Examining STEM Pathways among Students Who Begin College at Four-Year Institutions

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Introduction

In the last decade, the U.S. has seen roughly a 10 percentage point increase in the numbers of first-time, full-time students at four-year institutions starting college with the intention of pursuing a major in a science, technology, engineering, or mathematics (STEM) discipline (Eagan, Berdan, Hurtado, & Case, 2013; Hurtado, Eagan, & Hughes, 2012; National Science Foundation [NSF], 2012). Although interest in pursuing STEM majors continues to increase, overall STEM completion rates have remained stagnant. Huang, Taddese, and Walter (2000) found that just 26% of underrepresented students who began college in 1989 with an interest in pursuing a STEM degree actually earned a degree in STEM within six years. The authors similarly found that 46% of aspiring White and Asian American STEM majors completed a bachelor's degree in STEM within six years of enrollment. Analyzing data on the entering cohort of 2004, Hurtado, Eagan, and Hughes (2012) found that 43% of White STEM aspirants and 52% of Asian American STEM aspirants earned a STEM degree within six years, and just 29% of Latino, 21.8% of Black, and 24.9% of Native Americans who started college with an intention of majoring in STEM completed a STEM bachelor's degree within six years. By comparison, roughly 41.3% of Black students, 38.1% of Native American students, and 51.4% of Latino students who entered college in 2004 earned a bachelor's degree in any field within six years.

The "traditional" pathway of entering college as a STEM major and completing that degree program in four years is becoming anything but traditional or commonplace. Students who begin college at four-year campuses are increasingly switching into and out of STEM majors, concurrently enrolling in more than one campus, stopping out, and even dropping out of college. These patterns likely differ across students' background characteristics, initial intended majors, and the type of institution where they initially enroll. Given the varied pathways that students take toward earning a bachelor's degree in STEM, this paper addresses the following questions:

1. Who is entering four-year STEM institutions interested in a STEM degree? How do these trends compare across gender, ethnicity, economic and education background, type of institution, and STEM discipline (including psychology, economics, sociology, and other social sciences)? Among students who started college intending to pursue a non-STEM major, what are the characteristics of students who choose to switch into STEM?
2. Are the rates of persistence to certificate/degree different by type of student, type of institution, or discipline?
3. What percent of students interested in earning a STEM degree are enrolled in multiple institutions? What type of institutions are they enrolled in? What percent of these students earn a certificate or degree?

We present our completion findings across four, five, and six years to provide an understanding of time to degree and to offer insight as to which students and which institutions tend to have a shorter time to degree across all STEM disciplines as well as in the particular sub-disciplines of engineering, biomedical sciences, and physical sciences. The balance of the paper details the data source, key variables, and analytic methods used to address the three research questions articulated above before moving into a discussion of the findings.

Methods

Data

Analyses for this study relied upon several data sources. All of the trend analyses and analyses focused on the characteristics of students who intend to pursue STEM and non-STEM majors at college entry examined nationally weighted data collected from the Cooperative Institutional Research Program's (CIRP) annual Freshman Survey (TFS). Each year CIRP's TFS surveys hundreds of thousands of first-time, full-time entering freshmen at four-year colleges and universities nationwide. NSF relies on data provided by CIRP's Freshman Survey in its annual *Science and Engineering Indicators* report. Freshman Survey data are weighted within institution and within institutional type by gender, and the weighted data represent characteristics of the national population of first-time, full-time freshmen in nonprofit four-year colleges and universities in the U.S.

To examine persistence and completion rates of students, this study analyzed data from the 2004 CIRP TFS matched with enrollment and completion data from the National Student Clearinghouse (NSC). NSC provided term-to-term enrollment data as well as information about the type of degree (i.e., A.A., B.A., B.S.) students completed as well as the academic discipline or field of that degree. The timeframe for the NSC data ranged from August 2004 through June 2010, which allowed for analyses regarding four-, five-, and six-year degree completion for students who entered a four-year college or university as a first-time, full-time freshman. The TFS-NSC dataset also has been weighted by gender within institution and within institutional type to make this sample of first-time, full-time freshman representative of the national population of first-time, full-time students who entered college in the fall of 2004.

Variables

The CIRP Freshman Survey includes more than 250 variables representing student characteristics, pre-college experiences, and educational and career goals. To identify characteristics of students intending to pursue STEM majors upon college entry, we primarily relied upon student demographic characteristics, intended major, and pre-college academic preparation. These same student variables and institutional characteristics were merged with STEM completion data to understand differences in STEM completion rates across types of students and institutions.

Analyses

We primarily relied upon descriptive analyses. Drawing from trend data as well as single-year administrations of the CIRP Freshman Survey, we ran a series of frequencies and crosstabs to understand how the characteristics of students interested in pursuing STEM and non-STEM majors have shifted over time. These descriptive analyses also highlight the movement of STEM majors into non-STEM programs (and vice versa) during students' undergraduate career. All of the descriptive analyses are weighted such that the findings represent the population of first-time, full-time entering college freshmen in the U.S.

Limitations

While the longitudinal assessment of STEM degrees is extremely useful, several limitations are in order. First, CIRP Freshman Survey data includes students' major *intentions*, and these intentions or aspirations may differ from the major students subsequently declare. Thus, students responding to the CIRP Freshman Survey may have been less sure about their major and based their major intentions on positive experiences they had in certain classes in high school. Only in particular fields can we be more certain that students were on the science-track. For example, entering engineering aspirants are likely to have been admitted to Schools of Engineering when they took the Freshman Survey. In the particular case of physics, chemistry, or mathematics aspirants, fewer students initially choose these intended major categories and are less likely to choose these on a whim. We simply have to take students on their word regarding their initial interests. A second limitation is that the 2010-11 NCS data did not capture students' term-to-term academic major. NCS is beginning to collect such information now, which will allow improved accuracy of understanding the mobility and sustained commitment to STEM among students in higher education.

A third limitation is that, ideally, longitudinal studies will include college experience data. Other college experience studies have used smaller scale datasets to examine retention in STEM (Chang et al., 2010; Espinosa, 2011), but the downside is that data could only be collected to the fourth year of college; thus, with a smaller sample size, it becomes more difficult to identify differences by race and intended major. Instead, we have opted to use a broader, nationally representative sample of STEM aspirants who entered college in the fall of 2004; this sample allows for disaggregation across race, gender, and STEM sub-disciplines, which is a unique feature to our data.

Finally, we are limited by the data included on the surveys. Although the academic major codes are broad (90 different categories), not all majors classified as STEM may be represented. For example, engineering technology is not something we ask separately, so these students may be selected "other engineering" or simply chose "other" when reporting their intended major. Additionally, although we have a number of pre-college preparation measures, our list is nowhere near exhaustive.

Results

Characteristics of Students Intending to Major in STEM

Figure 1 presents more than 40 years of CIRP Freshman Survey data highlighting students' intended majors. In 1971, roughly one-third (32.7%) of first-time, full-time students expressed an interest in pursuing a STEM[1] degree. Another 10% of entering students in 1971 intended to pursue a degree in the social sciences[2]. Over the past 40 years, the biological sciences have made the largest gains in attracting student interest; in 1971, 5% of incoming students planned to major in the biological sciences, and that figure jumped to 12.6% in 2012. Engineering also has increased its share of students, as 6.5% of first-time, full-time students expressed intentions to major in engineering in the fall of 1971 compared to 10.4% in the fall of 2012. Mathematics has experienced the greatest loss in student interest, as 3.7% of incoming students in 1971 intended to pursue a math degree compared to 1.1% of first-time, full-time students in the fall of 2012. Overall, more than half (51.5%) of students who started college at a four-year institution in the fall of 2012 intended to pursue a major in the social sciences, science, technology, engineering, or mathematics (SS-STEM).

