Can an engineering summer bridge program effectively transition underrepresented minority students leading to increased student success?

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Introduction

Many approaches have been utilized to address gaps in retention rates between underrepresented minority (URM) students and majority students at predominantly white universities in post-secondary undergraduate engineering programs. The root cause of such disparities varies between institutions. At selective institutions, all students have already met high-level academic qualifications and their pre-college performance indicates strong potential for success. The fact that these "high-ability" URM students underperform suggests that influences beyond pre-college academic preparation and innate ability play a role in URM student success. These influences may include: academic isolation, social isolation, cultural isolation, negative stereotypes associated with ethnic identity, motivational vulnerability, financial insecurity, and discrimination [1, 2, 3, 4]. The academic, social and cultural isolation experienced by URM students reflects ineffective transition. While the transition from high school to college poses risks for all students, there is significant evidence indicating that URM students who are otherwise academically prepared are particularly at risk at this leverage point [5, 6, 7].

Historically, summer bridge programs were used to boost the scholastic skills of academically underprepared students with heavy focus on remediation so that these students had the academic background necessary to perform undergraduate coursework [8, 9, 10]. However, as stated before, at selective institutions where incoming students are academically well prepared, a focus remediation is not necessary. To that end, a different summer bridge paradigm was introduced at Georgia Institute of Technology in 1990 with the Challenge Program. Georgia Tech dismantled its prior program focused on remediation. Instead of providing remedial work, the program became a rigorous five-week introduction to the first quarter of the first year with focus on support and academic/social acculturation [11, 12]. The change in programmatic focus to transition instead of remediation resulted in an increase in URM student performance and retention [13, 14].

In January of 2004, after benchmarking the Challenge Program at Georgia Tech and similar programs at large predominant white institutions around the country, a minority program in a large selective Midwestern university launched a five-week summer bridge program to simulate the rigor of the first semester of the freshman engineering curriculum. It was designed with a focus on URM student transition, preparing incoming URM freshmen engineering students for the cultural shift from high school to global competition at a selective institution.

This study quantitatively examines the effect of this summer bridge program on the URM engineering student transition and student success through the analysis of 5 cohorts of URM students who participated from 2005 – 2009. The study compares first year retention rates, first semester performance, and graduation rates, by cohort, of: (i) URM summer bridge participants; (ii) URMs that did not participate in the program, and (iii) the total cohort. This work is the first

step towards a rigorous analysis of how socio-academic acclimatization affects success of URMs in engineering and how these analyses can inform the development of student programs.

Program Structure

A sample week of the bridge program can be seen in Table 1. Weekdays are strictly scheduled with academic activities while students receive relative flexibility to plan their weekends. The academic component of the program consists of non-credit bearing course equivalents to Chemistry I, Calculus I, English, and Matlab programming, which are gateway courses of the freshman year. These courses are taught at an accelerated pace by professors or graduate teaching assistants, preparing students for the cultural shift to life in a college classroom.

Table 1: Sample week in the engineering summer bridge program.

