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The Impact of Math and Science Remedial Education on Engineering Major Choice, Degree Attainment, and Time to Degree

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Abstract

Despite limited and mixed evidence regarding its efficacy, the use of postsecondary remedial education is widespread. Remedial education is often provided as an intervention that could potentially promote the success of students with lower academic preparation. In this study, we examine the impact of remedial education on students' engineering pathways and influence on graduation probability. In particular, engineering programs may offer remedial courses to students who may not have had opportunities to take more advanced mathematics and science courses during high school. Our data come from a selective engineering program at a top Midwestern university that requires first-year engineering to complete remedial classes in chemistry, math, and physics if their high school background did not provide them with the preparation to begin the traditional engineering course sequence. Although this is a single-institution study, this setting allows us to examine the impact of remedial courses on students at a four-year institution. This focus extends the literature on remedial education, which tends to focus on two-year colleges and less-selective four-year settings.

Using regression analyses on a sample of 33,369 students who matriculated between 2001 and 2016, we found that students taking remedial mathematics, chemistry, or physics college courses had a significantly lower probability of declaring an engineering major on time (typically in the second semester of college). Among those who declare engineering, remedial education is also associated with a lower graduation probability. Students who take remedial coursework who do graduate are less likely to do so in an engineering major, and they take roughly one third of an additional year in order to complete their degree. Remediation appears to have less of a negative impact on women and racially minoritized students compared to their counterpart students.

Research findings help inform engineering programs, faculty, university administrators, and other stakeholders regarding the role of remedial education in engineering and whether it aids students from academically disadvantaged backgrounds to pursue and succeed in engineering. The results have the potential to significantly advance our understanding of the pathways from high school to and through college engineering across different groups of students. Such understanding is essential insight to provide important recommendations for innovating and refocusing interventions aimed at increasing participation and graduation in engineering.

Keywords: remedial education, major choice, persistence, engineering, high school preparation

Introduction

This is a research paper examining the impact of remedial education courses on student engineering major choice, course grades, likelihood of graduation, and time to degree among those who graduate. Although previous studies have identified a myriad of factors that influence student engineering major choice and degree attainment (e.g., Darolia et al., 2018, 2020; Godwin et al., 2016; Griffith & Main, 2019; Lord et al., 2019; Main et al., 2022; Tan et al., 2021; Tyson et al., 2007), few studies have investigated the role of remedial education in the academic pathways of students pursuing engineering. Colleges offer remedial education programs to help address the differential preparation of incoming college students. Many colleges offer remedial education in mathematics, physics, and other subjects to help prepare students to access and complete the courses required for degree completion. High school math and science courses taken are particularly important in students' college engineering major choice and degree attainment (Main et al., 2022; Tan et al., 2021). Yet, there is a misalignment between what many high schools offer in terms of math courses and the admissions criteria of many state flagship universities (Rodriguez, 2018). Specifically, 29% of U.S. high schools do not offer calculus, and 6.9% of high schools do not offer the math courses that students may need to be more competitive for admission into their state public university (Rodriguez, 2018). This mismatch between high school course math offerings and the requirements of college-level courses is particularly relevant in engineering. That is, high school math and science preparation has important consequences for the likelihood of students entering and completing engineering programs.

Remedial education is motivated by its intent to provide equal opportunity to all incoming students, including those who may not be as well-prepared for science, technology, engineering, and mathematics (STEM) study. Often defined as courses offered at a pre-college level, the use of postsecondary remedial education is widespread (Chen, 2016; Ross et al., 2012). The general finding across remedial education in postsecondary education suggests that remedial mathematics does not improve student performance moving forward (di Pietro, 2014; Lagerlof and Seltzer, 2007). However, Bettinger and Long (2004) have found that students assigned to remedial education gain a boost in their probability of graduating, when compared to otherwise similar students who do not receive remediation. Despite limited and mixed evidence regarding its efficacy, remedial education is often provided as an intervention with the intent of potentially promoting the academic success of students with lower high school academic preparation. In this study, we contribute to the literature by examining the impact of remedial education on students' engineering pathways and influence on graduation probability and grade outcomes.