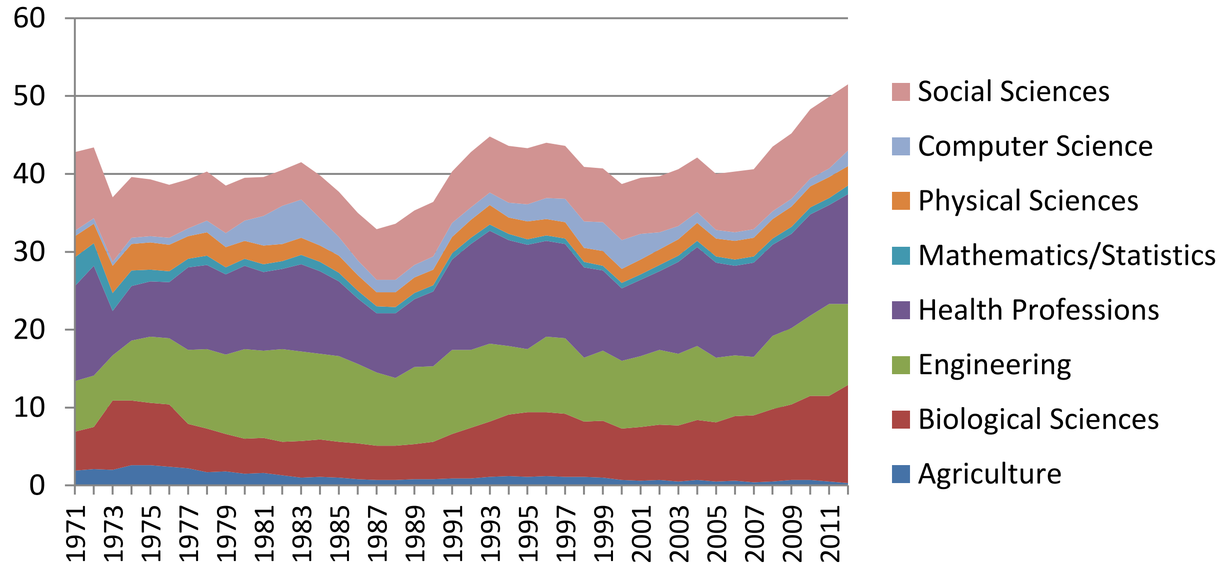

Figure 1 Academic Major Intentions among FTFT Undergraduates, 1971-2012

Race and ethnicity. Figure 2 shows the trends in STEM aspirations by race/ethnicity. Throughout the 1970s and early 1980s, White and Asian American students far outpaced their

[1] STEM: biological sciences, physical sciences, mathematics, engineering, health sciences, and computer science.
[2] Social sciences: economics, psychology, sociology, anthropology, political science, and other social science.

underrepresented racial minority (URM) counterparts in their plans to major in STEM. Just over 30% of White and Asian American students expressed interests in majoring in STEM in 1971 compared with roughly 22% of incoming URM students. From roughly 2007 through 2009, roughly equal proportions (34%) of incoming URM students and White and Asian American students planned to pursue a major in STEM; however, from 2010 through 2012, White and Asian American students (38%) have begun outpacing their URM peers (35%) in initial STEM interest.

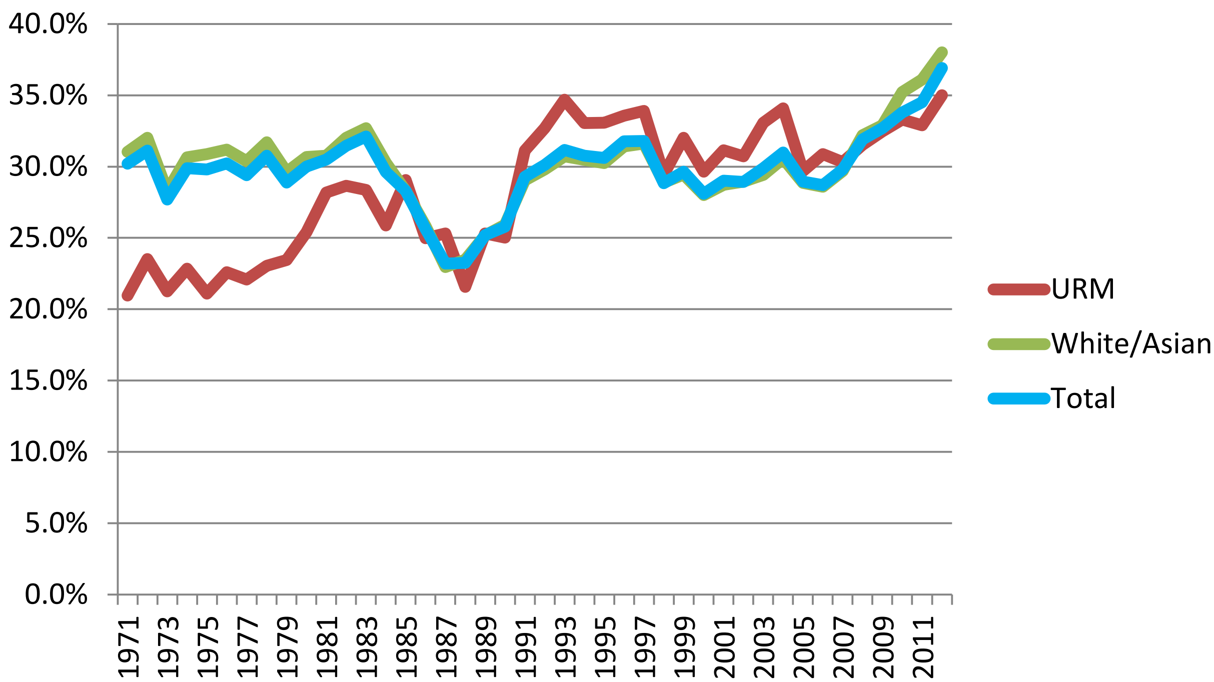

Figure 2 Percentage of Incoming First-Time, Full-Time Freshmen Intending to Major in STEM, 1971-2012

Although the trend lines in Figure 2 are encouraging with regard to URM students' increased interest in pursuing STEM majors, they remain underrepresented among STEM aspirants relative to representation among all incoming first-time, full-time freshmen. Figure 3 presents trends of the representation of students of color among STEM aspirants and among all incoming students. The trend lines demonstrate that, throughout the 1970s and 1980s, the share of STEM aspirants who identified as Black or African American was far below Black and African American students' representation among all incoming students; however, the trends reversed for a period between 1991 and 2008, where the representation of Black and African American STEM aspirants outpaced the proportion of incoming students who identified as Black or African American. The representation of Latino and Native American students among STEM aspirants has tracked relatively closely to these students' representation among all first-time, full-time freshmen. By contrast, Asian American students have been overrepresented among STEM aspirants relative to their representation among all incoming students, and this gap continues to expand. Beginning around 1985, the proportion of Asian American students who expressed an interest in pursuing a STEM degree began increasing much more rapidly than Asian Americans' share of all incoming first-year students. In 2012, 12.2% of all STEM aspirants identified as Asian American whereas just 8.8% of all incoming first-time, full-time students were Asian American.

