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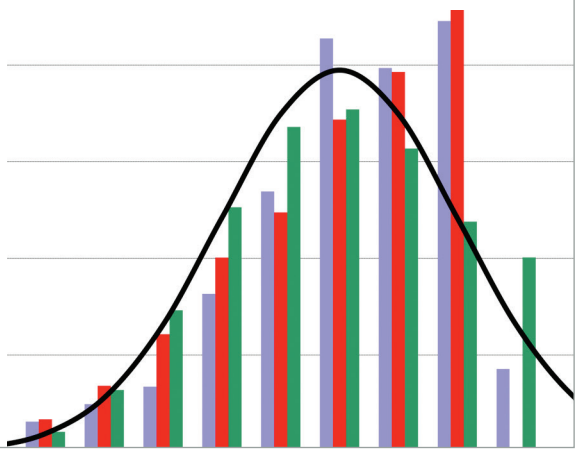

A Study of the Effectiveness of Developmental Courses for Improving Success in College

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Abstract

There is a growing view that students who enroll in developmental courses are less successful in completing their programs than non-developmental students. Nevertheless, even though developmental students as a group ultimately might not be as academically successful as non-developmental students, many of them might still derive benefit from taking developmental courses. In this paper we address the question, "Does taking developmental courses benefit students *at all*, in the sense that they are more successful than they would have been if they had not taken developmental courses?"

Data for the study consisted of ACT® Test and college outcomes data for over 118,000 students who first enrolled in one of 75 two-year and four-year postsecondary institutions. We compared the success of students who initially enrolled in six developmental courses in English, mathematics, or reading with those of students who initially enrolled in associated higher-level courses. We first estimated probabilities of success with respect to twelve outcome variables ranging from performance in the associated higher-level college course to Bachelor's degree completion in six years. The probabilities of success were conditioned on ACT Test score, enrollment status (full- or part-time), college type (two-year vs. four-year), and the grade received in the developmental course (if taken). We then compared the probabilities of success of students who did and did not take the developmental course, but who otherwise were similar.

Like others, we found that the developmental students in this study were less successful as a group than the non-developmental students with respect to GPA/persistence over time and degree completion within a fixed time period. Further consideration of time to degree, however, showed that developmental students typically completed a Bachelor's degree in six years at a rate similar to or higher than that of non-developmental students in five years.

Particular subgroups of developmental students, as characterized by their ACT Test scores, the grade they received in the developmental course, and their enrollment status benefited from taking the developmental course. In particular, students who received an A (or sometimes a B) grade in the developmental course appeared to benefit from taking it. Moreover, part-time students appeared to derive more benefit from taking developmental courses than full-time students did.

The report concludes with a discussion about the practical implications of these findings and possible contributing factors to academic success, such as the quality of developmental instruction, the time needed to complete a degree, and the noncognitive characteristics of developmental students.

Acknowledgement

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A Study of the Effectiveness of Developmental Courses for Improving Success in College

Policy makers have in recent years increased their scrutiny of developmental instruction in college. Underlying their scrutiny is a long-held frustration that despite massive expenditures in K-12 education, students are graduating from high school unprepared to do college-level work (e.g., ACT, 2012a; Greene & Winters, 2005; "Student readiness: The challenge for colleges," 2006). As a result, the number of students who take developmental courses remains significantly high; about 36% of U.S. freshmen enroll in at least one developmental course upon entry to college (Adelman, 2004; Attewell, Lavin, Domina, & Levey, 2006; National Center for Education Statistics (NCES), 2008). Vandal (2010) reported that many states have remediation rates between 30 and 40%, and rates for some states exceed 50%. In the academic year 2009-2010, developmental instruction was provided by nearly all public two-year colleges, 75% of public four-year institutions, and 66% of private four-year institutions (NCES, 2010).

Compounding policy makers' frustration is the growing view that students who enroll in developmental courses are less successful than non-developmental students in completing their programs. For example, NCES (2004) found that 30% of 1992 12th graders who enrolled in developmental coursework in college had completed a degree or certificate by 2000, compared to 69% of non-developmental college enrollees. National Education Longitudinal Study (NELS) data also showed that less than 25% of community college students who enrolled in developmental education completed a degree or certification program within eight years of enrollment, compared to 40% of similar students who did not enroll in developmental education (Attewell et al., 2006).

Other studies, however, report more positive outcomes, with developmental students having a greater likelihood of completing a Bachelor's degree than similar students who did not take developmental coursework (Adelman, 2006; Bettinger & Long, 2005a; Boylan, Bonham, & Bliss, 1992). Bettinger and Long (2005a) found that students who enrolled in developmental mathematics were 10% more likely to complete a Bachelor's degree than students not enrolled in developmental mathematics. The gap was even wider for English, with a difference in likelihood of 17% favoring English developmental students over non-developmental students. Still other studies concluded that developmental instruction is beneficial for persistence to the second year (Calcagno and Long (2008) report a 2.0 to 3.8 percentage point difference), but not for later college outcomes (e.g., Boatman & Long, 2010).

It is likely that the differences in the findings of these studies result from differences in their research design.[1] Important design characteristics are:

- the stated or implied definition of developmental education (developmental coursework) vs. the combination of developmental coursework, support programs and services;
- the college outcomes examined;
- the characteristics of the students studied (e.g., high vs. low achievement, full-time students only, purpose for enrolling, etc.);
- the methodology used (descriptive vs. regression modeling); or
- the lack or inclusion of statistical controls for relevant group differences, including prior academic preparation.

Most studies also do not consider that many students enroll in, but do not complete, developmental courses in the first place (Bailey, 2009; Russell, 2008; Sawyer & Schiel, 2000).

[1] See Adelman, 2006; Attewell et al., 2006; Bahr, 2008; Bettinger & Long, 2004; 2005a; Lewis & Farris, 1996; Schoenecker, Bollman, & Evens, 1996; and Weissman, Silk, & Bulakowski, 1995 for specific design details and comparisons of designs across studies.

Students are also frustrated. Not only are most developmental students ultimately unsuccessful; they incur substantial debt, loss of time and money, and student loan "hangovers" (Bailey, Jeong, & Cho, 2010, "Experts: Remedial classes need fixing," 2012), as well as lower self-esteem, greater frustration, and higher dropout rates (Bettinger & Long, 2007). They may also reduce their eligibility for financial aid (Bettinger & Long, 2005b).

Further, the costs of postsecondary education have continued to increase while the ability of state and federal governments to subsidize it has eroded (Bettinger & Long, 2007; Merisotis & Phipps, 2000; Russell, 2008). Current annual costs to states and students for developmental instruction are estimated at $1.9 to $2.3 billion dollars at community colleges and $500 million at four-year colleges (Bailey et al., 2010; Strong American Schools, 2008). Individual state estimates fall in the tens of millions of dollars (Saxon & Boylan, 2001; Florida Office of Program Policy Analysis and Government Accountability, 2006; Ohio Board of Regents, 2006).

Policy makers are questioning whether in a time of constrained financial resources, subsidizing developmental education is a wise use of public money. Some states and college systems have already restricted developmental coursework to two-year colleges (e.g., Florida, Kansas, Illinois, the CUNY system). Others have placed limitations on developmental courses by four-year colleges (Bettinger & Long, 2005a; "Experts: Remedial classes need fixing," 2012; Merisotis & Phipps, 2000; Saxon & Boylan, 2001). Parker (2007) reported that 22 states and systems had reduced or eliminated remedial coursework.

Key considerations in discussions about developmental education are its costs and benefits. In this report, we consider questions related to benefits: To what extent do developmental courses adequately prepare students for standard first-year college courses? To what extent do they adequately prepare students for longer-term success in college (as measured

by retention, grade point average (GPA), degree completion, etc.)? The overarching questions are "Does developmental instruction benefit students, and how can we measure benefit?"

Phipps (1998) identified four questions that postsecondary institutions need to answer in evaluating the effectiveness of developmental instruction:

1. Do students successfully complete developmental courses?
2. Do students move from developmental instruction to college-level work?
3. Do students who take developmental courses eventually complete college-level courses?
4. Are developmental students persisting and reaching their academic goals?

Implicit in these questions is the hope that students who successfully complete developmental courses will ultimately succeed in rates comparable to those of students who do not need to take developmental courses.

Most research to date has compared the overall success of developmental students as a group with that of non-developmental students; a typical finding is that developmental students are not as successful in the long term as non-developmental students. We ask a different question: "Does taking developmental courses benefit students *at all*, in the sense that they are more successful than they would have been if they had not taken developmental courses?" This question relates to "value-added": Even if taking developmental courses does not add enough value to make students as a group as likely to succeed as non-developmental students, does it add any value at all? Would students have been just as unlikely to succeed if they had not taken developmental courses?

Aside from providing information about whether developmental instruction adds value to students' attempts to succeed academically, answers to this question could focus attention on

determinants of success other than prior academic preparation and subsequent instruction. We describe other possible determinants in the discussion section of this report.

Ideally, one could measure value added by randomly assigning students who are recommended to take developmental courses either to take the developmental courses or to enroll directly in traditional college-level courses instead. The difference between the success rates of the two groups would reflect the benefit, if any, of taking developmental courses. For several reasons, of course, this kind of experiment is unlikely to be done.

An alternative approach to estimating the benefit of developmental coursework (Perkhounkova, Noble, & Sawyer, 2005) is based on operational data from course placement systems. With this method, we compare developmental students' conditional probability of success, given test scores, with the corresponding conditional probability of success of non-developmental students with similar test scores.

1. First, estimate the conditional probability of success from the test score and outcome data of students who first take a developmental course before taking the associated higher-level course. This conditional probability of success $P_{Dev}(x)$ is a function of the test score x.
2. Then, estimate the conditional probability of success from the test score and outcome data of non-developmental students (students who enroll directly in the associated higher-level course). This conditional probability of success $P_{NonDev}(x)$ is also a function of the test score x.
3. Compare the estimated conditional probability of success function of developmental students, $P_{Dev}(x)$, to the estimated conditional probability of success function of non-developmental students, $P_{NonDev}(x)$, at the actual test scores of developmental students.

If the developmental course is beneficial, then the conditional probability $P_{Dev}(x)$ should be larger than the conditional probability $P_{NonDev}(x)$ at most of the test scores x observed for the developmental students. In general, the difference between the two probabilities will vary by test score. This method therefore has the potential to identify which students will benefit most from taking a developmental course.

Because students who take developmental courses typically have lower test scores than students who do not take developmental courses, this comparison requires a certain degree of extrapolation. If an institution applied cutoff scores rigidly, there would be complete extrapolation. We have found, however, that at most institutions there is considerable overlap in the test score distributions of developmental and non-developmental students, largely due to two-stage placement testing and/or advisors' authority to waive course entry requirements.

Course Data

In this study, we analyzed data for six distinct pairs of courses:

1. Developmental English Composition and Standard English Composition
2. Arithmetic and Elementary Algebra
3. Elementary Algebra and Intermediate Algebra
4. Intermediate Algebra and College Algebra
5. Developmental Reading and American History
6. Developmental Reading and Psychology

Following the approach of Perkhounkova et al. (2005), we estimated, for each course pair, the conditional probability of success (defined in various ways), given test scores and other characteristics, for students who took the lower-level course (i.e., developmental course) before

taking the associated higher-level course[2]. We then estimated the conditional probability of success for students who enrolled directly in the higher-level course. To address the first question posed by Phipps (1998), we also estimated the conditional probability of success in the lower-level course.

Perkhounkova et al. (2005) showed that developmental instruction was effective only for students who earned a B or higher grade in the developmental course. We are not aware, however, of research related to pass/fail grades in developmental courses. In this study, we examined lower-level courses with A-F grades as well as lower-level courses with pass/fail grades.

In principle, one could estimate conditional probabilities of success, given many other variables, in addition to test scores. Examples include background characteristics, high school coursework and grades, or psychosocial and situational variables. Conditioning on other variables would permit us to study particular groups of students, thereby yielding a more nuanced and accurate description of the benefit of developmental courses. Because of limitations in the data available for this study, we have conditioned only on test scores, part-time vs. full-time enrollment status, and college type (two-year vs. four-year).

Data were not available on students' academic goals, but enrollment in a two-year (vs. four-year) college, and part-time (vs. full-time) enrollment, might be considered surrogates of academic goals. Moreover, students who enroll in two-year colleges, and those who enroll in college part-time, have lower probabilities of persisting in college and completing a degree. Two- and four-year colleges also differ in the types of degrees they provide (i.e., Associate's vs.

[2] For two of the three mathematics course pairs, the lower-level course and the higher-level course were both developmental courses. To avoid confusion, in this report the term "lower-level course" refers to the first course in each course pair, and the term "higher-level course" refers to the second course in each pair. The higher-level course could be either a developmental or college-level course.

Bachelor's degrees). Furthermore, two-year colleges are perceived as being better equipped and/or less costly to provide developmental instruction (e.g., Ignash, 1997; Vandal, 2010; Shults, 2000). We therefore statistically controlled for the type of institution (two-year vs. four-year) in which students initially enrolled and their first-year enrollment status (full-time vs. part-time).

To provide additional perspective on students who take developmental courses, we also estimated the likelihood that enrolled students would take any developmental courses, as well as the number of developmental courses they would take.

Data

The data for this study consisted of the ACT Test student records and college outcomes data for 118,776 students who first enrolled in one of 75 postsecondary institutions. First-year entering cohort years ranged from 2002 to 2008[3]. The postsecondary institutions included two-year and four-year institutions from two states that explicitly use ACT Test scores for course placement[4] and from three four-year institutions from a third state that does not. All of the states are located in the south-central region of the United States.

We used students' ACT English, Mathematics, and Reading scores to predict later college outcomes. We did not use the ACT Science score as a predictor because course placement is most typically done in English, mathematics, and reading (the latter associated with placement in reading-intensive social science courses).

Institutions and Enrollment Status

Of the 75 institutions, 40 were two-year colleges and 35 were four-year colleges. In the analyses, we associated each student with the institution in which he or she first enrolled. We associated students who initially enrolled in more than one institution with the institution in

[3] The time span for follow-up data depended on the cohort year. Students and institutions were included only in analyses for which outcome data were available.
[4] ACT English, Mathematics, and Reading cutoff scores of 19.

which they completed the most terms, but included in the analyses each student's entire academic record. Thus, for 72 of the 75 institutions, we were able to follow students who transferred to other in-state institutions.

We also classified students by full-time or part-time enrollment status using credit hours attempted during their first fall and spring terms. We used credit hours earned if credit hours attempted was missing. We classified students with fewer than 24 total credit hours attempted during the first year as part-time, and those with 24 attempted hours or more as full-time.

College Course Identification and Selection

Institutions provided complete college transcripts for all their enrolled students. Using the course code list from ACT's Course Placement Service® (ACT, 2012b) and the course catalogs for the institutions, we coded all courses as first-year vs. later, by level (developmental, standard college-level, or honors) and by whether the course was specific to a particular program or major (e.g., mathematics for elementary school teachers). We retained for analysis only the developmental or first-year college-level courses in English, mathematics, reading, and the social sciences that were not specific to a particular program or college major[5]. We calculated for each student the number of developmental courses taken within each subject area, as well as the number of times a given course was taken.

We identified the courses with known sequencing (e.g., Arithmetic to Elementary Algebra or Developmental Reading to Psychology), and retained the most frequently occurring course sequences across institutions. We also required the selected courses to have data from at least 10 institutions.

We excluded from the analyses students who skipped courses in the mathematics sequence. Moreover, if students took more than two mathematics courses in the mathematics

[5] We also excluded honors courses from the analyses.

course sequence, we used only the data for the first two courses, to avoid having intervening coursework influence test score-course outcome relationships. For example, if students took Arithmetic, Elementary Algebra, and Intermediate Algebra, we used only their data for Arithmetic and Elementary Algebra.

We also required, for each pair of lower- and higher-level courses, that students took the lower-level course either before or concurrently with the first time they took the higher-level course. For students who took a lower-level course multiple times, we retained data from both the first time they took the course and from the last time they took the course prior to (or concurrently with) taking the higher-level course.

For the higher-level course in a course pair, we retained data only from the first time students took the higher-level course.

Course Grades

Although most institutions reported grades using only one grading scale, others reported grades on both an A-F and a pass/fail (or satisfactory/unsatisfactory) scale. Thus, institutions could be included in both the A-F and pass/fail analyses. For all lower-level courses except Arithmetic, slightly more than half of the institutions using a pass/fail scale were two-year institutions. For Arithmetic, only one of 13 institutions using a pass/fail was a four-year institution. We recoded all pass/fail grades to a uniform pass/fail standard: "S," "Credit," "Pass," and "P" were recoded to passing; "U," "NC," "NR," and "NOT P" were recoded to failing[6].

