Assessment of a Summer Bridge Program: Seven Years and Counting

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Abstract

Analyses of new university engineering degree programs at an HBCU (Jackson State University) revealed that graduation rates (15%) were considerably lower than desired. An aggressive amelioration strategy centered around a ten week (expenses paid) resident summer bridge program for the student population of first time freshman (ftf) engineering majors with ACT Math scores from 17-25 (70% of ftf) was developed and started in summer 2009. Program assessment was accomplished using a control group of all other ftf engineering majors that began the same fall semester with identical ACT Math scores (17-25). The data indicate that there are two distinct populations (relative to graduation performance) within the 17-25 ACT Math score group. They are groups with ACT Math scores of 17-19 and 20-25. Analyses are made using these two subgroups. Summer bridge students (20-25) have a 4 year engineering graduation rate of 41% relative to 17% for the control group (71 and 107 students respectively). Summer bridge students (17-19) have a 4 year engineering graduation rate of 12% relative to 4% for the control group (50 and 119 students respectively). The six year engineering graduation rate for the 20-25 bridge students was 50% relative to 37% for the control group (32 and 54 students respectively). The six year engineering graduation rate for the 17-19 bridge students was 14% relative to 24% for the control group (29 and 49 students respectively). The paper contains comprehensive analyses of the seven summer cohorts (2009 through 2015) of ftf engineering majors including engineering, STEM and university graduation rates, times to graduate and retention rates. The unique parts of this summer bridge program are its 10 week resident length, enrolling students for six semester hours of mathematics college credit, making it cost free for the students and sustainment for eight summers. This paper clearly demonstrates that the program can more than double the engineering graduation rate for the student population with 17-25 ACT Math scores and the majority graduate in four years. To date, 100% of the 232 students in the bridge program are African Americans (not required).

Background

A detailed analysis of the cause(s) for low (15%) Engineering graduation rates clearly revealed the problem was challenges with mathematics. The majority of first time freshman engineering majors were struggling with mathematics and changing majors, largely due to poor preparation. Most did not meet the College Readiness Benchmark for Mathematics. A summer bridge program was developed for the ACT Math score of 17-25 because the preponderance (70%) of ftf engineering majors prior to 2009 were in this population. Students with an ACT Math score below 17 must take a developmental math course before enrolling in College Algebra and almost all these students change majors or leave the university without graduating. Students with ACT Math scores of 26 and above are deemed calculus ready and do not need a bridge program. The original bridge program objective was to substantially increase the historical six year engineering graduation rate and decrease the time to graduate. Many summer bridge programs have been developed and implemented. Some are described in references [1], [2], [3], [4], [5], [6], and [7]. The bridge program, named the Summer Engineering Enrichment Program (SEEP) [8], was initiated with the first summer cohort of 24 students in 2009 and has continued with the essential

qualities unchanged thru the summer of 2016 (and presumably beyond). The SEEP is open to any student who has applied to and been accepted to enroll at Jackson State University for the fall semester with a major in one of the five ABET accredited engineering (or computer science) degree programs. Major components of the SEEP program are (a). students are enrolled for credit in College Algebra (3hrs) and University Success (2 hrs.) the first summer term and in Trigonometry (3 hrs.) the second summer term, (b). SEEP students are housed together in campus dormitories, (c). classes are in mornings (M-Th) in the two story modern (2009) Engineering Building where all engineering and computer science classes are taught, (d). computer laboratories are open for required study periods all afternoon (graduate student tutors who attend morning lectures are available), (e). Fridays are set-aside for trips to engineering employers where students receive briefings and tours that always include some Jackson State University engineering alumni, (f). Two Fridays, during the second summer term, are set-aside for students to pre-register for the fall semester and meet their engineering advisor one-on-one, (g). Activity directors plan weekend functions and are accessible 24/7, (h). SEEP strives to create a permanent community of Engineering Learners and (i). SEEP is cost free to the student except for incidental expenses.

Previous papers about this bridge program revealed the following:

a. Reference 9 provided a preliminary assessment of one and two year SEEP retention rates in an engineering major based on the first three cohorts. Extensive evaluations of the performance of SEEP students in the Calculus sequence and Physics sequence were included. Retention rates were encouraging and it was hypothesized that graduation rates could double if trends continued.
b. Reference 10 focused on an assessment of retention rates after five summer cohorts. This paper revealed a preliminary indication of major differences in retention rates in an engineering major for ACT Math subgroups of 17-19 and 20-25. The numbers of students were so small that firm conclusions were not warranted. Future analyses should continue to evaluate the importance of these two subgroups.
c. Reference 11 reported on the emerging impact of SEEP on graduation rates. Only one cohort had completed four years and a semester. No engineering majors (0/11) graduated from the 17-19 ACT Math group in 4.5 years and, in fact all 11 had either changed majors or left the university. 54% (7/13) of the ACT 20-25 Math Group graduated in an Engineering major within 4.5 years. This was a strong indication of the significant difference in graduation rates for these two ACT Math subgroups.
d. Reference 12 reported that 4 year and 5 year graduation rates for SEEP engineering students were about 10% higher than for NON-SEEP students. Results indicated the SEEP students with the 20-25 Math ACT scores had retention and 4 year graduation rates about 20% higher than the SEEP 17-19 ACT Math group. The 5 year Engineering graduation rate based on the 2009 cohort for SEEP 20-25 was 54% (54% to 0%) higher than the 17-19 group. The average time to graduate was 4.18 years for SEEP engineering graduates (19) from the 2009 and 2010 cohorts.

There are now sufficient data to quantitatively assess SEEP graduation rate success relative to an even larger Control Group of first time freshman who began their engineering major in the identical fall semester as the summer SEEP students. The analyses that follow are performed by Math ACT sub groups (17-19 and 20-25) of the original Math ACT 17-25 grouping. Analysis of

the entire group (17-25) as an entity leads to less useful, if not erroneous, conclusions with respect to the entire population considered as a whole. The reason for the differences is hypothesized and discussed in the summary and conclusions.

SEEP and Control Group Characteristics Tables 1 and 2 below display the number of first time freshman in the first seven summer cohorts (2009 through 2015) that are used to compute graduation rates of 4, 4.5, 5, 5.5, 6, and 6.5 years and 1, 2, and 3 year retention rates. The half year graduation increments are used to more accurately display the substantial number of December graduates. This produces a significantly more accurate display (rather than using 4, 5, and 6 years) for time to graduate (directly related to cost to graduate). Table 1 contains cohort data for ftf engineering majors with ACT Math scores of 20-25 for both SEEP and Control Group (NON-SEEP) students while Table 2 contains analogous data for ftf engineering majors with ACT Math scores from 17-19.