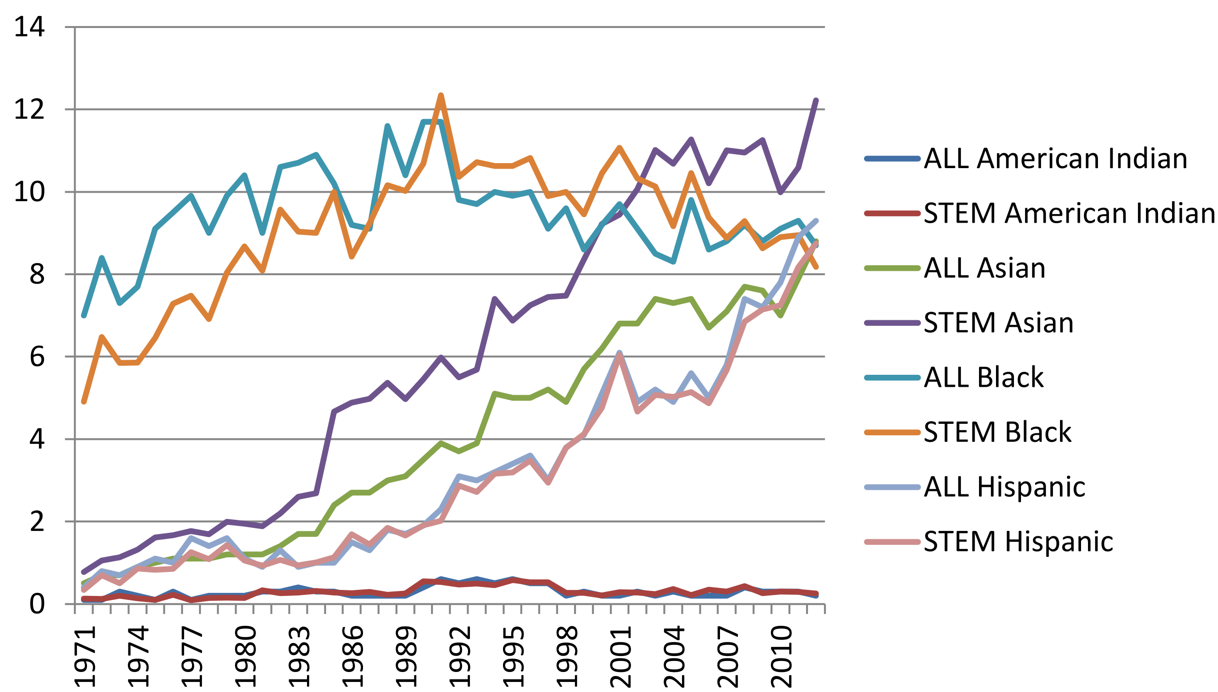

Figure 3 Racial/Ethnic Composition of STEM Aspirants vs. All FTFT Undergraduates, 1971-2012

Gender. Throughout the last four decades, the gender composition among STEM aspirants has shifted dramatically. As the trend lines in Figure 4 illustrate, the gender split among STEM aspirants shifted from being 61.8% men and 38.2% women in 1971 to 47.7% men and 52.3% women in 2012. Although women now represent the majority of first-time, full-time STEM aspirants, they remain underrepresented in STEM relative to their share of the college-going population. Women made up 54.3% of the incoming freshman class in the fall of 2012; thus, even with the gains women have made among STEM aspirants, their representation among aspiring STEM majors remains two percentage points lower than their share of incoming first-time, full-time students.

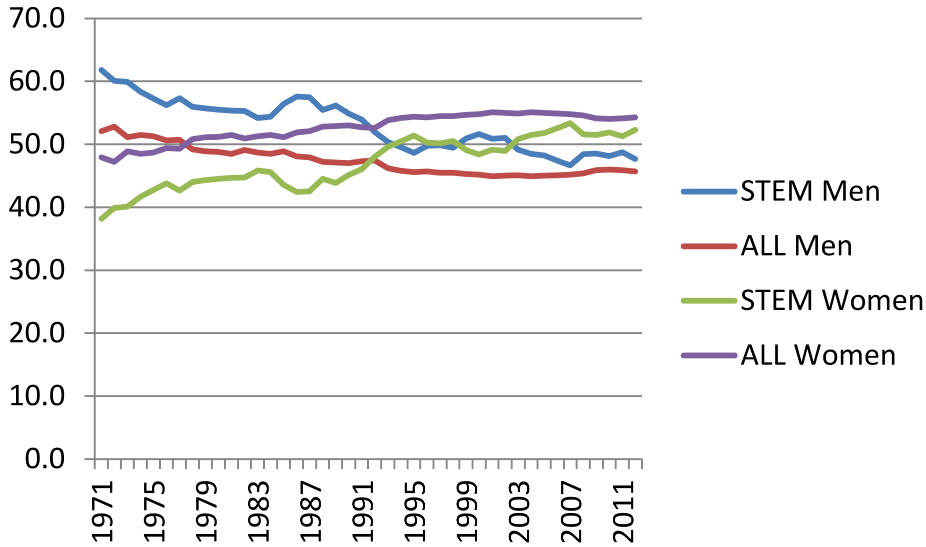

Figure 4 Gender Composition of STEM Aspirants vs. All FTFT Undergraduates, 1971-2012

Parental education. The composition of first-generation students (i.e., those whose parents did not attend any college) among STEM aspirants has tracked quite closely with the share of first-generation students among all incoming freshmen. Figure 5 shows that, as the share of first-generation students has declined among the population of first-time, full-time students, the proportion of first-generation students among STEM aspirants has also fallen. In 1971, roughly 40% of all first-time, full-time students identified as first-generation, and about the same proportion of aspiring STEM majors did the same. In 2012, 19.1% of all students were first-generation, and 19.5% of STEM aspirants came from families where neither parent had attended college.

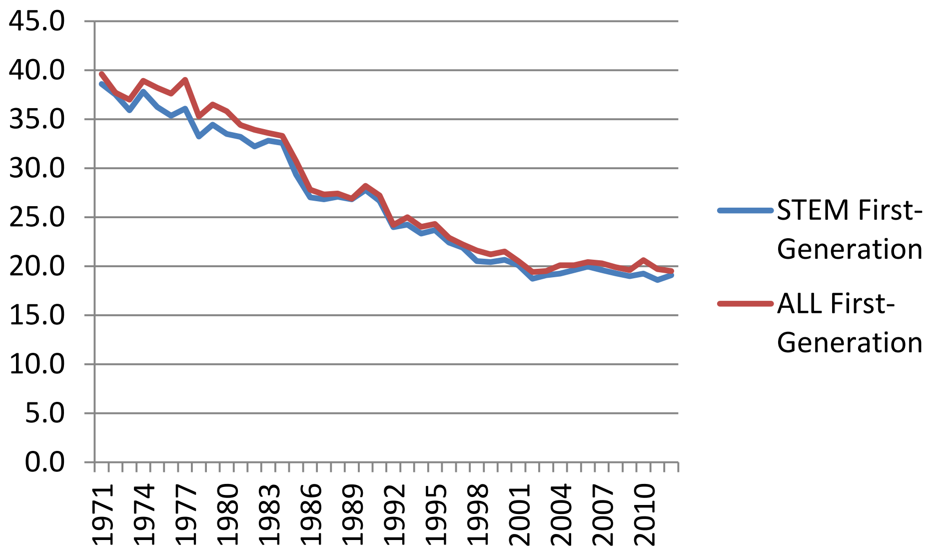

Figure 5 First-Generation STEM Aspirants vs. All First-Generation FTFT Undergraduates, 1971-2012

Comparing STEM, SS-STEM, and all students. Table 1 presents demographic characteristics and measures of students' pre-college preparation for STEM aspirants, SS-STEM aspirants (i.e., a group composed of all STEM and social science majors), and all incoming students for the fall of 2012. Men and Asian American students tend to be overrepresented among STEM aspirants relative to their share of all first-time, full-time incoming students. Distributions across categories of income among STEM aspirants roughly track to the representation of incomes present in the overall population of first-time, full-time students. Similarly, the education levels of STEM aspirants' mothers were roughly equivalent to the distributions seen for SS-STEM aspirants and the overall incoming freshman class.

The findings begin to diverge when considering measures of academic preparation. The results in Table 1 demonstrate that STEM students arrive on campus as more well-prepared, higher achieving compared to the student body as a whole. More than 57% of incoming STEM aspirants in the fall of 2012 reported having earned a cumulative high school GPA of an A- or higher, which outpaced the overall student body by 8.1 percentage points (49.5%). STEM students also earned higher grades than SS-STEM students, which includes the social sciences. When social science aspirants are included with other STEM majors, we find that 55.5% of students report having earned a high school GPA of an A- or higher.

Table 1 Pre-College Preparation among STEM Aspirants, SS-STEM Aspirants, and All Students, Fall 2012

	STEM	SS-STEM	All
Sex			
Men	47.7	45.0	45.7
Women	52.3	55.0	54.3
Race			
Black	8.2	8.6	8.7
Latino	8.7	9.7	9.3
Native American	0.3	0.2	0.2
Asian	12.2	11.2	8.8
White	59.3	58.6	61.3
Other	10.3	11.7	11.7
Income			
Below $50K	30.1	31.2	31.3
$50K-$100K	32.2	31.4	31.2
Above $100	37.7	37.4	37.6
Mother's Education			
No College	23.7	24.3	24.3
Some College	19.3	19.3	19.6
College Degree or Higher	57.0	56.4	56.2
Pre-College Preparation			
HS GPA: A- or Higher	57.6	55.5	49.5
Years of HS Math: 4 or more	90.7	89.5	87.6
Years of HS Physical Science: 3 or more	32.1	31.6	29.6
Years of HS Biological Science: 3 or more	21.1	20.3	18.3
Completed Calculus	38.3	35.8	30.1
Completed AP Calculus	41.2	37.7	30.0

Note: SS-STEM includes all social science and STEM majors.