We transformed A-F grades in the higher-level courses to two different levels of outcome variables: a B or higher grade (successful) vs. less than a B grade (unsuccessful), and a C or higher grade (successful) vs. less than a C grade (unsuccessful). For either level of outcome

[6] We also found grades that did not fit with either scale (e.g., audit, administrative withdrawal, etc.). We omitted these grades from the analyses.

variable, we classified withdrawals as unsuccessful.[7] We also classified students who took the lower-level course in a course pair, but did not take the higher-level course, as having an unsuccessful outcome.[8]

For higher-level courses with pass/fail grades, we transformed the pass/fail grades to outcome variable levels according to the same method described in the preceding paragraph.

For all lower-level courses, A-F or pass/fail grades from the last time the course was taken were retained in their original form as predictor variables for the analyses. A-F and pass/fail grades from the first time the course was taken were recoded to outcome variables and levels according to the same method described for higher-level courses.[9]

Longitudinal College Outcomes

Each institution also provided up to six years of longer-term outcome data. The data included term-by-term credit hours attempted, credit hours earned, retention indicators, cumulative GPAs, and Associate's or Bachelor's degree completion indicators. From these variables, we coded the following binary outcome variables:

- Earned 2.0 or higher Term 1 GPA and persisted to Term 2 at the same institution
- Earned 3.0 or higher Term 1 GPA and persisted to Term 2 at the same institution
- Earned 2.0 or higher Year 1 GPA and persisted to Year 2 at the same institution
- Earned 3.0 or higher Year 1 GPA and persisted to Year 2 at the same institution
- Earned 2.0 or higher Year 2 GPA and persisted to Year 3 at the same institution
- Earned 3.0 or higher Year 2 GPA and persisted to Year 3 at the same institution

[7] The percentages of withdrawals in the higher-level courses ranged from 7% in Standard English Composition and in Psychology to 21% in Intermediate Algebra.
[8] This adjustment affected 1% or less of students in any course pair.
[9] W grades were included with A-F grades from the lower-level courses when recoded to success outcome variables and levels. The percentages of W grades ranged from 11% in Developmental English Composition to 22% in Elementary Algebra. W grades were not included as predictors of success in higher-level courses or of other college outcomes.

- Earned 2.0 or higher GPA at time of degree completion or at last term enrolled (if degree was not completed)
- Earned 2.5 or higher GPA at time of degree completion or at last term enrolled (if degree was not completed)
- Earned 3.0 or higher GPA at time of degree completion or at last term enrolled (if degree was not completed)
- Earned Associate's degree within three years (students whose first institution was two-year)
- Earned Bachelor's degree within five years (students whose first institution was two- or four-year)
- Earned Bachelor's degree within six years (students whose first institution was two- or four-year)

The last three outcomes pertain to degree completion within specified time periods. For the years spanning the data for this study, the Integrated Postsecondary Education Data System (IPEDS) standard time frame for evaluating graduation rates was 150% of normal time. This corresponds to Associate's degree completion in three years and Bachelor's degree completion in six years. IPEDS now collects graduation rates from institutions at 100%, 150%, and 200% of normal time.

Limitations of the Data

The data for this study consisted of ACT-tested college students who were enrolled in two- and four-year institutions, mostly from two south-central states. These two states use ACT English, Mathematics, and Reading scores in course placement; the two-year colleges in these

states also use ACT's COMPASS® tests (ACT, 2012c) for course placement[10]. Although a large proportion of high school graduates in both states take the ACT Test, it is not required for two-year college admission. Further research is planned that will focus on ACT COMPASS-tested, two-year college students, to help determine the effectiveness of developmental instruction for the broader pool of students enrolled in two-year colleges. ACT COMPASS data could also assist in further differentiating the academic preparedness of students in the three lower-level mathematics courses.

We focused on explicitly defined pairs of lower-level and higher-level courses in this research. Developmental education does not operate in a vacuum, however. We had no information about students' participation in other educational support programs or student services (e.g., learning communities, tutoring, etc.). Moreover, in using particular course pairs, we did not study the content or level of other coursework taken, either within or across subjects. Either of these conditions could have influenced students' success in the higher-level course or later in college.

The sample for this study represented ACT-tested enrolled students, rather than all students who enrolled in these two- and four-year institutions. As such, the students in our sample were more likely to be college-bound and traditional-aged (17-19 age bracket).

This study compares college outcomes for students who did and did not first take a developmental course. The extent to which these two groups differ on characteristics not accounted for in the models could affect the results. For example, several studies (e.g., Boylan, 1995; Ignash, 1997) noted that students enrolled in developmental coursework are more likely to be nontraditional students with economic hardship (Bettinger & Long, 2007). These students

[10] ACT COMPASS is a computer-adaptive college placement testing program that evaluates students' current knowledge and skills in Reading, Writing Skills, Writing Essay, and Mathematics. It also includes tests for placing students with limited English proficiency in appropriate courses.

might benefit differently from developmental coursework than traditional-age students do. Differences on other student characteristics such as race/ethnicity, family income, high school GPA, or behavior might also affect the results. Because some within-institution sample sizes for particular courses are small, and because data on potential covariates were incomplete, we did not include the covariates in the models for this study. We hope to do so in future research.

We examined the race/ethnicity, family income, educational plans, and high school GPAs of similar students who took the lower-level courses in this study and those who enrolled directly in the higher-level courses. The comparisons are displayed in Table 1 (for students who took developmental reading or writing courses) and in Table 2 (for students who took developmental mathematics courses). For comparability purposes, students in the higher-level courses were limited to those who scored at or below the 95th percentile of the relevant ACT Test scores of students who took the lower-level course.[11] The underrepresented minority group in Tables 1 and 2 includes African American, American Indian/Alaskan Native, and Hispanic students.

[11] Score values for the course pairs were 17 for Standard English Composition (Developmental English Composition/Standard English Composition), 16 for Elementary Algebra (Arithmetic/Elementary Algebra), 17 for Intermediate Algebra (Elementary Algebra/Intermediate Algebra), 18 for College Algebra (Intermediate Algebra/College Algebra), 20 for American History (Developmental Reading/American History), and 19 for Psychology (Developmental Reading/Psychology).

Table 1

Demographic Characteristics of Lower-Scoring Students who took Lower- or Higher-Level Courses in English and Reading Course Pairs

	Dev. English Comp.	Std. English Comp.	Dev. Reading	Am. History	Dev. Reading	Psych.
HS core curriculum						
Taken	.54	.55	.54	.61	.54	.59
Not taken	.38	.38	.38	.33	.38	.34
Missing	.08	.07	.08	.07	.08	.07
Race/ethnicity						
Underrep. minority	.38	.37	.42	.30	.40	.32
White	.53	.54	.51	.61	.51	.59
Missing	.09	.09	.07	.08	.08	.09
Family income						
< $30,000	.39	.33	.37	.29	.39	.31
$30,000-$60,000	.28	.30	.28	.31	.27	.31
$60,000-$100,000	.11	.14	.12	.16	.12	.15
> $100,000	.04	.04	.04	.05	.03	.05
Missing	.18	.18	.19	.18	.18	.18
Educational plans						
2-year college	.08	.06	.07	.04	.08	.04
4-year degree or more	.73	.78	.74	.81	.74	.80
Other	.07	.06	.08	.05	.07	.05
Missing	.11	.12	.11	.11	.11	.11
High school GPA						
Mean	2.90	3.08	2.93	3.21	2.91	3.16
Proportion missing	.18	.17	.17	.15	.17	.16
ACT subject area score						
Mean	14.5	14.8	15.1	16.8	15.1	16.0

Table 2

Demographic Characteristics of Lower-Scoring Students who took Lower- or Higher-Level Courses in Mathematics Course Pairs

	Arith.	El. Algebra	El. Algebra	Int. Algebra	Int. Algebra	Col. Algebra
HS core curriculum						
Taken	.49	.48	.52	.60	.64	.64
Not taken	.42	.43	.40	.32	.30	.29
Missing	.09	.09	.08	.08	.07	.06
Race/ethnicity						
Underrep. minority	.36	.42	.42	.41	.34	.27
White	.56	.49	.49	.51	.58	.65
Missing	.08	.08	.08	.08	.08	.08
Family income						
< $30,000	.46	.43	.40	.37	.33	.26
$30,000-$60,000	.25	.26	.28	.29	.31	.33
$60,000-$100,000	.09	.10	.12	.13	.14	.17
> $100,000	.02	.03	.03	.04	.04	.06
Missing	.18	.19	.18	.17	.17	.18
Educational plans						
2-year college	.13	.08	.08	.05	.05	.03
4-year degree or more	.67	.73	.74	.78	.79	.82
Other	.10	.07	.07	.06	.06	.05
Missing	.10	.12	.11	.11	.10	.10
High school GPA						
Mean	2.77	2.82	2.92	3.00	3.10	3.27
Proportion missing	.18	.20	.18	.17	.16	.13
ACT subject area score						
Mean	15.0	14.8	15.6	16.0	16.7	16.8

Students who took lower-level courses were, in general, more likely to have families with incomes in the lowest income range, have a lower high school GPA, and have a lower ACT Test subject area score; and were less likely to plan to complete a Bachelor's degree or more. Racial/ethnic differences were found for two of the three mathematics course pairs and for both Developmental Reading/American History and Developmental Reading/Psychology. For all but one of these course pairs, students taking the lower-level course were more likely to be from an underrepresented minority group. For the Arithmetic/Elementary Algebra course pair, however,

students taking only Elementary Algebra were more likely to be from an underrepresented minority group.

In one state, data on degree completion extended only through year five, thereby preventing conclusions about six-year degree completion for institutions in that state. As a result, we could examine six-year Bachelor's degree completion rates for only a maximum of 22 institutions.

Method

Descriptive Statistics

We calculated sample sizes and means (or proportions), pooled across institutions, for each pair of courses studied. This information is reported in Appendix A.

Participation in Developmental Courses

We first modeled the probability of a student taking any developmental coursework in English, mathematics, and/or reading, given his or her corresponding ACT Test score. We calculated a variable indicating whether a student took any developmental course in English, mathematics, or reading; it was not limited to the six courses identified for this study.

We next predicted the total number of developmental courses a student would take in each subject area, given his or her corresponding ACT Test score. The outcome variables in this analysis included repeats of the same developmental course. Across the three subject areas, the maximum number of developmental courses taken ranged from four in reading to six in mathematics.

We estimated hierarchical logistic regression models to predict these variables (see discussion below), with ACT English, Mathematics, or Reading scores as predictors. For

predicting the number of courses taken, we estimated hierarchical linear regression models and included a quadratic term for the ACT Test score to improve model fit.

Evaluating the Success of Developmental Students

We estimated hierarchical logistic regression models (described below) for predicting students' chances of a B or higher, C or higher, or a passing grade in each lower-level course the first time they took it. These models describe the relationship between predictor variables and course outcomes and account for variation in these relationships across institutions. The predictor variables were the relevant ACT Test score, full-time/part-time enrollment status, and the interaction (product) of ACT Test score with full-time/part-time enrollment status.

Next, we estimated hierarchical logistic regression models for students who enrolled in a higher-level course after first taking the associated lower-level course. To predict the 12 outcomes described previously, we used the same variables as in the lower-level course models. We also estimated models with the following additional predictor variables: the grade students received in the lower-level course, the interaction of lower-level course grade with full-time/part-time enrollment status, and the interaction of lower-level course grade with the relevant ACT Test score.

We developed separate models for students receiving A-F grades and for those receiving pass/fail grades in the lower-level course. In general, both the student sample sizes and the numbers of institutions for lower-level courses with pass/fail grades were much smaller than those with A-F grades. As a result, the analyses for these particular courses were often constrained.

Finally, we estimated models for students who enrolled directly in a higher-level course without taking the associated lower-level course. The predictor variables were the relevant ACT

Test score, full-time/part-time enrollment status, and the interaction of ACT Test score with full-time/part-time enrollment status.

Hierarchical logistic regression. Logistic regression models the relationship between the probability *p* of a successful outcome and one or more predictor variables. In the case of a single predictor *X* with observed value *x*, the logistic model is:

$$\ln[p(x)/(1-p(x))] = a + bx,$$

where *a* and *b* are regression coefficients (weights) and ln is the natural logarithm function. In hierarchical logistic regression, the intercept coefficient *a* and the slope coefficient *b* potentially vary randomly across institutions. This property reflects the natural clustering of students within institutions. The hierarchical model estimates both fixed effects (the average regression coefficients across institutions) and random effects (the variability of the regression coefficients across institutions).

In this study, we estimated random slope and random intercept models when the estimated variability in the slopes or the intercepts across institutions was significantly different from zero ($p > .01$). We also used the institution-specific mean values for each predictor variable, as well as institution type (two-year vs. four-year), to predict outcomes at the institution level. All student and institutional predictor variables (except institution type) were grand-mean centered.

Results

Descriptive Results

Tables A-1 through A-6 in Appendix A contain pooled descriptive statistics for the six course pairs. Each table contains the number of institutions, the number of students, and the means (or proportions) for all predictor and outcome variables. These statistics are presented

separately for students who took the lower-level course before taking the associated higher-level course, and for those who enrolled directly in the higher-level course. The statistics are also presented separately according to the grading scale in the lower-level course (A-F or pass/fail).

From the "No. of students" columns in Tables A-1 through A-6, we can calculate the percentage of students who took the lower-level course before taking the associated higher-level course. This percentage ranged from 6% for Developmental Reading/American History to 31% for Elementary Algebra/Intermediate Algebra. Among the students who did take the lower-level course, the percentage who earned an A-F grade (vs. a pass/fail or other grade) also varied widely: It ranged from 55% (Developmental Reading/American History) to 95% (Elementary Algebra/Intermediate Algebra).

Compared to ACT-tested enrolled freshmen nationally, the students in our sample (even those who enrolled directly in standard college-level courses) had lower average ACT Test scores. The national average ACT Composite score of enrolled freshmen in 2005-06 (ACT, 2006) was 21.9, with a standard deviation of 4.7. The average Composite scores of students in the sample who enrolled directly in standard first-year college courses (Standard English Composition, College Algebra, American History, and Psychology) ranged from 20.9 to 21.4. As one would expect, students in Developmental English Composition, Arithmetic, and Developmental Reading had much lower average Composite scores (ranging from 15.6 to 18.0). However, students who received A-F grades in lower-level English and mathematics courses typically had somewhat higher average ACT Test scores than those who received pass/fail grades.[12] For Developmental Reading (taken before either American History or Psychology), the opposite was true.

[12] The exception was Elementary Algebra/Intermediate Algebra, for which average ACT Test scores were similar for the two groups.

In general, students who took lower-level courses before taking higher-level courses were more likely to have enrolled part-time than were students who took only the higher-level courses (by .06 to .38), and were less likely to enroll in a four-year college (by .08 to .19). Students who received pass/fail grades in the lower-level course were much more likely to have enrolled full-time (by .33 to .60) than those who received A-F grades and, with the exception of Arithmetic, were more likely to have enrolled in a four-year institution (by .08 to .12).

Across the hierarchical sequence of mathematics courses, course level related strongly to the proportion of students enrolled full-time and to the proportion of students enrolled at a four-year institution: The proportion of full-time students ranged from .24 for Arithmetic to .66 for Intermediate Algebra, and the proportion enrolled at a four-year institution ranged from .20 to .37 for the same courses.

An important consideration in using lower-level course grades in predictive models, either as predictors or outcome variables, is whether they have sufficient variability. All of the lower-level courses that assigned pass/fail grades had extremely high pass rates (.94 - .98). These high pass rates limited the analyses that could be done with pass/fail grades: Moreover, we could not estimate models for many of the long-term outcomes because none of the students who received a "Pass" grade in a lower-level course achieved a successful outcome later in college.

Students who take developmental courses in college have lower Associate's and five- and six-year Bachelor degree completion rates than students who take only higher-level courses, possibly because developmental courses typically do not count towards a degree. As shown in Tables A-1 through A-6, this was generally the case for almost all course pairs. The exceptions were Elementary Algebra/Intermediate Algebra (all three degree outcomes) and

Arithmetic/Elementary Algebra (Associate's degree). We did not have sufficient data to examine five-year degree completion rates for students who took Arithmetic.