Monday	Tuesday	Wednesday	Thursday	Friday
PREP CLASS 8:00 - 8:20	**PREP CLASS** 8:00 - 8:20	**PREP CLASS** 8:00 - 8:20	**PREP CLASS** 8:00 - 8:20	**PREP CLASS** 8:00 - 8:20
MATLAB 8:30 - 9:45	**MATLAB** 8:30 - 9:45	**MATLAB** 8:30 - 9:45	**MATLAB** 8:30 - 9:45	**MATLAB** 8:30 - 9:45
ENGLISH 10:00-10:50	**ENGLISH** 10:00-10:50	**ENGLISH** 10:00-10:50	**ENGLISH** 10:00-10:50	**ENGLISH** 10:00-10:50
CALCULUS 11:00-11:50	**CALCULUS** 11:00-11:50	**CALCULUS** 11:00-11:50	**CALCULUS** 11:00-11:50	**CALCULUS** 11:00-11:50
Lunch Break 12:00 - 12:50	**Lunch Break** 12:00 - 12:50	**Lunch Break** 12:00 - 12:50	**Lunch Break** 12:00 - 12:50	**Lunch Break** 12:00 - 12:50
CALCULUS RECITATION 1:00 - 1:50	**CALCULUS RECITATION** 1:00 - 1:50	**CALCULUS RECITATION** 1:00 - 1:50	**CALCULUS RECITATION** 1:00 - 1:50	**CALCULUS RECITATION** 1:00 - 1:50
CHEMISTRY LECTURE 2:00 - 2:50	**CHEMISTRY LECTURE** 2:00 - 2:50	**CHEMISTRY LECTURE** 2:00 - 2:50	**CHEMISTRY LECTURE** 2:00 - 2:50	**CHEMISTRY LECTURE** 2:00 - 2:50
CHEMISTRY RECITATION 3:00 - 3:50	**CHEMISTRY RECITATION** 3:00 - 3:50	**CHEMISTRY RECITATION** 3:00 - 3:50	**CHEMISTRY RECITATION** 3:00 - 3:50	**CHEMISTRY RECITATION** 3:00 - 3:50
PROJECTS 4:00 - 5:20	**PROJECTS** 4:00 - 5:20	**PROJECTS** 4:00 - 5:20	**PROJECTS** 4:00 - 5:20	**PROJECTS** 4:00 - 5:20
Dinner 5:30 - 6:20	**Dinner** 5:30 - 6:20	**Dinner** 5:30 - 6:20	**Dinner** 5:30 - 6:20	**Social Activity** 5:30 - 10:00
Study Hall 6:30-10:00	**Study Hall** 6:30-10:00	**Study Hall** 6:30-10:00	**Study Hall** 6:30-10:00	

In addition to the academic simulation, the program is designed to prevent the social isolation associated with URM student transition to college. Each day begins with a preparatory class that introduces students to different aspects of the campus and the opportunities available to enrich

the student experience. Following the preparatory class, students proceed through their series of academic courses. Students are introduced to collaborative learning and teamwork through a variety of mechanisms including mandatory study halls. To augment collaborative learning and cultural experiences, participants are enrolled in a course on cultural competency administered by one of the campus cultural centers. In addition, the program includes team-based engineering design through an immersive project experience. Student isolation is also minimized through frequent social interaction. Program participants reside on campus dormitories with access to dining halls for their meals. Social activities are hosted for students at different locations throughout the campus. In these social activities, participants interact with students from equivalent bridge programs from other disciplines such as technology, science, and agriculture. Participants also have access to all computer labs, libraries, and recreational sports facilities that they will have during their tenure as an undergraduate. The university is presented as a welcoming environment with the resources necessary for student success.

Data analysis

The data used for this analysis consisted of engineering student cohorts that entered the university as first-time, full-time engineering students in the fall semesters from 2005 – 2009. For these cohorts, URM is defined as a person who is a U.S. citizen and has identified themselves as Hispanic or Latino(a), Black or African American, or Native American. Each cohort was segmented in three groups for analysis: (i) URM engineering summer bridge students (SB URM); (ii) URMs that did not participate in the program (non-SB URM), and (iii) the total cohort. Summer bridge students apply to the program on their own accord and all incoming engineering freshmen are accepted to participate. As part of the application process, demographic attributes (e.g., gender, ethnicity, residency) and incoming metrics (e.g., standardized test scores, high school grade point average) on each student within the entering cohort are collected. Table 2 summarizes the size of each cohort and Table 3 compares characteristics of URM students who participated in the bridge program with those that did not. Some participants in the bridge program did not have corresponding incoming metrics associated with their records. As such, that data could not be included in Table 3.

Table 2: Cohort Size. (Parentheses indicate totals in following tables of participants whose demographic and high school data is available)

Cohort Size	**F'05**	**F'06**	**F'07**	**F'08**	**F'09**
SB URM	20	21	19	20	24 (21)
Non-SB URM	68 (67)	72 (71)	72	55	73 (70)
Total Engineering Cohort	1,685	1,703	1,559	1,638	1,602