Table 1 Math ACT 20-25: SEEP and Control Group (NON-SEEP) baseline data for graduation and retention computations

Summer Cohort	Number SEEP	Cumulative	Number Control	Cumulative	Characteristic
2009	13	13	32	32	4 to 6.5 Yr. Grad 1, 2, 3 year retention
2010	19	32	22	54	4 to 6.5 Yr. Grad 1, 2, 3 year retention
2011	18	50	29	83	4 to 5.5 Yr. Grad 1, 2, 3 year retention
2012	21	71	24	107	4 and 4.5 Yr. Grad 1, 2, 3 year retention
2013	26	97	33	140	1, 2, 3 year retention
2014	23	120	29	169	1, 2 year retention
2015	24	144	37	206	1 year retention

Table 2 Math ACT 17-19: SEEP and Control Group (NON-SEEP) baseline data for graduation and retention computations

Summer Cohort	Number SEEP	Number Cumulative	Number Control	Number Cumulative	Characteristic
2009	11	11	29	29	4 to 6.5 + Yr. Grad 1, 2, 3 year retention
2010	18	29	20	49	4 to 6.5 Yr. Grad 1, 2, 3 year retention
2011	11	40	38	87	4 to 5.5 Yr. Grad 1, 2, 3 year retention
2012	10	50	32	119	4 and 4.5 Yr. Grad 1, 2, 3 year retention
2013	12	62	34	153	1, 2, 3 year retention
2014	15	77	32	185	1, 2 year retention
2015	11	88	51	236	1 year retention

Methodology

The methodology used to obtain and analyze the data contained herein follows:

1) Student's name, majors and ACT Math scores for each summer cohort were obtained from the SEEP Program Director (a co-author) who has not changed from 2009 to present.
2) Access to official university records of all entering engineering students for fall 2009-fall 2016 were requested and obtained from the University Office of Institutional Research, the official records office for the university.
3) Extensive data were tabulated from records and transcripts in a very large spreadsheet for each of the 232 SEEP students and the 354 Control Group students. Data recorded include date of entry to university, enrollment for the succeeding fall semesters (until graduated or withdrew), semesters not enrolled, date of graduation or withdrawal, change of major date(s), grades in Calculus and Physics course sequences, GPA at the start of each fall semester, highest ACT Math score and highest ACT composite score.
4) A student was considered retained if they were enrolled for the beginning of the succeeding fall semester.
5) The tables appearing in this paper were constructed by amalgamating the data from the extensive spreadsheet described above. This was a very time consuming and painful undertaking. Data extraction was accomplished by the authors.
6) Data extraction errors were minimized by performing the extraction twice. Calculations with the data were also performed twice, usually independently.

The average times to graduate displayed in Table 5 are calculated by the following simple equation. Time to graduate = $\frac{A(4)+B(4.5)+C(5)+D(5.5)+E(6)+F(6.5)}{A+B+C+D+E+F}$

Where A, B, C, D, E, and F are the number of graduates in 4, 4.5, 5, 5.5, 6, 6.5 years respectively.

Analyses of Graduation Rates

Detailed analyses follow of graduation data comparing SEEP graduation rates with Control Group graduation rates for ftf engineering majors. Graduation rates are compared for graduation in an Engineering major, a STEM major and any University major. Additionally, graduation rates are computed separately for the two ACT Math subgroups of 17-19 and 20-25. Tables 3 and 4 contain detailed data for both SEEP and Control Group (NON-SEEP) graduation rates from Engineering, STEM and the University for ftf engineering majors who enrolled in fall 2009, 2010, 2011, or 2012. Table 3 is for students with ACT Math scores of 20-25 and Table 4 is for students with ACT Math scores of 17-19.

Table 3 SEEP and NON-SEEP (Control Group) graduation rate data for first time freshman engineering majors with ACT Math scores of 20-25

	ENGINEERING		**STEM**		**UNIVERSITY**	
Graduation Rates	SEEP	NON-SEEP (Control)	SEEP	NON-SEEP (Control)	SEEP	NONSEEP (Control)
4 YEAR	29/71 40.8%	17/107 15.9%	33/71 46.5%	17/107 15.9%	34/71 47.9%	19/107 17.8%
4.5 YEAR	34/71 47.9%	24/107 22.4%	38/71 53.5%	24/107 22.4%	39/71 54.9%	26/107 24.3%
5 YEAR	23/50 46%	23/83 27.7%	25/50 50%	25/83 30.1%	26/50 52%	27/83 32.5%
5.5 YEAR	23/50 46%	24/83 28.9%	25/50 50%	26/83 31.3%	26/50 52%	28/83 33.7%
6 YEAR	16/32 50%	20/54 37.0%	16/32 50%	22/54 40.7%	16/32 50%	24/54 44.4%
6+ YEAR	17/32 53.1%	20/54 37.0%	17/32 53.1%	22/54 40.7%	17/32 53.1%	25/54 46.3%

Table 4 SEEP and NON-SEEP (Control Group) graduation rate data for first time freshman engineering majors with ACT Math scores of 17-19

	ENGINEERING		STEM		UNIVERSITY	
Graduation Rates	SEEP	NON-SEEP (Control)	SEEP	NON-SEEP (Control)	SEEP	NONSEEP (Control)
4 YEAR	6/50 12%	5/119 4.2%	8/50 16%	6/119 5.0%	10/50 20%	6/119 5.0%
4.5 YEAR	8/50 16%	11/119 9.2%	12/50 24%	13/119 10.9%	14/50 28%	14/119 11.8%
5 YEAR	7/40 17.5%	16/87 18.4%	9/40 22.5%	19/87 21.8%	10/40 25%	20/87 23%
5.5 YEAR	7/40 17.5%	16/87 18.4%	10/40 25%	19/87 21.8%	11/40 27.5%	20/87 23%
6 YEAR	4/29 13.8%	17/49 34.7%	7/29 24.1%	17/49 34.7%	7/29 24.1%	18/49 36.7%
6+ YEAR	4/29 13.8%	17/49 34.7%	7/29 24.1%	17/49 34.7%	7/29 24.1%	18/49 36.7%

Figure 1 is a graphical display of SEEP graduation rates in Engineering, STEM and the University for each ACT Math group: 20-25 and 17-19 respectively. Figure 1 vividly shows the graduation rate differences between the two ACT Math groups. The nominal graduation rate for the ACT Math 20-25 group is 50%. The nominal university graduation rate for the ACT Math 17-19 group is 15% in Engineering and about 25% for STEM and University graduates. In understanding the data displayed in Figure 1 it is important to realize that different numbers of students are included in the 4, 5, and 6 year graduation rates. Four year graduation rates include data from four summer cohorts (2009-2012), five year graduation rates include data from three summer cohorts (2009, 2010, 2011) and 6 year graduation rates only include data from two summer cohorts (2009, 2010). There is substantial variation in graduation rates by SEEP cohort because of the small numbers of students in each. For instance, the (first) 2009 cohort had zero six-year engineering graduates from the 11 students in the 17-19 ACT Math score range while the 2010 17-19 ACT Math cohort of 18 students had four six year engineering graduates (0% and 22% graduation rates respectively).