Higher proportions of STEM (90.7%) and SS-STEM (89.5%) students reported taking four or more years of high school math compared to the student body as a whole (87.6%). Similarly, nearly one-third of all STEM students took three or more years of high school physical science, which was roughly 2.5 percentage points higher than the student body as a whole. More than one-in-five STEM aspirants took at least three years of high school biology compared to 20.3% of SS-STEM majors and 18.3% of all incoming freshmen. Nearly 40% of all intended

STEM majors completed Calculus in high school compared to about 30% of all students, and an even higher proportion of STEM students (41.2%) reported taking AP Calculus in high school. By contrast, 37.7% of SS-STEM students completed AP Calculus, and 30% of all students reported taking AP Calculus while in high school.

Table 2 breaks out these same characteristics across the sub-disciplines within STEM. The results illustrate that women are the majority in the biological sciences (61.5) but comprise just one in five engineering aspirants (20.6%). Three times as many women intended to pursue a degree in the health sciences in 2012 compared to men (75.2% vs. 24.8%), and the reverse was true for math and computer science (24.8% women, 75.2% men). Men outpace women by more than 13 percentage points among physical science aspirants (56.9% vs. 43.1%), and women are the dominant group in the social sciences at 69.7%.

The social sciences contain the greatest racial diversity, with 7.3% of social science aspirants identifying as Asian, 10.4% as Black, 13.6% as Latino, 0.2% as American Indian, and 15.5% as other or multiracial. By contrast, the physical sciences are the least racially diverse among STEM sub-disciplines, with 64.8% of students identifying as White, 9.9% as Asian, 6% as Latino, 5.1% as Black, 0.2% as American Indian, and 14% as other or multiracial. Asian students were most heavily represented in among math and computer science aspirants (15.5%). Among STEM disciplines, Black students had the strongest representation among health professions aspirants (9.8%) whereas Latino students were best represented among biological sciences aspirants (9.1%).

The most even distribution of students' parental income was found among health professions aspirants, where roughly one-third of students reported annual parental income below $50,000, one-third between $50,000 and $100,000, and just under one-third coming from families making more than $100,000. Engineering aspirants tended to come from wealthier families with 43% of students indicating their parents earned more than $100,000 per year. Nearly 40% of biological science aspirants and physical science aspirants also reported that their parents earned more than $100,000 per year. Social science aspirants tended to come from lower-income families, with 38.1% of these students reporting parental income below $50,000.

Parental education trends tended to track closely with income, as students with plans to pursue a major in engineering, the biological sciences, or the physical sciences substantially more likely to report that their mother had earned a college degree or higher. By contrast, nearly one-third of students in the health professions and social sciences reported that their mother had not attended any college.

Table 2 Student Characteristics and Pre-College Preparation across STEM Disciplines and Social Sciences

	Biological Sciences	Engineering	Health Professions	Math/ Computer Science	Physical Science	Social Science
Gender						
Men	39.5	79.4	24.8	75.2	56.9	30.3
Women	61.5	20.6	75.2	24.8	43.1	69.7
Race						
American Indian	0.2	0.2	0.4	0.1	0.2	0.2
Asian	14.0	12.6	8.8	15.5	9.9	7.3
Black	8.1	5.9	9.8	8.4	5.1	10.4
Latino	9.1	8.8	9.0	8.3	6.0	13.6
White	54.1	59.1	58.8	53.2	64.8	53.0
Other	14.5	13.4	13.2	14.5	14.0	15.5
Income						
Below $50K	30.3	25.2	34.1	32.0	25.8	38.1
$50K-$100K	30.0	31.8	34.1	31.0	34.4	28.6
Above $100	39.7	43.0	31.8	37.0	39.8	33.4
Mother's Education						
No College	25.9	23.3	31.7	26.7	21.9	31.4
Some College	15.6	15.1	17.6	15.7	15.9	16.7
College Degree or Higher	58.5	61.6	50.7	57.6	62.2	51.9
Pre-College Preparation						
HS GPA: A- or Higher	62.3	62	49.7	54.8	63.8	44.6
Years of HS Math: 4 or more	92.1	94.3	87.4	92.3	92.4	83.8
Years of HS Physical Science: 3 or more	29.1	38.1	26.6	32.8	50.0	27.8
Years of HS Biological Science: 3 or more	29.4	12.0	23.4	13.2	15.7	17.6
Completed Calculus	39.4	51.0	24.9	45.2	44.8	24.0
Completed AP Calculus	41.8	60.3	21.4	51.2	50.4	22.2

The selected pre-college preparation variables underscore the differences in high school grades and coursework across STEM disciplines and the social sciences. More than 60% of students planning to major in the biological sciences, engineering, or physical sciences reported high school GPAs of an A- or higher; by contrast, less than 50% of students pursuing programs in the health professions and social sciences reported the same. Students in the social sciences were the least likely to report having taken at least four years of high school math (83.8%), which compared to 94.3% of engineering aspirants. Half of all physical sciences aspirants indicated that they had taken at least three years of physical sciences courses in high school whereas just more than one-quarter (26.6%) of students intending to pursue a health professions degree did the same. Students planning to major in the biological sciences (29.4%) or health professions (23.4%) were more likely than their peers in other disciplines to take at least three years of biological science courses in high school.

Among specific math courses, we found that more than half of all engineering aspirants (51%) had taken basic Calculus in high school; by contrast, less than one-quarter of all health professions aspirants (24.9%) and social science aspirants (24%) had done the same. Similarly, students in engineering (60.3%), math and computer science (51.2%), and the physical sciences (50.4%) were substantially more likely to report having taken AP Calculus; just more than one in five students in the health professions (21.4%) and social sciences (22.2%) completed AP Calculus in high school.

Characteristics of Students Who Switch into STEM

We used descriptive analytic techniques on the 2004 CIRP Freshman Survey and 2010 National Student Clearinghouse dataset to understand the characteristics of students who did not initially plan to pursue a STEM degree as incoming freshmen but later switched into and earned a STEM bachelor's degree. Of the 34,616 students in the dataset who graduated with a STEM degree, 6,110 originally intended to pursue a non-STEM major. Students switching into STEM were more likely to be female (57%), and they were much more likely to be White (74%) compared to the characteristics of STEM aspirants (51.5% female, 67.7% White in the fall of 2004).

Table 3 shows the initial majors students who later switched into STEM had chosen as entering freshmen. More than one-third of students (34.6%) who switched into STEM arrived on campus in the fall of 2004 as undeclared. About 16.4% of STEM switchers initially started out planning to major in business, and another 13.6% had plans to pursue a bachelor's degree in education. Fewer than one in ten (9.4%) students who switched into STEM started out as social science majors, and 6.3% initially aspired toward a degree in the fine arts. STEM switchers also came from history and political science (3.6%), humanities (6.3%), and "other" majors (11.9%), which include professions and skilled trades.

Table 3 Initial Major Choices of Students Who Switched into STEM between 2004 and 2010

	Percent
Business	16.4
Education	13.6
English	1.4
History/Political Science	3.6
Humanities	2.8
Fine Arts	6.3
Social Sciences	9.4
Other	11.9
Undecided	34.6

STEM Completion across Discipline, Race/Ethnicity, and Institutional Type

STEM sub-discipline. STEM completion and persistence rates vary considerably across STEM sub-disciplines, categories of race/ethnicity, and institutional type. Figure 6 illustrates the differences in STEM persistence and completion by STEM sub-discipline among students who started college as a STEM aspirant in the fall of 2004. Among students who intended to pursue a life sciences major, 36.8% completed in the life sciences and another 6.2% completed in a different STEM field. Nearly one-third (30.7%) of life sciences aspirants switched to a non-STEM field but still completed their bachelor's degree within six years. Although 7% of life sciences aspirants were still enrolled at a four-year institution in spring of 2010, about one in six (17%) life sciences aspirants had dropped out of higher education by 2010.