It is worth noting, however, that students who took Developmental English Composition or Developmental Reading courses completed their Bachelor's degree in six years at rates comparable to the five-year completion rates of non-developmental students. For example, the six-year Bachelor's degree completion rate for Developmental English students was .36, and the five-year Bachelor's degree completion rate for Standard English Composition students was .37. Thus, students who took lower-level courses eventually completed their Bachelor's degrees at a rate similar to that of students who enroll directly in the corresponding higher-level courses, but they required more time to do so.

Taking Developmental Coursework

Across all students in the sample, 19% took one or more developmental courses in English, 37% took one or more developmental courses in mathematics, and 6% took one or more developmental courses in reading. These values were based on any developmental English, mathematics, or reading course included in a student's transcript, not just the six courses identified for this study. The percentages for English and mathematics were somewhat higher than those reported nationally (14% and 22%, respectively; Parsad & Lewis, 2003); the percentages for reading were slightly lower (11%).

Figure 1 shows the probability of taking any developmental English, mathematics, or reading coursework, given ACT Test score. The probabilities associated with the state cutoff score of 19 on ACT English, Mathematics, and Reading are also shown in the figure. The circled portions of the lines represent extrapolations.

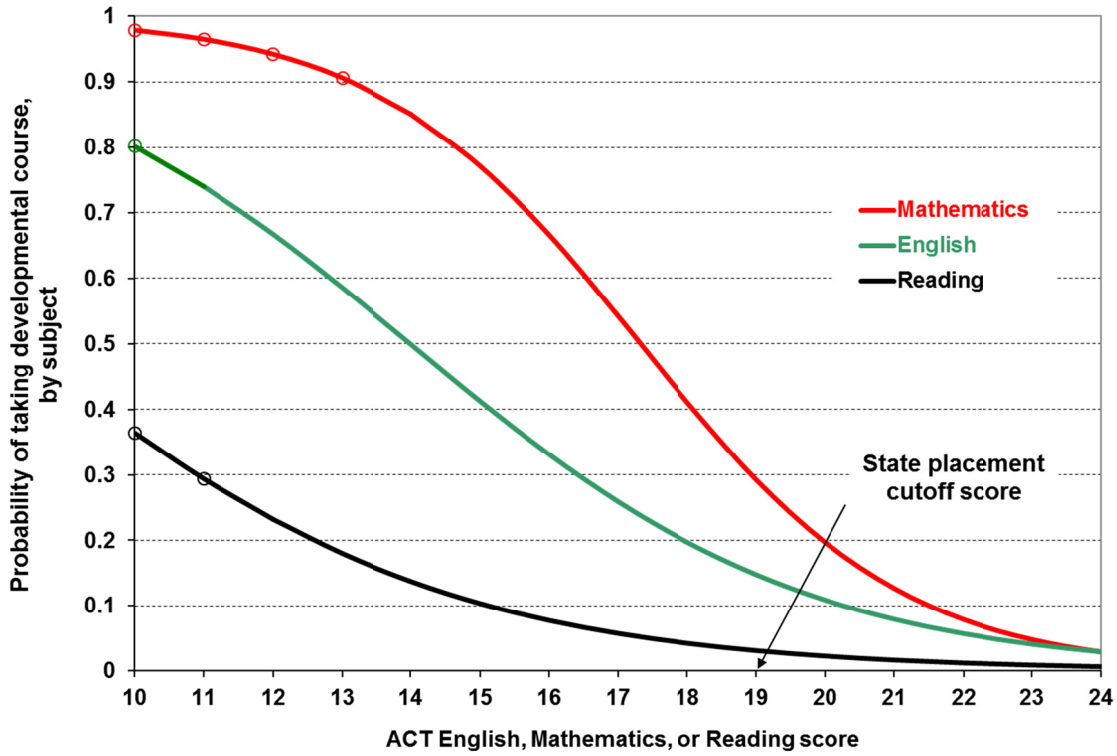

Figure 1. Probability of taking developmental English, mathematics, or reading, given ACT Test score.

The probability of taking developmental coursework was strongly and inversely related to ACT Test score. Students with an ACT Mathematics score of 19 had a .29 chance of taking developmental mathematics coursework, as compared to a .77 chance for those with a Mathematics score of 15. The corresponding probabilities for ACT English scores of 19 and 15 were .15 and .41, respectively; the probabilities for ACT Reading scores of 19 and 15 were .03 and .10, respectively. Thus, ACT English, Mathematics, and Reading score values lower than the state cutoffs corresponded to greater chances of taking a developmental course in those subjects, but not to certainty in taking a developmental course. This finding could be attributed to the fact that students were allowed to take a second test at college entry to demonstrate their preparation for higher-level coursework.

Figure 2 illustrates the expected number of developmental courses that students took, given their ACT Test scores. These results are based on the data of students who took at least one of the five developmental courses in the study, and are intended to illustrate the likelihood of students taking developmental courses multiple times, given their ACT Test score. The solid lines reflect results based on observed data (middle 90%); the circled portions of the lines represent extrapolations.

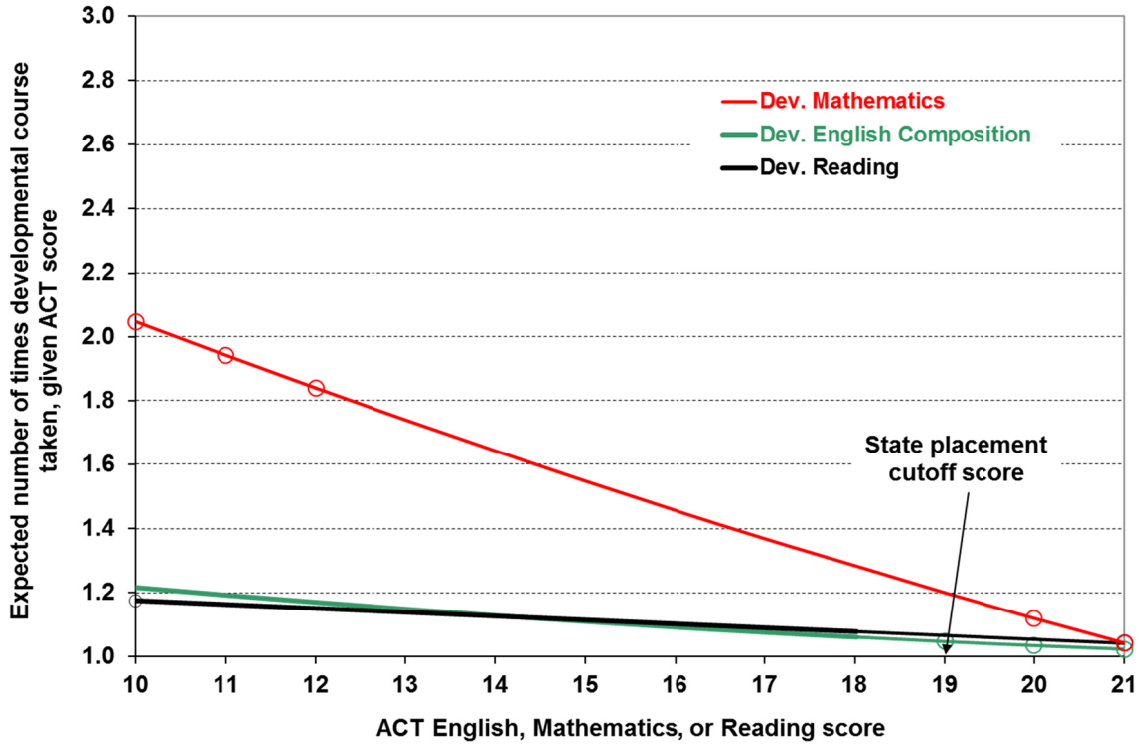

Figure 2. Expected number of times taking developmental English, mathematics, or reading courses, given ACT Test score, among students who took at least one developmental course in a subject.

The expected number of English and reading developmental courses taken was approximately 1, regardless of test score. There was a much stronger relationship, however, between the number of developmental mathematics courses taken and ACT Mathematics score. For students with Mathematics scores of 17 or lower, each 1 point decrease in score was associated with an increase of nearly .1 in the expected number of developmental mathematics

courses taken. Moreover, it is worth noting that some students with an ACT Mathematics score as high as 20 took at least one developmental mathematics course, and some would be expected to take more than one developmental mathematics course.

Models for Predicting Success in College

Table B-1 in Appendix B summarizes the six hierarchical logistic regression models for predicting success in lower-level courses. This table contains both the fixed effects (the estimated average regression coefficients across all institutions) and the variance components (estimates of the variance of the regression coefficients across institutions).

Tables B-2, B-4, B-6, B-8, B-10, and B-12 summarize the fixed effects of the models for predicting success in college (e.g., success in the associated higher-level course, retention/GPA, and degree completion). Each of these tables contains separate models for the following four student groups:

- All students who took a lower-level course before taking the associated higher-level course
- Students who took a lower-level course with an A-F grade scale before taking the associated higher-level course
- Students who took a lower-level course with a pass/fail grade scale before taking the associated higher-level course
- Students who enrolled directly in the higher-level course.

Each table shows, for every outcome variable, the institution-level and student-level coefficients. The coefficients that were not statistically significant are shaded. We removed college type and institution- and student-level interaction terms from the models when they were not statistically significant. We also removed institution-level coefficients for average lower-

level course grade and/or proportion full-time that were not statistically significant and were highly collinear with the intercept. ACT Test score, enrollment status, and lower-level course grade were retained in all models, regardless of statistical significance, as they were primary predictor variables in the study.

Tables B-3, B-5, B-7, B-9, B-11, and B-13 summarize the variance components associated with the fixed effect coefficients (intercept and slope) in the models. These tables are structured similarly to Tables B-2, B-4, B-6, B-8, B-10, and B-12.

Estimated Probabilities of Success

The fixed effects in Tables B-2, B-4, B-6, B-8, B-10, and B-12 can be used to calculate estimated probabilities of success at typical institutions. Distributions of probabilities for each course pair and outcome are summarized for all students and by selected course grades in Appendix C. In this section we illustrate and discuss the estimated probabilities for different outcome variables and under different scenarios.

Full-time/part-time enrollment status was an important predictor in most of the models. To simplify and condense the discussion, we focus on the college outcomes of full-time students only in the next sections. Comparable results for part-time students may be obtained from the first author. Following the discussion of the results for full-time students, we then report on typical differences in the results between part- and full-time students.

Developmental course outcomes for full-time students, by ACT Test score. Among the lower-level courses that used an A-F grade scale, ACT Test scores were strongly related to course success: For all courses, higher ACT Test scores corresponded to a greater probability of earning a B or higher grade. This result was also true for achieving a C or higher grade in all

lower-level courses (though the coefficient for ACT Mathematics score was not statistically significant for Arithmetic).

We obtained different results for the lower-level courses that used a pass/fail grade scale. ACT Test score was not associated with a "pass" grade in any of the lower-level courses, except for Arithmetic and Intermediate Algebra. These results are likely attributable to the very high "pass" rates and the small sample sizes for these courses. College type was not a statistically significant institution-level predictor for any of these courses and was therefore removed from these models.

Figures 3-5 illustrate the probabilities of success for each lower-level course and outcome. For all lower-level courses, students had at least a .86 probability of achieving a C or higher grade the first time they took the course, and at least a .93 probability of achieving a passing grade. Moreover, for all courses except Elementary Algebra, students in these courses had a greater than .50 probability of a B or higher grade in the course, irrespective of their ACT Test score. Elementary Algebra was the most difficult course for achieving a B or higher grade; the highest observed score (17) was associated with only a .70 probability of achieving a B or higher grade, as shown in Figure 4.

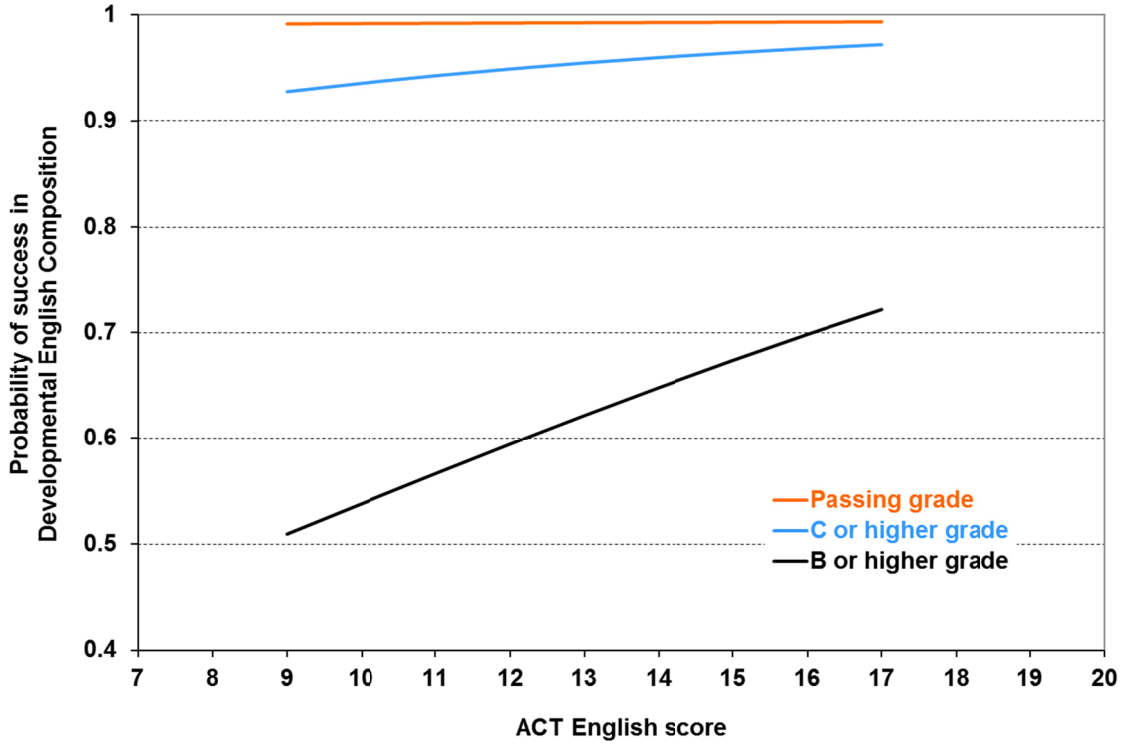

Figure 3. Probabilities of success in Developmental English Composition, first time taken, by ACT English score.

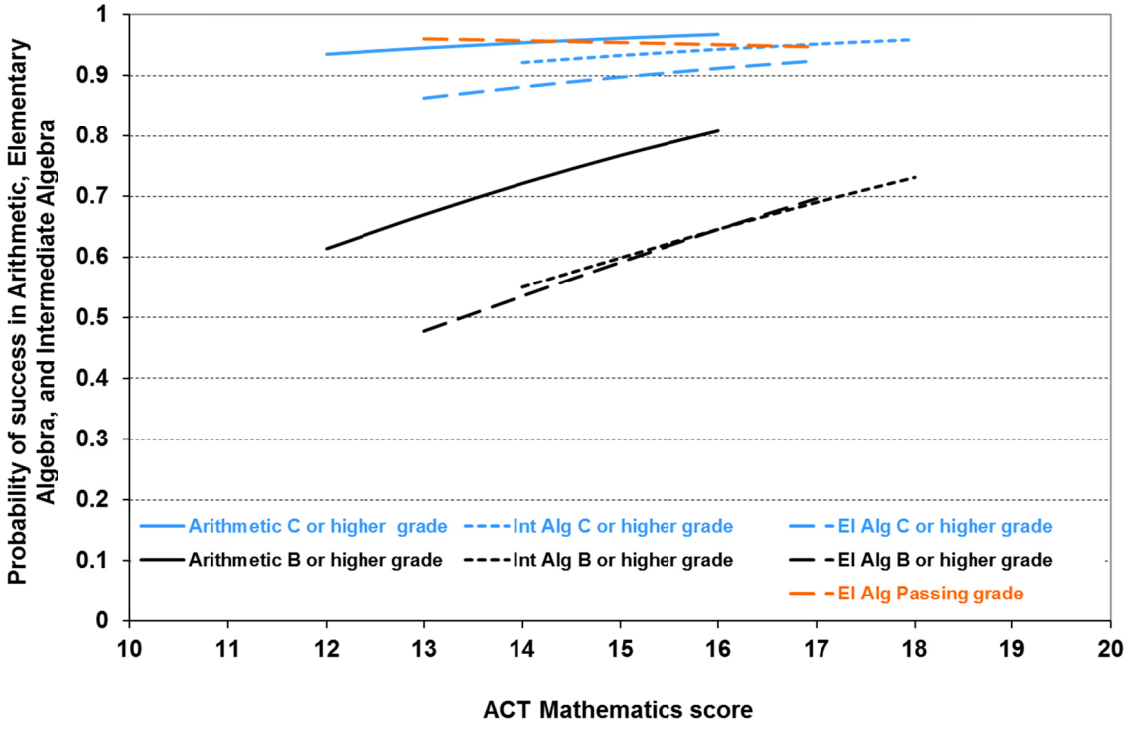

Figure 4. Probabilities of success in Arithmetic, Elementary Algebra, and Intermediate Algebra, first time taken, by ACT Mathematics score.