Figure 1 SEEP graduation rates: Engineering, STEM & University for ACT Math Groups 20-25 and 17-19

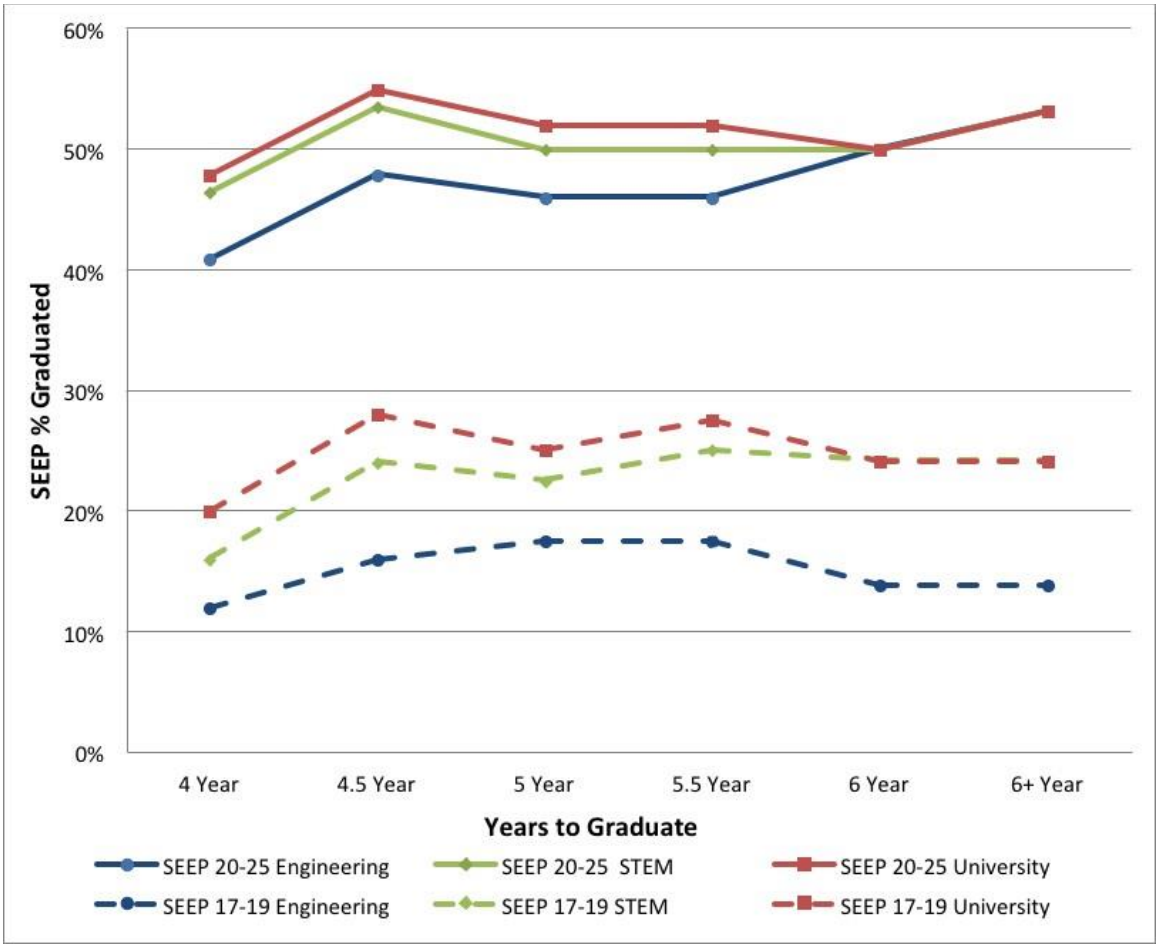
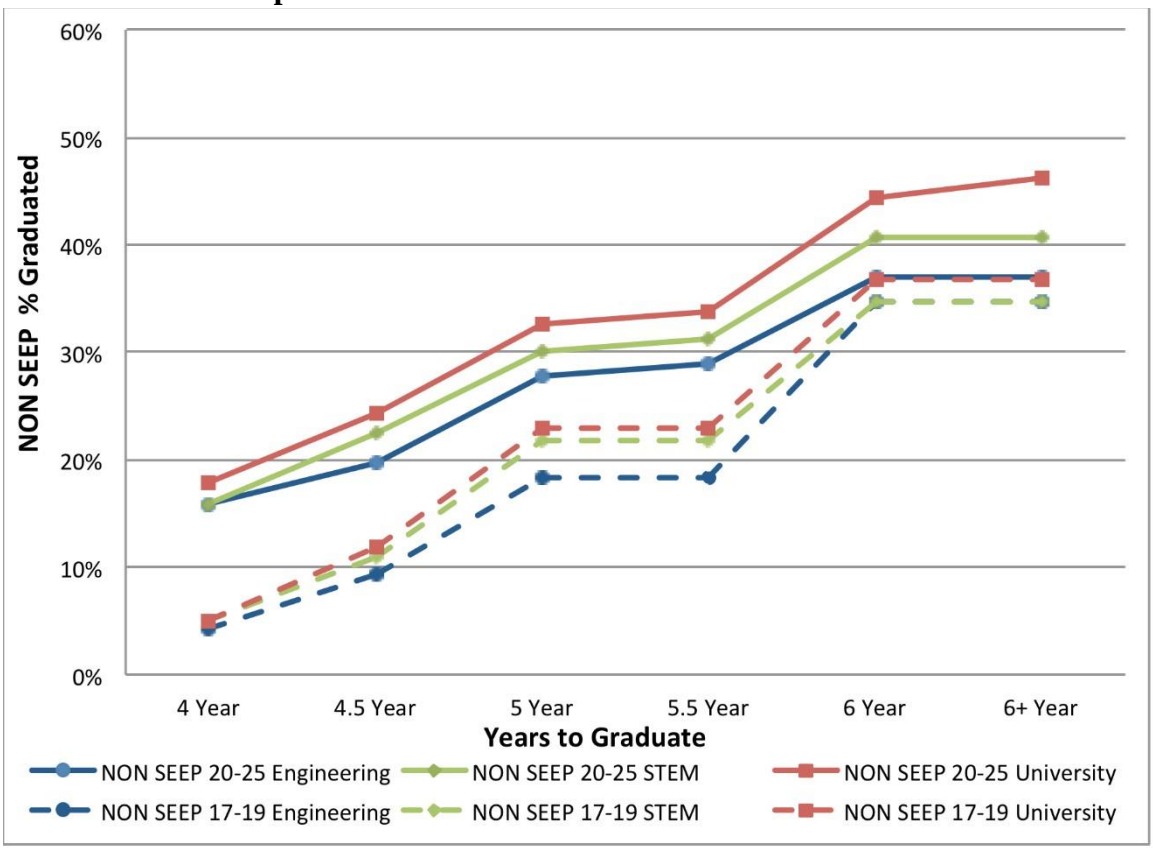