Table 3: Demographic breakdown of URM participants by ethnicity and gender

		2005 Cohort			2006 Cohort			2007 Cohort			2008 Cohort			2009 Cohort		
		Tot	M	F	**Tot**	M	F	**Tot**	M	F	**Tot**	M	F	**Tot**	M	F
SB URM	Black or African American	**12**	8	4	**15**	12	3	**15**	11	4	**14**	10	4	**14**	8	6
	Hispanic/Latino	**7**	7	0	**6**	3	3	**3**	2	1	**6**	6	0	**6**	5	1
	American Indian or Alaskan Native	**1**	1	0	**0**	0	0	**1**	1	0	**0**	0	0	**1**	0	1
non-SB URM	Black or African American	**23**	15	8	**26**	20	6	**18**	9	9	**19**	13	6	**23**	20	3
	Hispanic/Latino	**37**	33	4	**37**	29	8	**48**	39	9	**26**	20	6	**44**	35	9
	American Indian or Alaskan Native	**7**	5	2	**8**	8	0	**6**	6	0	**10**	6	4	**3**	2	1

From 2005 – 2009, URM attendance in the summer bridge program accounts for approximately 21 – 28% of the total URM population. As shown in Table 3, the majority of URM participants in the program are African American, suggesting that there is the potential for more targeted recruitment among Hispanics and Native Americans. While the majority of SB URM participants are male, female participants account for approximately 24 - 38% of the SB URM population over this time period with the peak of 38% occurring in the 2009 cohort. Summer bridge participation remained fairly stagnant over this time period, potentially due to limited exposure and funding for the program.

Due to the rigorous acceptance criteria of the university, all summer bridge URM participants were in good academic standing during their high school years with mean grade point averages (GPA) higher than 3.19 and average SAT scores above 1113 across each cohort. As shown in Table 4, average GPAs and SAT scores for the SB URM participants are generally lower compared to the non-SB URM population.

Table 4: Mean GPA and SAT scores for URM of each cohort (n/a indicates unavailable information for the particular cohort)

		High School Core GPA	**High School Math GPA**	**High School Science GPA**	**SAT Math**	**SAT Verbal**	**SAT Math & Verbal**
2005	SB URM	3.24	3.35	3.19	618	562	1180
	non-SB URM	3.42	3.48	3.36	633	583	1217
2006	SB URM	n/a	3.17	3.32	565	583	1148
	non-SB URM	n/a	3.43	3.42	594	634	1228
2007	SB URM	3.28	3.31	3.32	596	539	1134
	non-SB URM	3.31	3.37	3.30	621	566	1187
2008	SB URM	3.37	3.32	3.22	605	564	1169
	non-SB URM	3.43	3.40	3.45	641	596	1237
2009	SB URM	3.44	3.45	3.36	579	534	1113
	non-SB URM	3.45	3.46	3.46	628	568	1196

First Semester Academic Performance

First semester performance analysis indicates that, generally, participation in the summer bridge program yields higher first semester performance (Figure 1). The primary exceptions are 2007 and 2008, where the social acclimatization was altered to allow shared housing between students of different disciplines. After analyzing the performance results, students from each discipline were separated into residential learning communities by discipline. The GPA of participants then improved substantially and in 2009, the average GPA of SB URM participants was higher than the total cohort. As the program reaches maturity and administrators/organizers understand the variables that influence the effectiveness of the program (e.g., housing arrangements, quality of instruction), the GPA of SB URMs seems to increase as a result of program participation.

