Making it!... Or Not: Institutional Contexts & Biomedical Degree Attainment

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Abstract

Institutions vary in completion rates for undergraduates in the biomedical sciences based upon whether they invest in developing the skills of aspiring scientists or allocate resources in ways that divert talented, motivated students to other fields. This study examines the individual student characteristics, institutional contexts, and faculty and peer normative environments that account for differences in biomedical completion rates among 30,614 incoming freshmen with intentions to major in the biomedical sciences. Data show that 27.8% of biological science aspirants earned a biological science degree in four years and this figure jumped to 38.1% by the sixth year. Additionally, 19.4% of biological science aspirants earned a bachelor's degree in a non-biological science field within 4 years and 33.6% within six years.

A recent report from the President's Council of Advisors on Science and Technology (2012) calls for the conferment of one million additional science, technology, engineering, and math (STEM) degrees in the next decade to maintain the country's edge in technology and innovation. This report responds to a global reality in which foreign countries now confer more degrees in STEM than the United States (National Academy of Sciences, 2011). Furthermore, the number of students completing bachelor's degrees in the U.S. has not kept pace with current national demand for new scientific talent (PCAST, 2012). The underrepresentation of Black, Latino, and Native American individuals among science baccalaureates further exacerbates this problem, as underrepresented racial minority (URM) students have an increased likelihood of leaving the sciences and either completing a degree in a different field or leaving college altogether without attaining degrees (Higher Education Research Institute [HERI], 2010). Research has demonstrated that the lack of representation of Black, Latino, and Native American individuals among science bachelor's degree holders cannot be attributed to a lack of interest among these individuals, as URM students arrive at college with initial science major intentions that are comparable to White and Asian American peers (HERI, 2010). Additionally, URM students have higher degree aspirations and stronger motivations to make scientific contributions compared to White and Asian American students (Hurtado, Cerna, Chang, Saenz, Lopez, Mosqueda, et al., 2006).

Although the science completion gap between URM students and their White and Asian American peers has been attributed to differences in pre-college skill and academic preparation (George, Neale, Van Horne, & Malcom, 2001; Bonous-Hammarth, 2000), these factors alone do not entirely explain attrition from the sciences. Indeed perceptions of the campus climate (Nora, Barlow, & Crisp, 2005), experiences in introductory gate-keeper classes (Seymour, 2001), and various institutional interventions and structures play important roles in bachelor degree completion in STEM (Hurtado, Eagan, & Hughes, under review) and help to explain differential student outcomes. In short, some institutions do a better job than others at motivating students, developing talent, and turning an aspiration for a STEM degree into a reality (Hurtado, Eagan, & Hughes, under review; Hubbard & Stage, 2010).

Not much is known however regarding the impact differential institutional contexts have on bachelor's degree production in the biomedical sciences specifically; indeed no study to date uses longitudinal data to track *biomedical aspirants* from their freshman year to six years after college entry to understand differences in degree productivity in the biomedical sciences across institutional contexts. The purpose of this study is to identify the institutional and aggregate faculty characteristics that contribute to higher rates of degree completion in the biomedical sciences controlling for students' entering characteristics. Specific attention is placed on students coming from underrepresented ethnic and racial minority groups. We use Bronfenbrenner's Bioecological Model (1979, 1994, 1995) – in which development is argued to occur in the context of micro, meso, and macro environments – to frame our understanding of how institutional context supports the development of science talent. To do this work, we include data on student peers, faculty attitudes and behaviors, and programmatic commitment to innovation in undergraduate science initiatives.

This study contributes to the knowledge base by treating students aspiring to major in the biomedical sciences as a distinct group (instead of aggregating them with students in STEM generally) to reflect the unique entering characteristics of these students and to identify the institutional structures that work to support or impede completion in the biomedical sciences. In this way, this study has the potential to help institutions target their efforts in creating conditions that will retain talented students in a field that plays a pivotal role in healthcare and in solving pressing health related problems afflicting people both nationally and more globally. Further, by producing more graduates in the biomedical sciences that are from URM and other diverse backgrounds, institutions can do their part in increasing diversity in a future workforce that "may contribute ultimately to the elimination of health disparities" (NIH, 2013, ¶2).

Biomedical Major Persistence: Multilevel Ecological Perspectives

The premise of Bronfenbrenner's Bioecological Model (1979, 1994, 1995) is that an individual's experiences and development cannot be fully understood without also examining the contextual factors in which the experiences occurred. At the center of development is the individual and includes factors like sex, age, GPA, and marital status. Research on individual level factors demonstrates that prior academic preparation, previous achievement motivation, and ability contribute to student success in college (Astin, 1993; Bean, 1980; Bonous-Hammarth, 2000; George, Neale, Van Horne, & Malcom, 2001; Spady, 1970; Tinto, 1975, 1997). Next are the relationships between the individual and their environments, which occur across several nested levels. The microsystem includes those immediate contextual factors in which a person operates that directly affect him or her. Research on micro-level factors reveals that the relationships and interaction college students have with others in their academic community – such as interactions with supportive peers (Grandy, 1998) and faculty (Cole & Espinoza, 2008) – have a great impact on their experiences and outcomes. Characteristics of the department in which students learn also constitute microsystemic factors. At the next level is the mesosystem, which is comprised of the connection between microsystemic factors such as the relationship between a student's home and college lives. For example, the education level of students' parents or whether either parent works in the sciences may represent manifestations of the mesosystem, as the contexts perpetuated by students' home lives serve to shape particular experiences students may have during college. When the relationships between different microsystems are compatible, development occurs more smoothly.

Environments in which an individual does not play an active role but that affect her indirectly comprise the exosystem. The specific institution to which a student belongs represents an example of an exosystem. Although the student may never play a role in how the institution runs, these contexts have tremendous influences on the development of scientific talent and student success. For example, institutions that display a strong commitment to providing targeted support to URM students, humanize the educational process, take responsibility for student success, and facilitate student networking opportunities create environments more conducive to student success (Muesus, 2011). This may be why Historically Black Colleges and Universities (HBCUs) tend to a better job at graduating Black students in the sciences (Hubbard & Stage, 2010; Hurtado, Eagan, & Hughes, under review). Other important environmental components supportive of student success and retention in STEM disciplines are opportunities to do undergraduate research, the availability of academic support services, access to faculty for encouragement and academic help, and a learning environment characterized by cooperation rather than competition (Perna, Gasman, Gary, Lundy-Wagner, & Drezner, 2010).

The macrosystem represents the larger cultural context and includes overarching beliefs, attitudes, expectations, and values. Finally the chronosystem is comprised of those events that occur across time that affect a student. Bronfenbrenner's Bioecological Model demonstrates that a meaningful understanding of student retention in science disciplines requires an examination of the complex relationships occurring between an individual and her environments. Further this model implies that successful progression in a biomedical science degree and ultimate degree completion can be viewed in terms of the people, interventions, resources and opportunities that are available in various environments.

The Individual: Characteristics and Experiences Predicting Science Persistence

Although we recognize that the biomedical science population is unique, to address those individual and institutional factors that influence student retention and persistence in the biomedical sciences, we delve into literature that addresses STEM majors broadly so as to capture a more comprehensive account of the existing knowledge. In attempting to explain the differential success and persistence rates between college students, scholars have historically placed a strong emphasis on individual student factors and characteristics. Achievement on standardized tests, grades in high school, and STEM degree aspirations are highly predictive of completing a STEM degree (Adelman, 2006; Bonous-Hammarth, 2000, 2006; Chang et al., 2008; Chang, Cerna, Han, & Saenz, 2008; Elliott, Strenta, Adair, Matier, & Scott, 1996; George et al., 2001; Hurtado, Eagan, & Hughes, under review; Maltese & Tai, 2010; Museus et al., 2011; National Academies, 2011)

Precollege academic preparation including the rigor of a student's high school curriculum and access to advanced courses in mathematics and science also predict graduation in the sciences (Chang et al., 2008; Denson, Avery, & Schell, 2010; Ellington, 2006; Smyth & Ardle, 2004). URM students are notably more likely to face overlapping disadvantages than their White and Asian counterparts (Alon, 2007). Some of these disadvantages can be attributed to the inequitable access URM students have to properly resourced high schools (Adelman, 2006) and advance placement courses (May & Chubin, 2003), which negatively affects their subsequent ability to persist to degree completion in STEM disciplines once in college (Elliott et al., 1996).

The Microsystem: The Role of Departments and Classrooms in Science Persistence

Within the classroom and college environment, a number of factors contribute to or detract from student success. Heavy reliance on lectures and rote memorization, particularly in introductory STEM courses often results in disinterested and disengaged students and eliminates all but the most talented students (Seymour & Hewitt, 1997; Tobias, 1990). This type of teacher-centered instruction appears to be especially harmful to the academic success of URM students (Bayer Corporation, 2012), prompting scholars to call for teaching pedagogies that are more interactive, collaborative, student-centered, and that make a clear connection between course content and its real life applicability in the workplace and students' lives (Gasiewski et al., 2012). Student-centered teaching pedagogies enhance the classroom experience for students and improve educational outcomes (Cabrera, Crissman, Bernal, Nora, Terenzini, & Pascarella, 2002) and are especially crucial to the achievement of women and URM students taking introductory science courses (Gasiewski et al., 2012).

Other research demonstrates that the concern faculty show for students and their academic success also help to create a supportive learning environment (Eagan et al., 2012; Fries-Britt, Younger, & Hall, 2010; Museus & Liverman, 2010; Perna, Gasman, Gary, Lundy-Wagner, & Drezner, 2010). A study on Latino college students shows that faculty encouragement and support is an important predictor of STEM achievement (Cole & Espinoza, 2008). Likewise, Johnson's (2007) study on female students demonstrates that women persisted in the sciences at lower rates when they felt that their faculty discouraged questions and did not personally know or recognize students.