Figure 2 is a graphical display of the Control Group NON-SEEP graduation rates in Engineering, STEM and the University for ACT Math groups: 20-25 and 17-19. The graduation rate for the ACT Math 20-25 group varies from about 1.2 to 3.0 times that of the ACT Math 17-19 group. The four year Engineering graduation rate for the 20-25 ACT Math Control Group is 16% relative to 4% for the 17-19 ACT Math Control Group. This compares with 41% and 12% for the comparable SEEP groups shown in Figure 1. These data unequivocally indicate that the SEEP program increases the four year graduation rate in engineering by a factor well in excess of 2.5 compared with the Control Group (NON-SEEP) four year graduation rate in engineering for each ACT Math group.

Figure 2 NON-SEEP (Control Group) graduation rates: Engineering, STEM & University for ACT Math Groups 20-25 and 17-19



Figures 3, 4, and 5 show the Engineering, STEM and University graduation rates by ACT Math score for SEEP and NON-SEEP (Control Group) cohorts. Figure 3 directly compares the percent of ftf Engineering majors that graduate in Engineering for the SEEP cohort with the Control Group (NON-SEEP) cohort. The Math ACT 20-25 group comparisons are the upper two graphical displays and the Math ACT 17-19 are the lower two displays. Figure 4 directly compares the percent of STEM graduates for the SEEP Cohort and the Control Group (NONSEEP) cohort of ftf engineering majors. That is, relative to Figure 3, the first time freshman engineering majors who changed to another STEM major (i.e. Technology, Biology, Geosciences, Mathematics, Chemistry, or Physics) and graduated are included in Figure 4. Again, the Math ACT 20-25 group comparisons are the upper two graphical displays and the Math ACT 17-19 are the lower two. Figure 4 illustrates the benefit of the SEEP program (ACT Math 20-25) even more dramatically for STEM 4 year graduates. SEEP participants in the 20-25 ACT Math group increased the 4 year graduation rate by 31% (from 16% to 47%) relative to the Control Group (NON-SEEP). Figure 5 compares the number of University graduates for the SEEP cohorts and the Control Group (NON-SEEP) cohorts of ftf engineering majors. Relative to Figure 3, the ftf engineering majors who changed to any other University major and graduated are included in Figure 5. Figures 3, 4 and 5 also clearly show the benefit of the SEEP program in decreasing the time to graduate relative to the Control Group for both ACT Math groups for 4 year graduates. The SEEP benefit is much greater for the ACT Math 20-25 group relative to the

ACT Math 17-19 group; especially for the 4 and 4.5 year graduates that comprise the majority of SEEP graduates. The data also reveal that as time to graduate increases (to 6 years or even 6.5 years); the difference between graduation rates for the SEEP and NON-SEEP (Control Group) decreases. This trend is expected since all SEEP students begin Calculus 1 in the Fall semester of their freshman year and have just completed courses in College Algebra and Trigonometry during the summer. The Control Group students have no such recent review of College Algebra and Trigonometry and a number are not Calculus ready. Those not Calculus ready usually enroll in a five hour College Algebra and Trigonometry class the fall semester of their freshman year. Figures 3, 4, and 5 follow:

Figure 3 Engineering graduation rate by ACT Math Score (SEEP vs. NON-SEEP)