We additionally contribute to the literature by focusing on remedial education at a research-intensive four-year institution. Previous studies have tended to focus on remedial education at two-year colleges and other types of postsecondary institutions, leaving the question of potential applicability to research-intensive institutions, which tend to admit students with high levels of math and science preparation. Boatman & Long (2018), for example, have found that the effects of remediation can vary depending on the student's level of college preparedness. Whereas selective postsecondary institutions may be less likely to admit students in need of remediation courses, many of their programs that heavily utilize mathematics, reading, and writing may provide remedial courses to their first-year students to help narrow potential gaps in student preparation. In particular, engineering programs may offer remedial courses to students who are otherwise prepared for college level courses, but may not have had opportunities to take more advanced mathematics and science courses at the high school level. In this study, we examine such a program—a selective, research-intensive university in the Midwest offering a top-ranked engineering program. This Midwestern University engineering program requires some of their first-year engineering students to complete remedial classes in chemistry, math, and physics if their high school background did not provide them with sufficient preparation to begin the traditional engineering course sequence. Students assigned to remedial courses are considered to have potential for success in the engineering program, but likely did not have access to adequate preparation in math, chemistry, and/or physics prior to college matriculation.

This setting allows us to examine the impact of remedial courses on the progress of engineering students and their persistence. In particular, we are interested in whether these students continue in engineering, declare their engineering major on time, and graduate in the same length of time as their non-remediated peers. Research findings will help inform engineering programs, university administrators, and other stakeholders regarding the role of remedial education in engineering and whether it aids students from academically disadvantaged backgrounds to pursue and succeed in engineering. The results have the potential to significantly advance our understanding of the pathways from high school to and through college engineering. Such understanding is essential insight to provide important recommendations for innovating and refocusing interventions aimed at increasing participation and degree completion in engineering.

Literature Review

Estimates suggest that as many as 50% of all entering college students take remedial courses during their post-secondary studies (Scott-Clayton, 2018). Remedial courses are designed to provide academically underprepared students with additional skills to succeed in college-level courses, as well as to close any gaps in their preparation for their intended courses and major. Many remedial courses focus on mathematics, reading, and writing, and differences in high school preparation in these areas are often identified through some form of testing given by the student's postsecondary institution. In general, remedial courses are offered at both two-year and four-year postsecondary institutions, both public and private. Because remedial courses are taken by so many postsecondary students across different types of academic institutions, it is critical to evaluate whether remedial courses are effective in improving academic outcomes and whether the effects vary across different academic contexts.

The effects of remedial education have been controversial because while studies of its efficacy have been generally mixed with more evidence that it has negative effects, remedial education continues to be offered without clear evidence of its efficacy. The literature on post-secondary remediation has focused primarily on its use in the two-year college setting, as this is where the majority of remediation coursework takes place (e.g., Calcagno & Long, 2008; Martorell & McFarlin, 2011; Wang, Wan & Prevost, 2017; Xu & Dadgar, 2018). In a meta-analysis of over 500 college, high school, and middle school students, Yeany & Miller (1983) did not find a significant additional increase in student science achievement with remedial education, but that the identification and feedback influences science achievement positively.

There are a few studies examining the impact of remediation in the four-year college sector focusing on the effects on college credits earned, completing a degree, whether the degree is completed "on time," and whether the student transfers to another major. Findings suggest that many students who begin remediation courses do not complete the remedial sequence (Bailey, Jeong, & Cho, 2010). For those who are in remediation, studies find very little support for positive impacts (Crisp & Delgado, 2014; Clotfelter et al., 2015). Studies that have found positive impacts on degree completion and persistence use methodology that may not be fully capturing the causal impact of remediation, as they do not fully control for selection into remediation (Bettinger & Long, 2009). Boatman and Long (2018) examined the impact of remedial education on students in 2-year and 4-year colleges. They found that the lowest effects of remedial education are among students at 2-year colleges, rather than 4-year colleges. Although there has been extensive literature on remediation at two-year and less-selective four-year institutions, there has been little examination of the use of remedial coursework at selective, research intensive four-year institutions.