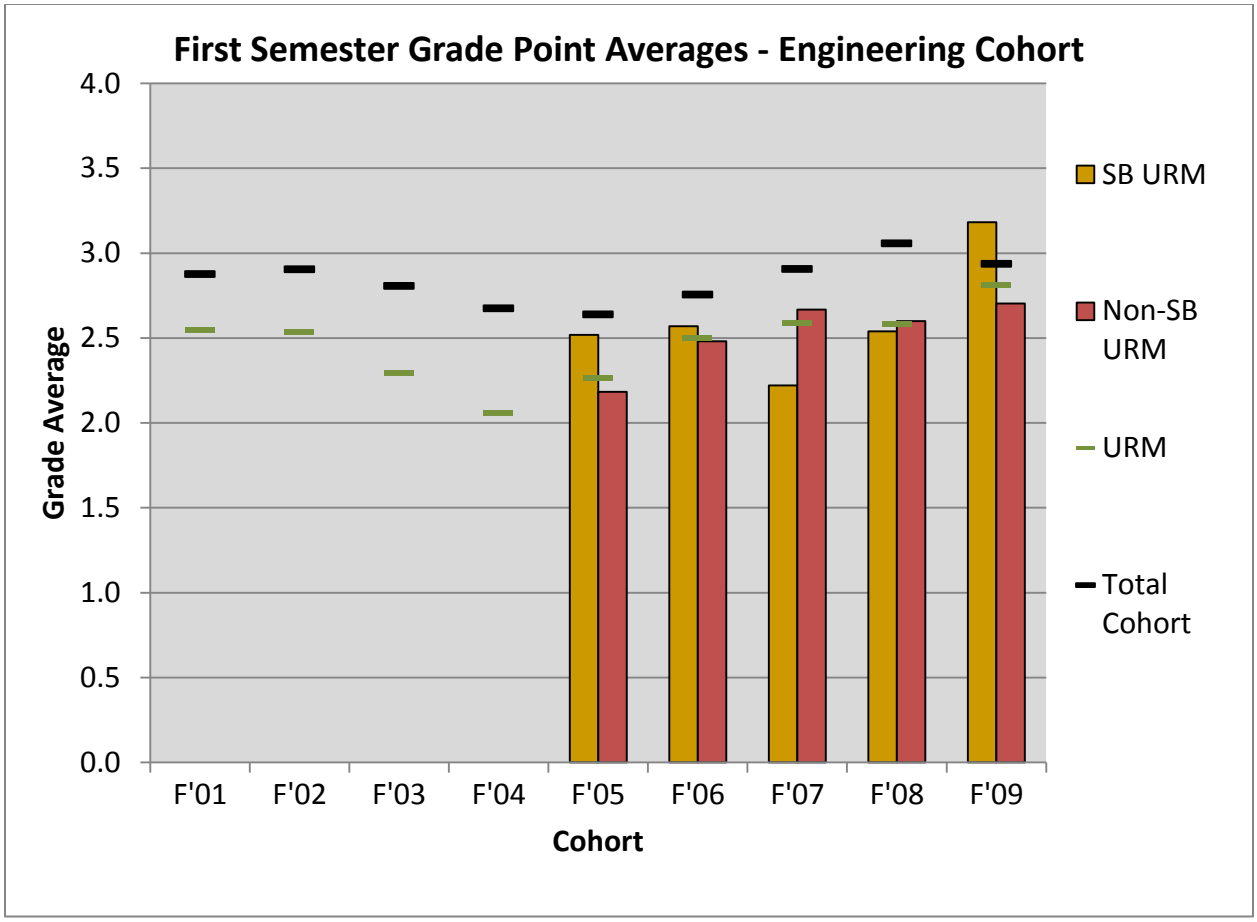

Figure 1: First Semester GPA of the engineering cohorts from 2001 to present. Data is grouped by summer program participation for URM engineering students. Comparisons were also drawn between all URM students and the total cohort of engineering students. The last year (2009) showed an almost complete removal of the disparity in academic performance between URM students and the rest of the cohort.

First Year Retention

Since 2005, the first year retention rate of the summer bridge program has dramatically improved (Figure 2). Participation by URM engineering students in the summer bridge program has been associated with a higher likelihood of being retained in engineering when compared to those URM engineering students who did not participate. These rates are substantially higher than the rates of the total cohort of engineering students. The exception is the SB program class of 2007 in which, as aforementioned, the social acclimation of students was altered to allow shared housing between students of different disciplines. There is no proof that this variation in the program accounts for the 2007 results in first-semester performance and retention. This change, however, was one of the few made to the program in 2007, suggesting that more frequent social interactions with non-engineering SB students might have caused a shift in academic expectations and work/study habits.

