

# The Association Between Developmental Education and 6-Year Degree Completion: A Comparison of STEM and Non-STEM Majors

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## Introduction

Degree completion is an ever-growing concern for students, policymakers, educators, and researchers. For students, completing a degree within 6 years is often seen as a marker of success, but in reality, many students struggle to meet this 6-year time frame (Shapiro et al., 2017). Developmental education courses have been designed to support underprepared students. These courses attempt to bridge the gap in academic knowledge among students who enter postsecondary education underprepared for college-level coursework. The effectiveness of these programs, however, particularly in terms of promoting degree attainment, remains an issue of debate. Some studies suggest that developmental courses improve student outcomes such as persistence (Bettinger & Long, 2009), while other studies suggest that these courses may delay or even hinder progress toward degree completion (Bailey et al., 2010).

The difficulties associated with developmental education may be particularly pronounced among science, technology, engineering, and mathematics (STEM) majors. STEM majors are known for requiring rigorous coursework and having high levels of attrition (Chen, 2013). As opposed to non-STEM majors, where students have greater flexibility in selecting their course sequencing, STEM majors often have rigid, prerequisite-heavy course sequences that could require developmental work. Taking developmental courses can delay the beginning of a student's major coursework and lead to students dropping out or delaying the completion of their degrees. A better understanding of whether developmental education affects 6-year degree completion differently for STEM versus non-STEM majors is important for informing academic policy.

As mentioned, there are mixed findings about developmental courses in the literature, and while previous research has explored overall degree completion among students with developmental education (Valentine et al., 2017), fewer studies have specifically looked at whether these courses disproportionately affect students from certain majors. Therefore, in the present study I seek to clarify the impact of developmental courses on students' completion of a baccalaureate degree within 6 years, with a specific focus on the differences between STEM and non-STEM majors. In addition, I look at demographic factors such as gender, race/ethnicity, and family income to explore how these characteristics may moderate this relationship.

This study has implications for higher education policy as well as institutional decision-making. If it is found that developmental courses have different effects on STEM and non-STEM majors, postsecondary institutions may need to reconsider the structure and placement of these courses in these degree programs. Additionally, the identification of demographic moderators can help

institutions design targeted support strategies to address the needs of a diverse student population. This will help institutions develop policies to improve degree completion rates while simultaneously striving to ensure students receive needed support.

This study is guided by the following research questions:

1. What is the association between developmental courses and degree completion by Year 6 for students in STEM versus non-STEM fields?
2. Do demographic factors such as gender, race/ethnicity, and family income moderate the relationship between developmental courses and 6-year degree completion in STEM and non-STEM fields?

## Method

The sample for the study included 10,229 students from a southern state who graduated in the class of 2021. This state had a statewide contract with ACT wherein most students took the ACT before graduating. Among these students, most were White, were female, had not taken any developmental courses, and were non-STEM majors at the end of their first year of college. See Table 1 for summary statistics characterizing the sample. In this table, we can see important differences between the group of students who took at least one developmental course and the group who did not. There were substantially more African American students in the developmental education group than in the non-developmental education group. There were also more students from families with an income of less than \$36,000, as well as more female students. There were fewer students who persisted to the second year, more non-STEM majors, and fewer students completing a baccalaureate degree. The developmental education group also had notably lower high school GPAs (HSGPA), ACT Composite (ACTC) scores, and first-year college GPAs (FYGPA).

**Table 1.** Sample Characteristics

Characteristic		Total sample	No dev ed courses	Any dev ed courses
<b><i>N</i></b>		10,229	7,527	2,702
<b>Race/ethnicity <i>n (%)</i></b>	African American	1,490 (14.6)	680 (9.0)	810 (30.0)
	American Indian/Alaska Native	46 (0.4)	34 (0.5)	12 (0.4)
	Asian	222 (2.2)	188 (2.5)	34 (1.3)
	Hispanic	1,002 (9.8)	657 (8.7)	345 (12.8)
	Native Hawaiian/Pacific Islander	7 (0.1)	5 (0.1)	2 (0.1)
	White	6,664 (65.1)	5,400 (71.7)	1,264 (46.8)
	Two or more races	438 (4.3)	310 (4.1)	128 (4.7)
	Prefer not to respond / missing	360 (3.5)	253 (3.4)	107 (4.0)
<b>Family income <i>n (%)</i></b>	<\$36K	2,992 (29.3)	1,805 (24.0)	1,187 (43.9)
	\$36K–\$60K	2,248 (22.0)	1,637 (21.7)	611 (22.6)
	\$60K–\$100K	2,348 (23.0)	1,924 (25.6)	424 (15.7)
	>\$100K	1,866 (18.2)	1,649 (21.9)	217 (8.0)
	Missing	775 (7.6)	512 (6.8)	263 (9.7)