The Exosystem: Institutional Factors Predicting Science Persistence

Another important aspect of the institutional context is the campus climate, with negative racial experiences undermining the persistence of URM students (Museus, Nichols, & Lambert, 2008). A study by Chang and colleagues (2011) revealed that URM students majoring in the biomedical and behavioral sciences who highly identified with the sciences and who also experienced high levels of negative racial interactions were less likely to persist than their peers who experienced lower levels of such interactions. Additionally, it is not uncommon for URM students to encounter college and classroom contexts that engender stereotypes that devalue and marginalize students from underrepresented backgrounds and in which there exists an expectation of failure (Steele, 1992; McGee & Martin, 2011). When women and URM students in STEM majors experience stereotype threat (i.e. "the anxiety caused by the expectation of being judged based on a negative group stereotype" (p. 427)), they have increased odds of leaving STEM (Beasley & Fisher, 2012).

Institutional interventions that target URM students or students in STEM disciplines have the potential to be effective methods of increasing STEM degree persistence and degree attainment (Jones, Barlow, & Villarejo, 2010; May & Chubin, 2003; Palmer, Davis, & Thompson, 2010). Effective interventions tend to connect students to a support network of peers and STEM-related engagement opportunities, both of which contribute to the retention of URM students in STEM (Palmer, Maramba, & Dancy, 2011). The Meyerhoff Scholars Program at the University of Maryland, Baltimore County serves as a prime example of a highly successful institutional intervention that effectively increases the persistence of STEM students, especially those from URM backgrounds. In a study of the program, Maton and colleagues (2009) found that Meyerhoff students were nearly five times more likely than comparison students to pursue a STEM Ph.D. Program participants rated the following programmatic components as being "important" to their success: the financial scholarship they received as a Meyerhoff scholar, being part of the Meyerhoff Program community, the summer bridge program, study groups, academic advising from staff, and the summer research opportunities (Maton et al., 2009). In another study of URM students who participated in a targeted retention program for students in STEM, participants had better grades and a greater likelihood of completing a science degree than a propensity scored matched comparison group (Slovacek, Whittinghill, Flenoury, & Wiseman, 2012).

Other pragmatic interventions that have a demonstrated effectiveness in supporting the achievement and retention of participating students majoring in STEM include supplemental instruction (Barlow & Villarejo, 2004; Rath et al., 2007), cooperative education (Jaeger et al., 2008), and involvement in a major-related club (Chang et al., 2010). Involvement in undergraduate research is especially beneficial for the retention of women of color in STEM (Espinoza, 2011), and Black and Latino students working towards biology degrees (Jones, Barlow, & Villarejo, 2010). In a qualitative study of STEM undergraduates, Gasiewski and colleagues (2010) found that students cited their participation in research programs as being a major reason contributing to their decision to continue in their respective STEM major. Students who are more highly involved in research (Taraban & Logue, 2012) and those who conduct research early in their college career reap the most benefits in terms of persistence and performance (Jones, Barlow, & Villarejo, 2010).

Empirical studies generally consider institutional characteristics such as size, control, selectivity, and institutional type when examining retention. Institutions that have more full-time students and ones that are publicly controlled do not do as well as smaller institutions and private ones in retaining students to bachelor degree completion (Oseguera, 2005). Female students have better odds of finishing their STEM degrees at private institutions (rather than public ones), and female students of color persist in STEM at higher rates at institutions that have a higher percentage of students majoring in STEM (Espinosa, 2011). Institutions seem to be more successful at producing minority scientists when they have a higher proportion of faculty who are also from ethnic or racial minority backgrounds (Hubbard & Stage, 2010).

More selective institutions, as determined by the average grades and SAT scores of the incoming freshman classes, generally have higher degree completion rates (Bowen, Chingos & McPherson, 2009; DeAngelo, Franke, Hurtado, Pryor, & Tran, 2011; Titus, 2004, 2006), even among URM students (Bowen & Bok, 1998; Melguizo, 2010), which is to be expected given that more highly selective institutions typically enroll the most academically talented students and have access to the greatest amount of institutional resources. Selective institutions, however, have lower than expected retention rates from the first to the fourth year for students who pursue STEM majors (Chang, Eagan, Lin & Hurtado, 2011; Chang, et al., 2010; Espinosa, 2011). STEM aspirants at selective institutions who earn bachelor’s degrees are just as likely to earn those degrees in STEM as their peers at less selective institutions (Hurtado, Eagan, & Hughes, under review). Thus, it appears institutional selectivity represents a unique case when predicting completion of STEM bachelor’s degrees. Per student institutional expenditures also matter when it comes to student retention, with more expenditures translating to higher retention rates (Cragg, 2009; Gansemer-Topf & Schuh, 2006; Oseguera, 2005; Titus, 2006).

The body of research examining STEM completion and retention clearly demonstrates that understanding student pathways through STEM requires analysts to consider both individual and contextual measures. A recent study by Hurtado, Eagan, and Hughes (under review) underscores the need to account for students’ background characteristics, campus initiatives designed to increase STEM completion rates, and structural characteristics of the institution when analyzing national data on degree completion patterns. This study extends the work by

Hurtado, Eagan, and Hughes (under review) by considering a subset of STEM aspirants: students who arrived in college in 2004 with plans to pursue a biomedical major. In our models, we account for individual measures as well as the contextual elements that students encountered once they arrived on campus. The following sections describe our sample, measures, and analytic approach.

Method

Data

This study examines the individual characteristics and institutional contexts that jointly predict students' completion of a bachelor's degree in the biomedical sciences relative to not completing a degree at all or completing a bachelor's degree in a field outside of the biomedical sciences within six year of college entry. Data for this study come from the Cooperative Institutional Research Program's (CIRP) 2004 Freshman Survey, which was administered by the Higher Education Research Institute (HERI). Incoming students across the United States took the 2004 Freshman Survey either during freshman orientation or during the first few weeks of the fall term. The survey collected information about students' demographic backgrounds, prior academic preparation, high school activities, educational and career aspiration, and expectations for college. A grant from the National Institutes of Health (NIH) allowed for the inclusion of more institutions that do not typically participate in the CIRP Freshman Survey (i.e. minority-serving institutions and institutions with NIH-sponsored undergraduate research programs). We merged the 2004 Freshman Survey data with student degree and enrollment data from the National Student Clearinghouse (NSC).

To provide additional information about the institutional context students encountered in college, we merged in several aggregated student-level variables and institutional characteristics from the Integrated Postsecondary Educational Data System (IPEDS) to the institution-level dataset. We also merged in data from the 2011 Best Practices in STEM (BPS) survey administered by HERI. The BPS collected information from STEM deans and department chairs about the extent to which their institution provided undergraduate research opportunities, outreach and retention programs to targeted groups, faculty development programs for STEM faculty, and the funding sources of these programs. Further, aggregate data from the CIRP Faculty Survey administered in 2007 and 2010 was additionally merged into our dataset to provide contextual information about faculty attitudes and instructional strategies at institutions students attended in our sample. Faculty provided information about the extent to which they engaged undergraduates in research, used student-centered pedagogy in their courses, and graded on a curve.

After combining the 2004 Freshman Survey responses with the 2010 NSC data and the various sources providing contextual information about campuses environments, we had a large and unique dataset to examine completion in the biomedical sciences. After accounting for non-response to the BPS and faculty surveys, and using only cases in which students reported on the 2004 Freshman Survey that they intended to major in a biomedical science related discipline (Appendix A provides the full list of majors we classified as being in the biomedical sciences), our final analytic sample included 30,614 biomedical science aspirants across 296 four-year colleges and universities.

Variables

Student-level characteristics. The dependent variable in this study was a three-part categorical variable corresponding to students' degree status four and six years after enrolling in college: completed a bachelor's degree in the biomedical sciences, completed a bachelor's degree in a field that is *not* in the biomedical sciences, or did not complete a bachelor's degree at all (which indicates that the student was either still working on their degree or was no longer enrolled at a postsecondary institution). We derived this dependent variable from NSC data by cross-referencing students' bachelor's degree status (i.e., graduated or not graduated) with their bachelor's degree major. In the analyses, we used "completed a bachelor's degree in the biomedical sciences" as the reference group so that we could compare students in this category to a) students who completed degrees in non-biomedical science disciplines and b) students who were either still completing their degrees or dropped out of higher education.

The analyses accounted for several student-level independent variables, including background characteristics like race, gender, income, parent occupation and education (Hurtado, et al., 2007); prior preparation like school GPA, SAT scores, and years of math and science in high school (Chang et al., 2008); and pre-college experiences such as frequency of studying with other students, participation in summer research program, experience volunteering work at a hospital, feeling overwhelmed (Hurtado, et al., under review). The analysis also controlled for entering degree aspirations (MD, master's, doctoral), behavioral expectations once in college (chances students thought they would communicate regularly with professors, make a "B" average, work full-time), and students' academic self-concept and social self-concept at college entry. (Item Response Theory techniques were used to create the self-concept constructs. See Sharkness et al., 2010 for more information.) Given the importance of science identity on student outcomes in the sciences (Carlone & Johnson, 2007), we included a factor representing students' STEM identity at college entry. (See Chang et al., 2011 for additional information about this factor). Finally, we controlled for students' specific intended major in the biomedical sciences (i.e. chemistry, nursing, pre-med, etc.) with the comparison group being majoring in a 'biology-related major' to determine if some departments did better or worse at retaining aspirants in the biomedical sciences. Appendix B contains the variables used in this analysis and the corresponding coding schemes for each variable.

Institution-level characteristics. The analyses also accounted for a number of institutional characteristics and opportunities available to undergraduate students in the sciences. For example, we controlled for institutional size, type (research/doctoral granting institutions, master comprehensive institutions, liberal arts/baccalaureate granting institutions), control (public/private), and selectivity (measured by the average SAT score of entering freshmen). We rescaled the selectivity variable so that a one-unit change of the variable in HGLM model corresponded to a 100-point change in average SAT scores. Additionally, we controlled for whether an institution had a designation as a Historically Black College or University (HBCU), Hispanic-Serving Institution (HIS), or what we define as an emerging HSI (meaning Hispanic students comprising 15-24% of undergraduate students).

To investigate how faculty practices in the institutional context influences completion in the biomedical sciences, we included variables measuring the percentage of faculty who a) involve undergraduates in their research and b) grade on a curve. We also control for faculty's use of student-centered pedagogy (i.e. class discussions, cooperative learning, experiential learning, and group projects) in the classroom. (See Higher Education Research Institute (2011) for more information regarding this construct.) In our model we additionally include three items from the BPS survey, representing the extent to which institutions offered undergraduate research opportunities to freshmen, provided targeted financial aid to STEM students, and provided research opportunities to all undergraduates. Finally to capture the impact of the peer environment on retention in the biomedical sciences, we use aggregated student data to measure the proportion of students aspiring to a medical degree and the percentage pursing STEM majors. Appendix B provides a full list of the variables in the analysis.