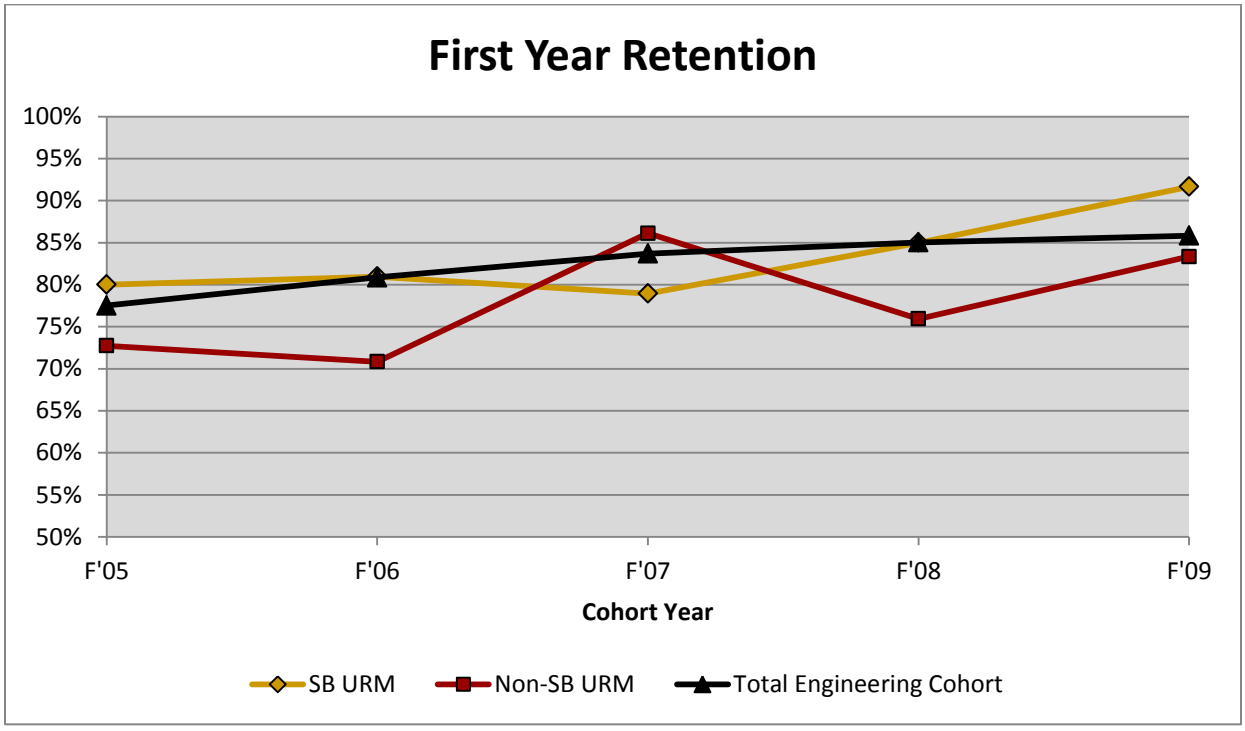

Figure 2: First year retention data exhibited an upward trend for the summer bridge program since it was introduced in 2005.

Graduation

Four-year graduation rate appears very low for all students. A look at six year graduation rates, for the years where it is available, demonstrates a continuing persistence of the disparity between the URM population and the total engineering cohort. To date, participation in the summer bridge program for URM students has not begun to close the gap between URM engineering students and the total cohort. This data indicates that there are additional leverage points beyond

the transition from high school to college that must be addressed to increase URM engineering student success beyond the first year.