<b>Gender</b> <i>n (%)</i>	Male	4,228 (41.3)	3,229 (42.9)	999 (37.0)
	Female	6,001 (58.7)	4,298 (57.1)	1,703 (63.0)
<b>Persistence</b> <i>n (%)</i>	No	2,017 (19.7)	1,221 (16.2)	796 (29.5)
	Yes	8,212 (80.3)	6,306 (83.8)	1,906 (70.5)
<b>STEM major</b> <i>n (%)</i>	Non-STEM	7,939 (77.6)	5,708 (75.8)	2,231 (82.6)
	STEM	2,290 (22.4)	1,819 (24.2)	471 (17.4)
<b>Baccalaureate attainment</b> <i>n (%)</i>	No	5,349 (52.3)	3,248 (43.2)	2,101 (77.8)
	Yes	4,880 (47.7)	4,279 (56.8)	601 (22.2)
<b>FYGPA</b> <i>M (SD)</i>		2.87 (0.89)	3.06 (0.79)	2.34 (0.96)
<b>HSGPA</b> <i>M (SD)</i>		3.37 (0.52)	3.51 (0.46)	2.99 (0.51)
<b>ACTC</b> <i>M (SD)</i>		21.68 (4.72)	23.25 (4.30)	17.29 (2.56)

## Measures

### ACT Composite Score

The official ACTC scores were collected from the final ACT test administration that students completed before graduating high school. These scores were obtained either through statewide school-day testing or during a national test administration.

### Cumulative HSGPA

To calculate each student's HSGPA, ACT averaged self-reported grades from up to 23 courses in English, mathematics, social studies, and the natural sciences. Sanchez and Buddin (2016) showed a strong correlation between students' self-reported HSGPA and their transcript GPA. Additional research supports the reliability of self-reported data for research purposes (Camara et al., 2003; Kuncel et al., 2005; Shaw & Mattern, 2009).

### Demographic Variables

The study examined three self-reported demographic variables: gender, race/ethnicity, and family income, as detailed in Table 1. Due to low numbers of students in some racial/ethnic groups, I combined data for students identifying as American Indian/Alaska Native (0.4%), Native Hawaiian/Pacific Islander (0.1%), and two or more races (4.7%).

### Postsecondary Indicators

Official FYGPA, persistence to the second year, developmental course enrollment, and baccalaureate degree completion were obtained from student transcripts at the colleges where students enrolled immediately after high school.

## Data Analysis

To explore the relationship between developmental course enrollment and 6-year baccalaureate degree attainment, I used five logistic models in this analysis, incorporating key demographic

and academic variables and also progressively introducing interaction terms to explore moderating effects. Model 1 serves as a baseline model; this model assesses the direct effects of developmental course enrollment, STEM major status, HSGPA, ACTC score, gender, race/ethnicity, family income, FYGPA, and persistence to degree attainment.

$$\text{Model 1. } \text{logit}(P(BA)) = \beta_0 + \beta_1(\text{Any Developmental Course}) + \beta_2(\text{STEM Major}) + \beta_3(\text{HSGPA}) + \beta_4(\text{ACTC}) + \beta_5(\text{Gender}) + \beta_6(\text{Race/Ethnicity}) + \beta_7(\text{Family Income}) + \beta_8(\text{FYGPA}) + \beta_9(\text{Persistence}) + \varepsilon$$

Model 2 introduces an interaction term between developmental course enrollment and STEM major to determine whether the effect of developmental education differs between STEM and non-STEM majors.

$$\text{Model 2. } \text{logit}(P(BA)) = \beta_0 + \beta_1(\text{Any Developmental Course}) + \beta_2(\text{STEM Major}) + \beta_3(\text{Any Developmental Course} \times \text{STEM Major}) + \beta_4(\text{HSGPA}) + \beta_5(\text{ACTC}) + \beta_6(\text{Gender}) + \beta_7(\text{Race/Ethnicity}) + \beta_8(\text{Family Income}) + \beta_9(\text{FYGPA}) + \beta_{10}(\text{Persistence}) + \varepsilon$$

