awarded an NSF scholarship.

Conclusions

Most (88%) of the scholarship recipients (10/13 from the 2009 cohort and 11/11 from the 2010 cohort) successfully persisted from pre-engineering into their engineering majors. The students were provided with financial assistance, an environment that fostered academic, social, and personal support. These students are well on their way to graduation and becoming part of a competitive workforce in which they will be contributors. At least one student will be attending graduate school.

Analysis of the performance of the scholarship recipients indicates that ACT math score, particularly of 29 or higher, is an excellent predictor of success in engineering and that participation in academic support programs is beneficial to academic performance. A focus on providing scholarships to students without other scholarship options may lead to lower values of performance metrics, such as GPA, but it provides educational opportunities to students with limited resources and thus expands the pool of engineering talent.

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