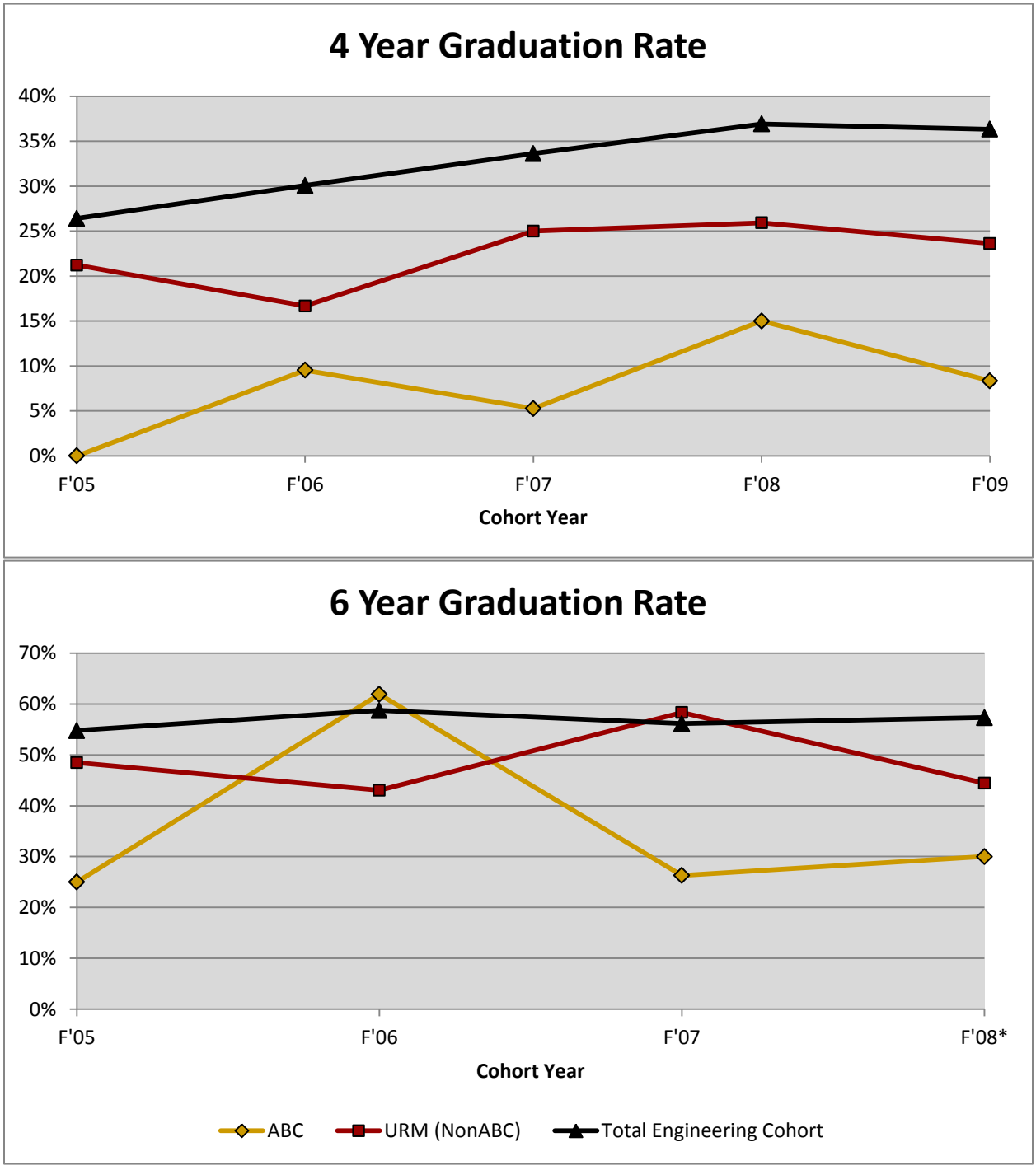

Figure 3: Percentage of students graduating from the University in Engineering in 4 years (top) and 6 years (bottom).

Discussion

The summer bridge program described in this study has the desired positive impact on URM engineering students transitioning to the university, as demonstrated in the almost complete removal of the disparity in first-year academic performance between URM students and the rest of the engineering cohort. A review of the demographics and incoming metrics of URM cohorts underscores this impact. Average high school GPAs and standardized test scores are generally lower for summer bridge participants than other URMs. As it is ultimately up to the particular student to decide to apply and participate in this intensive summer experience, this observation suggests that participants might be aware of gaps in their academic experience and conscious that they need to work diligently. The summer bridge program provides them with the academic and social tools to overcome this and other potential barriers to first-year success that students of all academic performance levels face. As the first-semester performance and first-year retention data show, the bridge program enables participants to perform at parity and, in some cases, outperform peers who may have a slight edge in terms of incoming metrics. Nonetheless, this parity was not realized in the first years in which the program was implemented, which suggests that the success of these interventions comes from iterative, multi-year efforts to optimize program components and enhance their effectiveness.