Analyses

We weighted the data to so that the sample represented the population of first-time, full-time students who entered college in 2004 with intentions to pursue a bachelor's degree in the biomedical sciences. See DeAngelo et al. (2011) and Hurtado, Eagan, & Hughes (under review) for additional information about the weighting procedures. After weighting the data, we addressed cases with missing values by using the multivariate normal approach to multiple imputation available in STATA 11. DeAngelo et al. (2011) provide additional details about the multiple imputation procedure on this data.

We examined our data with univariate descriptive statistics after addressing issues with missing data. Next, we analyzed the data using multinomial hierarchical generalized linear modeling (HGLM). Multinomial HGLM represented the most appropriate analytic technique given our categorical, unranked outcome and the clustered nature of our data. Multinomial HGLM accounts for variance at both the individual (student) level and group (institutional) level in analyses with multi-level data and a categorical outcome variable (Raudenbush & Bryk, 2002). Single-level statistical techniques, such as logistic regression, do not account for the clustered nature of the data sample in which students are nestled into institutions, which increases the risk of incorrectly concluding that a parameter is significant when it is not (i.e. a Type I statistical error) (Raudenbush & Bryk, 2002).

To justify the use of multinomial HGLM, the outcome variable must vary significantly across institutions. We examined null models (i.e., models without any independent variables) to determine the extent to which our outcomes of four- and six-year STEM completion varied across institutions. These null models showed that the between-institution variance component in the outcome variables significantly varied across institutions. Given this significant variation and our interest in examining how institutional contexts a) directly affect students' likelihood of completion in the biomedical sciences and b) enhance or mitigate the association between student-level variables and degree completion, we proceeded with the use of multinomial HGLM.

Limitations

While the longitudinal assessment of the factors that predict institutional degree productivity in the biomedical sciences contributes new knowledge to the higher education literature, several limitations exist. First, students self-reported the major they intended to pursue in 2004, which means that students may not have formally been admitted to their major or made any formal major declarations at the time that they completed the 2004 Freshman Survey. Thus it is possible that students indicated a desire to pursue a degree in the biomedical sciences, but never actually pursued it. We simply have to take students' word regarding their initial interests. A second limitation is that the 2010 NCS data did not capture students' term-to-term academic major and whether students stayed in their initial major or switched. Because NCS is now just beginning to collect such information, future research will have improved accuracy of understanding the changing major interests of students in the biomedical sciences.

A third limitation is that this study does not control for students' college experiences to examine retention in STEM. Since many institutions that were involved in the freshman survey were not involved in the two follow-up CIRP surveys measuring college experiences (one administered at the end of the first year in college and the other during the spring or summer after the fourth year in college) and due to low longitudinal response rates, the addition of the college experience data would have required us to drop student cases where data was missing on one of the time points. Additionally, controlling for college experiences would have privileged the sample to include only those individuals who had persisted in college long enough to be eligible to complete one of the follow-up surveys. Thus, the present study focuses on the individual (micro) level and institutional (exo) level in Bronfrenbrenner's framework to understand individual outcomes.

This study's analysis of secondary data limited us to the variables that were collected by the survey. Specifically, some variables don't capture the level of detail that would add additional clarity to the interpretation of the results. For example, one variable asks students whether they partook in community service at a hospital to which students could answer yes or no. We do not know from this question what the nature of that volunteer work was or how frequently students engaged in it. Additionally, because some institutions did not participate in the BPS survey and/or the HERI Faculty Surveys, our initial sample of biomedical science aspirants shrank by 50 campuses and 1,768 students (the final sample size is already reflected in the description of the sample above).

Finally, because we surveyed all STEM deans and department chairs within our institutional sample, we had many institutions that contained more than one response about the extent to which they provided various opportunities to students and faculty. Given the potential variation with these responses within institutions, we conducted sensitivity analyses in our statistical modeling. We analyzed three separate institutional models: the lowest value for each BPS response within an institution; the average value for each BPS response within each institution; and the largest value for each BPS response within each institution. We found similar results across the three different datasets (least, average, greatest); thus, the results we report in our findings correspond to the model choosing the average values from the BPS variables.

Results

Descriptive Statistics

Table 1 provides descriptive statistics for variables in the model, and the results show that 27.8% of biomedical science aspirants earned a biomedical science degree in four years and this figure jumped to 38.1% by the sixth year. Additionally, 19.4% of biomedical science aspirants earned a bachelor's degree in a non-biomedical science field within 4 years and 33.6% within six years. The racial breakdown of the original sample of biomedical science aspirants included 2% Native American, 2% who marked 'other', 7% Latino, 10% Black, 14% Asian American or Pacific Islander, and 64% White. The sample was 69% female. Roughly 38% of students reported having medical degree aspirations with 24% of biomedical science aspirants planning to pursue a Ph.D. or Ed.D. Students had strong pre-college preparation, as the average composite SAT score was 1155, and students averaged about four years of math in high school and roughly two years of biology. See Table 1 for a full list of the descriptive statistics associated with each variable.

Biomedical Science Completion versus Non-Biomedical Science Completion

Table 2 shows the HGLM results for biomedical science completion compared to earning a degree in a non-biomedical science field within four and six years of college entry. We present and interpret the results such that higher scores on the independent variable reflect increased probabilities of earning a biomedical science bachelor's degree relative to a bachelor's degree in a non- biomedical science field. We report delta-p statistics for only those coefficients significant at the $p < 0.05$ threshold (Petersen, 1985; Cruce, 2009). Although Table 2 includes results for both four- and six-year completion, we focus on the six-year results and, where appropriate, note any substantial differences in predictors between four- and six-year completion.

Two institutional variables significantly predicted students' likelihood to earn a bachelor's degree in biomedical science relative to a bachelor's degree in a non- biomedical science field within six years. Degree earners at larger institutions had significantly lower likelihoods of earning their bachelor's degree in the biomedical sciences. Specifically, a 10% increase in the number of undergraduate full-time equivalent (FTE) students at an institution corresponded with a 5.82 percentage point decrease in biomedical science aspirants' likelihood to graduate with a biomedical science degree relative to a non-biomedical science degree. Additionally, students enrolled at emerging Hispanic Serving Institutions (EHSI) had significantly higher probabilities of earning a bachelor's degree in the biomedical sciences, with attendance at an EHSI being associated with a 12.01 percentage point increase in students' probability of earning a biomedical science degree. Thus, the size and composition of the college peer group has distinct effect on completing a biomedical science degree compared to a non-biomedical science degree within six years.

The selectivity of the institution matters only with respect to biomedical science degree completion in four-years; for every 100-point increase in the average SAT composite score of the incoming freshman class, there was a 4.75% decrease in likelihood of completing a biomedical science degree compared to a non-biomedical science degree. The disadvantage of going to a more selective school disappears at year six, suggesting that students at more selective institutions take longer to complete a biomedical science degree compared to a non-biomedical science degree.

In addition to the institutional variables, several background characteristics significantly predicted biomedical science aspirants' probability of earning a biomedical science degree compared to a degree in a non-biomedical science field. Asian American and Pacific Islander degree earners and those who marked "other" for race had a significantly higher likelihood of being retained in biomedical science relative to their White classmates (6.73% and 10.42% respectively) after six years. Notably, all things being equal, Black, Latino, and Native American students were just as likely as white students to complete a degree in the biomedical sciences versus completing a degree in a non-biomedical science field at the end of the fourth or sixth years. Likewise, although female students were not significantly different from their male counterparts with regard to six-year biomedical science completion probabilities, we detected a significant difference in completion probabilities at the end of the fourth year, as women's probability of earning their degree in the biomedical sciences fell 5.91 percentage points below the rate for men. Thus, women take longer than men to complete degrees in the biomedical sciences, but their completion rates are not significantly different after six years.

Degree earners who indicated English as their native language completed in the biomedical sciences at significantly lower rates than non-native English speakers (7.08 percentage points). This finding may well be a proxy for international students in the freshman class, many of whom come to the U.S. with specific STEM related career goals. Having at least one parent who worked in a STEM-related job gave degree earners a 3.97 percentage point advantage in their probability to complete in the biomedical sciences relative to their peers whose parents worked in non-STEM occupations.

Students' pre-college preparation significantly predicted their likelihood of completing a biomedical science degree in six years relative to a non-biomedical science degree. For every one-unit increase from the mean in students' high school grade point average, they experienced a 5.91 percentage point increase in their probability of being retained in biomedical science. This effect varied significantly across institutions, as we found that being at an institution where faculty relied more heavily on student-centered pedagogies significantly enhanced the relationship of high school GPA and biomedical science completion. In other words, high-achieving biomedical science aspirants were even more likely to complete their degree in the biomedical sciences when they encountered a campus context that emphasized student-centered teaching. Additionally, a 100-point increase from the mean in degree earners' SAT composite scores translated into a 4.04 percentage point increase in their probability of earning a degree in biomedical science. Similarly, taking more years of math and biology in high school corresponded with slightly higher rates of biomedical science completion in six years.

Four of the six pre-college experiences tested in the model exerted a significant influence on biomedical science completion measured six years after college entry. Completers who reported feeling more overwhelmed by all they had to do in high school or who more frequently socialized with others from different ethnic groups had somewhat lower biomedical science retention probabilities. By contrast, spending more hours per week studying and doing homework in high school and having some experience doing community service work at a hospital predicted an increased likelihood to stay in biomedical science through degree completion by the sixth year.

Students' entering aspirations and expectations for college had particular salience in predicting whether they earned a bachelor's degree in a biomedical science field or a non-biomedical science field. Completers who upon college entry reported higher chances that they would communicate regularly with their professors once in college had a slightly increased likelihood of earning a biomedical science degree in six years. Having a stronger academic self-concept predicted a significantly increased likelihood of staying in biomedical science; every one standard deviation (S.D.=10) increase from the mean in students' academic self-concept predicted a 5.2 percentage point increase in students' probability of earning a biomedical science degree. By contrast, students with stronger social self-concepts had significantly lower biomedical science completion probabilities. Each standard deviation increase from the mean of social self-concept corresponded with a 5.9 percentage point decrease in students' probability of earning a biomedical science degree.