Engineering programs appear to do a better job of retaining their students within engineering, as 38.8% of engineering aspirants completed a degree in that sub-discipline within six years, and another 8.3% switched to a different STEM major. Nearly one-quarter (23.2%) of engineering aspirants completed a bachelor's degree in a non-STEM field, and about one in ten (9.6%) were still enrolled in a four-year institution. Slightly more engineering aspirants (17.5%) than life sciences aspirants had left higher education within six years of enrollment.

Students who began college in a physical sciences major were unlikely to persist in the physical sciences to degree completion. Less than one-quarter (22.9%) of physical sciences aspirants completed a degree in that discipline within six years, and 20% switched to a different STEM major. Nearly 30% of students who came to college with plans to pursue a physical sciences major switched to a non-STEM degree program and earned a bachelor's degree within six years. Although 18% of physical sciences aspirants had dropped out of college by the spring of 2006, 7.7% of initial physical sciences students were still enrolled at a four-year institution.

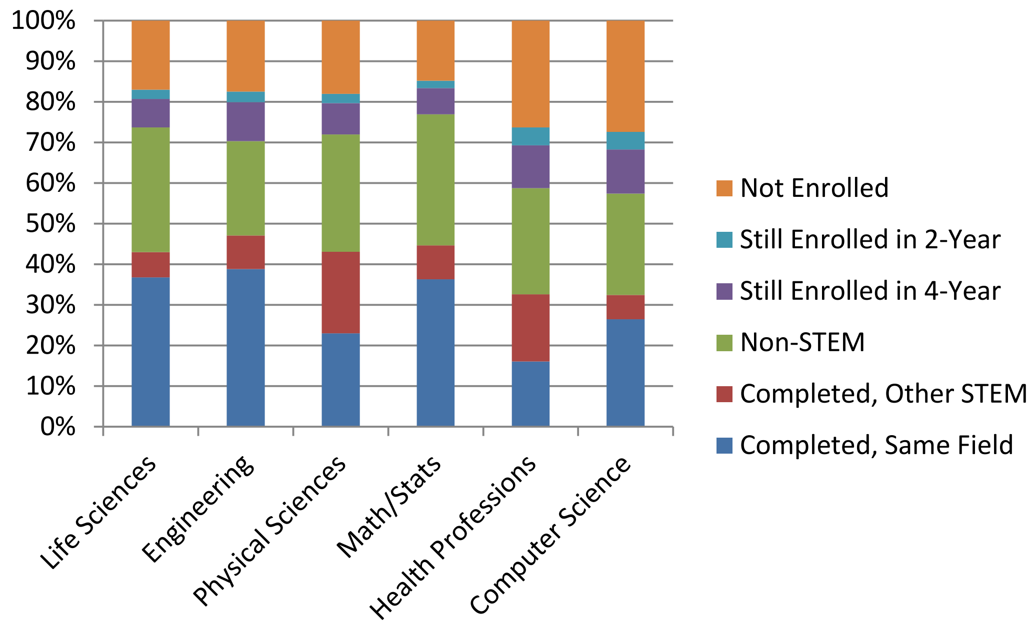

Figure 6 Enrollment/Completion Status of 2004 FTFT STEM Aspirants, by STEM Sub-Discipline

Among mathematics and statistics aspirants, 36.3% completed a degree in mathematics or statistics within six years, and 8.3% earned a bachelor's degree in a different STEM field. One third (32.3%) of students who intended to major in mathematics or statistics earned their bachelor's degrees in a non-STEM field – the highest of any STEM sub-discipline. Overall, students who started college as mathematics or statistics majors were the most likely to earn a bachelor's degree in any field – 66.9%, and they were the least likely of any STEM sub-discipline to have dropped out of higher education (14.8%).

Students who started out planning to major in the health professions were the least likely to complete a bachelor's degree in their initial STEM sub-discipline, as just 16.1% earned a degree in the health professions. Another 16.5% of health professions aspirants switched to a different STEM field, and just more than a quarter (26.1%) completed in a non-STEM field. Students with plans to pursue a health professions bachelor's degree were second only to their computer science colleagues with regard to their likelihood of dropping out of college – 26.3%

of health professions aspirants had left higher education without a degree by the spring of 2010; by contrast, 27.4% of students who intended to major in computer science had dropped out of college.

Just more than a quarter of computer science aspirants completed a degree in that field within six years, and just 6% switched from computer science to another STEM discipline. About one-quarter earned their bachelor's degrees from a non-STEM program, and just over 10% were still enrolled at a four-year campus in the spring of 2010.

STEM completion by race/ethnicity. Although we have reached a point in recent years where underrepresented racial minority students aspire toward STEM degrees at the same rates as their White and Asian American peers, disparities in STEM completion across race/ethnicity persist. Figure 7 presents data on the four-, five-, and six-year completion rates for all STEM aspirants who entered college in the fall of 2004 and for STEM aspirants across five categories of race/ethnicity: White, Asian American, Latino, Black, and Native American. Overall, just over 40% of first-time, full-time STEM aspirants who entered four-year colleges in the fall of 2004 completed a STEM degree within six years. Asian American students outpace all of their peers in STEM completion, as 29.6% of Asian American STEM aspirants completed a STEM degree within four years, 46.6% in five years, and 52.4% in six years. White students perform better than average but lag far behind their Asian American counterparts. Less than one-quarter of White students completed their STEM degree with four years, and by six years 43% had earned a STEM bachelor's degree – near 10 percentage points lower than Asian American students.

Underrepresented students fared far worse. After four years, just 12.3% of Latino, 9.4% of Black, and 11.6% of Native American STEM aspirants had completed a STEM bachelor's degree. Six years after college entry, in the spring of 2010, STEM completion rates for Latino, Black, and Native American students had more than doubled but had not crossed the 30% threshold. Fewer than three in ten Latino STEM aspirants (29%) earned a STEM degree in six years, and one-quarter (24.9%) of Native American students did the same. By spring 2010, 21.8% of Black students who had entered college in 2004 intending to major in STEM had earned a STEM bachelor's degree.

Figures 8 and 9 show STEM and non-STEM completion rates for URM and White and Asian American students. After six years, roughly one-quarter of URM STEM aspirants earned a STEM degree, and another 22.6% earned a degree in a non-STEM field. More than half (52.7%) of all URM STEM aspirants had not earned a bachelor's degree within six years of college enrollment. By contrast, 44.5% of White and Asian American STEM aspirants completed a STEM bachelor's degree within six years – a proportion nearly as high as the combined STEM and non-STEM completion rate among URM STEM aspirants. Another 27.9% of White and Asian American STEM aspirants earned a bachelor's degree in a non-STEM discipline, with just more than a quarter (27.6%) of White and Asian American STEM aspirants having not earned any bachelor's degree within six years. As noted in the introduction, six-year completion rates for Black, Latino, and Native American students, regardless of discipline, are 41.3%, 38.1%, and 51.4%, respectively.