Many studies that examine remedial courses at four year colleges have used a regression discontinuity analysis to compare outcomes of students just below and above the testing cut-off for remediation, as most remedial programs place students in these courses based on an initial test score (e.g., Calcagno & Long, 2008; Jacob & Lefgren, 2004; Melguizo et al., 2016). These studies find mostly zero or negative impacts on credits earned and degree completion (Martorell & McFarlin, 2011; Calcagno & Long, 2008; Scott-Clayton & Rodriguez, 2015). Overall, there has been little evidence of overall positive impacts of remediation. Remedial coursework appears to be merely keeping students from progressing into the sequence of college-level coursework (Scott-Clayton & Rodriguez, 2015). However, Bettinger & Long (2009) have found that students in remedial courses may have a slightly increased probability of persistence. The literature also suggests that the impact of remediation is related to academic achievement. The students with the highest academic achievement who are assigned to remedial education often experience the largest negative impacts of the coursework on their persistence and degree completion (Scott-Clayton & Rodriguez, 2012; Martorell & McFarlin, 2011). Meanwhile, the students with the lower academic achievement experience little impact, or the smallest negative impacts of remediation programs (Boatman & Long, 2018).

Our paper contributes to this discussion by focusing on a selective, research intensive 4-year college, and on an academically competitive field—engineering. Further, we add to the literature by investigating student major choice, which has not yet been examined by other scholars. We contribute to the literature in the following ways. First, we are examining the use of remediation in a selective undergraduate institution. Second, we are specifically investigating the impact of remedial education for students at a selective undergraduate school of engineering on their likelihood of declaring a major on-time and graduating from the institution. Finally, for students who do graduate, we look at the relationship between remediation and their time to degree, as well as whether they ultimately graduate with an engineering degree. This specific focus of our paper extends the literature to test whether remediation has any benefits in a more selective setting, such as in engineering.

Conceptual Framework

Scott-Clayton & Rodriguez (2015) proposes that remedial education has three functions: "as development for future coursework, discouragement from further study, or simply a diversion onto a separate track" (p. 6). The development view proposes that although students might experience some initial setback by delaying their coursework, the benefits associated with taking remedial courses supersede these initial disadvantages over the longer term. Meanwhile, discouragement suggests that assignment to remediation may discourage students from further study because of the stigma or label of poor performance. The third view of the function of remediation, diversion, suggests that remedial education is a sorting mechanism to place students into different course sequences. Previous literature, as discussed by Scott-Clayton & Rodriguez (2015), have found evidence for each of these alternatives. In their study using regression discontinuity analysis on transcript data across six community colleges, Scott-Clayton & Rodriguez (2015) found that of the three alternatives, remediation appears to have a diversionary impact. That is, while students persist at the same rates, some students end up taking remedial courses, rather than college-level courses. They did not find evidence that remedial education helped to develop students' skills further nor did remedial education discourage student progress. We extend their work, which focuses on remediation in community colleges, to a different educational environment. Here, we test whether the function of remediation in an engineering program at a research-intensive institution is development, discouragement, and/or diversion.

Data

In order to estimate the effect of remedial education on major choice, we analyze transcript records from a sample of all first-year engineering students at a large engineering program in the Midwest. The 33,693 students matriculated between 2001 and 2016. These students applied and received admission to a college of engineering and entered the engineering curriculum in their first-year at the university. The normal progression is for students to take general requirements in the first-year and then declare a field of engineering as their major at the end of the first year or in the second semester. Students then take more specific training within their chosen field for their remaining time at the university. We consider each student as having taken remedial courses if the student started their first year in a course earlier in the sequence than the recommended first-year courses in either math, physics, or chemistry. Students are placed into these classes based on their performance on a test administered before they matriculate; however, there is some non-compliance in this sorting process (Scott-Clayton et al., 2014).

The descriptive statistics for the sample are summarized in Table 1 for the whole sample, as well as for the sub-samples of students who did or did not take remedial courses in their first year. Over the time period studied 11% of students are classified as having taken at least one remedial course. The majority of these students take remedial mathematics. As shown in the third column of Table 1, 82% of students taking a remedial course took remedial math, with 24% in remedial chemistry, and 19% in remedial physics. Students in remedial courses take an average of 1.25 total remedial courses, indicating that while most students are taking remedial math, a percentage of these students are also taking a second remedial level course, either in chemistry or physics. This composition is shown in the last column of Table 1, where the sample is restricted to the students taking at least remedial math.