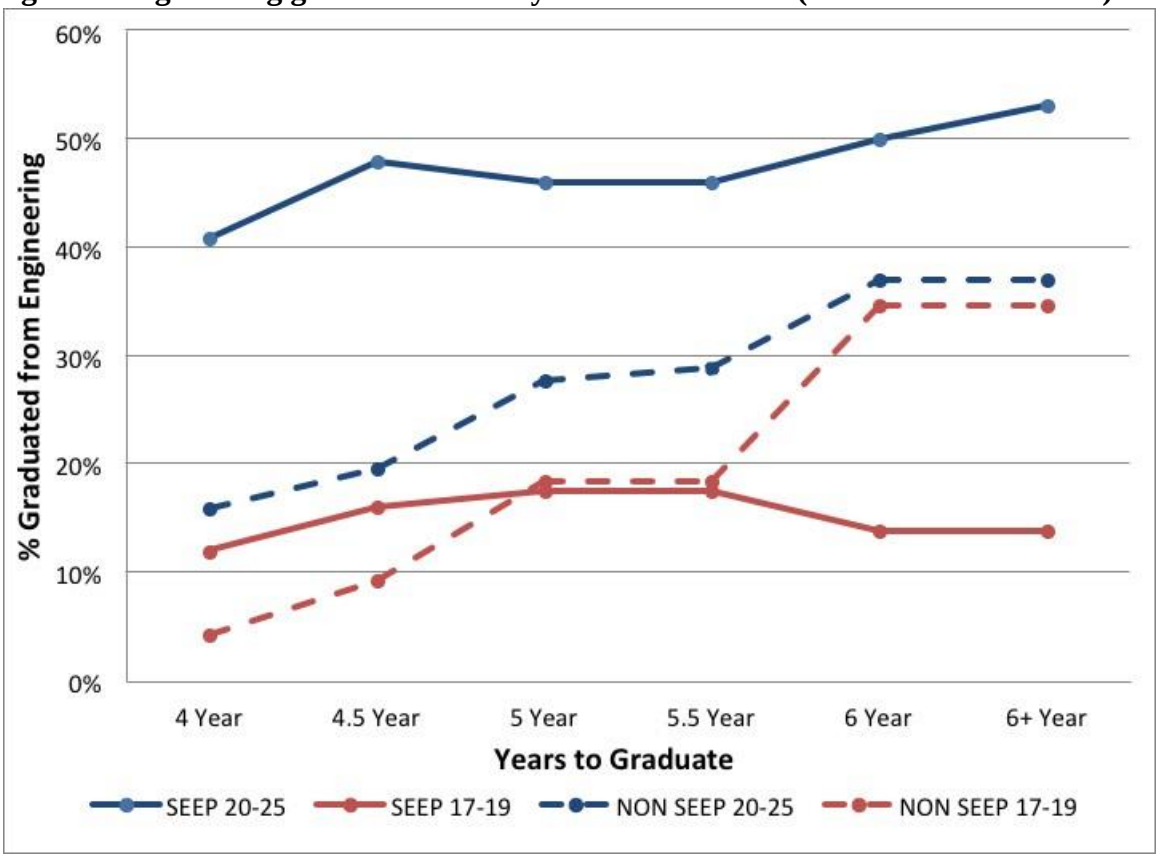


Figure 4 STEM graduation rate by ACT Math Score (SEEP vs. NON-SEEP)

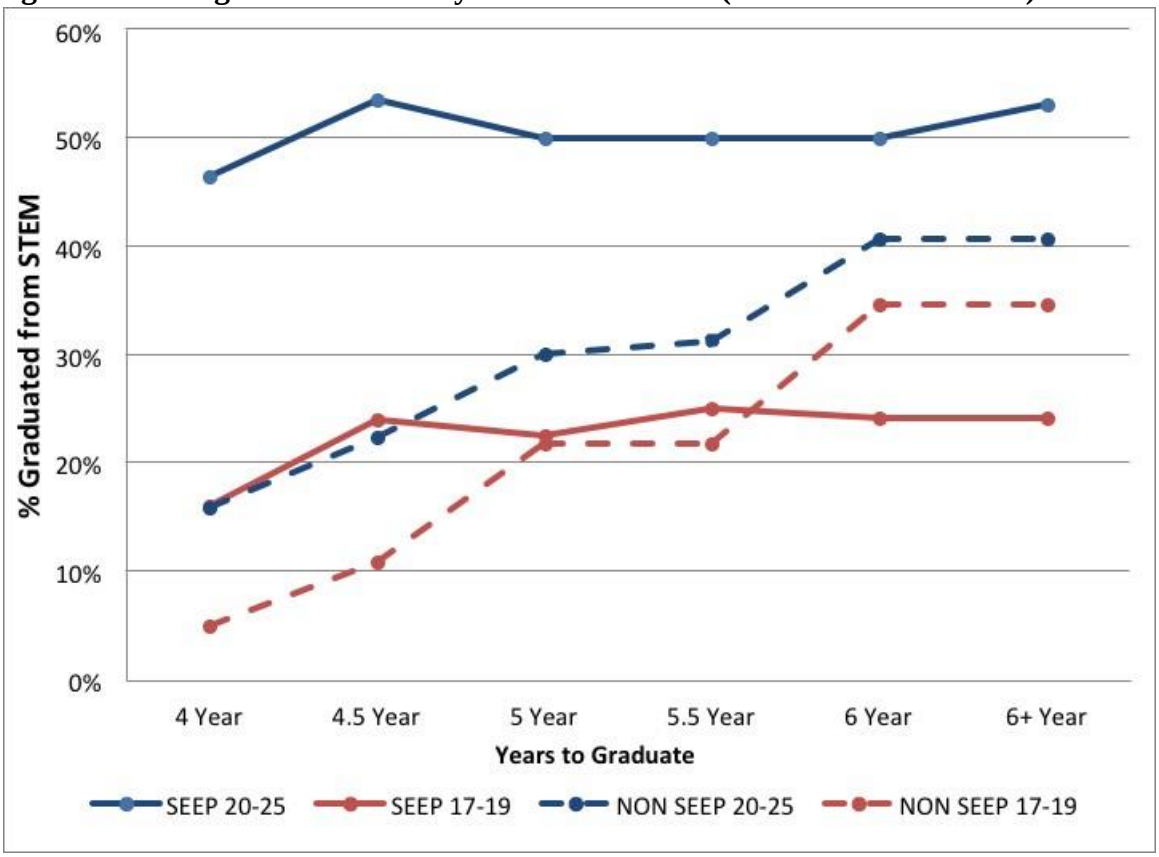
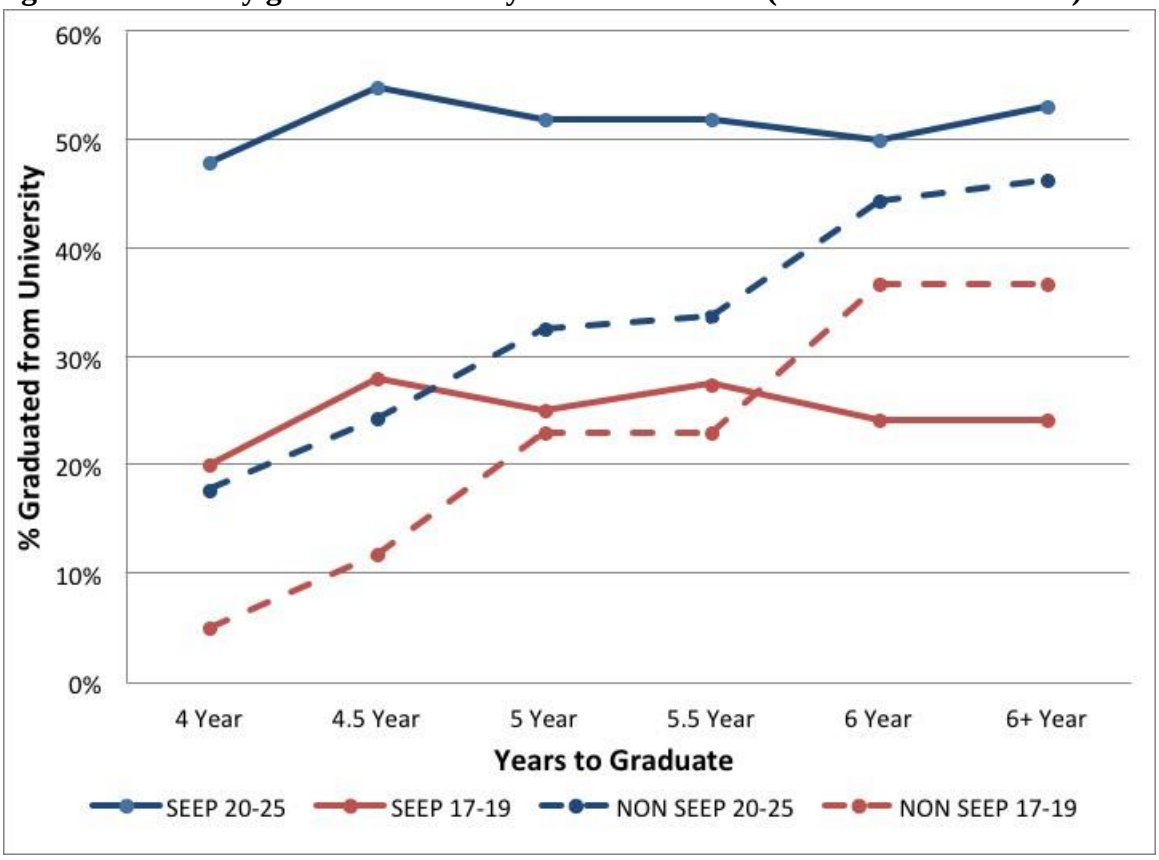