Model 3 builds on Model 2 by including gender as a moderator. This model explores whether gender further affects the impact of developmental coursework across students from STEM and non-STEM majors. Similarly, Model 4 examines whether the influence of developmental course enrollment varies across racial/ethnic groups within STEM and non-STEM majors. Finally, Model 5 explores whether family income moderates the impact of developmental course enrollment on degree completion in STEM and non-STEM majors.

$$\text{Model 3. } \text{logit}(P(BA)) = \beta_0 + \beta_1(\text{Any Developmental Course}) + \beta_2(\text{Gender}) + \beta_3(\text{STEM Major}) + \beta_4(\text{Any Developmental Course} \times \text{Gender}) + \beta_5(\text{Any Developmental Course} \times \text{STEM Major}) + \beta_6(\text{Gender} \times \text{STEM Major}) + \beta_7(\text{Any Developmental Course} \times \text{Gender} \times \text{STEM Major}) + \beta_8(\text{HSGPA}) + \beta_9(\text{ACTC}) + \beta_{10}(\text{Race/Ethnicity}) + \beta_{11}(\text{Family Income}) + \beta_{12}(\text{FYGPA}) + \beta_{13}(\text{Persistence}) + \varepsilon$$

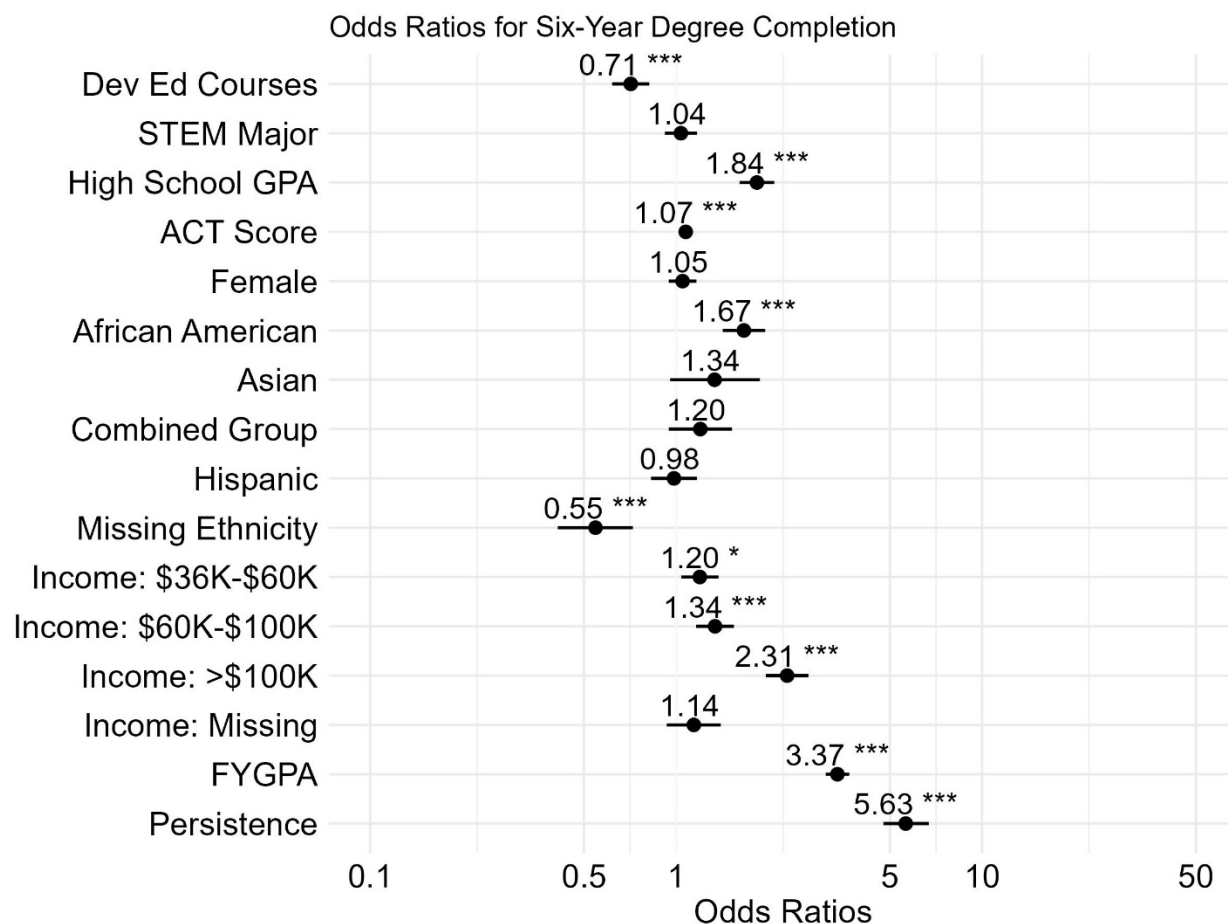
$$\text{Model 4. } \text{logit}(P(BA)) = \beta_0 + \beta_1(\text{Any Developmental Course}) + \beta_2(\text{Race/Ethnicity}) + \beta_3(\text{STEM Major}) + \beta_4(\text{Any Developmental Course} \times \text{Race/Ethnicity}) + \beta_5(\text{Any Developmental Course} \times \text{STEM Major}) + \beta_6(\text{Race/Ethnicity} \times \text{STEM Major}) + \beta_7(\text{Any Developmental Course} \times \text{Race/Ethnicity} \times \text{STEM Major}) + \beta_8(\text{HSGPA}) + \beta_9(\text{ACTC}) + \beta_{10}(\text{Gender}) + \beta_{11}(\text{Family Income}) + \beta_{12}(\text{FYGPA}) + \beta_{13}(\text{Persistence}) + \varepsilon$$