The program effectively transitions participants to life as an engineering student in the academic, social, and emotional/affective dimensions. In the academic dimension, participants become familiar with the rigor, work load, and study habits required to succeed as an engineering student at a large selective university. In the social dimension, the program facilitates the creation of a learning community that extends beyond the duration of the program and into students' first year at the university. In the emotional/affective dimension, the program influences non-cognitive traits such as self-efficacy and grit by intentionally exposing participants to experiences such as rigorous tests, team-based collaboration, mentoring and role-modeling.

These effects need to be studied more carefully to generate a better granular understanding of the influence of each program element on first-semester GPA, first-year retention, and four- and six-graduation rates. Future work should also explore additional experiences that non SB program participants may have had to compare the effectiveness of the SB program described herein relative to other summer experiences.

Overall, the success of the bridge program in affecting first year retention and academic performance taken in conjunction with the analysis of 4- and 6-year graduation rates (for cohorts where such information is available, as shown in Figure 3) indicates that there are additional leverage points beyond the first year that must be addressed in order to improve URM engineering student persistence to graduation. The program effectively prepares students at this university for the shared first-year experience of engineering students. The second year, however, represents the transition to specific majors, which presents a different set of challenges. For instance, the authors are currently analyzing course sequence and course performance data to determine gateway courses beyond the freshman year in addition to performing qualitative analyses to determine potential causes of the continued graduation rate gap. These studies will inform the development of targeted interventional strategies that will lead URM students from successful persistence into the second year to eventual graduation as an engineering student.

References

[1] M. Nettles, Toward black undergraduate student equality in American higher, New York: Greenwood Press, 1988.

[2] W. Allen, "The color of success: African-American college student outcomes at predominately white and historically black public colleges and universities," *Harvard Educational Review,* vol. 62, pp. 45-65, 1992.

[3] E. Seymour and N. Hewitt, Talking about leaving: Why undergraduates leave the sciences, Coulder, CO: Westview Press, 1997.

[4] C. Steele and J. Aronson, "Stereotype threat and the intellectual test performance of African Americans," *Journal of Personality and Social Psychology,* vol. 69, pp. 797-811, 1995.

[5] W. Bowen and D. Bok, The shape of the river: Long-term consequences of considering race in college and university admissions, Princeton, NJ: Princeton University Press, 1998.

[6] G. Campbell, R. Denes and C. Morrison, Access denied: Race, ethnicity, and the scientific enterprise, New York, NY: Oxford University Press, 2000.

[7] W. Pearson and A. Fechter, Who will do science? Educating the next generation, Baltimore, MD: Johns Hopkins University Press, 1994.

[8] C. R. Logan, J. Salisbury-Glennon and L. D. Spence, "The learning edge academic program: Toward a community of learners," *Journal of The First-Year Experience and Students in Transition,* vol. 12, no. 1, pp. 77-104, 2000.

[9] L. W. Perna and W. S. Swail, "Pre-college outreach and early intervention programs: An approach to achieving equal educational opportunity," *Thought and Action,* vol. 17, no. 1, pp. 99-110, 2001.

[10] M. Valeri-Gold, M. P. Deming and K. Stone, "The bridge: A summer enrichment program to retain African-American collegians," *Journal of the Freshman Year Experience,* vol. 4, no. 2, pp. 101-117, 1992.

[11] M. Anderson-Rowland, M. Reyes and M. McCartney, "MEP summer bridge program: Mathematics assessment strategies.," in *ASEE Annual Conference,* Washington, DC, 1998.

[12] M. Reyes, M. Anderson-Rowland and M. McCartney, "Freshman introductory engineering seminar course: Coupled with bridge program equals academic success and retention.," in *Frontiers in Education*, Tempe, AZ, 1998.

[13] R. Smothers, "To Raise the Performance Of Minorities, a College Increased Its Standards," *New York Times,* 29 June 1994.

[14] T. E. Murphy, M. Gaughan, R. Hume and J. S. Gordon Moore, "College Graduation Rates for Minority Students in a Selective Technical University: Will Participation in a Summer Bridge Program Contribute to Success?," *Educational Evaluation and Policy Analysis,* vol. 32, no. 1, pp. 70-83, 2010.