There are some statistically significant differences in the characteristics of the students who took remedial courses from those who did not at this sample institution. Compared to students who did not take remedial courses, students in remedial courses have lower SAT scores, by almost one hundred points. They also take an average of fewer than one STEM Advanced Placement (AP) course prior to matriculating, whereas their non-remediating counterparts take an average of more than one STEM AP course. In this sample, 82% of students requiring remediation matriculate with no STEM AP credits, while only 63% of non-remediated students do so. There is no difference in gender representation across the two sub-samples. International students are less likely to take remedial courses. White students comprise 76% of the students who take remedial courses and 62% of the students who did not take remedial courses. Meanwhile, African American/Black or Hispanic/Latinx (underrepresented racially minoritized (URM)) students comprise 10% of the sample of students who take remedial courses compared to only 5% of the students who did not take remedial courses. Given the current low representation of URM students across engineering in general (ASEE, 2017, 2019; NSF, 2020), their relative representation in remedial courses makes examining the impact of these courses on academic pathways even more important (e.g., Attewell et al., 2006; Bahr, 2010; Flores et al., 2014).

In terms of academic outcomes, only 28% of remediated students declare engineering as their major on time (by the end of their first year of college), compared to 69% of non-remediated students. The gap is similar in terms of graduation, with 43% of the remediated students earning a degree in engineering, compared to 82% of the non-remediated students. Remediated students are slightly less likely to graduate, with only 78% receiving a four-year degree, compared to 82% of non-remediated students. For those who do graduate, students who receive remediation in their first year take an average of half a year longer to complete their degree.

Methods

To examine the impact of remedial education in this educational setting, we estimate a set of logistic and linear regressions. In particular, we estimate models of whether a student declares engineering as a major on-time (by the end of their first year) and whether they graduate. Additionally, for the sample of students who do graduate, we examine how taking remedial courses impacts their time to degree and whether they graduate with a degree in engineering. The general equation for these models is shown in equation (1):

(1) $Y_{it} = \beta_0 + \pi Remedial_i + \gamma X_{it} + \delta_t + \varepsilon_{it}$

where X is a matrix of personal characteristics including gender, race/ethnicity, number of STEM AP courses taken in high school, and composite SAT score. We include cohort fixed effects to capture trends in the outcomes, and we use robust standard errors. The coefficient π measures the associated difference in the outcome of interest (declaring major on time, graduating, majoring in engineering, and time to degree) for students who took remedial courses in their first year compared to those who did not. We also expand on these models by introducing heterogeneity in two ways. First, we examine whether the subject of the remedial course—mathematics, chemistry or physics—has a differential impact on student academic outcomes. Second, we allow for heterogeneity in the impact of remediation by gender, race/ethnicity, and academic achievement.

Results

Engineering Major Choice

Marginal effects from logistic estimations of the probability of declaring engineering as a major by the end of the first year are reported in Table 2. The results in column (1) for the base model indicate that students who took at least one remedial course in their first year were almost 41 percentage points less likely to declare engineering as their major on time. We control for academic achievement through composite SAT and number of STEM APs taken. Of course, it is quite possible that there are selection effects of remediation that this procedure does not eliminate. However, this large negative impact of remediation on declaring engineering on time (defined as second semester of college) suggests that remediation may be delaying or hindering its goal.

In the second column of Table 2 we expand our model to examine whether subject of remediation has any impact on major choice. The majority of students who take remedial education courses do so in math, but there are non-trivial numbers of students receiving remediation in either one of the other subjects, or a combination of two or more subjects. Students enrolled only in remedial math are 46 percentage points less likely than non-remediated students to declare engineering on time. The impact is quite similar for students taking two or more remedial subjects. Remedial chemistry also has a large significant negative impact on majoring in engineering, whereas taking remedial physics alone has the smallest negative impact with only 11 percentage points. These results indicate that no matter the type of remedial coursework needed, the probability of declaring engineering as a major on time is reduced quite significantly. Additionally, it is clear that taking remedial coursework in mathematics delays the major choice process the most.

Columns (3) through (5) of Table 2 allow for heterogeneity in the impact of remedial education by academic achievement, gender, and race/ethnicity. In Column (3) the remedial indicator is interacted with indicators for whether the student is in the bottom, second, or third quartile of SAT scores. Quartiles are defined for the entire sample over the time period available. Although students with stronger high school academic achievement are less likely to receive remediation, there are still non-negligible numbers of students in each SAT quartile receiving remediation (50% in the bottom quartile, 24% in the second, 17% in the third, and 8% in the top quartile). The results in Table 2 indicate that the effect of remediation on declaring engineering on time is not significantly different, regardless of academic achievement as measured by SAT score. If the negative impact of remediation is largely related to unobservable factors that correlate with measurable academic achievement that lead to placement in remediation, the effect would be larger for the students in the bottom quartile of academic achievement. Thus, remediation itself seems to have a negative effect.