Figure 5 University graduation rate by ACT Math score (SEEP vs. NON-SEEP)



Average Time to Graduate

The benefit of the SEEP Program in decreasing time to graduate cannot be overemphasized. Over 90% of students at this HBCU have student loans. A decrease of one semester in time to graduate translates directly to a decrease of about 11% or more in the amount of student loans owed upon graduation. Table 5 below summarizes the SEEP and Control Group (NON-SEEP) average time to graduate using the methodology described previously. December graduates were represented by a graduation time of 4.5 years or 5.5 years as appropriate and May graduates were represented by a graduation time of 4, 5 or 6 years. SEEP and NON-SEEP (Control Group) times to graduate are shown side by side with the number of graduates in parentheses. The rows in Table 5 display the two ACT Math groups 20-25 and 17-19 below one another for graduates with an Engineering major (Civil, Computer, Electrical, Telecommunications Engineering or Computer Science). SEEP graduates totaled 70 with 45 in Engineering, 20 in another STEM major and an additional 5 in another University major. Coincidentally, there were also 70 total graduates in the (NON-SEEP) Control Group even though it consisted of substantially more students (about 60% more) as indicated by data in Tables 3 and 4. On average, SEEP engineering graduates (both ACT Math groups) save nominally a semester in time to graduate relative to Control Group (NON-SEEP) graduates. SEEP non-engineering STEM graduates in the ACT Math 20-25 group save a semester plus relative to the Control Group. Although very

small numbers, SEEP non STEM university graduates save 71% to 85% of a year in time to graduate relative to the Control Group on STEM (NON-SEEP) graduates. Table 5 follows with the number of graduates in parenthesis.

Table 5 Average time to graduate in years

Major Area	SEEP	Control Group (NON-SEEP)
20-25 ENGR	4.15 (37)	4.32 (28)
17-19 ENGR	4.12 (8)	4.58 (20)
20-25 STEM	4.40 (10)	5.07 (7)
17-19 STEM	5.05 (10)	4.70 (5)
20-25 UNIV	4.5 (2)	5.21 (7)
17-19 UNIV	4.33 (3)	5.17 (3)

Retention Analyses: SEEP vs. Control Group

One of the original objectives of the SEEP program was to increase retention rates in an engineering major as an integral part of the strategy to increase ftf engineering major's graduation rates in Engineering. The seven summer SEEP Cohorts (2009 through 2015) provide data to evaluate the effect of the SEEP program on retention in an engineering major as well as retention in a STEM major and retention in the University. One year retention rates have seven cohorts of data, two year retention rates have six cohorts of data and three year retention rates have five cohorts of data. Students were considered retained if they enrolled in the following fall semester. Table 6 that follows contains rolled up data and 1, 2, and 3 year retention rates in Engineering, STEM and in the University for ftf engineering majors.

Table 6 Retention rates for SEEP and Control Cohorts

SEEP/ Control ACT Math	1 Year Retention			2 Year Retention			3 Year Retention		
	ENGR	STEM	UNIV	ENGR	STEM	UNIV	ENGR	STEM	UNIV
SEEP (20-25)	95 144 66%	106 144 73.6%	120 144 83.3%	70 120 58%	79 120 65%	92 120 77%	59 97 61%	66 97 68%	78 97 80.4%
Control (20-25)	117 206 56.7%	129 206 62.6%	148 206 71.8%	77 169 45.6%	85 169 50.3%	101 169 50.3%	59 140 42.1%	66 140 47.1%	79 140 56.4%
SEEP (17-19)	44 88 50%	52 88 59.1%	74 88 84.1%	33 77 42.9%	42 77 55%	57 77 74%	25 62 40%	27 62 43.5%	40 62 64.5%
Control (17-19)	123 236 52.1%	142 236 60.2%	169 236 71.6%	63 185 34.1%	82 185 44.3%	108 185 58.4%	33 153 21.6%	48 153 31.4%	69 153 45.1%

The data in Table 6 are more readily assimilated though the graphical illustrations that follow. Note that there are a different number of students in the 1, 2, and 3 year retention data. The variation in retention from one cohort to another can result in an occasional unexpected percent. For instance, the three year Engineering retention rate is 3% higher than the two year retention rate for SEEP 20-25. Figure 6 shows the 1, 2 and 3 year Engineering, STEM and University retention rates for the SEEP 20-25 ACT Math group relative to the 20-25 Control Group (NONSEEP). Figure 7 shows the 1, 2, and 3 year Engineering, STEM and University retention rates for the SEEP 17-19 ACT Math group relative to the 17-19 Control Group (NON-SEEP). Figure 8 shows the 1, 2 and 3 year Engineering, STEM and University retention rates for the SEEP 2025 group relative to the SEEP 17-19 group. Figure 9 shows 1, 2, and 3 year Engineering STEM and University retention rates for the 20-25 Control Group (NON-SEEP relative to the 17-19 Control Group (NON-SEEP). Figures 6, 7, 8, and 9 follow:

Figure 6 ACT Math 20-25 retention: SEEP vs. Control Group (NON-SEEP)