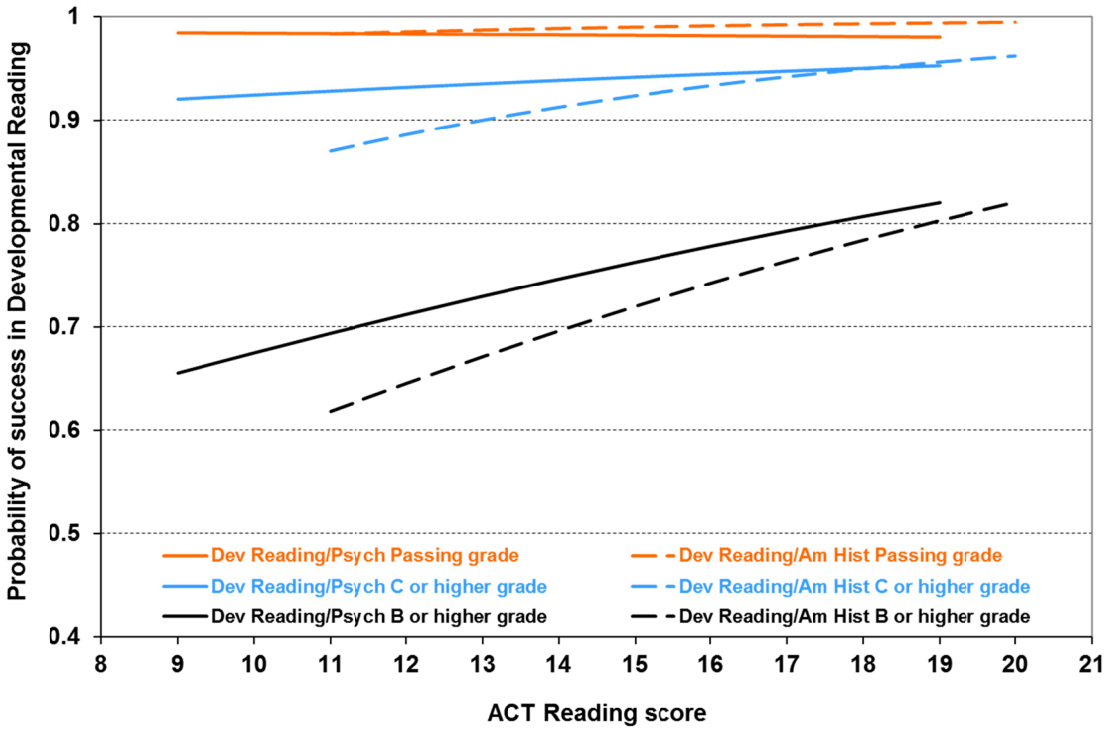

Figure 5. Probabilities of success in Developmental Reading (prior to taking either American History or Psychology), first time taken, by ACT Reading score.

Higher-level course outcomes for full-time students, by ACT Test score. As shown in Appendix B, ACT Test scores were positive and statistically significant predictors of success in all of the higher-level courses. This result pertains both to students who first took the lower-level course and to those who enrolled directly in the higher-level course.

For Standard English Composition, Elementary Algebra/Intermediate Algebra, Developmental Reading/American History, and Developmental Reading/Psychology, students who first took the lower-level course before taking the higher-level course had similar or lower probabilities of success in the higher-level course than would have been expected had they enrolled directly to that course. This result was true of both the B-or-higher and the C-or-higher success criteria.

Figures 6, 7, and 8, and Appendix C illustrate this finding. In these and subsequent figures, solid and dashed lines reflect the middle 90% of observed scores. The solid lines show estimated probabilities of success for students who enrolled directly in the higher-level course. The dashed lines show estimated probabilities of success for students who first took the lower-level course. Circles on the solid lines represent extrapolation to scores below those of students who enrolled directly in the higher-level course.

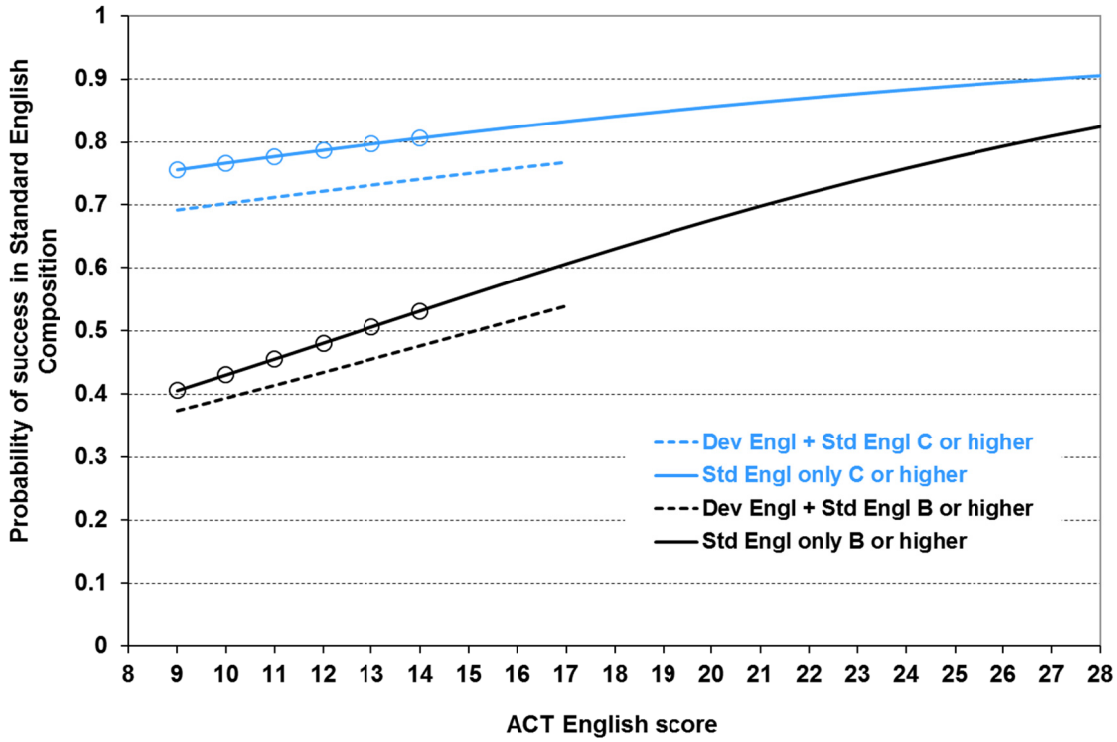

Figure 6. Probability of success in Standard English Composition with and without taking Developmental English Composition.

As shown in Figure 6, students with ACT English scores between 9 and 17 had a .75 or higher estimated probability of a C or higher grade in Standard English Composition, had they enrolled directly in the course. If they took Developmental English Composition first, however, they had a *lower* estimated probability of a C or higher grade (.69 or higher). A similar result occurred for earning a B or higher grade in Standard English Composition.

We found a similar result for Elementary Algebra/Intermediate Algebra (Figure 7). Students who first took Elementary Algebra had lower probabilities of either a B or higher grade or a C or higher grade in Intermediate Algebra than would be expected, had they enrolled directly in Intermediate Algebra. For the C or higher outcome, the differences between the two student groups in their probability of success increased slightly as ACT Mathematics score increased.

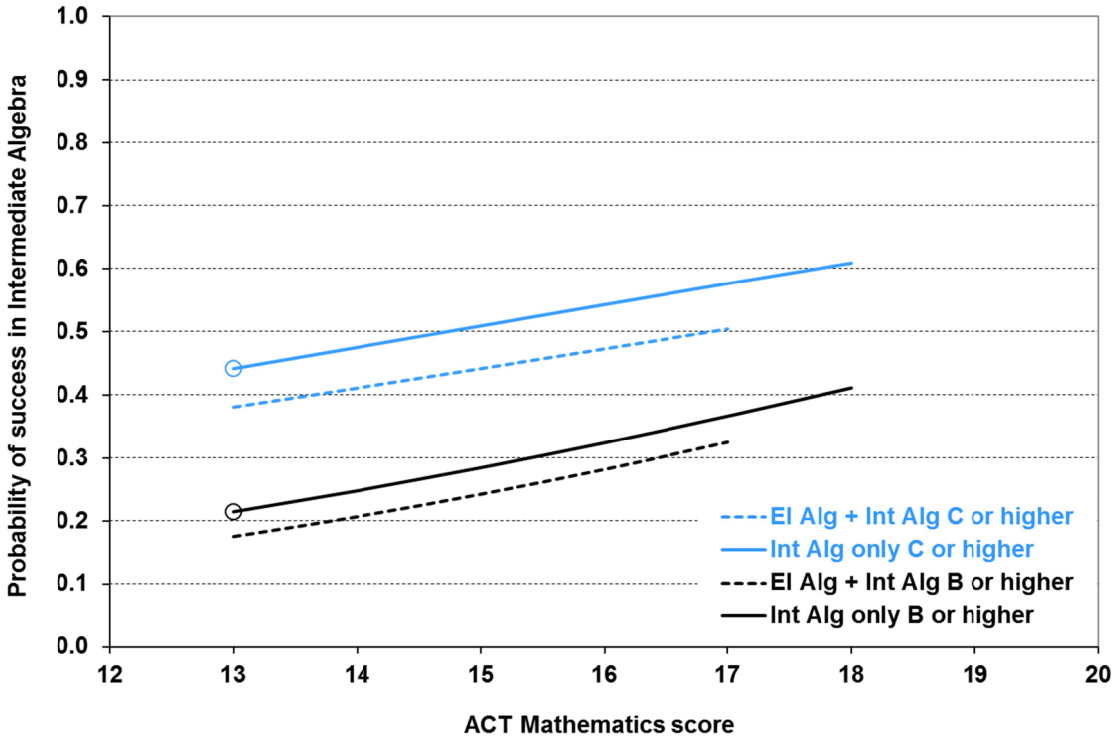

Figure 7. Probability of success in Intermediate Algebra with and without taking Elementary Algebra.

The results for the Developmental Reading/American History and Developmental Reading/Psychology student groups were similar; the results for Developmental Reading/American History are shown in Figure 8. Students who first took Developmental Reading had a lower probability of obtaining either a B or higher grade or C or higher grade in American History, regardless of their ACT Reading score, than students who enrolled directly in

the higher-level course. For the B or higher outcome, differences in probability of success between the two student groups increased markedly as ACT Reading score increased. For students with very low scores, the differences between groups in the probability of a B or higher grade were small.

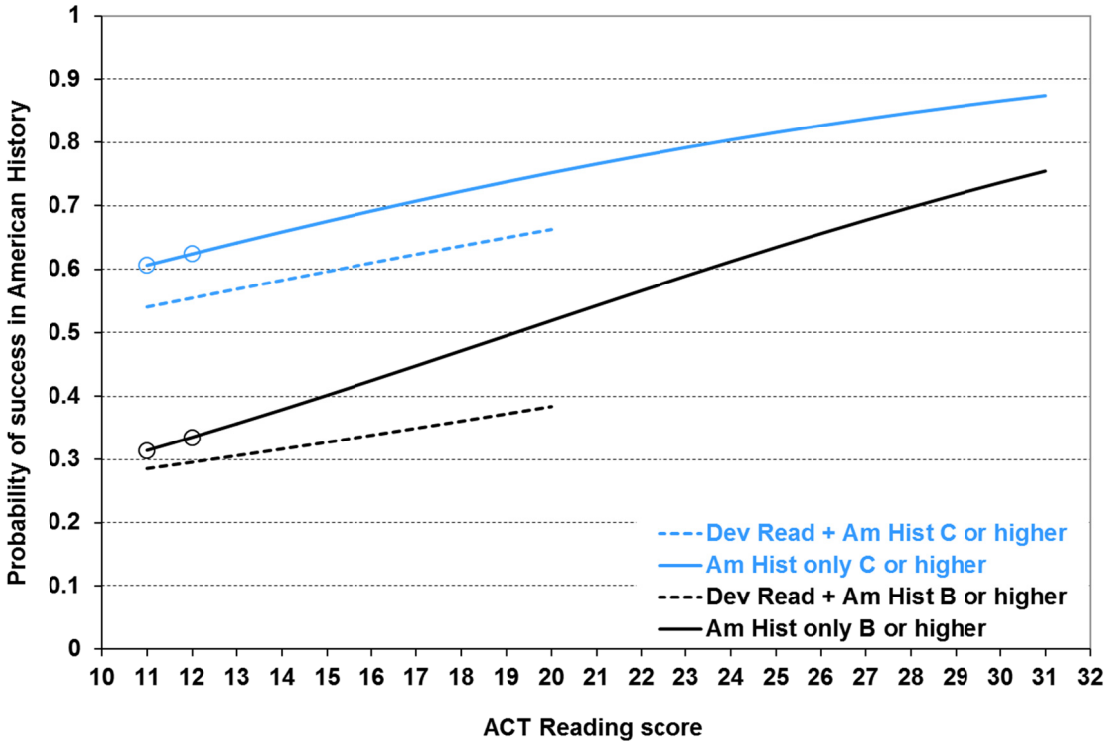

Figure 8. Probability of success in American History with and without taking Developmental Reading.

In contrast, there were positive results for other course pairs. As shown in Figure 9, students who first took Arithmetic had a higher probability of success in Elementary Algebra than would be expected, had they enrolled directly in Elementary Algebra. Students who took Arithmetic had consistently higher probabilities of success than students who enrolled directly in Elementary Algebra (by .03 to .09 for C or higher and .05 to .06 for B or higher). It is also interesting to note that as ACT Mathematics score increased, differences increased slightly

between the two groups' probabilities of a B or higher grade, and decreased between the two groups' probabilities of a C or higher grade.

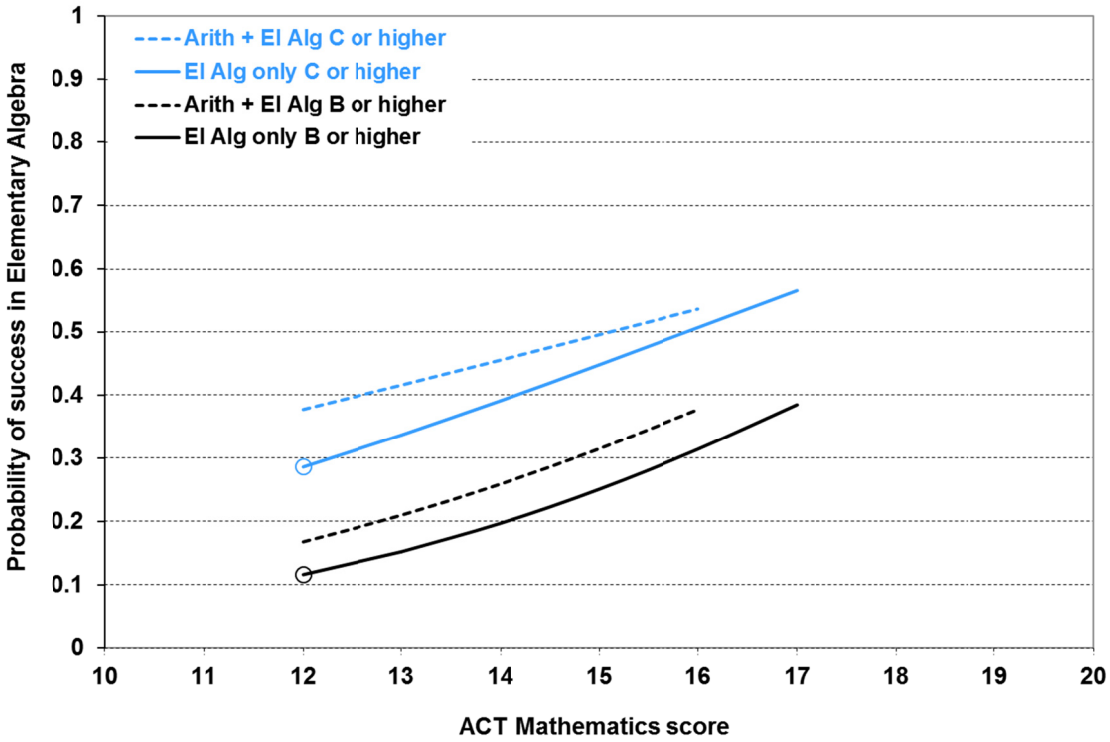

Figure 9. Probability of success in Elementary Algebra with and without taking Arithmetic.