By contrast, there are significant differences in the effect of remediation by gender and race/ethnicity. Female students experience a significantly smaller negative impact from remediation than do male students—a 36 percentage point decrease in probability of declaring engineering on time versus a 42 percentage point decrease for male students. The main difference by race/ethnicity is for URM students (Hispanic/Latinx and African American/Black students). URM students experience only a 31 percentage point drop in the probability of declaring engineering on time, whereas students of all other races/ethnicities experience a 42 percentage point drop. This finding suggests that while remediation overall has a negative impact as measured by this outcome, the effect is not as strong for URM students. Overall, the results in Table 2 indicate that remediation has a significant negative impact on initial major declaration.

Probability of Graduation and Time to Degree

In Table 3, we examine the long-term impact of remediation by examining the probability of graduating (first four columns), and for those who graduated between 2001 and 2011, the time to degree (final four columns). (Some students in the sample may graduate after 2011, but it is not possible to distinguish them from those who will not eventually graduate.) Students receiving remediation are significantly less likely to graduate than those not in remedial courses by 4.5 percentage points. As we found with initial major declaration, there is no difference in this impact by academic achievement. In contrast to Table 2, there are no differences in the probability of graduation by gender or race/ethnicity. Therefore, although remediation has a significantly smaller negative impact on female and URM students in terms of initial major choice, it has the same impact on all students in terms of graduation probability.

Once the sample is limited to students who graduated, there is evidence that remediation increases time to degree by roughly a third of a year. There is also heterogeneity by academic achievement (column 6). Time to degree for remediated students in the top quartile of academic achievement as measured by SAT scores is increased by a little over half of a year. This impact is similar for those in the third quartile, but significantly larger for those in the bottom two quartiles. Students receiving remediation from the bottom SAT quartile have extended time to degree by roughly 1 year, as compared to students not taking remedial courses. This represents a significant time and monetary cost for students in remedial courses. Similar to graduation probability, there are no differences in time to degree by gender or race/ethnicity.

Graduation with an Engineering Degree

Table 4 summarizes how remediation affects the major field at graduation, again limited to the sample of students who graduated. Students in remedial courses during their first year are 33.5 percentage points less likely to graduate with a degree in engineering. This effect is slightly larger for students in the middle two quartiles of the academic achievement distribution, but is smallest for female and URM students. Taken together with the results of the previous two tables, these results provide interesting insight into the pathways of remediated students in engineering. Remediation significantly delays students in their progress in the major, as well as to a degree in any field. Students are much less likely to declare engineering on time, stay in engineering, and graduate. Among students who do graduate, they do so significantly later than their non-remediated peers. However, these impacts appear to be less negative for women and URM students.

Discussion and Conclusion

Our research findings indicate that students placed in remedial courses in engineering are significantly less likely to declare their major on time and to graduate. As such, our findings suggest that in this academic environment, remediation appears to function more as a discouragement for students from further engineering study, as described by our conceptual framework drawing from Scott-Clayton & Rodriguez (2015). For students who end up majoring in a different field, remediation serves as a diversion onto a separate track from engineering. Further, for those who do graduate, the time to degree is significantly longer, and the probability of doing so with a degree in engineering is significantly lower. These results show remediation places a large cost on students. Although our estimates are unable to capture causal impacts, as students are not randomly sorted into remediation, the extremely large negative impacts that are in most cases constant across academic achievement level suggest that it is unlikely that our results are due to sorting alone. Rather, it appears that the requirement to take remedial courses places students at a strong disadvantage in their progress through the engineering degree, slowing them down, and for many, "discouraging" them from receiving a degree from the university at all. It is also possible that the label or signal of being assigned to remediation is affecting students' decisions regarding their academic pathways or further pursuit of engineering (e.g., Papay et al., 2016). Altogether, this warrants further study especially given that students in this sample have been admitted into a selective, research-intensive university and have been identified as students with high potential to succeed in postsecondary education.