$$\text{Model 5. } \text{logit}(P(BA)) = \beta_0 + \beta_1(\text{Any Developmental Course}) + \beta_2(\text{Family Income}) + \beta_3(\text{STEM Major}) + \beta_4(\text{Any Developmental Course} \times \text{Family Income}) + \beta_5(\text{Any Developmental Course} \times \text{STEM Major}) + \beta_6(\text{Family Income} \times \text{STEM Major}) + \beta_7(\text{Any Developmental Course} \times \text{Family Income} \times \text{STEM Major}) + \beta_8(\text{HSGPA}) + \beta_9(\text{ACTC}) + \beta_{10}(\text{Gender}) + \beta_{11}(\text{Race/Ethnicity}) + \beta_{12}(\text{FYGPA}) + \beta_{13}(\text{Persistence}) + \varepsilon$$

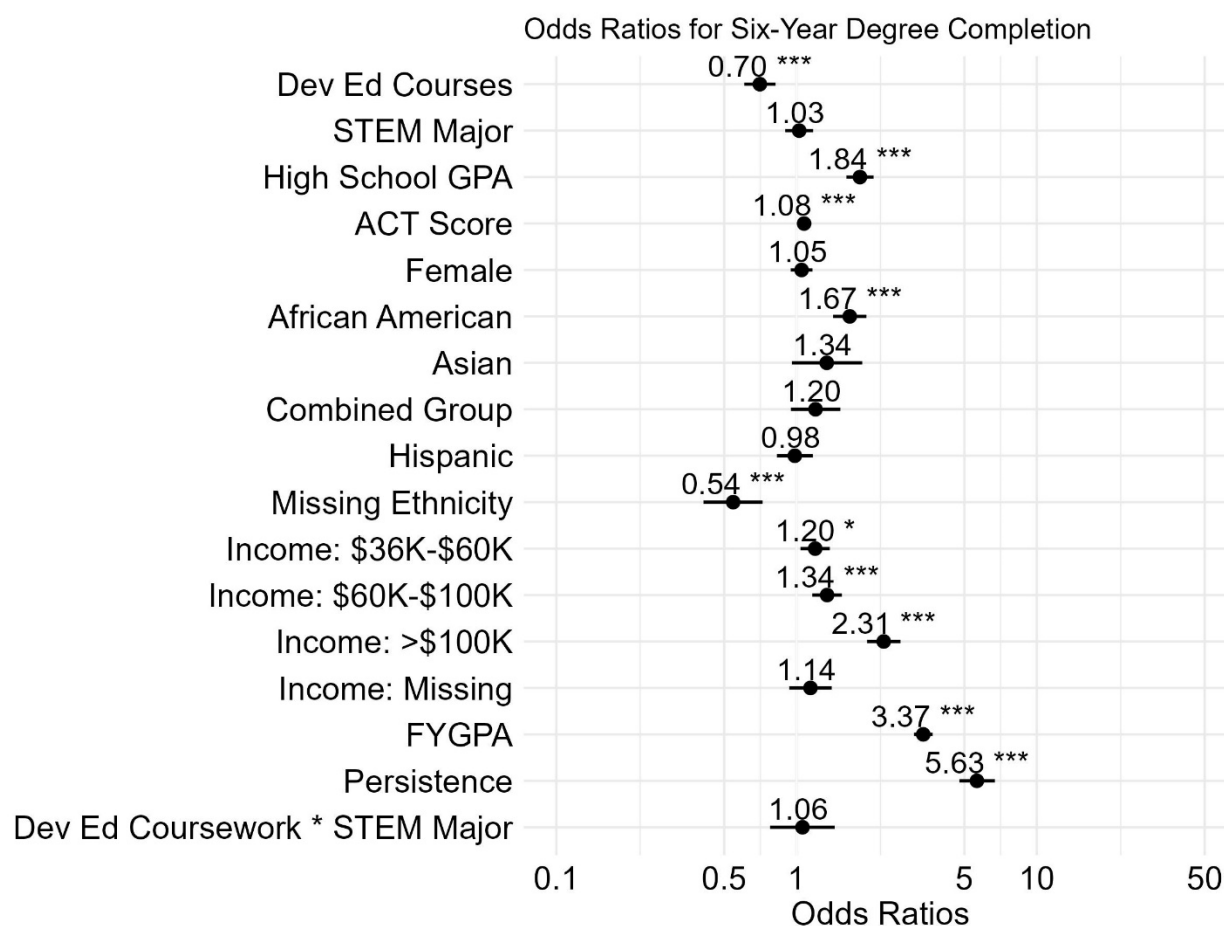
## What is the association between developmental courses and degree completion by Year 6 for students in STEM versus non-STEM fields?