The probability of success in College Algebra of students who first took Intermediate Algebra was slightly higher than that of students who enrolled directly in the higher-level course. As shown in Figure 10, the probability of either a B or higher grade or a C or higher grade in College Algebra of students who first took Intermediate Algebra was slightly higher than that of students who enrolled directly in the higher-level course (by .02 to .05).

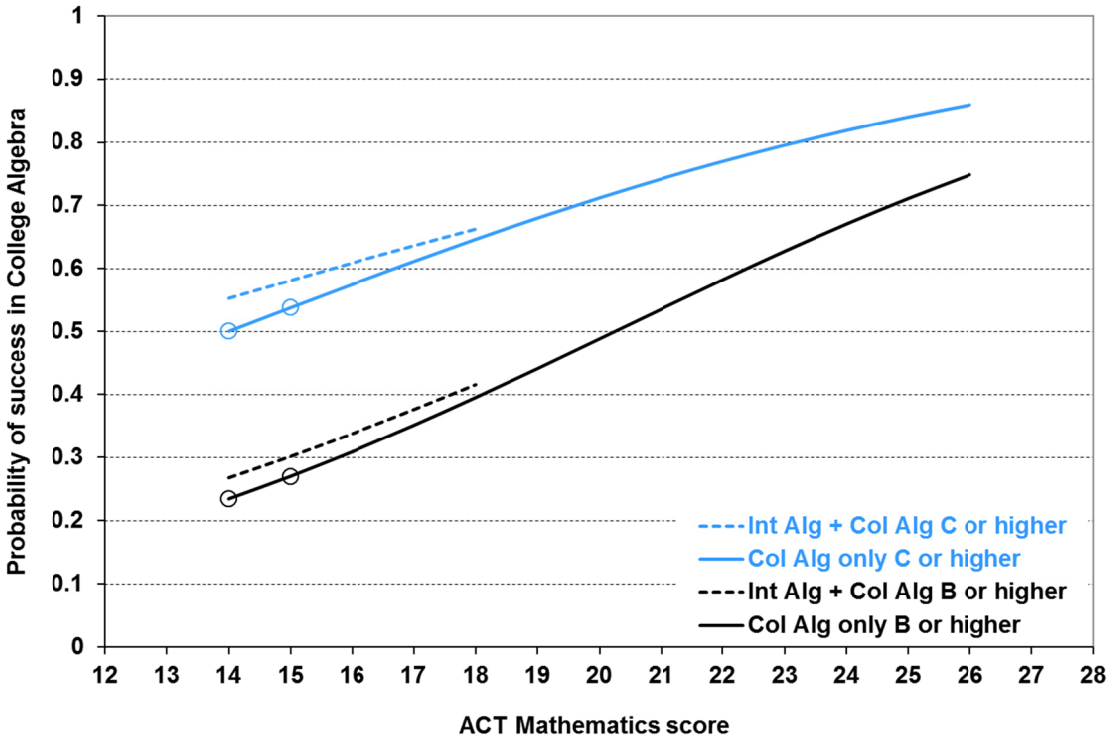

Figure 10. Probability of success in College Algebra with and without taking Intermediate Algebra.

Lower-level course grades as predictors of success in higher-level courses. Across all course pairs, the probability of success in the higher-level course for students who took the lower-level course also depended on the A-F grade they received in the lower-level course. The pass/fail grade in the lower-level course was, for almost all course pairs, not a statistically significant predictor of higher-level course success.[13]

For all course pairs except those including Developmental Reading, the probability of earning a B or higher grade in the higher-level course also depended on ACT Test score, even when lower-level course grade was included in the models. ACT Reading score was not a

[13] The exceptions were Developmental English Composition/Standard English Composition (both B or higher and C or higher outcomes) and Developmental Reading/Psychology (C or higher outcome only). We could not even develop higher-level course models using pass/fail grades for Arithmetic/Elementary Algebra and Elementary Algebra/Intermediate Algebra.

statistically significant predictor of success in American History or Psychology after Developmental Reading grade was added to the models.

In the analysis of Developmental English Composition/Standard English Composition, Developmental Reading/American History, and Developmental Reading/Psychology, only students who received an A grade in the lower-level course had a higher probability of success in the higher-level course than would be expected, had they not taken the lower-level course. Figure 11 illustrates this result for Developmental Reading/Psychology (C or higher grade; see also Table C-6 in Appendix C).

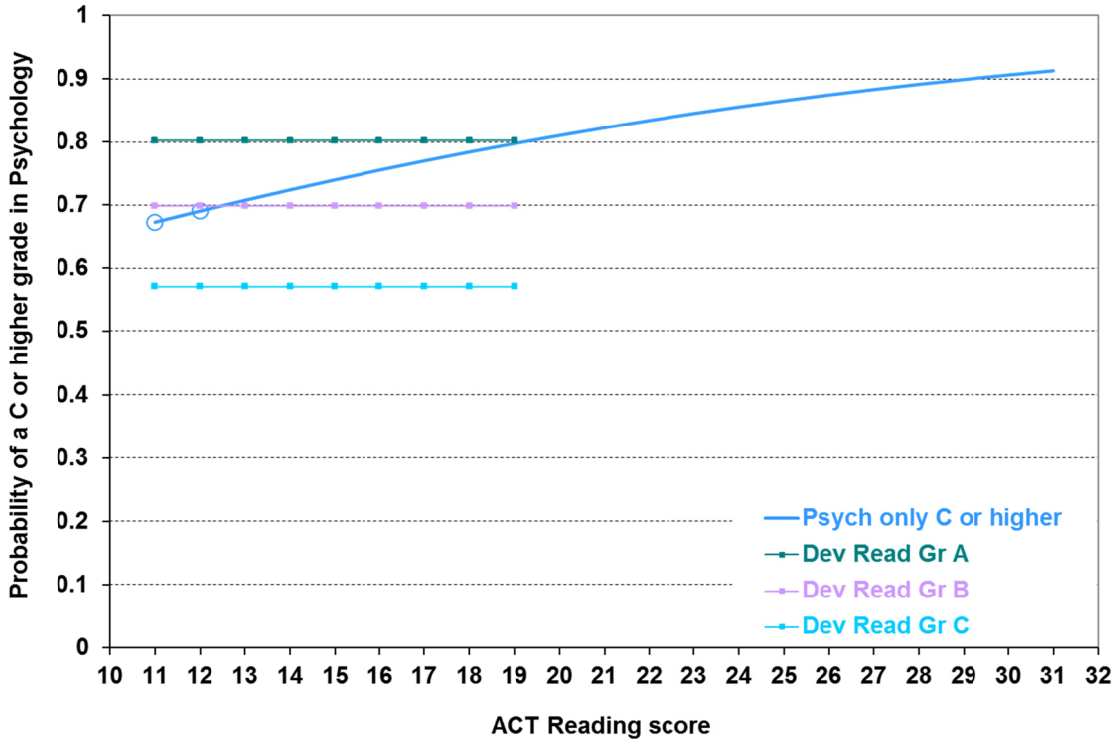

Figure 11. Probability of C or higher grade in Psychology by Developmental Reading grade and ACT Reading score.

In Figure 11, the estimated probability of a C or higher grade in Psychology ranged from .67 to .91 for students who enroll directly in the course (for ACT Reading scores of 11 to 31). The corresponding probabilities of success for students who first enroll in Developmental

Reading were .80, .70, and .57 for grades of A-C, respectively. Therefore, a grade of A was the only grade where the probabilities of success in Psychology always exceeded those for students who enroll directly in Psychology (with decreasing benefits as ACT Reading score approached 19).

For most mathematics course pairs, only A or B grades in the lower-level course corresponded to higher probabilities of success in the higher-level course than would be expected, had students enrolled directly in the higher-level course. This result occurred for both the B or higher and C or higher outcome levels (with the exception of the C or higher outcome for the Arithmetic/Elementary Algebra course pair). Figure 12 below illustrates this result for B or higher grades in Elementary Algebra, given ACT Mathematics score and grade in Arithmetic. A and B grades in Arithmetic were associated with substantially higher probabilities of B or higher grades than would be expected for similar students who enrolled directly in Elementary Algebra. C grades in Arithmetic were associated with virtually no increase in the probability of B or higher grades in Elementary Algebra, but were associated with increases in the probability of a C or higher grade.

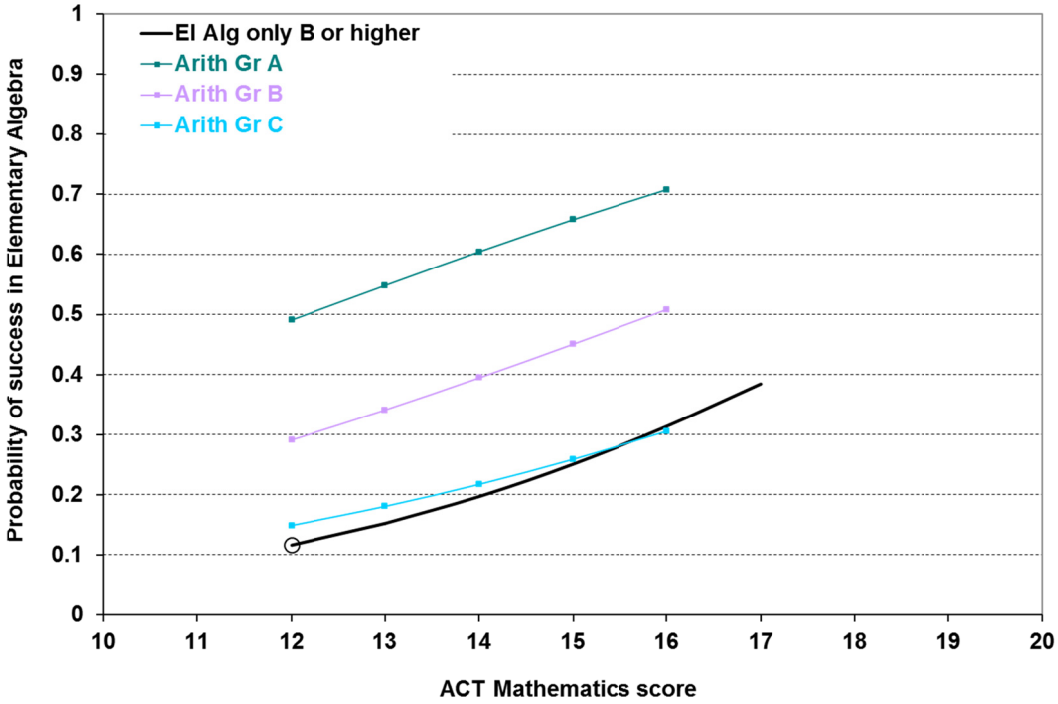

Figure 12. Probability of B or higher grade in Elementary Algebra by Arithmetic grade and ACT Mathematics score.

For Elementary Algebra/Intermediate Algebra and Intermediate Algebra/College Algebra, a lower-level course grade of B was associated with higher probabilities for those with scores of 17 or lower. The difference in probabilities decreased as ACT Mathematics score increased. The results for Intermediate Algebra/College Algebra are shown in Figure 13 for the B or higher success criterion.

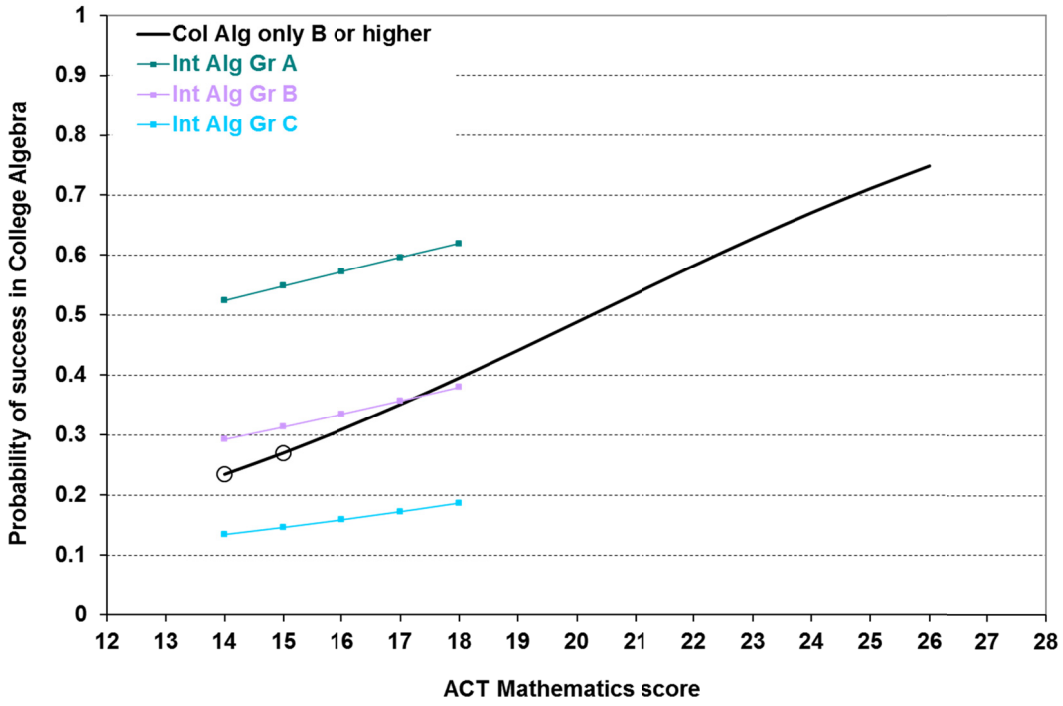

Figure 13. Probability of B or higher grade in College Algebra by Intermediate Algebra grade and ACT Mathematics score.

Early college outcomes of full-time students. We next discuss outcomes related to the Term 1, Year 1, and Year 2 success of full-time students according to their lower-level coursework[14].

For most course pairs, taking the lower-level course was associated with substantially higher probabilities of a Term 1 GPA of 2.0 or higher, or 3.0 or higher, and persisting to Term 2 than would be expected, had students enrolled directly in the associated higher-level course. Figure 14 illustrates this result for Intermediate Algebra/College Algebra.

[14] Lower- and higher-level coursework could have been taken before, during, or after the first fall term. Lower-level courses taken the last time before the higher-level course were taken the first fall or winter term, or summer terms just prior, by 84% (Intermediate Algebra) to 96% (Arithmetic) of students. Higher-level courses were taken during this time period by 76% (American History) to 95% (Standard English Composition) of students.