Completers who in 2004 reported aspirations for a medical degree were 10.46 percentage points more likely to stay in biomedical science compared to their peers who indicated aspirations for a bachelor's degree, and this effect varied significantly across institutions. Premedical aspirants at institutions where faculty more regularly graded on a curve were significantly less likely to earn a biomedical science degree compared to their premedical peers at institutions where curve grading was utilized less frequently. Likewise, premedical students attending more selective institutions had lower biomedical science retention rates than their peers at less selective institutions. For every 100-point increase in the average SAT scores of the freshman class at an institution, premedical students experienced a 2.26 percentage point decrease in their probability to complete a biomedical science degree within six years.

Degree earners with aspirations to attain a Ph.D. or Ed.D. were 5.24 percentage points more likely to stay in biomedical science compared to their classmates who reported having bachelor's degree aspirations. By contrast, biomedical science aspirants with plans for a law degree had a 17.58 percentage point lower probability of staying in biomedical science relative to their peers with bachelor's degree aspirations.

Finally, we found significant variation in biomedical science completion across the specific intended major students pursued. Nursing aspirants were 20.31 percentage points more likely to earn a biomedical science degree in six years relative to their peers pursuing majors in the biological sciences. Biological sciences included students aspiring to pursue biology, biochemistry or biophysics, microbiology or bacteriology, zoology, and other biomedical science. Alternatively, students intending to major in pharmacy had a 17.19 percentage point disadvantage in their biomedical science completion probability compared to those in the biology-related majors. Similarly students intending to pursue medicine, dentistry, or veterinary medicine were 11.65 percentage points less likely than their classmates aspiring for biology-related majors to complete a biomedical science degree in six years.

Biomedical Science Completion versus No Completion

Table 3 shows the results of the HGLM analyses comparing students who completed a degree in the biomedical sciences with students who did not complete a bachelors degree at all, at both four and six years after college entry. As with the previous discussion, we focus on the six-year model and draw contrasts with findings from the four-year model. Aspirants attending research/doctoral institutions are 11.54 percentage points less likely to complete a biomedical science degree and instead more likely to not have attained a degree yet compared to their counterparts at master's comprehensive universities. More selective institutions had significantly higher biomedical science completion rates than less selective institutions. A 100-point increase in institutional selectivity translated into a 13.44 percentage point increase in students' probability of earning a bachelor's degree in biomedical science relative to no bachelor's degree. Finally, the results show that students attending emerging HSIs were 13.29 percentage points more likely than their peers at PWIs to complete in biomedical science.

Most of the background characteristics tested in the model had a significant influence on six-year biomedical science completion. Students from two underrepresented backgrounds had significantly lower probabilities of earning a biomedical science degree within six years compared to their White peers, and these gaps in degree completion grew more pronounced from the fourth to the sixth year. Specifically, Native American students were 18.66 percentage points less likely and Latino students were 8.40 percentage points less likely than White students to earn a biomedical science degree in six years. Black students at PWIs were 30.73 percentage points less likely compared to their white peers to finish a biomedical science degree in four years; however, this disparity in completion disappears by the sixth year after college entry. The elimination of this gap after six years suggests that Black students take a longer time compared to white students to finish their science degrees. Also, although the four-year model indicates that Black students are less likely to complete a degree in the biomedical sciences in four years compared to White students, Black students attending HBCUs graduate with a biomedical science degree 38.12 percentage points higher than Black students at non-HBCUs. In fact, Black students at HBCUs complete in the biomedical sciences at higher rates than White students. Students marking ‘other race’ were significantly more likely (8.73%) than White students to complete a biomedical science degree within six years. Asian American students have significantly higher probabilities of earning a biomedical sciences degree within four years compared to their White peers, but this gap disappears at the six-year mark.

Women had a 5.32 percentage point edge over men in terms of their six-year biomedical science degree completion probability. By contrast, Native English speakers had a 8.27 percentage point lower probability of completing a biomedical science degree compared to non-native English speakers; this effect was twice as large in the six-year model relative to the four-year completion model, suggesting that non-native speakers continue to widen the biomedical science completion gap as time passes.

In addition to race and gender, income also had a significant influence on students' likelihood of earning a biomedical science degree within six years. Students from families making under $25,000 were 10.90 percentage points less likely to complete a biomedical science degree in six years compared to students with family incomes between $50,000 and $99,999; the six year gap was larger than the gap in the four-year model, suggesting that low-income students fall further behind middle-income students as time passes. Similarly, students from families earning between $25,000 and $49,000 had a 4.28 percentage point lower probability of earning a biomedical science degree within six years. Student from high middle-income families (i.e. earning between $199,000 and $199,999) have a slight advantage over their middle-class peers in biomedical science degree completion four year after college entry, but this advantage disappears after the sixth year. Additionally, higher levels of mother's education significantly and positively predicted students' biomedical science completion likelihood at the sixth year.

Students' prior preparation and pre-college experiences significantly predicted their probabilities of completing a biomedical science degree within six years. Earning higher high school grades predicted a much greater likelihood of earning a biomedical science degree in the fourth and sixth years after college entry. A one-unit increase in GPA corresponded with an 11.28% increase in the likelihood of attaining a biomedical science degree. Institutional selectivity slightly mitigated the positive relationship between high school GPA and biomedical science degree completion after four years, but this cross-level interaction effect proved non-significant in the six-year model.

Higher SAT scores improved students' chances of completing a biomedical science degree. A 100-point increase from the mean in students' composite SAT scores predicted a 4.46 percentage point increase in their probability of completing a biomedical science bachelor's degree in six years. Students who completed more years of math and biology in high school had an advantage in their biomedical science completion rates after six years, while more years in physical sciences slightly reduced one's odds of earning a degree in the biomedical sciences.

Among pre-college experiences, we found that students who reported more frequently socializing with others from a different racial or ethnic group had significantly lower probabilities of earning a biomedical science degree within six years. By contrast, students who did community service work at a hospital or who spent more hours per week studying and doing homework in high school had significantly better odds of completing a biomedical science degree. Students who more frequently studied with other students in high school were slightly more likely to graduate in a biomedical science major four years after college entry; however, this effect disappeared by year six.

Students who reported stronger chances of working full-time while attending college had reduced odds of finishing a biomedical science degree four and six years after college entry; this effect doubled from year four to year six. Alternatively students who expected to communicate regularly with professors had slightly greater probabilities of finishing a biomedical science degree by year six. Further, having high degree aspirations upon college entry predicted significantly greater odds of completing a biomedical science degree. Students with plans for a master's degree had a 4.89 percentage point probability advantage at year six over their classmates who only aspired to attain a bachelor's degree. In the four-year model, students who planned to pursue a medical degree were 7.19 percentage points more likely to earn a biomedical science degree compared to their peers who aspired only a bachelor's degree. Given that this effect goes away in the six-year model, it appears that biomedical science aspirants aspiring towards a bachelors degree tend to take longer to complete their degrees than those aspiring for a medical degrees. Further the gap after the fourth year between medical degree aspirants and their peers with bachelor's degree intentions significantly varied across campus contexts. In the four-year model, medical degree aspirants attending campuses where faculty more frequently graded on a curve had lower likelihoods of biomedical science degree completion. In both the four- and six-year models, medical degree aspirants at more selective institutions had slightly lower probabilities of completing a biomedical science degree.

Respondents with a stronger academic self-concept had a significantly higher likelihood of completing a four-year biomedical science degree, as a one standard deviation increase in academic self-concept corresponded to a 2.5 percentage point increase in students' biomedical science degree completion probability. Alternatively respondents with higher scores on social self-concept were significantly less likely to earn a biomedical science degree, as a one standard deviation in this construct translated into a 3.0 percentage point lower probability of completing a degree in biomedical science.

Finally, the results show that students' intended major significantly affected their likelihood of earning a biomedical science degree in four and six years. Nursing and chemistry aspirants were not significantly different from their counterparts pursing biology majors in terms of biomedical science degree completion. In contrast, students planning to pursue pre-pharmacy (-15.77%) and those pursing pre-med, pre-dental, and pre-vet programs (-9.54%) were less likely to finish a biomedical science degree in six years compared to their classmates in a biology-related major. The finding for pre-pharmacy students may be due to the fact that many of these students move directly into Pharm.D. programs at their institutions and do not pick up a bachelor's degree along the way. Alternatively, some campuses award the bachelor's degree in pharmacy and the Pharm.D. degree at the same time point.

Discussion/Conclusion

The key finding from this study points to the importance of institutional context and structural differences in impacting institutional strength in producing biomedical science graduates. Emerging Hispanic-serving institutions (EHSI), for example, appear to provide a college environment that better serves biomedical science aspirants. Indeed EHSIs are very successful in not only fostering bachelor's degree attainment but also in fostering degree attainment *in* the biomedical sciences. Most impressively, students attending these institutions have an edge in biomedical science degree completion in both the fourth and sixth years after college entry.

Similarly, HBCUs promote degree attainment in the biomedical sciences among Black students, and these institutions substantially mitigate the higher likelihood for non-degree completion among this student group. Black students' success in the sciences appears to be more common at HBCUs and may be a reflection of the supportive institutional cultures and learning environments that HBCUs provide for Black students as evidenced by the greater levels of engagement and better relationships these students have with their professors compared to black students at PWIs (Nelson Laird, Bridges, Morelon-Quainoo, Williams, & Homes, 2007). Black students in the sciences also report receiving high levels of support and recognition from faculty as developing scientists at HBCUs (Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011).

Biomedical science aspirants at larger institutions are more likely to switch and complete a degree in a different field than remain in the biomedical sciences. Since larger institutions tend to have larger class sizes, especially in introductory science courses, students may find their first experiences in STEM classroom to be both impersonal and intimidating, which may turn them off to the sciences (Seymour & Hewitt, 1997).

Finally the findings reinforce the notion that peer normative contexts matter in the production of scientists. For example, although students are more likely to graduate with a biomedical sciences degree in six years compared to not getting any degree at more highly selective institutions, biomedical sciences aspirants who earn a degree in four years at a more selective institution are more likely to earn that degree *outside* of the biomedical sciences. Thus, it seems that more selective institutions may be diverting talent from the biomedical sciences into other fields and disciplines.