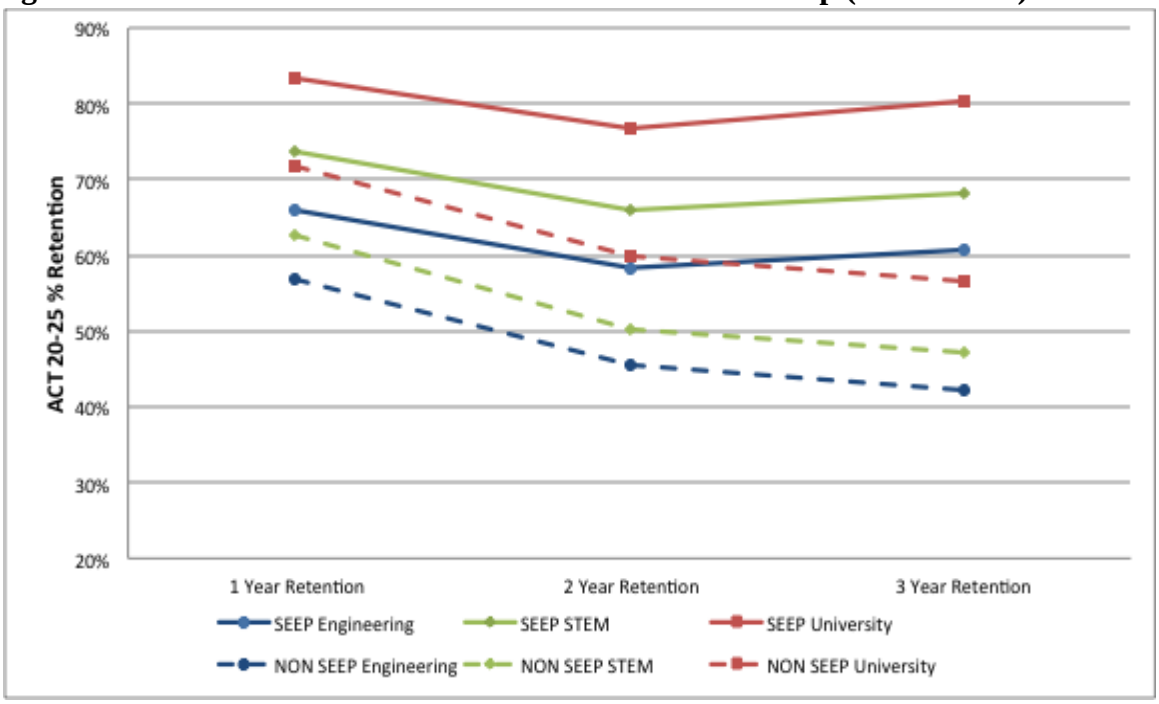


Figure 7 Math ACT 17-19 retention: SEEP vs. Control Group (NON-SEEP)