Our results show large negative impacts that are in some cases much larger than those seen in past studies. There are likely two main reasons for this difference. First, we are not controlling for all selection into remedial courses. However, our study shows larger impacts than past studies that also did not fully control for selection. This leads to the second and more likely explanation, which is that it relates to the specific context we studied—an engineering program at a selective school. It is likely that our results are more indicative of how remedial education may impact students in this more focused and selective setting, than in a more general setting widely studied thus far, such as across community colleges. Therefore, while it is a limitation that our study focuses only on a single institution, we provide an initial examination of how remedial education could impact students specifically in engineering at a selective research institution. We provide additional evidence that the impact of remedial education can vary by institutional context, and that further research is needed to focus on selective research institutions more generally, especially in relation to engineering fields.

The negative relationship between remedial education and academic outcomes found in an engineering program at a selective research institution is of critical importance because it has implications for expanding the engineering workforce, as well as diversifying engineering participation. Previous studies have shown that URM students are more likely to attend high schools that offer relatively fewer math and science courses, and that college URM students are more likely to be assigned to remedial courses (e.g. Engberg & Wolniak, 2013; Darolia et al, 2020; Legewie & DiPrete, 2014; Rodriguez, 2018; Wang, 2013). In this setting, although there is a negative impact of remediation for all students, women and URM students groups fare better with remediation than do male and White students, respectively. Altogether, our findings suggest that remedial education needs to be further investigated in engineering, and that it is necessary to develop new strategies for preparing students for engineering programs entailing partnerships between K-12 and postsecondary schools, as well as a closer examination of admissions practices (e.g., Holloway et al., 2014) and student placement into college remediation (e.g. Scott-Clayton et al., 2014).

Many students who enter remediation in engineering at this institution do not continue to progress in the degree, and many do not graduate. For this institution, this is the loss of many matriculated students to which it has dedicated significant resources. For the students, this is the loss of much time spent pursuing a degree they ultimately do not obtain, as well as the monetary and emotional cost of doing so. Given the large negative relationships between remediation and the outcomes studied here, future research should continue to examine the causal impact of remediation on progress through the engineering degree. With that information, schools of engineering can better serve their incoming students, and work to contribute to broadening participation and diversifying the composition of engineering graduates. Remedial education is intended to provide equal opportunity to all incoming students, including those with less high school math and science preparation, and further research is needed to determine whether remedial education is serving its purpose.

Research findings can help inform engineering programs, university administrators, and other stakeholders regarding the role of remedial education in engineering and whether it aids students from academically disadvantaged backgrounds to pursue and succeed in engineering. Importantly, research in this area has the potential to significantly advance our understanding of the pathways from high school to and through college engineering across different groups of students. Such understanding is essential insight to provide important recommendations for innovating and refocusing interventions aimed at broadening and increasing participation in engineering.

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Table 1: Descriptive Statistics for first-year engineering students (2001-2016 starting cohorts), by remedial status

	Full Sample	Non-Remedial		Remedial	Remedial Math
Any Remedial	0.11	0.00		1.00	1.00
Remedial Chemistry	0.03	0.00		0.24	0.22
Remedial Math	0.09	0.00		0.82	1.00
Remedial Physics	0.02	0.00		0.19	0.08
Number Remedial Courses		0.00		1.25	1.30
				(0.476)	(0.510)
Engineering GPA in 1st Year	3.07	3.14	***	2.45	2.35
	(1.061)	(0.990)		(1.379)	(1.407)
Declare Engineering end of 1st year	0.64	0.69	***	0.28	0.23
Receive degree in Engineering	0.48	0.82	***	0.43	0.39
Graduate	0.62	0.82	***	0.78	0.78
Time to Degree	4.61	4.63	***	5.06	5.07
	(1.002)	(1.03)		(1.20)	(1.156)
Female	0.21	0.21		0.22	0.20
URM	0.05	0.05	***	0.10	0.10
Other Race	0.24	0.26	***	0.11	0.11
White	0.63	0.62	***	0.76	0.75
Asian American	0.07	0.07	***	0.04	0.04
International	0.21	0.23	***	0.08	0.08
# of STEM Aps	1.07	1.16	***	0.36	0.31
	(1.770)	(1.833)		(0.907)	(0.839)
Composite SAT score	1292	1303	***	1217	1208
	(125)	(123)		(115)	(113)
Observations	33,693	29,827		3,866	3,156