We can see from Figure 1 (Model 1) that the odds ratio for students taking any developmental courses was 0.71 (see the appendix for all model odds ratios). This means that these students were less likely than students who did not take developmental courses to graduate with a baccalaureate degree within 6 years. In Model 2, which introduced an interaction between developmental course taking and STEM major declaration, that interaction was not significant, indicating that the effect of developmental courses on 6-year degree attainment did not differ by declared major ([Figure 2](#)).

**Figure 1.** Odds Ratios for Model 1



*Note.* The reference groups for the predictor variables were no developmental course taking, non-STEM major, male, White, and a family income of less than \$36,000. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

**Figure 2. Odds Ratios for Model 2**

*Note.* The reference groups for the predictor variables were no developmental course taking, non-STEM major, male, White, and a family income of less than \$36,000. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

## Do demographic factors such as gender, ethnicity, and family income moderate the relationship between developmental courses and 6-year degree completion in STEM and non-STEM fields?

None of the three-way interactions between demographic characteristics (gender, race/ethnicity, and family income), developmental course taking, and declared major (Models 3, 4, and 5) were statistically significant. This indicates that the effect of developmental course taking by declared major was the same across levels of gender, race/ethnicity, family income, and major. While no significant three-way interactions were found, a significant interaction between developmental course taking and gender was found in Model 3, and a significant interaction between developmental course taking and STEM major was found in Model 5. Compared to male students who took developmental courses, female students who took developmental courses



were 0.68 times as likely to complete a baccalaureate degree in 6 years. STEM majors who took developmental courses were 1.66 times as likely to complete a degree within 6 years as non-STEM majors and those who did not take developmental courses.

## Discussion

In this technical brief, I examined the impact of developmental course enrollment on 6-year baccalaureate degree completion, incorporating demographic and academic factors. The findings of this study indicate that students who are enrolled in developmental courses were significantly less likely to complete their degrees within 6 years compared to those who were not. The odds ratio of 0.71 suggests that developmental coursework is associated with a smaller likelihood of timely degree completion. This may be because students who are enrolled in developmental courses are not academically prepared for college coursework, requiring that they add semesters of coursework before attempting the required sequenced courses. That said, the interaction between developmental course enrollment and STEM major status was not significant in Model 2, which indicates that the impact of developmental education was consistent across both STEM and non-STEM majors.