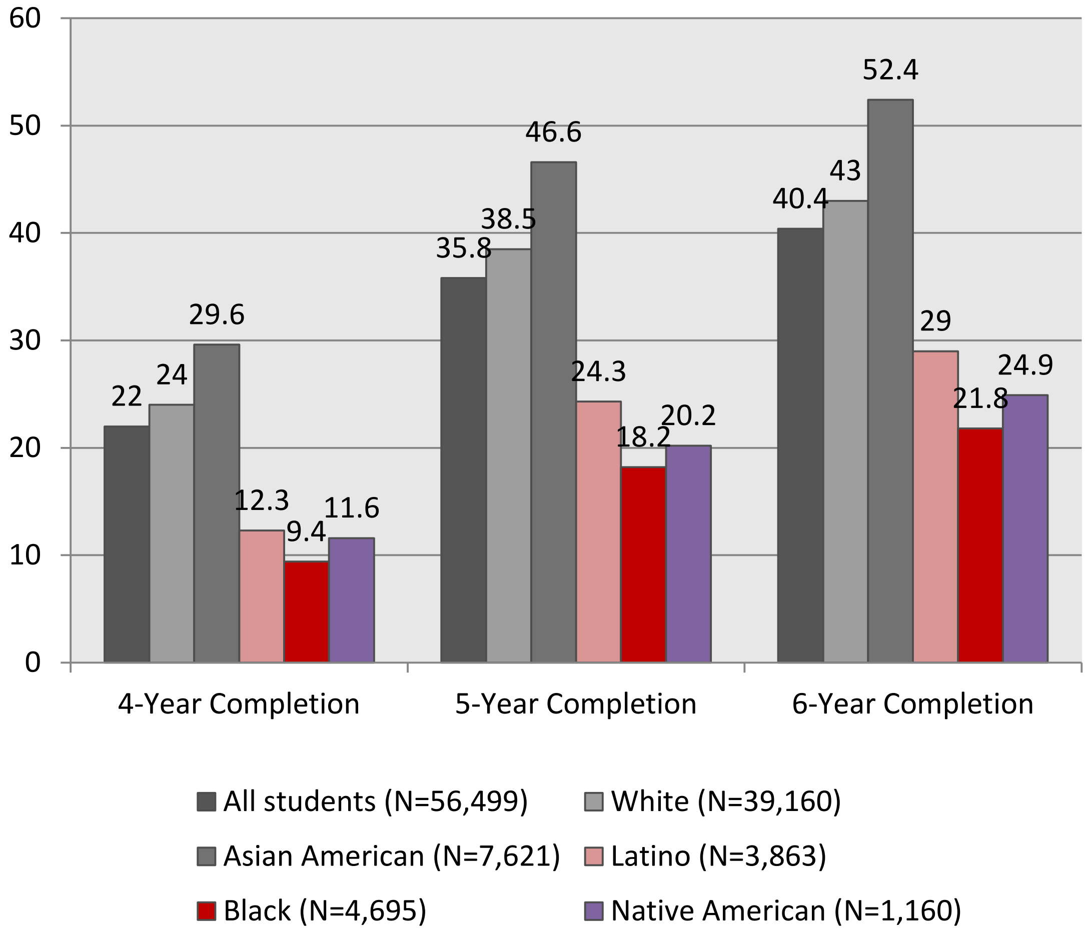

Figure 7 Percentage of 2004 STEM Aspirants Who Completed STEM Degrees in Four, Five, and Six Years, by Race/Ethnicity

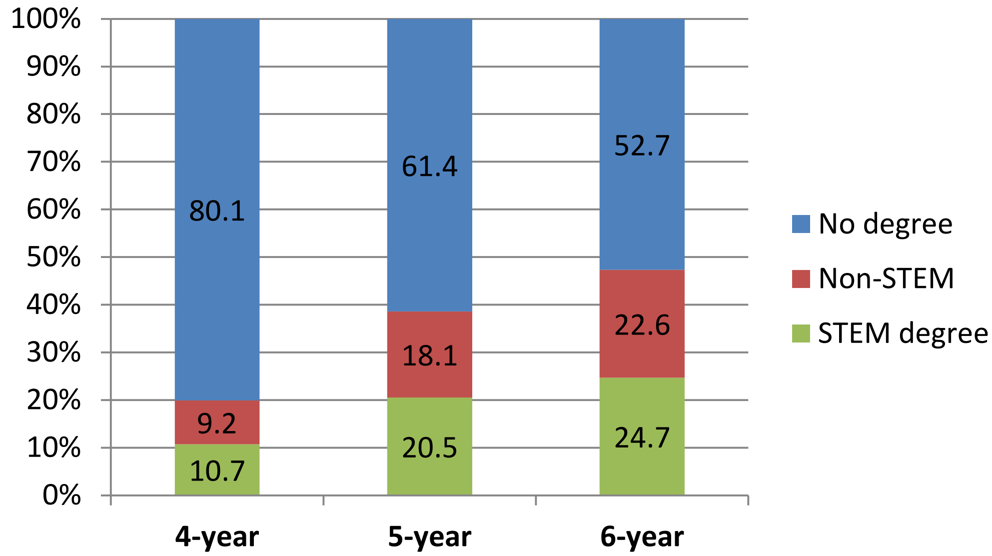

Figure 8 Completion Rates of Underrepresented Minority STEM Aspirants

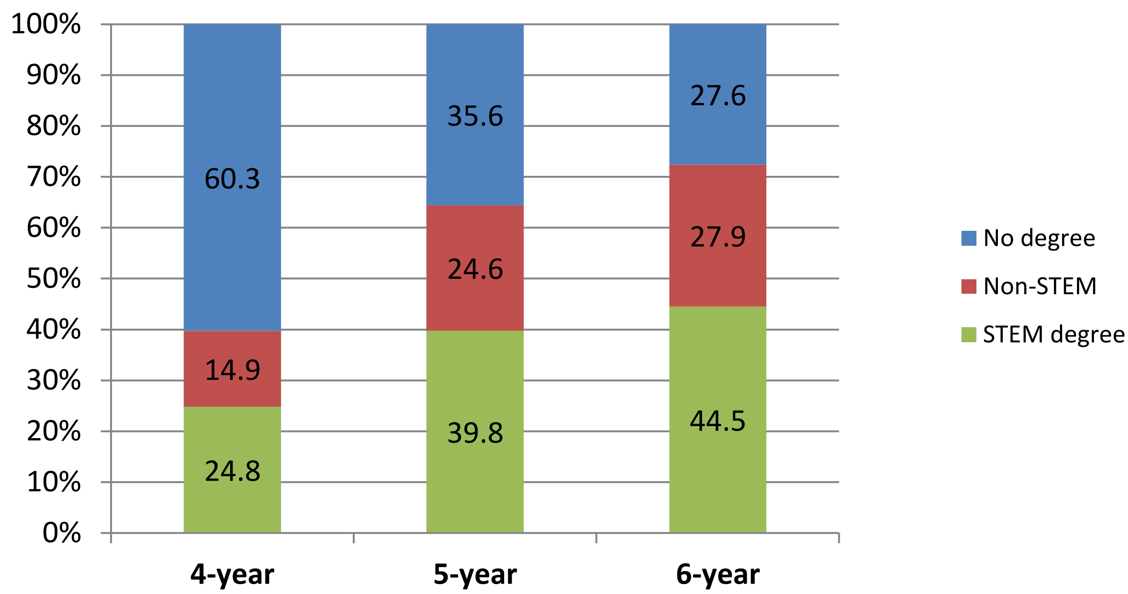

Figure 9 Completion Rates of White/Asian American STEM Aspirants

STEM completion by gender. Table 4 shows descriptive statistics for four-, five-, and six-year completion for STEM generally and for engineering, biomedical sciences, and physical sciences specifically. A higher proportion of women (23.3%) complete STEM degrees within four years relative to men (20.6%); however, men outpace women in STEM completion after five (37.4% vs. 34.2%) and six (42.8% vs. 38.1%) years. Women who started college wanting to pursue an engineering degree earned those credentials at higher rates than their male peers. Women comprised just 16.9% of students who entered college in the fall of 2004 with plans to major in engineering. After four years, one in five female engineering aspirants had completed their engineering degree programs compared to 15.1% of men. Nearly 40% of women who intended to major in engineering completed their engineering degree within five years, and 43.4% completed in six years. By contrast, just more than one-third (34.6) of men wanting to major in engineering finished an engineering bachelor's degree in five years, and 401.% finished by the end of the sixth year.