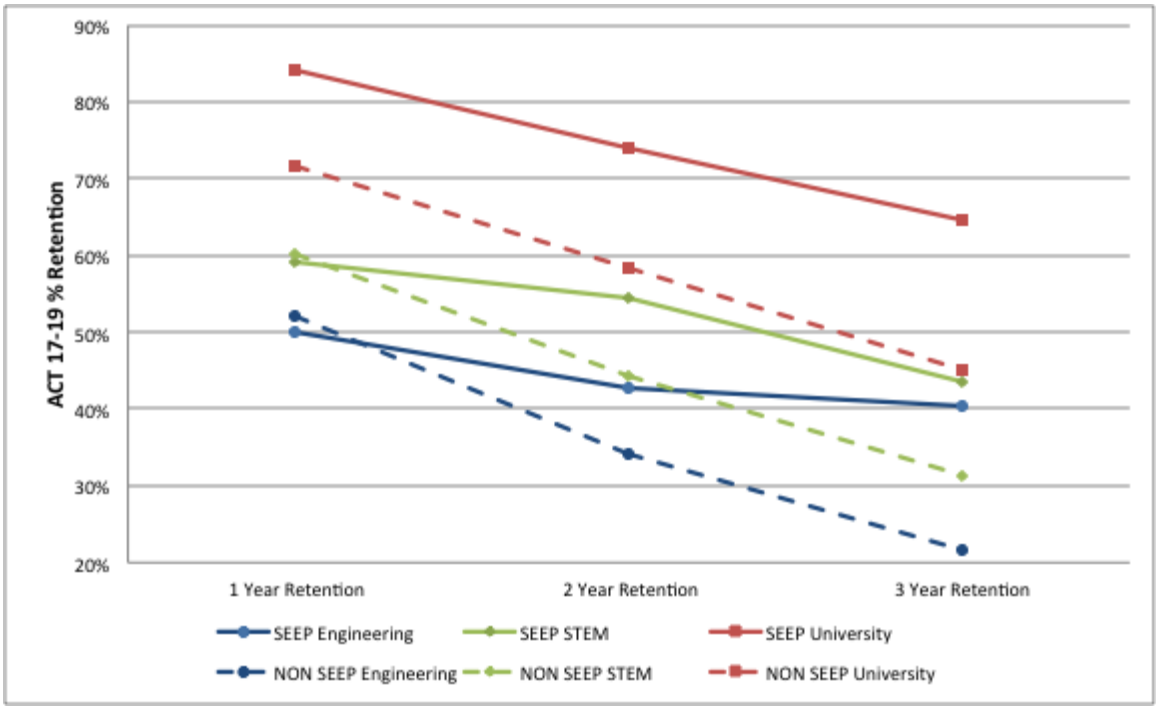


Figure 8 SEEP retention rates: Math ACT 20-25 vs. 17-19

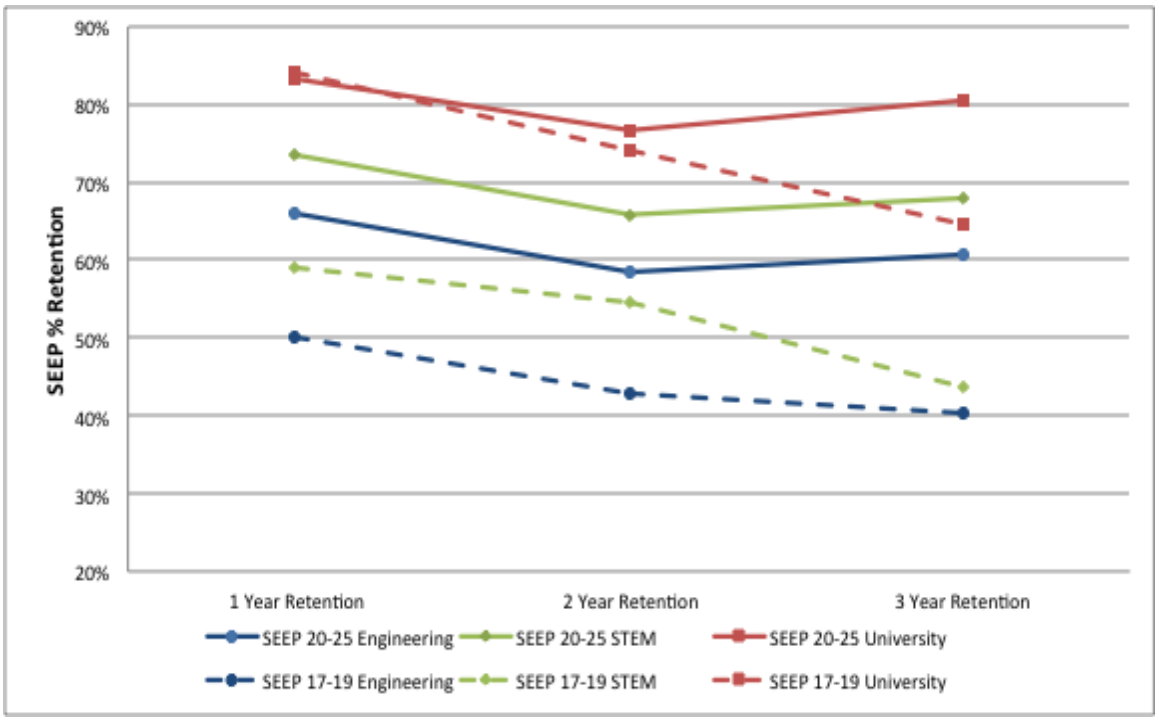
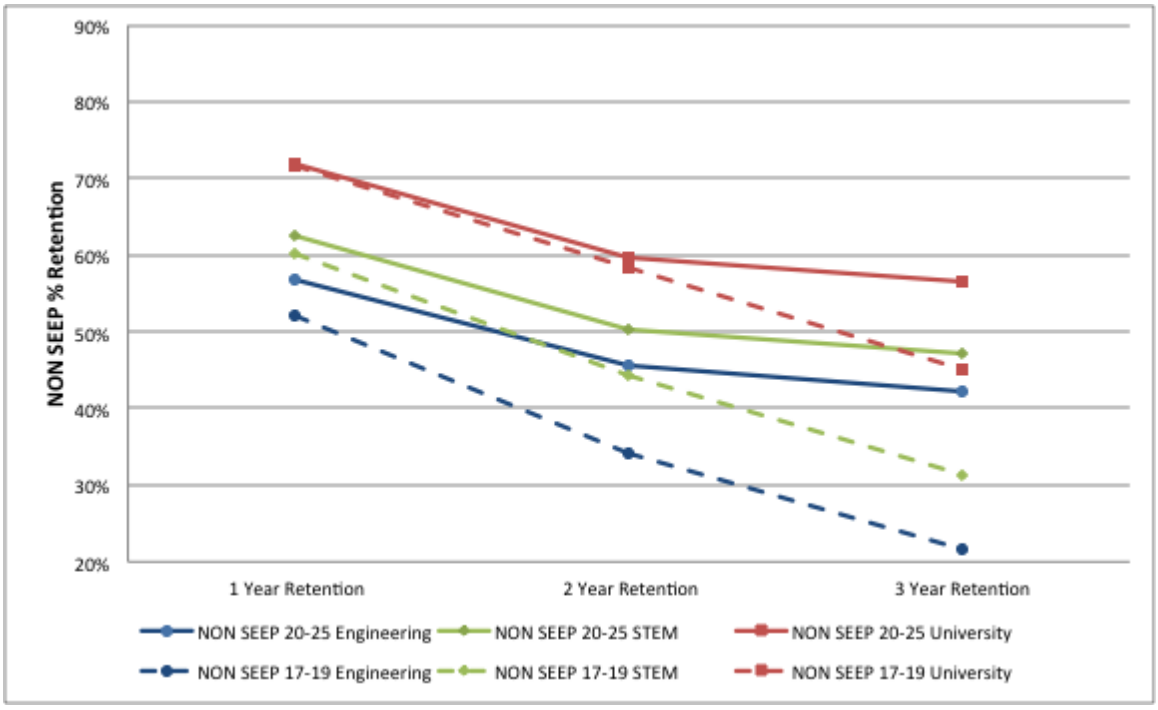


Figure 9 Control Group (NON-SEEP) retention rates: Math ACT 20-25 vs. 17-19



The principle takeaway from Figures 6-9 is that regardless of how retention rates are compared, the 3 year retention rate is about 20% greater for SEEP students relative to Control Group students (regardless of comparing Engineering, STEM or University retentions) or for ACT Math 20-25 relative to ACT Math 17-19. SEEP participants improved 3 year retention between 10% and 22% in most cases.

Conclusions

Seven years of data from this Summer Engineering Enrichment Program (SEEP) compared with identical data for a simultaneous Control group of students with the same characteristics have resulted in the following conclusions for the population of first time freshman engineering majors with ACT Math scores of 17-25 (with subgroups of 17-19 and 20-25):

(1). SEEP program students (relative to the Control group)

(a). increased their 4 year graduation rate in an engineering major from 17% to 41% (ACT Math 20-25) and from 4% to 12% (ACT Math 17-19).

(b). increased their 6 year graduation rate in an engineering major from 37% to 50% (ACT Math 20-25) and from 14% to 25% (ACT Math 17-19)

(c). decreased average time to graduate in engineering by at least a semester.

(d). increased their 3 year retention rate in an engineering major by about 20% (ACT Math 20-25) and by about 10% (ACT Math 17-19).

(2). SEEP program students who changed majors from engineering to either another

STEM major or to another University (non-STEM) major showed comparable six year graduation rate and 3 year retention rate increases.

(3). SEEP program students who changed to another STEM or University major showed a decrease of over ½ year in time to graduate. The average time to graduate exceeded 5 years for three of the four STEM and University Control Groups.

(4). These data clearly show that first time freshman engineering majors with ACT Math scores of 20-25 can achieve (a). an engineering graduation rate of at least 50% with a SEEP program (b). an average time to graduate of 4.15 years and almost 80% graduate in four years.

(5). Based on the four year and six year graduation rates in engineering for the two ACT Math groups, it is more cost effective to limit SEEP participants to those with ACT Math scores of 20-25 if the principle concern is cost effectiveness of the intervention (cost per additional engineer graduate for the SEEP program).

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