Additional analyses looked at whether gender, race/ethnicity, and family income moderated the relationship between developmental education and degree attainment. These models, which tested a three-way interaction, found no significant moderating effects, indicating that the impact of developmental course taking on 6-year degree attainment was similar across demographic groups. This indicates that students from all backgrounds, regardless of gender, race/ethnicity, or family income, face similar outcomes when enrolling in developmental courses.

This study raises some important considerations and implications for higher education policy and practice. Given that students who take developmental courses are often less academically prepared for college and that taking these courses is linked to lower 6-year graduation rates across all student groups, institutions should consider how these courses are structured. Additionally, exploring alternative support mechanisms to supplement instruction could be beneficial. By providing targeted academic support and resources, institutions can better address the unique needs of these students and improve their chances of timely graduation. To improve student outcomes, it is important to maximize the efficacy of developmental courses. Future research could explore innovative strategies to make these courses more effective, ensuring that students are better prepared for the challenges of STEM majors.

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## Appendix

**Table A1.** Model 1 Odds Ratios

Predictors	Odds ratio	Std. error	<i>p</i>
(Intercept)	0.00	0.00	<.001
Dev ed coursework	0.71	0.05	<.001
STEM major	1.04	0.06	.560
HSGPA	1.84	0.12	<.001
ACTC score	1.07	0.01	<.001
Gender: Female	1.05	0.06	.362
Race: African American	1.67	0.14	<.001
Race: Asian	1.34	0.23	.092
Race: Combined group	1.20	0.15	.133
Race: Hispanic	0.98	0.09	.854
Race: Missing	0.55	0.08	<.001
Income: \$36K–\$60K	1.20	0.09	.013
Income: \$60K–\$100K	1.34	0.10	<.001
Income: >\$100K	2.31	0.19	<.001
Income: Missing	1.14	0.12	.199
FYGPA	3.37	0.15	<.001
Persistence	5.63	0.49	<.001

*Note:* Observations = 10,229; Tjur's  $R^2$  = 0.380; *p*-values < .05 are considered statistically significant.

**Table A2.** Model 2 Odds Ratios

Predictors	Odds ratio	Std. error	p
(Intercept)	0.00	0.00	<.001
Dev ed coursework	0.70	0.05	<.001
STEM major	1.03	0.07	.709
HSGPA	1.84	0.12	<.001
ACTC score	1.08	0.01	<.001
Gender: Female	1.05	0.06	.365
Race: African American	1.67	0.14	<.001
Race: Asian	1.34	0.23	.092
Race: Combined group	1.20	0.15	.133
Race: Hispanic	0.98	0.09	.851
Race: Missing	0.54	0.08	<.001
Income: \$36K–\$60K	1.20	0.09	.013
Income: \$60K–\$100K	1.34	0.10	<.001
Income: >\$100K	2.31	0.19	<.001
Income: Missing	1.14	0.12	.198
FYGPA	3.37	0.15	<.001
Persistence	5.63	0.49	<.001
Dev ed coursework * STEM major	1.06	0.17	.717

*Note.* Observations = 10,229; Tjur's  $R^2$  = 0.380;  $p$ -values < .05 are considered statistically significant.

**Table A3.** Model 3 Odds Ratios

Predictors	Odds ratio	Std. error	<i>p</i>
(Intercept)	0.00	0.00	<.001
Dev ed coursework	0.90	0.11	.391
Gender: Female	1.11	0.08	.127
STEM major	0.99	0.10	.910
HSGPA	1.84	0.12	<.001
ACTC score	1.08	0.01	<.001
Race: African American	1.67	0.14	<.001
Race: Asian	1.33	0.23	.097
Race: Combined group	1.20	0.15	.131
Race: Hispanic	0.98	0.09	.854
Race: Missing	0.54	0.08	<.001
Income: \$36K–\$60K	1.19	0.09	.016
Income: \$60K–\$100K	1.33	0.10	<.001
Income: >\$100K	2.30	0.19	<.001
Income: Missing	1.14	0.12	.213
FYGPA	3.36	0.15	<.001
Persistence	5.64	0.49	<.001
Dev ed coursework * Gender: Female	0.68	0.10	.007
Dev ed coursework * STEM major	0.90	0.23	.685
Gender: Female * STEM major	1.08	0.15	.570
Dev ed coursework * Gender: Female * STEM major	1.25	0.41	.493

*Note.* Observations = 10,229; Tjur's  $R^2$  = 0.381; *p*-values < .05 are considered statistically significant.