Notes: Stars indicate significant differences between remedial and non-remedial sub-samples.
* p<0.1; ** p<0.05; *** p<0.01

Table 2: Impact of remedial education on probability of declaring Engineering major at end of first-year

	(1)	(2)	(3)	(4)	(5)
Any Remedial	-0.408***		-0.425***	-0.419***	-0.422***
	[0.00811]		[0.0226]	[0.00901]	[0.00907]
Remedial Math only		-0.462***			
		[0.00905]			
Remedial Chemistry only		-0.352***			
		[0.0306]			
Remedial Physics only		-0.114***			
		[0.0241]			
Two or more Remedial courses		-0.432***			
		[0.0144]			
Q1 AcadAchievement X Remedial			0.0378		
			[0.0285]		
Q2 AcadAchievement X Remedial			0.0161		
			[0.0305]		
Q3 AcadAchievement X Remedial			-0.00750		
			[0.0327]		
Female X Remedial				0.0552***	
				[0.0197]	
URM X Remedial					0.114***
					[0.0257]
Other Race X Remedial					0.00633
					[0.0539]
Asian Am X Remedial					0.0465
					[0.0392]
International X Remedial					0.0276
					[0.0596]
Observations	33,693	33,693	33,693	33,693	33,693

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Marginal effects from Logistic regression reported. All models also control for cohort effects, gender, race/ethnicity, number of STEM APs taken, and composite SAT score.

Table 3: Impact of remedial education on probability of graduating, and time to degree for graduates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		graduate				ttd		
Any Remedial	-0.0452***	-0.0290	-0.0434***	-0.0565***	0.316***	0.576***	0.310***	0.281***
	[0.00854]	[0.0303]	[0.00927]	[0.00997]	[0.0275]	[0.124]	[0.0315]	[0.0307]
Q1 AcadAch X Remedial		0.0128				-0.325**		
		[0.0285]				[0.129]		
Q2 AcadAch X Remedial		-0.0476				-0.241*		
		[0.0359]				[0.136]		
Q3 AcadAch X Remedial		-0.0574				-0.206		
		[0.0384]				[0.140]		
Female X Remedial			-0.00967				0.0332	
			[0.0195]				[0.0571]	
URM X Remedial				0.00868				-0.0409
				[0.0240]				[0.100]
Other Race X Remedial				0.0469				0.0441
				[0.0368]				[0.172]
Asian Am X Rem				0.0194				0.0781
				[0.0300]				[0.121]
International X Remedial				0.0316				0.407**
				[0.0468]				[0.195]
Constant					5.574***	5.686***	5.574***	5.590***
					[0.0996]	[0.101]	[0.0997]	[0.0997]
Observations	20,172	20,172	20,172	20,172	16,418	16,418	16,418	16,418
R-squared					0.064	0.065	0.064	0.066

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Sample for columns (1) through (4) is restricted to those who matriculated between 2001 and 2011. Sample for columns (5) through (8) is further restricted to those who graduated. Results for graduation probability are marginal effects from logistic regression. All models also control for cohort fixed effects, gender, race/ethnicity, number of STEM APs, and composite SAT score.

Table 4: Impact of remedial education on probability of graduating with a degree in Engineering

	(1)	(3)	(4)	(5)
Any Remedial	-0.335***	-0.259***	-0.354***	-0.349***
	[0.0116]	[0.0379]	[0.0129]	[0.0130]
Q1 AcadAch X Remedial		-0.0439		
		[0.0331]		
Q2 AcadAch X Remedial		-0.0927**		
		[0.0386]		
Q3 AcadAch X Remedial		-0.0882**		
		[0.0405]		
Female X Remedial			0.0595***	
			[0.0156]	
URM X Remedial				0.0551**
				[0.0254]
Other Race X Remedial				0.0495
				[0.0422]
Asian Am X Remedial				0.0355
				[0.0323]
International X Remedial				-0.0180
				[0.0667]
Observations	16,418	16,418	16,418	16,418

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Marginal effects from Logistic regression reported. Sample restricted to students matriculating between 2001 and 2011, that graduated from the university. All models also control for cohort effects, gender, race/ethnicity, number of STEM APs taken, and composite SAT score.