Several findings connect biomedical science degree completion with socioeconomic status. Students from low-income families or those who expect to work full-time in college complete in the biomedical sciences at significantly lower rates than their more affluent peers. With medical schools in particular growing increasingly concerned with the economic diversity of applicants and matriculates (Freeman, Ferrer, & Greiner, 2007; Jolly, 2008; Magnus & Mick, 2000), these findings are especially alarming.

Further racial differences exist in students' propensity to complete a degree. Specifically although students from URM backgrounds complete degrees in the biomedical sciences versus the non-science at similar rates as their White counterparts, URM students have much higher probabilities of not having attained any degree. These finding provide support for additional retention interventions that target students from low-income and URM families so that these students can complete bachelor's degrees generally and bachelor's degrees in their original intended area of biomedical sciences more specifically.

With respect to other demographic student characteristics, the good news is that although women are less likely to complete a degree in biomedical sciences and more likely to complete a degree in a different disciple at year four, this discrepancy goes away by year six at which point they are equally as likely compared to men to complete a biomedical science degree in 6 years. Further women are more likely than men to complete a degree in BBS rather than complete no degree with four and six years. In other words, men who are not successful in the biomedical sciences tend to not complete any degree rather than switch to a different discipline. It is also interesting that, across the board, English native speakers are *less* likely to attain a biomedical science degree than their non-native English speaking peers. Future research should further parcel out international students from the group of non-native English students to gain a better picture of what is happening here.

While many of the findings related to the significance of demographics and pre-college experiences confirmed by previous research, this study offers several new finding regarding the conditional effects of institutional structures, which may be of interest to STEM educators, institutions, and policy makers. First, faculty grading procedures matter; students who aspire to eventually attain a medical degree who go to institutions where a higher percentage of the faculty grade on a curve are more likely to either switch into a non biomedical science degree or not complete a degree at all, than attain a biomedical science degree. Grading on a curve tends to privilege students who begin a course with the requisite skill set for success, but can marginalize and discount the growth of students who demonstrate knowledge gains.

In addition to the connection between completing a biomedical science degree and faculty's evaluation practices, professors' pedagogical approach in the classroom can significantly affect students' probability of earning a bachelor's degree in the biomedical sciences. Student-centered pedagogy strengthened the positive relationship between high school GPA and biomedical science completion. Thus, campuses can cultivate and retain talented students in the biomedical sciences at higher rates by engaging them in the classroom through activities such as class discussions and cooperative learning. This finding confirms previous work that found that student-centered teaching techniques enhance academic engagement (Gasiewski et al., 2012).

Our findings also indicate that medical school aspirants have reduced probabilities of completing biomedical science degrees and are more prone to finish a degree in a different discipline or not complete at all, when they attend institutions that are more highly selective than the average selectivity of our sample. Although the data does not indicate why this is the case, it could be that institutions of greater selectivity also have more highly competitive peer environments. Students' perceptions of highly competitive peer academic environments have negative effects on student learning and performance (Walberg, 1979) and have been associated with more difficulty in adjusting and transitioning to the science environment for first year students (Hurtado, Han, Sáenz, Espinosa, Cabrera, & Cerna, 2007)..

It is important that institutions and departments gain a greater understanding of the role that the environmental conditions they create for students play in predicting bachelor's degree completion in the biomedical sciences and will learn how data can be used to improve the learning environments they offer. Given the findings from this study, it would be constructive for institutions to examine the practices distinct departments constituting the biomedical sciences use. In this way institutions can identify the practices and programmatic interventions both in and out of the classroom that are most effective in increasing degree attainment given students' background characteristics. The next step would be to determine whether such practices can be implemented in other departments and/or scaled up to other STEM disciplines. As a result, institutions may be able to better retain talent in the sciences and become more effective producers of biomedical science degrees. Future research can build on the findings from this study by more closely examining how the institutional cultures at EHSI and HBCUs promote biomedical sciences degree attainment and identifying the institutional structures and practices that contribute to this culture. Future research should also attempt to pinpoint the exact terms in students' college careers that they switch to non-science majors, as this information might shed light on why students are switching and indicate possible interventions that can curb this trend.

References

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college.* Washington, DC: U.S. Department of Education.

Alon, S. (2007). Overlapping disadvantages and the racial/ethnic graduation gap among students attending selective institutions. *Social Science Research*, *36*(4), 1475-1499.

Astin, A.W. (1993). *What matters in college? Four critical years revisited.* San Francisco, CA: Jossey-Bass.

Barlow, A. E. L., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching, 41*(9), 861-881.

Bayer Corporation. (2012). Bayer facts of science education XV: A view from the gatekeepers-STEM department chairs at America's top 200 research universities on female and underrepresented minority undergraduate STEM students. *Journal of Science Educational Technology, 21*, 317-324.

Bean, J.P. (1980). Dropouts and turnover: The synthesis and test of a causal model of student attrition. *Research in Higher Education*, *12*(2), 155-187.

Beasley, M.A., & Fischer, M.J. (2012). Why they leave: The impact of stereotype threat on the attrition of women and minorities from science math and engineering majors. *Social Psychology* of *Education, 15*(4), 427-448

Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science, mathematics, and engineering majors. *Journal of Negro Education, 69*(1-2), 92-111.

Bonous-Hammarth, M. (2006). Promoting student participation in science, technology, engineering and mathematics careers. In W. R. Allen, M. Bonous-Hammarth, & R. T. Teranishi (Eds.), *Higher education in a global society: Achieving diversity, equity, and excellence* (pp. 269-282). Oxford: Elsevier.

Bowen, W.G., & Bok, D. (1998). *The shape of the river: Long term consequences of considering race in college and university admissions*. Princeton, NJ.: Princeton University

Bowen, W.G., Chingos, M.M., & McPherson, M.S. (2009). *Crossing the finish line: Completing college at America's public universities*. Princeton, NJ: Princeton University.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and by design.* Cambridge: Harvard University Press.

Bronfenbrenner, U. (1994). Ecological models of human development. In T. Husen & T. Neville Postlethwaite (Eds.), *The international encyclope- dia of education* (2nd ed., Vol. 3, pp. 1643-1647). Oxford, England: Pergamon Press.

Bronfenbrenner, U. (1995). Developmental ecology through space and time: A future perspective. In P. Moen & G.H. Elder (eds.), *Examining lives in context: Perspectives on the ecology of human development* (pp. 619-47). Washington, DC: American Psychological Association.

Cabrera, A.F., Crissman, J.L., Bernal, E.M., Nora, A., Terenzini, P.T., & Pascarella, E.T. (2002). Collaborative learning: Its impact on college students' development and diversity. *Journal of College Student Development*, *43*(1), 20-34.

Carlone, H.B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187-1218.

Chang, M. J., Cerna, O., Han, J., & Saenz, V. (2008). The contradictory roles of institutional status in retaining underrepresented minorities in biomedical and behavioral science majors. *Review of Higher Education, 31*(4), 433-464.

Chang, M.J. Sharkness, J., Newman, C., & Hurtado, S. (2010, May). *What matters in college for retaining aspiring scientists and engineers.* Paper presented at the annual meeting of the American Educational Research Association, Denver, CO.

Chang, M.J., Eagan, M.K., Lin, M.H., & Hurtado, S. (2011). Considering the impact of racial stigmas and science identity: Persistence among biomedical and behavioral sciences aspirants. *Journal of Higher Education, 82*(5), 564-596.

Cole, D. & Espinoza, A. (2008). Examining the academic success of Latino students in science technology engineering and mathematics (STEM) majors. *Journal of College Student Development, 49*(4), 285-300.

Cragg, K.M. (2009). Influencing the probability for graduation at four-year institutions: A multi-model analysis. *Research in Higher Education, 50*(4), 394-413.

Cruce, T.M. (2009). A note on the calculation and interpretation of the delta-p statistic for categorical independent variables. *Research in Higher Education, 50*(6), 608-622. doi:10.1007/s11162-009-9131-1

DeAngelo, L., Franke, R., Hurtado, S., Pryor, J. H., & Tran, S. (2011). *Completing college: Assessing graduation rates at four-year institutions*. Los Angeles: Higher Education Research Institute, UCLA.

Denson, C. D., Avery, Z. A., & Schell, J. D. (2010). Critical inquiry into urban African-American students' perceptions of engineering. *Journal of African American Studies, 14*(1), 61–74.

Eagan, K., Figueroa, T., Hurtado, S., & Gasiewski, J. (2012). *Faculty Accessibility Cues: Opening the Doors to Classroom Communication*. Paper presented at the Annual Forum of the Association for Institutional Research, New Orleans, LA.

Eagan, K., Hurtado, S., & Chang, M. (2010). *What Matters in STEM: Institutional Contexts That Influence STEM Bachelor's Degree Completion Rates*. Paper presented at the Annual Meeting of the Association for the Study of Higher Education, Indianapolis, IN.

Ellington, R. M. (2006). *Having their say: Eight high-achieving African-American undergraduate mathematics majors discuss their success and persistence in mathematics*. Unpublished doctoral dissertation, University of Maryland, College Park. Retrieved January 2, 2013, from Dissertations and Theses Database.

Elliott, R., Strenta, A. C., Adair, R., Matier, M., & Scott, J. (1996). The role of ethnicity in choosing and leaving science in highly selective institutions. *Research in Higher Education, 37*(6), 681-709.

Espinosa, L.L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review, 81*(2), 209-240.

Fries-Britt, S., Younger, T., & Hall, W. (2010). Underrepresented minorities in physics: How perceptions of race and campus climate affect student outcomes. In Dancy, T.E. (Ed.), *Managing diversity: (Re)visioning equity on college campuses* (pp. 181-198). New York, NY: Peter Lang Publishing

Gansemer-Topf, A.M., & Schuh, J.H. (2006). Institutional selectivity and institutional expenditures: Examining organizational factors that contribute to retention and graduation. *Research in Higher Education 47*(6), 613-642.