Table 4 Completion Rates by Gender and Sub-Discipline

	Men	Women
4-Year STEM	20.6	23.3
5-Year STEM	37.4	34.2
6-Year STEM	42.8	38.1
4-Year Engineering	15.1	20.2
5-Year Engineering	34.3	39.6
6-Year Engineering	40.1	43.4
4-Year Biomedical Sciences	22.8	22.4
5-Year Biomedical Sciences	32.3	31.5
6-Year Biomedical Sciences	34.4	34.0
4-Year Physical Sciences	23.1	22.7
5-Year Physical Sciences	30.5	27.2
6-Year Physical Sciences	32.8	28.1

Completion rates in the biomedical sciences were more even between men and women. Just under one-quarter of men (22.8%) and women (22.4%) who started college wanting to pursue a biomedical degree finished their program within four years. Roughly one-third of men

(34.4%) and women (34.0%) completed a biomedical science degree within six years. By contrast, men retained a slight advantage over women in their likelihood to complete a degree in the physical sciences. After four years, about 23.1% of men and 22.7% of women who entered college intending to major in the physical sciences had earned a bachelor's degree in one of those fields. By the end of the sixth year after college entry, 32.8% of men and 28.1% of women who started a physical sciences major had earned a physical science bachelor's degree.

STEM completion by institutional type. Table 5 presents descriptive statistics for STEM completion rates by minority serving status. Four types of institutions are compared: predominantly White institutions (PWIs), Historically Black Colleges and Universities (HBCUs), emerging Hispanic-Serving Institutions (i.e., campuses that have an undergraduate population composed of between 15 and 24% Hispanic/Latino students), and Hispanic-Serving Institutions (HSIs). findings from the general STEM completion models for selected institutional variables. The findings show that emerging HSIs have the highest STEM completion rates at each time point: four, five, and six years. Just more than one-quarter (26.7%) of STEM aspirants enrolled at an emerging HSI earned a STEM degree in four years, and that figure jumped to 44.1% after five years and nearly half (47.5%) after six years. At each time points, PWIs have a lower STEM completion rate than emerging HSIs: 23.7% after four years, 38% after five years, and 42.6% after six years.

Table 5 STEM Completion Differences by Minority-Serving Institution Status

	4-Year	5-Year	6-Year
PWI	23.7	38.0	42.6
HBCU	8.0	15.6	19.3
Emerging HSI	26.7	44.1	47.5
HSI	10.0	22.2	28.6

HSIs graduate 10% of their STEM aspirants within four years and just less than one-quarter (22.2%) after five years. By the end of the sixth years, 28.6% of STEM aspirants who enrolled at an HSI in 2004 had earned a STEM bachelor's degree. HBCUs had the lowest STEM completion rates, with just 8% of STEM aspirants earning a STEM degree after four years and 15.6% after five years. By the end of the sixth years, 19.3% of STEM aspirants had completed their STEM degree.

Although HSIs and HBCUs graduate substantially lower proportions of incoming STEM aspirants after six years than their PWI and emerging HSI, the multivariate models, which controlled for several dozen student and institutional predictors, indicated that the differences between MSIs and PWIs became non-significant after accounting for differences in the types of students HBCUs and HSIs enroll and the types of resources available to these campuses. Additionally, these multivariate models demonstrated that Black STEM aspirants are significantly more likely to graduate with a STEM degree if they attended an HBCU than had they enrolled at a PWI.

Tables 6 and 7 further break out STEM completion by institutional control (i.e., public vs. private) and broad Carnegie classification (doctoral/research, masters comprehensive, and liberal arts). Completions rates are presented across four, five, and six years for all of STEM, engineering, biomedical sciences, and physical sciences. Across all STEM disciplines, private colleges and universities retain a substantial advantage in STEM completion. STEM completion rates at private institutions after four years were nearly double the rates at public colleges and universities (34.6% vs. 17.5%). After five years, about one-third (33.3%) of STEM aspirants attending public institutions had earned a STEM bachelor's degree compared with 43.2% who had enrolled at private campuses. At the six-year mark, public institutions still fell about eight percentage points below the STEM completion rate for private colleges and universities (38.3% vs. 46.7%). Our multivariate models suggest that these differences in raw completion rates become non-significant after accounting for differences in the types of students enrolled at public and private institutions and for resource disparities across these broad categories (Hurtado, Eagan, & Hughes, 2012).

STEM completion rates also varied considerably across Carnegie classification. Doctoral and research universities graduates less than one-quarter (23.6%) of their STEM aspirants within four years; however, that figure jumped to 44.5% after six years. By contrast, about 29.5% of STEM aspirants attending liberal arts institutions completed their STEM degrees within four years, and 37.1% earned a STEM bachelor's degree within six years of enrollment. Masters comprehensive institutions consistently had the lowest STEM completion rates across each time point, with 16.5% of STEM aspirants degreeing in STEM within four years and just more than one-third (33.8%) finishing within six years.

Table 6 shows similar patterns when examining engineering completion. The four-year engineering completion rate among private institutions (28.1%) was more than double the rate at public colleges and universities (13.1%). After six years, a 5.7 percentage point gap persisted, with 45.2% of engineering aspirants at private institutions having earned an engineering degree compared to 39.5% of engineering aspirants attending public institutions. Just under one in five (18.8%) engineering aspirants who enrolled at doctoral and research universities finished an engineering degree in four years compared to 7.3% and 15.9% of students at masters comprehensive and liberal arts campuses, respectively. After six years, 44.6% of students who started college at doctoral and research universities with plans to pursue engineering had earned a bachelor's degree in that discipline compared to 32.5% attending masters comprehensive campuses and 22% enrolled at liberal arts colleges.

Table 6 STEM and Engineering Completion Rates by Institutional Control and Carnegie Classification

	4-Year STEM Completion	5-Year STEM Completion	6-Year STEM Completion	4-Year Engineering	5-Year Engineering	6-Year Engineering
Public	17.5	33.3	38.3	13.1	33.7	39.5
Private	34.6	43.2	46.7	28.1	41.5	45.2
Doctoral/Research	23.6	39.7	44.5	18.8	39.9	44.6
Masters Comprehensive	16.5	28.8	33.8	7.3	24.2	32.5
Liberal Arts	29.5	34.2	37.1	15.9	19.7	22.0

Table 7 presents institutional completion rates for the biomedical sciences and physical sciences. Fewer than one in five (18.4%) of biomedical sciences aspirants at public institutions had finished a degree in the biomedical sciences within four years compared to nearly one-third (32.5%) of students at private institutions. By the end of six years, nearly one-third of students who started in the biomedical sciences at a public institution had earned a degree in one of those fields compared to 39.7% enrolled at private campuses. Students enrolled at liberal arts colleges had the highest four-year completion rate in the biomedical sciences, with 29.2% earning a bachelor's degree by the end of the fourth year. This figure exceeded the rate at doctoral and research universities by 5.5 percentage points (23.7%) and was 11 percentage points higher than that of masters comprehensive institutions (18.2%). After six years, 36.3% of biomedical science aspirants at doctoral and research universities had earned a bachelor's degree within this broad field compared to 34.4% at liberal arts colleges and 30.3% at masters comprehensive institutions.

Although doctoral and research universities outperformed liberal arts and masters comprehensive institutions for STEM completion rates, engineering completion rates, and biomedical science completion rates, liberal arts campuses actually fared better when examining completions in the physical sciences. About 36.1% of physical sciences aspirants who enrolled at a liberal arts college earned a bachelor's degree in the physical sciences within four years compared, which was substantially higher than the rates of 21% and 20.5% among students attending doctoral/research universities and masters comprehensive institutions, respectively. By the sixth year, 41.1% of students who started as a physical sciences major at a liberal arts college had completed a physical sciences bachelor's degree – a rate that far exceeded the 28.7% and 29.6% of students at doctoral/research and masters comprehensive institutions, respectively. Physical sciences completion rates at public colleges and universities consistently lagged behind those of private institutions. After four years, 17.2% of physical sciences aspirants at public institutions had earned a bachelor's degree in that broad discipline compared to 34.3% of students enrolled at private campuses. Nearly 13 percentage points separate public and private institutions with regard to physical science completion after six years (26.4% vs. 39.3%).