**Table A4.** Model 4 Odds Ratios

Predictors	Odds ratio	Std. error	p
(Intercept)	0.00	0.00	<.001
Dev ed coursework	0.65	0.06	<.001
Race: African American	1.53	0.19	<.001
Race: Asian	1.46	0.35	.110
Race: Combined group	1.05	0.17	.747
Race: Hispanic	1.03	0.12	.765
Race: Missing	0.45	0.08	<.001
STEM major	1.01	0.08	.885
HSGPA	1.83	0.12	<.001
ACTC score	1.07	0.01	<.001
Gender: Female	1.05	0.06	.351
Income: \$36K–\$60K	1.20	0.09	.012
Income: \$60K–\$100K	1.34	0.10	<.001
Income: >\$100K	2.31	0.19	<.001
Income: Missing	1.14	0.12	.201
FYGPA	3.39	0.15	<.001
Persistence	5.64	0.49	<.001
Dev ed coursework * Race: African American	1.35	0.24	.092
Dev ed coursework * Race: Asian	0.65	0.36	.438
Dev ed coursework * Race: Combined group	1.39	0.44	.296
Dev ed coursework * Race: Hispanic	0.85	0.19	.457
Dev ed coursework * Race: Missing	1.73	0.68	.162
Dev ed coursework * STEM major	1.23	0.28	.360
Race: African American * STEM major	0.78	0.17	.253
Race: Asian * STEM major	0.94	0.38	.886
Race: Combined group * STEM major	1.47	0.48	.237

Predictors	Odds ratio	Std. error	p
Race: Hispanic * STEM major	1.12	0.28	.647
Race: Missing * STEM major	1.90	0.74	.100
Dev ed coursework * Race: African American * STEM major	1.12	0.44	.769
Dev ed coursework * Race: Asian * STEM major	1.03	1.07	.981
Dev ed coursework * Race: Combined group * STEM major	0.47	0.34	.298
Dev ed coursework * Race: Hispanic * STEM major	0.53	0.30	.267
Dev ed coursework * Race: Missing * STEM major	0.23	0.23	.142

*Note.* Observations = 10,229; Tjur's  $R^2$  = 0.382;  $p$ -values < .05 are considered statistically significant.

**Table A5.** Model 5 Odds Ratios

Predictors	Odds ratio	Std. error	p
Intercept	0.00	0.00	<.001
Dev ed coursework	0.71	0.09	.005
Income: \$36K–\$60K	1.22	0.12	.039
Income: \$60K–\$100K	1.34	0.12	.001
Income: >\$100K	2.37	0.24	<.001
Income: Missing	1.43	0.20	.011
STEM major	1.00	0.14	.999
HSGPA	1.83	0.12	<.001
ACTC	1.07	0.01	<.001
Gender: Female	1.05	0.06	.375
Race: African American	1.66	0.14	<.001
Race: Asian	1.33	0.23	.098
Race: Combined group	1.19	0.14	.147
Race: Hispanic	0.99	0.09	.879
Race: Missing	0.55	0.08	<.001
FYGPA	3.38	0.15	<.001



Predictors	Odds ratio	Std. error	<i>p</i>
Persistence	5.64	0.49	<.001
Dev ed coursework * Income: \$36K–\$60K	1.03	0.18	.864
Dev ed coursework * Income: \$60K–\$100K	1.14	0.21	.471
Dev ed coursework * Income: >\$100K	0.96	0.23	.870
Dev ed coursework * Income: Missing	0.60	0.15	.046
Dev ed coursework * STEM major	1.66	0.43	.048
Income: \$36K–\$60K * STEM major	1.06	0.21	.748
Income: \$60K–\$100K * STEM major	1.05	0.20	.803
Income: >\$100K * STEM major	1.10	0.23	.657
Income: Missing * STEM major	0.76	0.22	.341
Dev ed coursework * Income: \$36K–\$60K * STEM major	0.49	0.20	.078
Dev ed coursework * Income: \$60K–\$100K * STEM major	0.47	0.21	.089
Dev ed coursework * Income: >\$100K * STEM major	0.32	0.19	.052
Dev ed coursework * Income: Missing * STEM major	0.59	0.41	.451

*Note.* Observations = 10,229; Tjur's  $R^2$  = 0.382; *p*-values < .05 are considered statistically significant.



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