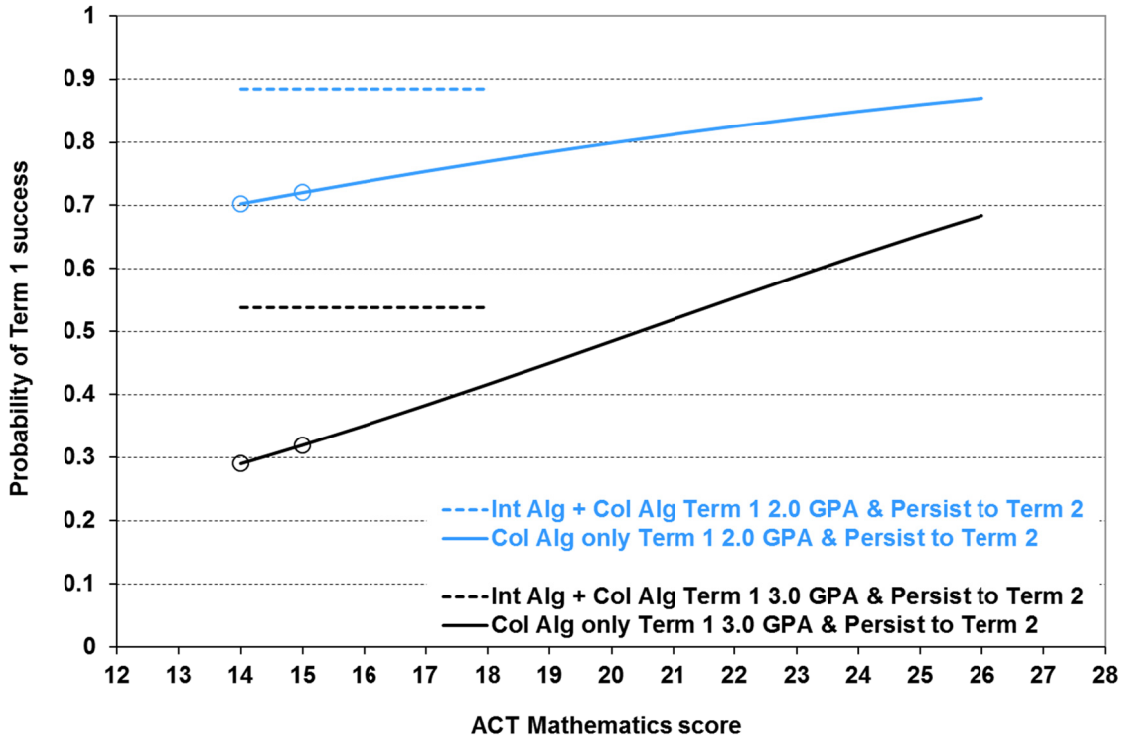

Figure 14. Probability of a Term 1 cumulative GPA of 2.0 or 3.0 or higher and persisting to Term 2, for students who did and did not take Intermediate Algebra before College Algebra.

Figure 14 also illustrates another result: For students who enroll directly in the higher-level course, ACT Test score was almost always a statistically significant predictor of early college success. (Note the steep slopes of the solid lines.) In contrast, ACT Test score was not a statistically significant predictor of early college success for students who first enroll in the lower-level course. (Note that the dotted lines are nearly flat.) This result is what one should expect: Placement decisions for most students in the study were based on ACT Test scores, resulting in restriction in the range of ACT test scores for students in the lower-level courses. Moreover, if lower-level coursework is effective in providing the knowledge and skills that are necessary for success in the next course, then test scores obtained before taking lower-level coursework no longer reflect what students know and are able to do, once they take the coursework.

The benefit of taking lower-level courses for improving students' early college success gradually decreased over time and, in some cases, disappeared. Figure 15 illustrates this result for Intermediate Algebra/College Algebra. Note that the probabilities of success for students who enroll in Intermediate Algebra were higher than those for students who enroll directly in College Algebra, but the differences between the two student groups were smaller than those shown in Figure 14.

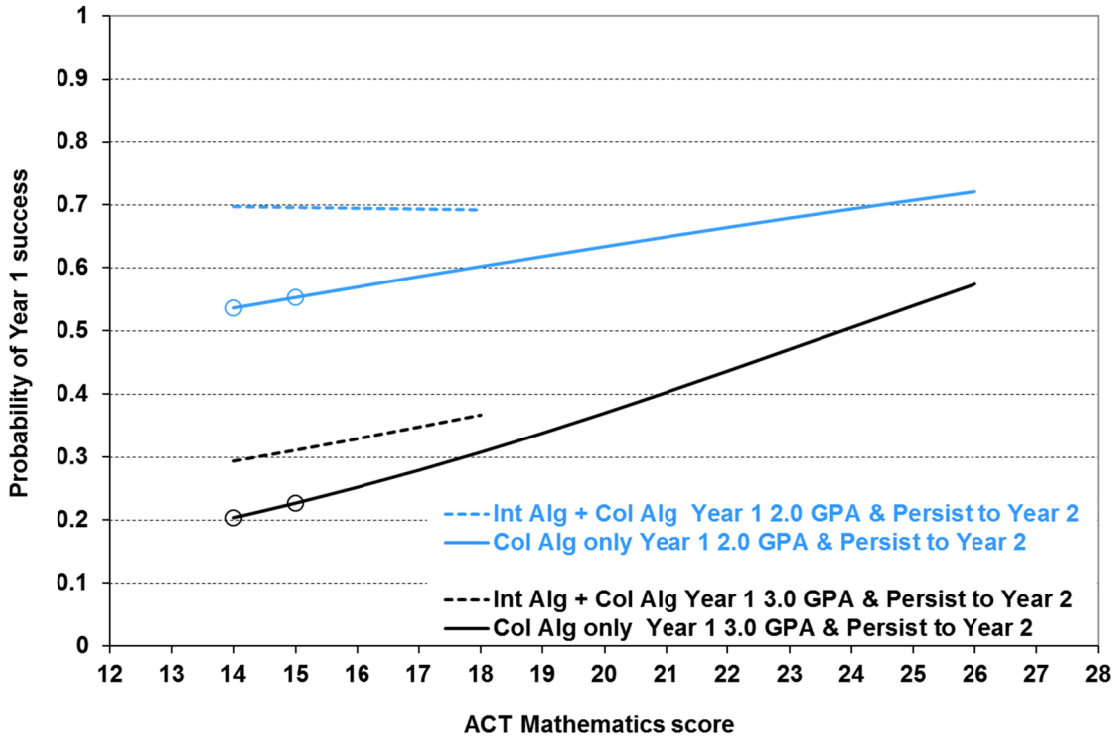

Figure 15. Probability of a Year 1 cumulative GPA of 2.0 or 3.0 or higher and persisting to Year 2 for students who did and did not take Intermediate Algebra before College Algebra.

With respect to the Year 2 cumulative GPA/persistence outcomes, the probability of success of students who first took the lower-level course in each course pair was generally comparable to the probability of students who enrolled directly in the associated higher-level course. For most lower-level courses, the benefit to Year 2 cumulative GPA/persistence also depended on ACT Test score, but was small nonetheless

Lower-level course grades as predictors of early college outcomes of full-time students. Grades as low as a D in Developmental English Composition or Arithmetic were associated with a higher probability of success in Term 1 than would be expected, had lower-scoring students enrolled directly in the higher-level course. Grades of A and B, and occasionally C (depending on ACT Test score), in the lower-level course were associated with higher probabilities of Term 1 success for the other developmental courses.

For Year 1 college outcomes (Year 1 cumulative GPA/persist to Year 2), grades of A and B in the lower-level course were almost always associated with a higher probability of success than would be expected, had students enrolled directly in the higher-level course. For some lower-level course/outcome combinations, however, the benefit of a B grade depended on ACT Test score.

For one-third of the course pair/outcome level combinations for Year 2 success (Year 2 GPA/persist to Year 3), only a grade of A in the lower-level course was associated with a higher probability of success than would be expected, had students enrolled directly in the higher-level course. Figure 16 shows the results for Psychology and the Year 2 2.0 GPA outcome. For almost all of the other lower-level courses and outcomes, grades of A and B in the lower-level course were associated with higher probabilities of success.

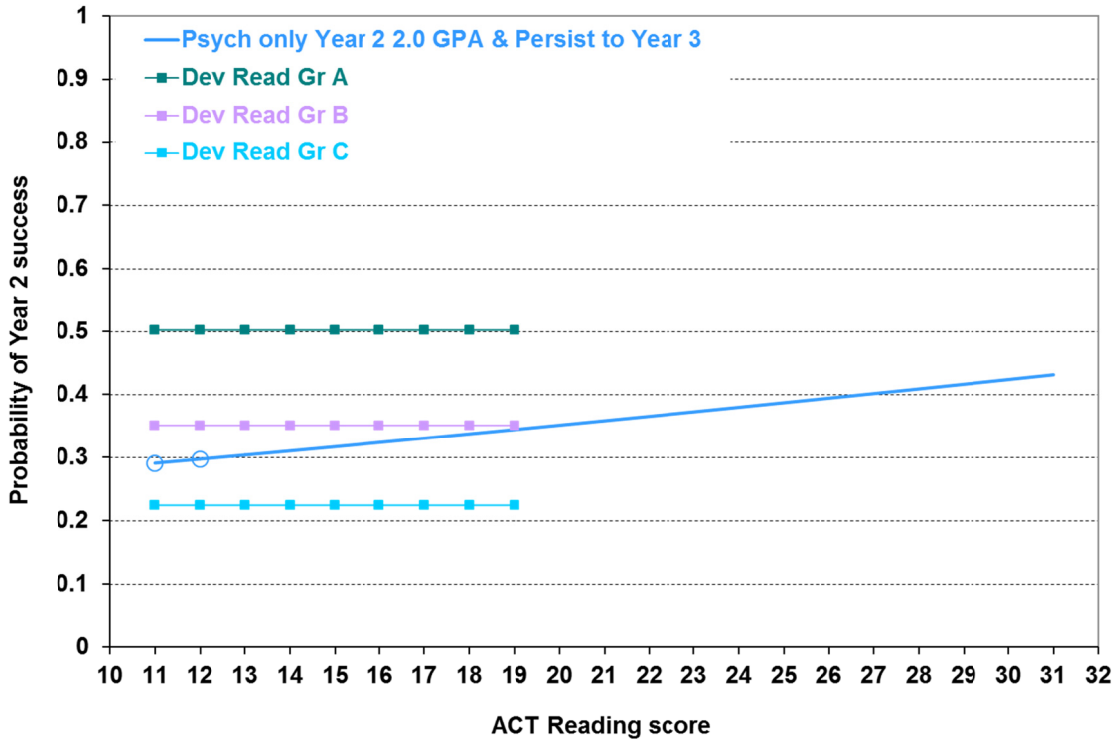

Figure 16. Probability of a Year 2 GPA of 2.0 or higher and persisting to Year 3 for students who took Psychology, by Developmental Reading grade.

ACT Mathematics score had a statistically significant negative weight in some of the joint models with Elementary and Intermediate Algebra grade for predicting Year 1 and/or Year 2 outcomes. Further investigation pointed to the transfer of two-year college students to four-year institutions as the likely cause. First, the negative weights occurred only for two-year institutions. Moreover, we modified the retention component of the success criteria to include transfer to other institutions (instead of retention at the same institution). When we re-estimated the models with the new criteria, the statistically significant negative weights disappeared.

Cumulative GPA at graduation/last term enrolled for full-time students. In this section we examine outcomes defined by cumulative GPA at graduation/last term. As in previous analyses, we compared students who did and did not take a lower-level course before taking the associated higher-level course in each course pair.

For students who enrolled directly in the higher-level course, ACT Test score was almost always a statistically significant predictor of cumulative GPA at graduation/last term. (The sole exception was students who enrolled directly in Intermediate Algebra when predicting a 2.0 or higher GPA). In contrast, ACT Test score was not a statistically significant predictor of GPA at graduation/last term in the joint models that included lower-level course grade[15]. For these students, the grade in the lower-level course predicted GPA at graduation. This finding is consistent with other ACT research studies that have shown that the effect of ACT Test score diminishes or disappears once first-year grades are considered (e.g., Allen & Robbins, 2010; Radunzel & Noble, 2012).

For most course pairs, the probabilities of a GPA at graduation/last term of 2.0, 2.5, or 3.0 for students who first enroll in the lower-level course were similar to or lower than those that would be expected, had they enrolled directly in the higher-level course. Figure 17 illustrates this result for Developmental English Composition/Standard English Composition. Note that the probabilities were increasingly disparate between the two student groups as ACT English score increased.

[15] The exceptions were models for students who took Developmental English Composition, Arithmetic, and Developmental Reading for a pass/fail grade before taking either American History or Psychology.

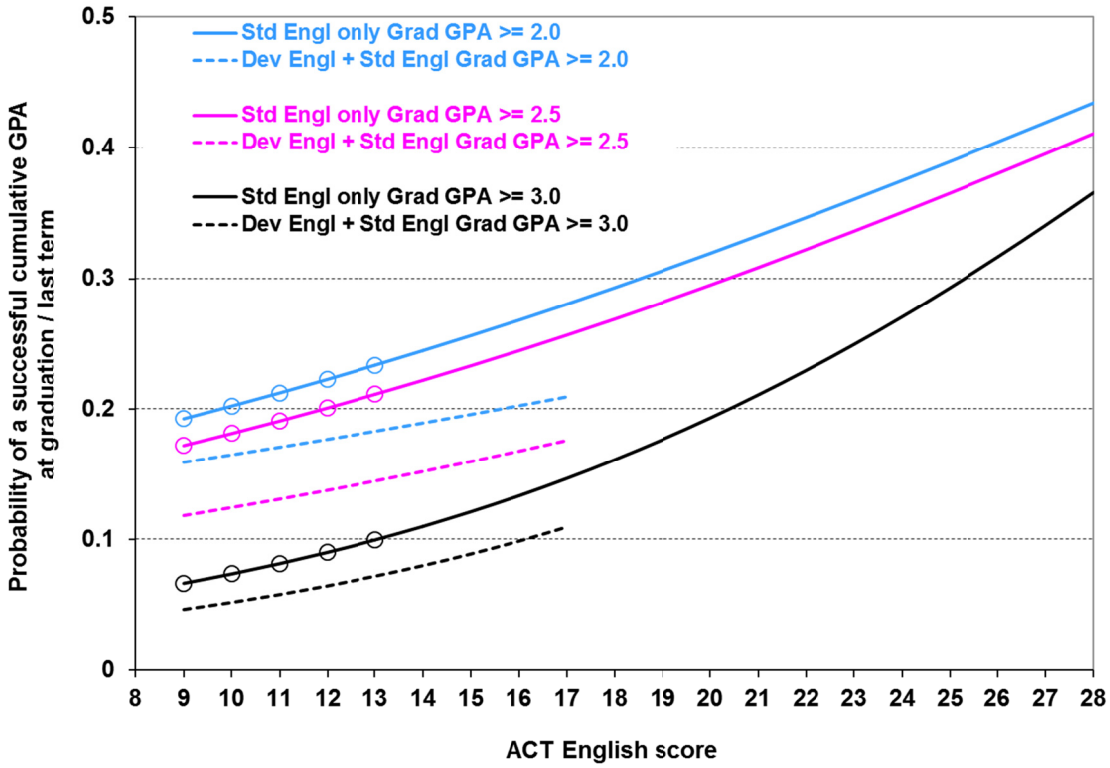

Figure 17. Probability of a GPA at graduation/last term of 2.0, 2.5, or 3.0 or higher for students who did and did not take Developmental English Composition before Standard English Composition.

We found a small benefit to GPA at graduation/last term for students who took Arithmetic before Elementary Algebra (see Figure 18). Differences in probabilities were slight (.07 or less; see Table C-2) between the two student groups at all three GPA levels. However, at the 3.0 GPA level, students who first took Arithmetic had increasingly greater probabilities of success as ACT Mathematics score increased, compared to students who enrolled directly in Elementary Algebra.

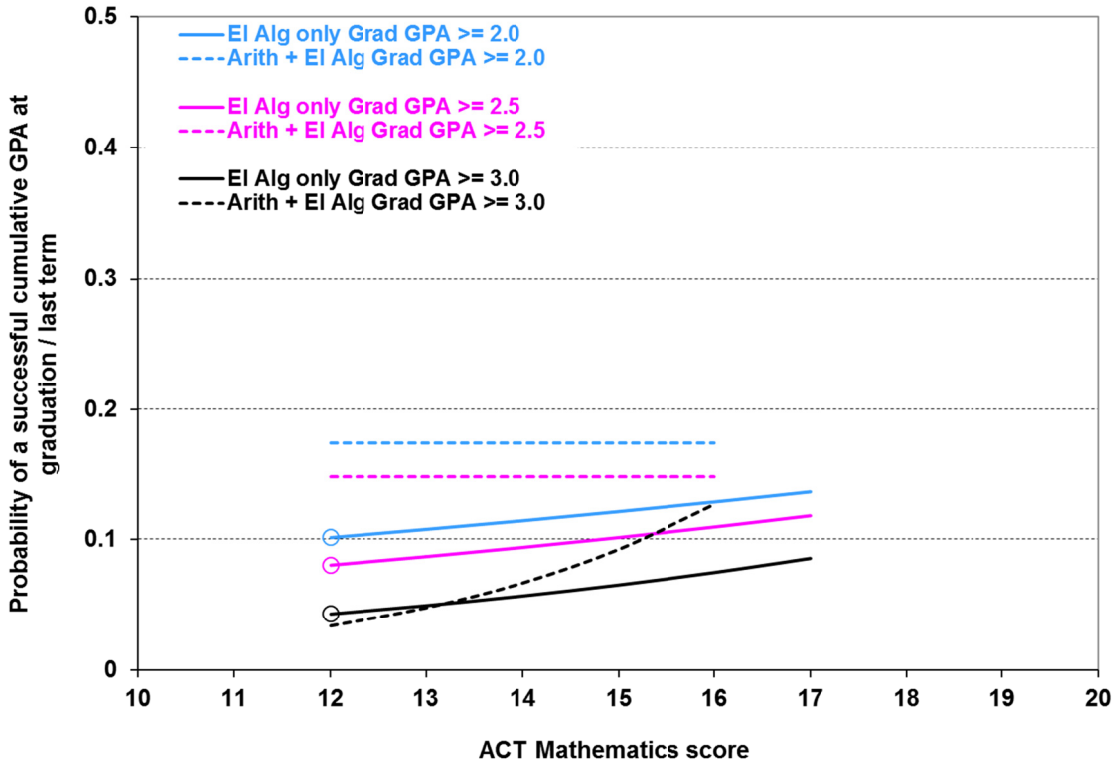

Figure 18. Probability of a GPA at graduation/last term of 2.0, 2.5, or 3.0 or higher for students who did and did not take Arithmetic before Elementary Algebra.