Table 7 Biomedical Science and Physical Science Completion Rates by Institutional Control and Carnegie Classification

	4-Year Biomedical Sciences	5-Year Biomedical Sciences	6-Year Biomedical Sciences	4-Year Physical Science	5-Year Physical Science	6-Year Physical Science
Public	18.4	29	31.8	17.2	24.5	26.4
Private	32.5	38.3	39.7	34.3	38.3	39.3
Doctoral/Research	23.7	33.9	36.3	21.0	27.3	28.7
Masters Comprehensive	18.2	27.5	30.3	20.5	27.2	29.6
Liberal Arts	29.2	33.2	34.4	36.1	40.1	41.1

Enrollment Mobility of STEM Students

Figure 10 shows three different mobility patterns by five broad disciplinary categories: STEM, social sciences, business, education, and arts and humanities. Data used to calculate these patterns come from the 2004 CIRP Freshman Survey and 2010 National Student Clearinghouse. Rates of reverse transfer (i.e., starting at a four-year institution and transferring to a community college between 2004 and 2010) are highest among aspiring education majors (15.7%) and intended STEM majors (15.1%). Students who came to college planning to major in the arts and humanities were the least likely to engage in reverse transfer, as just 12.1% of arts and humanities aspirants did so.

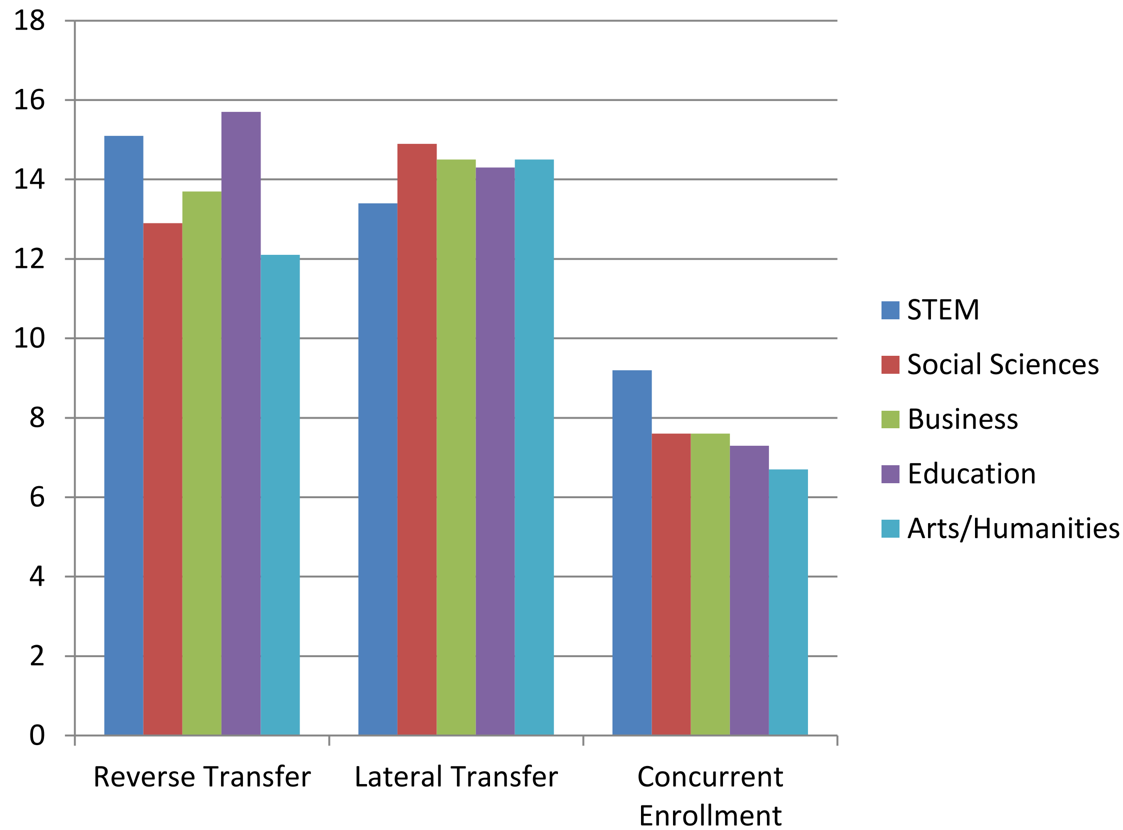

Figure 10 Mobility Patterns of FTFT Undergraduates Entering College in 2004, by Major

STEM aspirants were the least likely to laterally transfer (i.e., move from one four-year institution to a different four-year institution. Just 13.4% of STEM aspirants transferred from their native four-year institution to a different four-year institution during the six-year period spanning 2004 to 2010. By contrast, students in the social sciences were the most likely to laterally transfer, as 14.9% of those intending to pursue a social science major transferred to a different four-year institution.

The findings in Figure 10 show that STEM aspirants engaged in concurrent enrollment (i.e., simultaneously enrolling at two institutions – either two-year or four-year). Just under one in 10 (9.2%) of STEM aspirants were concurrently enrolled at some point during the six-year period of the study, which was 1.6 percentage points higher than both social science (7.6%) and business (7.6%) aspirants. Arts and humanities students were the least likely to be concurrently enrolled while in college (6.7%).

Table 8 shows STEM completion rates by mobility status. What is clear from the findings in Table 8 is that very few students who experienced a reverse transfer between 2004 and 2010 completed a STEM degree by the spring of 2010. Just 0.7% of STEM aspirants who transferred from a four-year institution to a two-year institution earned a STEM bachelor's degree within four years. Just more than 3% completed a STEM degree in five years, and after six years 5.7% of STEM aspirants who engaged in reverse transfer had earned a STEM bachelor's degree.

Table 8 STEM Completion Rates by Mobility Status

	4-Year	5-Year	6-Year
Reverse transfer	0.7	3.2	5.7
Lateral transfer	5.8	17.2	24.2
Concurrent enrollment	17.0	30.7	36.4
All students	21.9	35.9	40.5

Students who had completed a lateral transfer tended to be more likely than their peers with a reverse transfer to complete a STEM degree. After four years, 5.8% of STEM aspirants who laterally transferred completed a bachelor's degree in STEM, and that figure more than tripled to 17.2% after five years. By the end of six years, nearly one-quarter (24.2%) of STEM aspirants who transferred from one four-year campus to another four-year campus had earned a STEM bachelor's degree.

Simultaneously enrolling in more than one campus did not seem to slow down students' progress toward a STEM degree as much as transferring. Roughly one in six (17%) of STEM aspirants who concurrently enrolled while an undergraduate completed their STEM degree within four years. After five years, nearly one-third (30.7%) of STEM aspirants who enrolled at more than one campus simultaneously had earned a STEM bachelor's degree, and that figure jumped to 36.4% after six years – just four points lower than the six-year STEM completion rate for all students.

Conclusion

Although the last decade has seen increased interest in majoring in STEM – with STEM major aspirations at their highest in the past four decades, institutions, states, and federal and private agencies need to continue to focus on facilitating STEM aspirants' progression toward bachelor's degrees in these disciplines. STEM aspirants are among the most prepared at college entry, as their high school GPAs and math and science preparation outpace their non-STEM counterparts; thus, the loss of these incredibly talented students is alarming.

With students' interest in STEM rising, we continue to see stagnant STEM bachelor's degree completion rates. Nationally, just over 40% of incoming students complete their degrees in STEM, and the findings presented in this paper highlight disparities across race and sub-disciplines within STEM. More than half of all Asian American STEM aspirants and 43% of White STEM aspirants complete a STEM degree within six years, yet the STEM completion rates of Latino (29%), Native American (24.9%), and Black (21.8%) continue to lag. Nearly half of all engineering aspirants complete a bachelor's degree in a STEM field, but less than one-third of entering health sciences and computer science majors do the same.

This research showed that STEM aspirants take a variety of non-traditional pathways, including transferring from a four-year institution to a two-year institution, laterally transferring to a different four-year campus, or concurrently enrolling in more than one college. These mobility patterns have an effect on how quickly and whether students earn a STEM degree. Not surprisingly, we found that students engaging in reverse transfer are substantially less likely to complete a STEM degree within six years, but students who concurrently enroll in multiple institutions are only slightly less likely than their peers who persisted at their native campus to complete a STEM degree in six years. Future research needs to build upon the descriptive findings presented in this paper to better isolate the unique effects of student mobility patterns. Such analyses can identify the types of STEM students most likely to engage in reverse transfer, lateral transfer, or concurrent enrollment and subsequently determine whether these enrollment patterns significantly predict STEM completion.

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