Gasiewski, J., Garcia, G., Herrera, F., Tran, M., & Newman, C. (2010). *Barricades, Bridges, and Programmatic Adaptation: A Multi-campus Case Study of STEM Undergraduate Research Programs*. Paper presented at the Annual Forum of the Association for Institutional Research, Chicago, IL.

Gasiewski, J.A., Eagan, M.K., Garcia, G.A., Hurtado, S., & Chang, M.J. (2012). From gatekeeping to engagement: A multicontextual, mixed method study of student academic engagement in introductory STEM courses? *Research in Higher Education, 53*(2), 229-261.

George, Y.S., Neale, D.S., Van Horne, V., & Malcom, S.M. (2001). *In pursuit of a diverse science, technology, engineering, and mathematics workforce: Recommended research priorities to enhance participation by underrepresented minorities.* Washington, D.C.: American Association for the Advancement of Science (AAAS). Retrieved January 2, 2013, from http://ehrweb.aaas.org/mge/Reports/Report1/AGEP/AGEP_report.pdf

Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *The Journal of Higher Education, 69*(6), 589-620.

Higher Education Research Institute. (2011). *CIRP construct technical report: 2010-2011 appendix faculty construct parameters.* Los Angeles: Higher Education Research Institute.

Higher Education Research Institute (HERI). (2010). *Degrees of success: Bachelor's degree completion rates among initial STEM majors*. Los Angeles: Higher Education Research Institute.

Hubbard, S.M., & Stage, F.K. (2010). Identifying comprehensive public institutions that develop minority scientists. *New Directions for Institutional Research, 2010*(148), 53-62.

Hurtado, S., Cerna, O. S., Chang, J. C., Saenz, V. B., Lopez, L. R., Mosqueda, C., et al. (2006). *Aspiring scientists: Characteristics of college freshmen interested in the biomedical and behavioral sciences*. Los Angeles: Higher Education Research Institute, UCLA.

Hurtado, S., Eagan, K., & Hughes, B. (under review). *Priming the Pump or the Sieve: Institutional Contexts and URM STEM Degree Attainments*.

Hurtado, S., Eagan, M. K., Tran, M., Newman, C., Chang, M. J., & Velasco, P. (2011). "We do science here": Underrepresented students' interactions with faculty in different college contexts. *Journal of Social Issues, 67*(3), 553-579.

Hurtado, S., Han, J. C., Sáenz, V. B., Espinosa, L., Cabrera, N., & Cerna, O. (2007). Predicting transition and adjustment to college: Biomedical and behavioral science aspirants' and minority students' first year of college. *Research in Higher Education, 48*(7), 841-887.

Jaeger, A. J., Eagan, M. K., & Wirt, L. G. (2008). Retaining students in science, math, and engineering majors: Rediscovering cooperative education. *Journal of Cooperative Education and Internships, 42*(1), 20-32.

Johnson, A.C. (2007). Unintended consequences: How science professors discourage women of color. *Science Education, 91*(5), 805-821.

Jones, M.T., Barlow, A.E.L., & Villarejo, M. (2010). Importance of undergraduate research for minority persistence and achievement in biology. *Journal of Higher Education, 81*(1), 82-115.

Maltese, A.V., & Tai, R.H. (2010). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education, 95*(5), 877-907.

Maton, K.I.,. Sto Domingo, M.R., Stolle-McAllister, K.E., Zimmerman, J.L., & Hrabowski, F.A. (2009). Enhancing the number of African Americans who pursue STEM PhDs: Meyerhoff Scholarship Program outcomes, processes, and individual predictors. *Journal of Women and Minorities in Science and Engineering, 15*(1), 15-37.

May, G. S., & Chubin, D. E. (2003). A retrospective on undergraduate engineering success for underrepresented minority students. *Journal of Engineering Education, 92*(1), 27–39.

McGee, E.O., & Martin, D.B. (2011). "You would not believe what I have to go through to prove my intellectual value!" Stereotype management among academically successful black mathematics and engineering students. *American Educational Research Journal, 48*(6), 1347-1389.

Melguizo, T. (2010). Are students of color more likely to graduate from college if they attend more selective institutions? Evidence from a cohort of recipients and nonrecipients of the Gates Millennium Scholarship Program. *Educational Evaluation and Policy Analysis, 32*(2), 230-248.

Museus, S. D., Nichols, A. H., & Lambert, A. D. (2008). Racial differences in the effects of campus racial climate on degree completion: A structural equation model. *Review of Higher Education, 32*(1), 107–134.

Museus, S.D. (2011). Generating ethnic minority student success (GEMS): A qualitative analysis of high-performing institutions. *Journal of Diversity in Higher Education, 4*(3), 147-162.

Museus, S.D., & Liverman, D. (2010). High-performing institutions and their implications for studying underrepresented minority students in STEM. *New Directions for Institutional Research, 2010*(148), 17-27.

Museus, S.D., Palmer, R.T., Davis, R.J., & Maramba, D.C. (2011). Racial and ethnic minority students' success in STEM education. *ASHE Higher Education Report*, 36(6).

National Academy of Sciences (2011). *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*. Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline. Washington, DC: The National Academies Press.

Nelson Laird, T.F., Bridges, B.K., Morelon-Quainoo, C.L., William, J.M., & olmes, M.S. (2007). African American and Hispanic student engagement at minority serving and predominatly white institutions. *Journal of College Student Development,* 48(1), 39-56.

NIH. National Institutes of Health. (2013). *Biomedical Research Training Program for Individuals from Underrepresented Groups.* Retrieved May 8, 2013 from http://www.nhlbi.nih.gov/funding/training/redbook/brtpug.htm

Nora, A., Barlow, E., & Crisp, G. (2005). Student persistence and degree attainment beyond the first year in college: The need for research. In A. Seidman (Ed.), *College student retention: Formula for student success* (pp. 130-153). Westport, CT: Praeger.

Oseguera, L. (2005). Four and six-year baccalaureate degree completion by institutional characteristics and racial/ethnic groups. *Journal of College Student Retention, 7*(1-2), 19-59.

Palmer, R. T., Davis, R. J., & Thompson, T. (2010). Theory meets practice: HBCU initiatives that promote academic success among African Americans in STEM. *Journal of College Student Development, 51*(4), 440-443.

Palmer, R.T., Maramba, D.C., & Dancy, T.E. (2011). A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *Journal of Negro Education, 80*(4), 491-504.

Perna, L.W., Gasman, M., Gary, S., Lundy-Wagner, V., & Drezner, N.D. (2010). Identifying strategies for increasing degree attainment in STEM: Lessons from minority-serving institutions. *New Directions for Institutional Research, 2010*(148), 41-51.

Petersen, T. (1985). A comment on presenting results from logit and probit models. *American Sociological Review, 50,* 130-131. doi:10.2307/2095348

President's Council of Advisors on Science and Technology (PCAST). (2010). *Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's Future.* Washington, D.C.: Executive Office of the President. Retreived January 1, 2012 from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

Rath, K. A., Peterfreund, A. R., Xenos, S. P, Bayliss, F., & Carnal, N. (2007). Supplemental instruction in introductory biology I: Enhancing the performance and retention of underrepresented minority students. *CBE-Life Sciences Education,* 6, 203-216.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage Publishing.

Seymour (2001). Tracking the processes of change in US undergraduate education in science, mathematics, engineering, and technology. *Science Education, 86*(1), 79-105.

Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.

Sharkness, J., DeAngelo, L., & Pryor, J. (2010). CIRP Construct Technical Report. Retrieved June 2, 2012, from http://www.gseis.ucla.edu/heri/PDFs/technicalreport.pdf

Slovacek, S., Whittinghill, J., Flenoury, L., & Wiseman, D. (2011). Promoting minority success in the sciences: The minority opportunities in research programs at CSULA. *Journal of Research in Science Teaching, 49*(2), 199-217.

Smyth, F.L., & McArdle, J.J. (2004). Ethnic and gender differences in science graduation at selective colleges with implications for admission policy and college choice. *Research in Higher Education, 45*(4), 353-381.

Spady, W.G. (1970). Dropouts from higher education: An interdisciplinary review and synthesis. *Interchange, 1*(1), 64-85.

Steele, C. M. (1992, April). Race and the schooling of Black Americans. *The Atlantic,* 1-6. Retrieved January 8, 2013 from http://www.theatlantic.com/magazine/archive/1992/04/race-and-the-schooling-of-black-americans/306073/6/.

Taraban, R., & Logue, E. (2012). Factors that affect undergraduate research experiences. *Journal of Educational Psychology, 104*(2), 499-514.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45*(1), 89-125.

Tinto, V. (1997). Classrooms as communities: Exploring the educational character of student persistence. *Journal of Higher Education, 68*(6), 599-623.

Titus, M.A. (2006). Understanding college degree completion of students with low socioeconomic status: The influence of the institutional financial context. *Research in Higher Education*, *47*(4), 371-398.

Tobias, S. (1990). Stemming the science shortfall at college. In S.Tobias (ed.), *They're Not Dumb, They're Different.* Tucson, Arizona: Research Corporation.

Walberg, H. J. (1979). *Educational environments and effects: Evaluation, policy, and productivity*. Berkeley, CA: McCutchan.