Degree completion of full-time students. In this section we examine degree completion, including completing an Associate's degree in three years or completing a Bachelor's degree in five or six years. For students who enrolled directly in the higher-level course, ACT Test score was a statistically significant predictor of degree completion for four of the six course pairs. The exceptions were students who enrolled directly in Elementary Algebra (and did not take Arithmetic) and Intermediate Algebra (and did not take Elementary Algebra). This finding may be attributed to the restriction in the range of ACT Mathematics scores for these courses (functional range of a maximum of 5 score points) in conjunction with small sample sizes and the smaller proportions of students in these courses who completed degrees.

Among the English, Elementary Algebra/Intermediate Algebra, and Intermediate Algebra/College Algebra course pairs, taking the lower-level course was associated with a higher

probability than expected of completing a Bachelor's degree in six years, had students enrolled directly in the higher-level course. In general, this result occurred at all ACT Test score levels. Similar results occurred for the Intermediate Algebra/College Algebra course pair for three-year Associate's degree completion. Figures 19 and 20 show the results for Developmental/Standard English Composition and Intermediate Algebra/College Algebra, respectively.

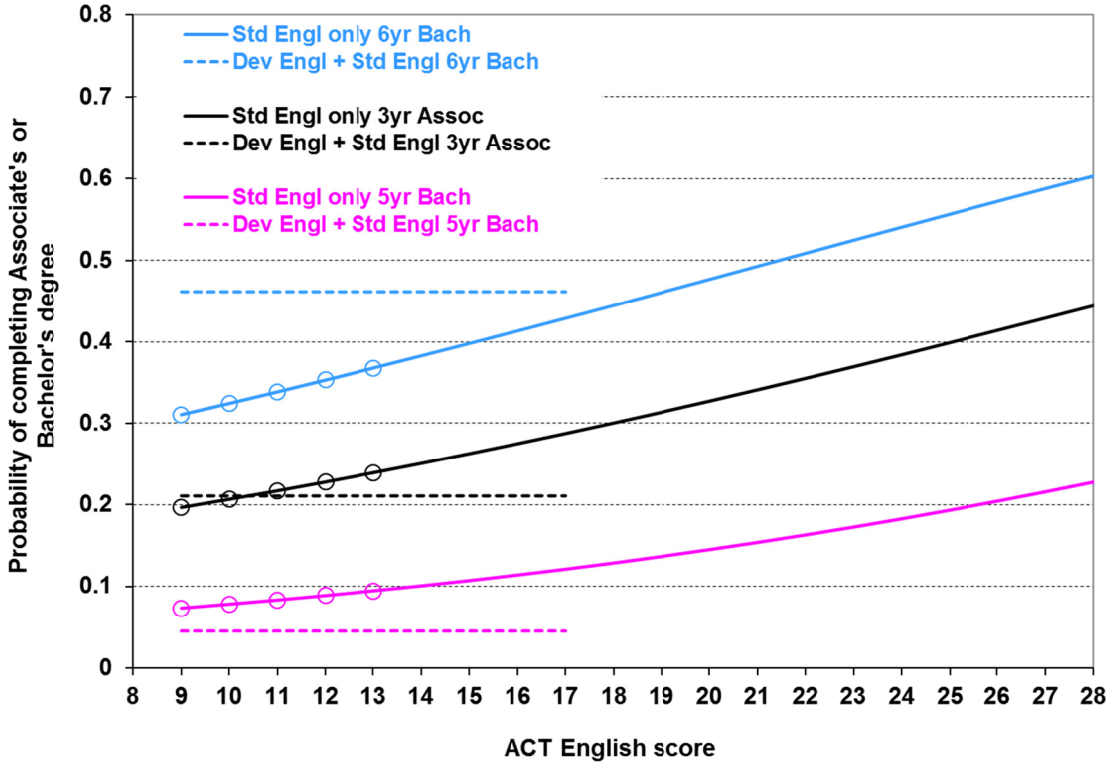

Figure 19. Probability of completing an Associate's degree in three years or a Bachelor's degree in five or six years for students who took Standard English Composition with and without taking Developmental English Composition.

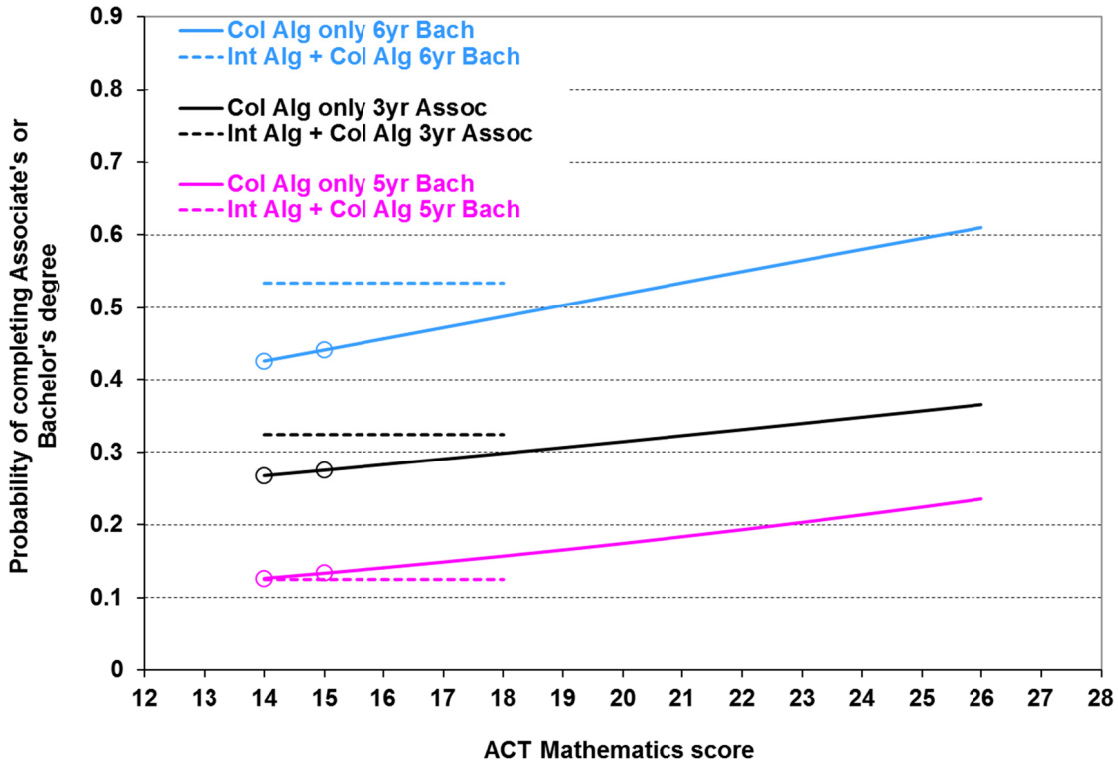

Figure 20. Probability of completing an Associate's degree in three years or a Bachelor's degree in five or six years for students who took College Algebra with and without taking Intermediate Algebra.

There was little or no benefit with respect to five-year Bachelor's degree completion. The reason for this result, of course, is that institutions typically do not award credit towards earning a degree for developmental coursework.

We also compared the probability curves for five-year Bachelor's degree completion of students who enrolled directly into the higher-level course with those for six-year degree completion of students who first took the lower-level course. In a pattern similar to the descriptive results discussed previously, students who took the lower-level courses had a higher probability of completing a six-year Bachelor's degree than similar students who took the higher-level course had in completing either a five- or six-year Bachelor's degree.

Lower-level course grades as predictors of GPA at graduation/last term and degree completion for full-time students. ACT Test score was not a statistically significant predictor of degree completion in the joint models that included lower-level course grade.[16] As noted earlier, this result is what one should expect: Placement decisions for most students in the study were based on ACT Test scores, resulting in restriction in the range of ACT test scores for students in the lower-level courses. Moreover, if lower-level coursework is effective in providing the knowledge and skills that are necessary for success in the next course, then test scores obtained before taking lower-level coursework no longer reflect what students know and are able to do, once they take the coursework.

When predicting cumulative GPA at graduation/last term, only a grade of A in developmental English or mathematics courses was associated with a higher probability of success than would be expected, had students enrolled directly in the corresponding higher-level course. Figure 21 illustrates this result for Developmental English Composition/Standard English Composition.

[16] The sole exception was Associate's degree completion for students who took Arithmetic prior to enrolling in Elementary Algebra.

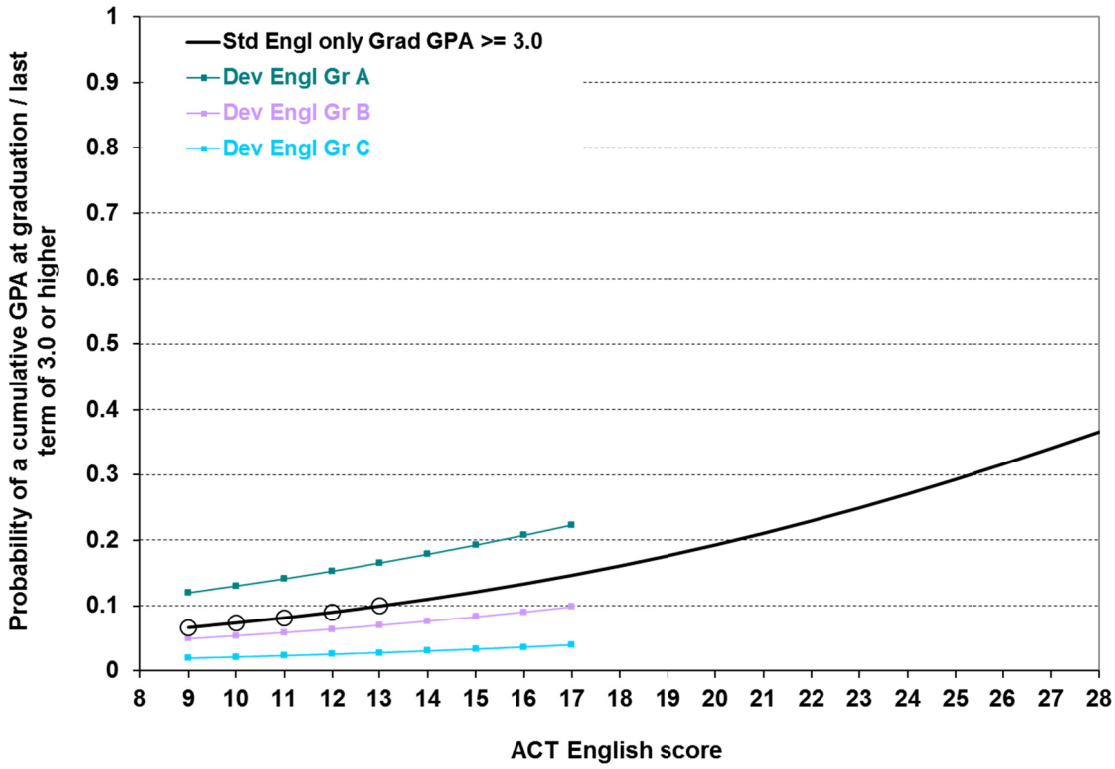

Figure 21. Probability of a cumulative GPA at graduation/last term of 3.0 or higher for students who took Standard English Composition, by Developmental English Composition grade.

This result was true for all GPA levels and all lower-level English and mathematics courses except Arithmetic. In Arithmetic, a grade of B was also associated with a higher probability of a 3.0 or higher GPA, but only for students with higher ACT Test scores (see Figure 22). Arithmetic course grade was not a statistically significant predictor of 2.0 or higher, or 2.5 or higher, cumulative GPA at graduation/last term.

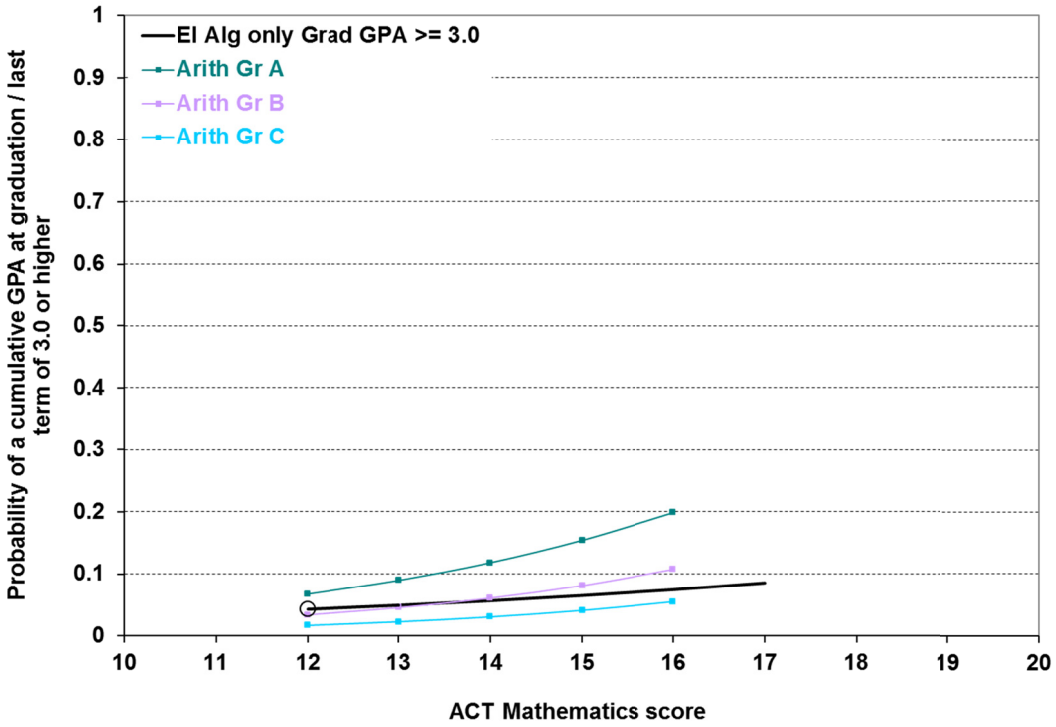

Figure 22. Probability of a cumulative GPA at graduation/last term of 3.0 or higher for students who took Elementary Algebra, by Arithmetic grade.

For Developmental Reading (before American History), a grade of A was associated with a slightly higher probability (maximum difference of .05; see Table C-5) of achieving a cumulative GPA at graduation/last term of 2.0 or higher but only for those students with very low ACT Reading scores. Figure 23 illustrates this result for the 2.0 or higher GPA outcome.