Table 1.
Descriptive Statistics (n=30,614 biomedical aspirants across 296 institutions)

	MEAN	SD	Min.	Max.
Institutional Characteristics				
Percentage of students w/ MD aspirations	0.25	0.12	0	0.62
Control (1=public; 2=Private)	1.7	0.46	1	2
Institutional Type: Research/Doctoral	0.23	0.42	0	1
Institutional Type: Masters Comprehensive	0.41	0.49	0	1
Institutional Type: Liberal arts/baccalaureate	0.36	0.48	0	1
Percentage of undergraduate STEM majors	12.55	10.7	0.97	91.3
HBCU	1.04	0.21	1	2
Undergraduate Full Time Enrollment (log)	8.08	0.89	6.28	10.4
Percentage of STEM faculty involving undergraduates in research	1.59	0.26	1	2
Percent of STEM faculty who grade on a curve	1.82	0.49	1	4
Avg. STEM faculty score on student-centered pedagogy construct	-0.03	0.4	-1.5	1.34
Selectivity (100)	11.2	1.47	0	15.1
Institution offers undergraduate research opportunities to freshmen	1.68	0.47	0	2
Institution provides targeted financial aid to STEM students	0.88	0.31	0	1
Emerging HSI (15-24% of undergraduates are Latino)	0.04	0.2	0	1
HSI (25% or more of undergraduates are Latino)	0.04	0.21	0	1
Institution offers undergraduates research opportunities	2.57	0.55	1	3
Institutional expenditures per FTE student	33.66	62.6	9.19	972
Background Characteristics				
Native American	0.02	0.15	0	1
Black	0.1	0.3	0	1
Latino	0.07	0.25	0	1
Asian American or Pacific Islander	0.14	0.35	0	1
White	0.64	0.48	0	1
Other Race	0.02	0.14	0	1
Student's Gender	0.69	0.46	0	1
Low Income (Under $24,999)	0.12	0.32	0	1
Low Middle Income ($25K-49,999)	0.18	0.39	0	1
Middle Income ($50K-99,999)	0.37	0.4	0	1
High Middle Income ($100K-199,999)	0.23	0.42	0	1
High Income ($200K+)	0.1	0.3	0	1
Student Native English Speaker	0.89	0.31	0	1
Mother's education	5.35	1.89	1	8

	MEAN	SD	Min.	Max.
Either parent has a STEM-related occupation	0.28	0.45	0	1
Prior Preparation				
Average High School Grade	6.73	1.31	1	8
SAT Composite score (100)	11.55	1.78	4.6	16
Years of HS Study: Mathematics	5.94	0.54	1	7
Years of HS Study: Physical Science	3.9	1.27	1	7
Years of HS Study: Biological Science	3.93	1.05	1	7
Pre-college Experiences				
Studied with Other Students	2.25	0.61	1	3
Felt Overwhelmed by All I Had to Do	2.19	0.6	1	3
Socialized with diffent ethnic Group	2.69	0.51	1	3
Studying or Homework	4.55	1.56	1	8
Participated in a pre-college summer research program	0.1	0.29	0	1
Community Service: Hospital work	1.25	0.43	1	2
Entering Aspirations and Expectations				
To Get Training for a Specific Career	2.77	0.5	1	3
Work Full-time while Attending College	1.92	0.86	1	4
Communicate Regularly with Professors	3.24	0.69	1	4
Make at Least a "B" Average	3.62	0.57	1	4
Transfer to Another College	1.96	0.88	1	4
TFS Academic Self-Concept Score	50.85	7.95	12.7	66.9
TFS Social Self-Concept Score	47.83	9.28	18.1	68.1
Medical Degree Aspiration	0.38	0.49	0	1
Masters Degree Aspiration	0.19	0.39	0	1
Ph.D./Ed.D. Degree Aspiration	0.24	0.43	0	1
Law Degree Aspiration	0	0.06	0	1
Plan to live on campus	0.81	0.39	0	1
STEM Identity	0.11	1	-2.2	2.22
Intended Major				
Biological Sciences Aspirant	0.42	0.49	0	1
Chemistry Aspirant	0.06	0.25	0	1
Pharmacy Aspirant	0.09	0.28	0	1
Nursing Aspirant	0.18	0.39	0	1
MD, Dentistry, or Veterinary Medicine Aspirant	0.25	0.43	0	1

Table 2.
HGLM Results for Biomedical Science Completion versus non-Biomedical Science Completion

	Four-Year BioSci vs. Non-BioSci				Six-Year BioSci vs. Non-BioSci			
	Coef.	S.E.	Sig.	Delta-P	Coef.	S.E.	Sig.	Delta-P
Institutional Characteristics								
Intercept	2.21	0.88	*		0.72	0.62		
Percentage of students w/ MD aspirations (10)	-0.27	0.48			-0.48	0.49		
Control (1=public; 2=Private)	0.04	0.15			0.03	0.13		
Institutional Type: Research/Doctoral (ref. masters comp.)	-0.16	0.16			-0.11	0.14		
Institutional Type: Liberal arts/baccalaureate (ref. masters comp.)	-0.14	0.18			-0.15	0.18		
Percentage of undergraduates in STEM (10)	0.01	0.01			0.00	0.01		
HBCU	-1.36	0.84			-0.26	0.53		
Undergraduate Full Time Enrollment (log)	-0.31	0.11	**	-7.72%	-0.23	0.10	*	-5.82%
Percentage of STEM faculty involving undergraduates in research	0.29	0.34			0.12	0.28		
Percent of STEM faculty who grade on a curve	0.24	0.16			0.10	0.12		
Avg. STEM faculty score on student-centered pedagogy construct	0.06	0.14			0.03	0.12		
Selectivity (100)	-0.19	0.08	*	-4.75%	0.07	0.08		
Institution offers undergraduate research opportunities to freshmen	0.19	0.13			0.13	0.11		
Institution provides targeted financial aid to STEM students	-0.22	0.19			-0.20	0.15		
Emerging HIS	0.39	0.15	**	9.05%	0.50	0.16	**	12.01%
HIS	-0.38	0.35			-0.12	0.25		
Institution offers undergraduates research opportunities	-0.14	0.11			-0.15	0.10		
Institutional expenditures per FTE student	0.00	0.00			0.00	0.00		
Background Characteristics								
Native American	0.02	0.19			-0.09	0.13		
Black	-1.25	0.82			-0.24	0.48		
HBCU	1.32	0.77			0.29	0.45		
Selectivity (100)	-0.03	0.07			-0.02	0.06		
Latino	-0.14	0.11			-0.13	0.08		
Asian American or Pacific Islander	0.26	0.09	**	6.13%	0.27	0.09	**	6.73%
Other Race	0.22	0.16			0.43	0.16	**	10.42%
Student's Gender	-0.24	0.06	***	-5.91%	-0.05	0.05		
Selectivity (100)	0.04	0.04			-0.02	0.04		
Low Income (Under $24,999)	-0.06	0.09			-0.11	0.07		
Low Middle Income ($25K-49,999)	-0.09	0.07			-0.03	0.06		
High Middle Income ($100K-199,999)	0.01	0.06			-0.02	0.05		
High Income ($200K+)	-0.07	0.07			-0.08	0.06		
Student Native English Speaker	-0.35	0.07	***	-8.23%	-0.29	0.06	***	-7.08%
Mother's education	-0.01	0.01			0.00	0.01		
Either parent has a STEM-related occupation	0.19	0.05	***	4.66%	0.16	0.03	***	3.97%
Prior Preparation								
Average High School Grade	0.25	0.03	***	5.94%	0.24	0.02	***	5.91%
Student-centered pedagogy factor	0.17	0.07	*	4.04%	0.18	0.05	***	4.42%
Selectivity (100)	-0.02	0.02			-0.02	0.02		
SAT Composite score (100)	0.23	0.02	***	5.45%	0.16	0.02	***	4.04%
Years of HS Study: Mathematics	0.13	0.04	**	3.15%	0.10	0.03	**	2.44%
Years of HS Study: Physical Science	-0.01	0.02			0.00	0.01		
Years of HS Study: Biological Science	0.07	0.02	***	1.74%	0.06	0.02	***	1.60%

	Four-Year BioSci vs. Non-BioSci				Six-Year BioSci vs. Non-BioSci			
	Coef.	S.E.	Sig.	Delta-P	Coef.	S.E.	Sig.	Delta-P
Pre-college Experiences								
Studied with Other Students	0.03	0.03			0.05	0.03		
Felt Overwhelmed by All I Had to Do	-0.05	0.03			-0.07	0.03	**	-1.83%
Socialized with different ethnic Group	-0.12	0.05	*	-2.93%	-0.10	0.04	**	-2.48%
Studying or Homework	0.04	0.01	**	1.01%	0.04	0.01	**	1.07%
Participated in a pre-college summer research program	-0.10	0.06			-0.04	0.05		
Community Service: Hospital work	0.15	0.04	***	3.73%	0.22	0.04	***	5.35%
Entering Aspirations and Expectations								
To Get Training for a Specific Career	0.14	0.04	***	3.29%	0.08	0.04		
Work Full-time while Attending College	-0.02	0.03			-0.01	0.02		
Communicate Regularly with Professors	0.04	0.04			0.08	0.03	**	1.87%
Make at Least a "B" Average	0.05	0.05			0.04	0.04		
Transfer to Another College	-0.01	0.03			0.00	0.02		
TFS Academic Self-Concept Score	0.02	0.00	***	0.55%	0.02	0.00	***	0.52%
TFS Social Self-Concept Score	-0.03	0.00	***	-0.66%	-0.02	0.00	***	-0.59%
Medical Degree Aspiration	0.51	0.09	***	12.30%	0.42	0.07	***	10.46%
Grading on a curve	-0.40	0.13	**	-9.82%	-0.30	0.11	**	-7.61%
Selectivity (100)	-0.07	0.05			-0.09	0.04	*	-2.26%
Masters Degree Aspiration	0.04	0.08			0.06	0.06		
Ph.D./Ed.D. Degree Aspiration	0.27	0.08	***	6.70%	0.21	0.07	**	5.24%
Law Degree Aspiration	-0.82	0.40	*	-19.65%	-0.75	0.27	**	-17.58%
Plan to live on campus	-0.14	0.07	*	-3.35%	-0.09	0.05		
STEM Identity	0.03	0.03			0.02	0.02		
Intended Major								
Chem Aspirant	0.00	0.08			-0.05	0.07		
Pharmacy Aspirant	-0.51	0.13	***	-12.69%	-0.70	0.15	***	-17.19%
Nursing Aspirant	1.18	0.18	***	24.00%	0.90	0.13	***	20.31%
MD, Dentistry, or Veterinary Medicine Aspirant	-0.56	0.07	***	-13.86%	-0.47	0.06	***	-11.65%

Note: *p < 0.05, ** p < 0.01, *** p < 0.001

Table 3.
HGLM Results of Biomedical Science Completion versus No Completion

	Four-Year BioSci vs. No Completion				Six-Year BioSci vs. No Completion			
	Coef.	S.E.	Sig.	Delta-P	Coef.	S.E.	Sig.	Delta-P
Institutional Characteristics								
Intercept	-0.11	0.89			0.50	0.84		
Percentage of students w/ MD aspirations (10)	0.98	0.82			0.86	0.83		
Control (1=public; 2=Private)	0.33	0.24			0.10	0.24		
Institutional Type: Research/Doctoral (ref. masters comp.)	-0.43	0.22			-0.47	0.21	*	-11.54%
Institutional Type: Liberal arts/baccalaureate (ref. masters comp.)	0.00	0.22			-0.23	0.24		
Percentage of undergraduates in STEM (10)	-0.02	0.01			-0.01	0.01		
HBCU	-1.10	0.70			0.00	0.50		
Undergraduate Full Time Enrollment (log)	0.01	0.15			0.22	0.14		
Percentage of STEM faculty involving undergraduates in research	0.56	0.31			0.34	0.29		
Percent of STEM faculty who grade on a curve	0.18	0.20			0.14	0.17		
Avg. STEM faculty score on student-centered pedagogy construct	0.04	0.18			0.07	0.17		
Selectivity (100)	0.62	0.10	***	15.08%	0.59	0.10	***	13.44%
Institution offers undergraduate research opportunities to freshmen	0.02	0.19			-0.01	0.16		
Institution provides targeted financial aid to STEM students	-0.08	0.22			0.02	0.20		
Emerging HIS	0.47	0.22	*	11.33%	0.58	0.17	***	13.29%
HIS	-0.73	0.42			-0.23	0.32		
Institution offers undergraduates research opportunities	-0.17	0.14			-0.17	0.12		
Institutional expenditures per FTE student	0.00	0.00			0.00	0.00		
Background Characteristics								
Native American	-0.62	0.15	***	-13.43%	-0.76	0.15	***	-18.66%
Black	-1.91	0.67	**	-30.73%	-0.92	0.51		
HBCU	1.61	0.65	*	38.12%	0.56	0.49		
Selectivity (100)	-0.08	0.07			-0.04	0.08		
Latino	-0.31	0.11	**	-7.01%	-0.34	0.10	***	-8.40%
Asian American or Pacific Islander	0.17	0.08	*	4.24%	0.11	0.09		
Other Race	0.27	0.15			0.39	0.17	*	8.73%
Student's Gender	0.29	0.06	***	6.39%	0.22	0.06	***	5.32%
Selectivity (100)	0.03	0.04			0.08	0.05		
Low Income (Under $24,999)	-0.34	0.07	***	-7.36%	-0.44	0.08	***	-10.90%
Low Middle Income ($25K-49,999)	-0.14	0.05	**	-3.20%	-0.18	0.07	**	-4.28%
High Middle Income ($100K-199,999)	0.10	0.05	*	2.35%	0.09	0.06		
High Income ($200K+)	0.02	0.05			-0.05	0.08		
Student Native English Speaker	-0.18	0.06	**	-4.28%	-0.35	0.10	***	-8.27%
Mother's education	0.02	0.01			0.07	0.01	***	1.69%
Either parent has a STEM-related occupation	0.06	0.04			0.03	0.05		
Prior Preparation								
Average High School Grade	0.48	0.02	***	11.44%	0.49	0.02	***	11.28%
Student-centered pedagogy factor	0.04	0.06			0.06	0.07		
Selectivity (100)	-0.04	0.01	**	-0.98%	0.00	0.02		
SAT Composite score (100)	0.29	0.02	***	6.82%	0.19	0.02	***	4.46%
Years of HS Study: Mathematics	0.16	0.04	***	3.68%	0.16	0.04	***	3.89%
Years of HS Study: Physical Science	-0.02	0.02			-0.04	0.02	*	-1.02%
Years of HS Study: Biological Science	0.06	0.02	***	1.38%	0.05	0.02	**	1.31%

	Four-Year BioSci vs. No Completion				Six-Year BioSci vs. No Completion			
	Coef.	S.E.	Sig.	Delta-P	Coef.	S.E.	Sig.	Delta-P
Pre-college Experiences								
Studied with Other Students	0.07	0.03	*	1.60%	0.06	0.04		
Felt Overwhelmed by All I Had to Do	-0.02	0.03			0.00	0.04		
Socialized with different ethnic Group	-0.26	0.04	***	-5.75%	-0.24	0.04	***	-5.92%
Studying or Homework	0.07	0.02	***	1.53%	0.10	0.01	***	2.51%
Participated in a pre-college summer research program	-0.09	0.08			-0.06	0.08		
Community Service: Hospital work	0.13	0.05	**	2.92%	0.23	0.06	***	5.60%
Entering Aspirations and Expectations								
To Get Training for a Specific Career	0.05	0.04			0.05	0.06		
Work Full-time while Attending College	-0.11	0.02	***	-2.45%	-0.20	0.03	***	-4.82%
Communicate Regularly with Professors	0.02	0.03			0.07	0.03	*	1.64%
w	0.09	0.04	*	2.14%	0.07	0.04		
Transfer to Another College	-0.09	0.02	***	-2.04%	-0.03	0.02		
TFS Academic Self-Concept Score	0.01	0.00	***	0.31%	0.01	0.00	*	0.25%
TFS Social Self-Concept Score	-0.01	0.00	***	-0.23%	-0.01	0.00	***	-0.30%
Medical Degree Aspiration	0.32	0.07	***	7.19%	0.15	0.08		
Grading on a curve	-0.36	0.12	**	-7.68%	-0.01	0.14		
Selectivity (100)	-0.09	0.05	*	-2.12%	-0.15	0.04	***	-3.71%
Masters Degree Aspiration	0.18	0.07	**	3.93%	0.20	0.06	**	4.89%
Ph.D./Ed.D. Degree Aspiration	0.07	0.08			0.12	0.08		
Law Degree Aspiration	-0.66	0.46			-0.13	0.45		
Plan to live on campus	0.20	0.06	***	4.43%	0.27	0.06	***	6.54%
STEM Identity	-0.01	0.02			-0.03	0.02		
Intended Major								
Chem Aspirant	-0.05	0.08			-0.10	0.09		
Pharmacy Aspirant	-1.00	0.21	***	-19.68%	-0.64	0.11	***	-15.77%
Nursing Aspirant	0.27	0.15			0.02	0.11		
MD, Dentistry, or Veterinary Medicine Aspirant	-0.41	0.06	***	-9.04%	-0.39	0.07	***	-9.54%

Note: *p < 0.05, ** p < 0.01, *** p < 0.001

Appendix A.

List of Majors Defined as Being in the Biomedical Sciences

- 'Biology Related Majors'
  - Biology
  - Biochemistry or Biophysics
  - Microbiology or Bacteriology
  - Zoology
  - Other Biological Science
- Chemistry
- Pre-Pharmacy
- Nursing
- Pre-Medicine, Dentistry or Veterinary

Appendix B.

Table of Measures

Variable Name	Coding Scheme
Dependent Variable	
STEM Completion	1=Completed bachelor's degree in STEM; 2=Completed bachelor's degree in a non-STEM field; 3=Did not complete a bachelor's degree (measured at 4 and 6 years)
Institutional Characteristics	
Percentage of students w/ MD aspirations (10)	Continuous
Control	1=public, 2=private
Institutional Type: Research/Doctoral (ref. masters comp.)	0=no, 1=yes
Institutional Type: Liberal arts/baccalaureate (ref. masters comp.)	0=no, 1=yes
Percentage of undergraduates in STEM (10)	Continuous
HBCU	0=no, 1=yes
Undergraduate Full Time Enrollment (log)	Continuous
Percentage of STEM faculty involving undergraduates in research	Continuous
Percent of STEM faculty who grade on a curve	Continuous
Avg. STEM faculty score on student-centered pedagogy construct	Continuous
Selectivity (100)	Continuous
Institution offers undergraduate research opportunities to freshmen	0=not at all to 2=to a great extent
Institution provides targeted financial aid to STEM students	0=no, 1=yes
Emerging HSI (15-24% of undergraduates are Latino)	0=no, 1=yes
HSI (25% or more of undergraduates are Latino)	0=no, 1=yes
Institution offers undergraduates research opportunities	1=not at all to 3=to a great extent
Institutional expenditures per FTE student	Continuous
Background Characteristics	
Native American	0=no, 1=yes
Black	0=no, 1=yes
Latino	0=no, 1=yes
Asian American or Pacific Islander	0=no, 1=yes

Variable Name	Coding Scheme
Other Race	0=no, 1=yes
Student's Gender	1=male, 2=female
Low Income (Under $25K)	0=no, 1=yes
Low Middle Income ($25K-49,999)	0=no, 1=yes
High Middle Income ($100K-$199,999)	0=no, 1=yes
High Income ($200K+)	0=no, 1=yes
Student Native English Speaker	0=no, 1=yes
Mother's education	1=grammar school or less to 8=graduate degree
Either parent has a STEM-related occupation	0=no, 1=yes
Prior Preparation	
Average High School Grade	1=D to 8=A or A+
SAT composite score	Continuous
Years of HS study: Math	1=None to 7=Five or more
Years of HS Study: Physical Science	1=None to 7=Five or more
Years of HS study: Biological sciences	1=None to 7=Five or more
Pre-College Experiences	
Studied with Other Students	1=not at all to 3=frequently
Felt Overwhelmed by All I Had to Do	1=not at all to 3=frequently
Socialized w/Diff Ethnic Group	1=not at all to 3=frequently
Studying or Homework	1=none to 8=over 20 hours
Participated in a pre-college summer research program	0=no, 1=yes
Community Service: Hospital work	1=no, 2= yes
Entering Aspirations and Expectations	
To Get Training for a Specific Career	1=not important, 2= somewhat important, 3= very important
Work Full-time while Attending College	1=no chance to 4=very good chance
Communicate Regularly with Professors	1=no chance to 4=very good chance
Make at Least a "B" Average	1=no chance to 4=very good chance
Transfer to Another College	1=no chance to 4=very good chance
Academic self-concept construct	Continuous
Social self-concept construct	Continuous
Medical Degree Aspiration	0=no, 1=yes
Masters Degree Aspiration	0=no, 1=yes
Ph.D./Ed.D. aspiration	0=no, 1=yes
Law Degree Aspiration	0=no, 1=yes
Plan to live on campus	0=no, 1=yes
STEM Identity	Continuous
Intended Major	
Chem Aspirant	0=no, 1=yes
Pharmacy Aspirant	0=no, 1=yes
Nursing Aspirant	0=no, 1=yes
MD, Dentistry, or Veterinary Medicine Aspirant	0=no, 1=yes