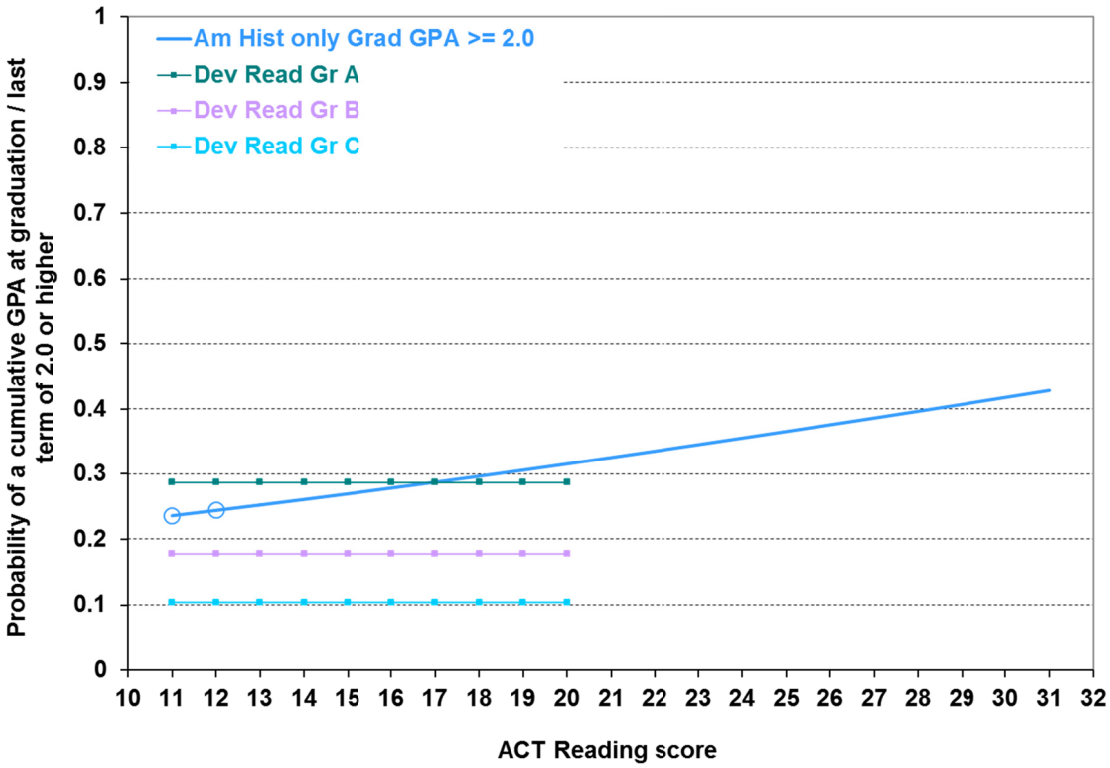

Figure 23. Probability of a cumulative GPA at graduation/last term of 2.0 or higher for students who took American History, by Developmental Reading grade.

Lower-level course grade was a significant predictor for three-year Associate's and five-year Bachelor's degree completion for almost all course pairs (except Arithmetic/Elementary Algebra). However, only a lower-level course grade of A was associated with higher probabilities of achieving a three-year Associate's degree for students enrolling in Developmental English Composition or Intermediate Algebra. The result for the Intermediate Algebra/College Algebra course pair is illustrated in Figure 24. Similarly, a grade of A in Developmental English Composition or Intermediate Algebra was associated with higher probabilities of completing a five-year Bachelor's degree. A grade of A in Developmental English Composition or Intermediate Algebra increased the probability of completing a Bachelor's degree within five years by .05 or .06, respectively, for students with very low ACT Test scores.

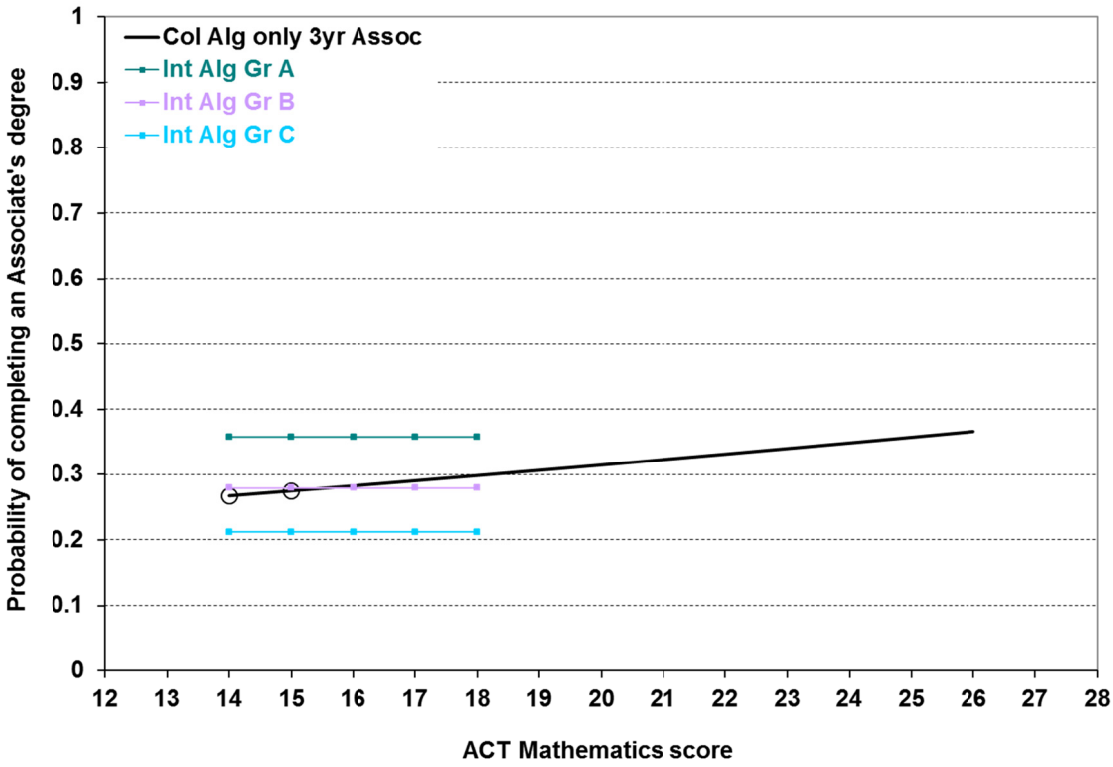

Figure 24. Probability of completing an Associate's degree in 3 years for students who took College Algebra, by Intermediate Algebra grade.

Lower-level course grade was not a statistically significant predictor of Bachelor's degree completion in six-years, or could not be modeled, for almost all course pairs. The one exception was Elementary Algebra/Intermediate Algebra, where an A grade was associated with a .14 increase in the probability of completing a Bachelor's degree in six years, regardless of ACT Mathematics score.

In contrast, the probability of completing an Associate's degree in three years or of completing a Bachelor's degree in five years associated with any grade in Developmental Reading was similar to or lower than that of students who enroll directly in Psychology (see Figure 25) or in American History.

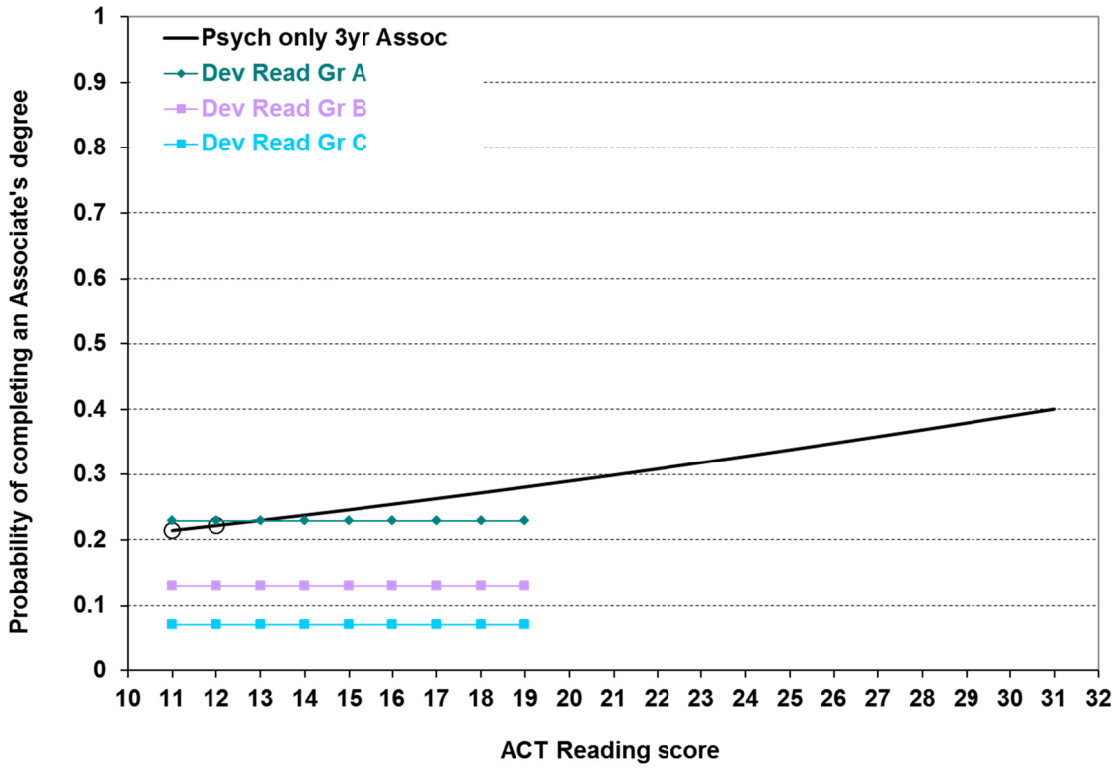

Figure 25. Probability of completing an Associate's degree in 3 years for students who took Psychology, by Developmental Reading grade.

Full-time/part-time enrollment status. For the vast majority of course pairs, student groups, and outcome variables, students' first-year enrollment status was a statistically significant predictor of college success. Full-time students were more likely than part-time students to achieve a C/2.0 or higher, or B/3.0 or higher, outcome. The exceptions were first-time course outcomes for Elementary Algebra and Developmental English Composition, and five-year Bachelor's degree completion for Developmental English Composition, Arithmetic, and Elementary Algebra. The results are shown in Appendix D.

Tables D-1 through D-6 summarize the estimated probabilities of success for full- and part-time students who did and did not take the lower-level course prior to taking the higher-level course. The other predictor variables (ACT Test score and grade in lower-level course) were held constant at their respective means. Of students who first enroll in the lower-level

course, the probabilities of subsequent college success for full-time students exceeded those of part-time students by .08 to .13, on average. Of students who enrolled directly in a higher-level course, the differences in probability of subsequent college success between full- and part-time students were larger, ranging from .14 to .32, on average.

Success in the higher-level course (B or higher and C or higher outcomes) of each course pair depended on student enrollment status, as well as on whether they first took the lower-level course. Full-time students who enrolled directly in a higher-level course had higher estimated probabilities of a B or higher or C or higher grade than similar students who first took the associated lower-level course[17]. We found similar results for part-time students in Developmental Reading/American History and in Developmental Reading/Psychology. However, part-time status was associated with higher estimated probabilities of a C or higher grade for all other course pairs, if students first enrolled in the associated lower-level course.

When examined within enrollment status group, probabilities of success associated with taking and not taking the lower-level course before the higher-level course differed substantially for early college outcomes: For part-time students, probabilities of success associated with Term 1 (2.0 and 3.0 or higher), first-year (2.0 or higher), and second-year (2.0 or higher) GPA/persistence indicators were much higher for students who first enroll in the lower-level course than for those who enroll directly in the higher-level course, regardless of the course pair examined. The differences were particularly large for Term 1 outcomes. In comparison, the differences in probabilities of early college success associated with taking and not taking the lower-level course for full-time students were considerably smaller. Though differences in probability of success for Term 1 generally favored full-time students first taking the lower-level

[17] An exception was Arithmetic/Elementary Algebra.

course, these differences decreased over time and frequently reversed themselves to favor students who first enroll in the higher-level course.

Estimated probabilities of achieving a GPA of 2.0, 2.5, or 3.0 at graduation/last term enrolled generally differed within enrollment status group by whether students first enroll in the lower-level course. Probabilities did not differ substantially for part-time students who did and did not first enroll in the lower-level course; we did find differences for full-time students, however. In general, these differences favored full-time students who enroll directly into the higher-level course. Conversely, for Arithmetic/Elementary Algebra, full-time students who first enroll in the developmental course had a somewhat higher probability of a 2.0 or higher, or 2.5 or higher, GPA at graduation than their counterparts who enroll directly in the higher-level course.

Timely degree completion universally favored full-time students, but also depended on whether students took a lower-level course prior to taking the higher-level course. Part-time students who did and did not take Developmental Reading prior to American History or Psychology were similarly likely to complete an Associate's or Bachelor's degree (five or six years) in a timely way. For full-time students, enrolling directly in Standard English Composition, American History, or Psychology was associated with higher probabilities of completing an Associate's or a Bachelor's degree (five or six years) than for those first enrolling in the corresponding lower-level course. In contrast, full-time students who first enroll in Elementary Algebra had a higher probability of completing a Bachelor's degree in six years than students who enroll directly into Intermediate Algebra.

Part-time students taking Intermediate Algebra and College Algebra had higher estimated probabilities of timely Associate's and six-year Bachelor's degree completion than those taking

only College Algebra. Similar finding occurred for part-time students taking Developmental English Composition before Standard English Composition or Elementary Algebra before Intermediate Algebra, but only for six-year degree completion.

College Type. As shown in the tables in Appendix B, college type was a statistically significant predictor of some outcomes, although not as frequently as full-time/part-time enrollment status. There were no simple consistent patterns where college type was statistically significant. For example, for the English Composition course pair, students first enrolling at two-year colleges had higher probabilities of Term 1 and Year 1 success (Term 1 2.0 or higher and 3.0 or higher, Year 1 3.0 or higher) than those enrolling at four-year institutions. This finding occurred regardless of whether students first took the lower-level course before taking the higher-level course.

In contrast, students at four-year institutions had higher estimated probabilities of success related to Year 2 outcomes (2.0 or higher only) than did students at two-year colleges for all course pairs except Arithmetic/Elementary Algebra. These results were paralleled at the 3.0 level, but only for students who enrolled directly in higher-level courses, and were not found for Elementary Algebra/Intermediate Algebra.

Not surprisingly, with the exception of students who took Arithmetic or Developmental Reading prior to American History, students who first enroll at a four-year institution had higher estimated probabilities of completing a Bachelor's degree within five years than students who first enroll at a two-year institution.

Discussion

Previous research has shown that developmental students are less successful overall than students who do not take developmental courses (Attewell et al., 2006; NCES, 2004). In this

study, we examined the effectiveness of developmental courses from another, more basic perspective: Do students derive any benefit at all from taking developmental courses? In other words, even if students who take developmental courses are less successful later on than non-developmental students, are the developmental students more successful than they would have been if they had not taken the developmental courses? To answer this question, we compared the college success of developmental and non-developmental students who had the same ACT Test scores, enrollment status, and who enrolled in similar institutions. We measured college success using many different outcome variables: completing the subsequent course with a satisfactory grade; cumulative GPA/persistence the first term, first year, and second year; cumulative GPA at graduation; and degree completion (Associate's in three years or Bachelor's in five or six years). We compared the conditional probabilities of success, given ACT Test score and enrollment status, of six groups of students who took particular developmental courses with the corresponding conditional probabilities of students who enrolled directly in the associated higher-level course.

The overall results reported here confirm previous research findings: Taken as a whole, developmental students appear less successful overall than non-developmental students in terms of GPA/persistence over time and degree completion within specified periods of time. Our results also show, however, that particular subgroups of developmental students do benefit, especially when we take into account the greater time they need to complete their degrees.

Success in College Depends on Prior Academic Preparation

It bears repeating that better prepared students (as measured by their ACT Test scores) are more successful in college than less prepared students, no matter what outcome, short-term or

long-term, that we consider. This result pertains both to students who take developmental courses and to students who enroll directly in higher-level courses.

Among students who take developmental courses, however, the grade they receive in these courses is often a better predictor of long-term academic success than their ACT Test scores. This finding is not surprising. If developmental coursework is effective in providing the knowledge and skills that are necessary for success in the next course, then test scores obtained before taking developmental coursework no longer reflect what students know and are able to do after they take the course. Moreover, placement decisions for the vast majority of students in the study were based on ACT Test scores. The resulting distributions of ACT test scores for the lower-level courses were restricted, in some cases quite severely. The range of scores for Arithmetic, Elementary Algebra, and Intermediate Algebra each included only five ACT Test score points.

This finding also underscores the importance, when validating test scores or other measures for course placement, of ensuring that no intervening instruction has occurred (or else is statistically controlled for). ACT's Course Placement Service (ACT, 2012b) recommends that institutions include in their validity studies data only from first-time students without prior developmental instruction. The ACT Course Placement Service also recommends that institutions identify students who are taking developmental coursework at the same time as standard college-level courses.

Simply Taking Developmental Courses Results in Few Long-Term Benefits

For most of the developmental courses, simply taking the courses (without considering the grades earned in them) did not result in any apparent benefit to success in the subsequent

higher-level courses. The two exceptions were Arithmetic and Intermediate Algebra, where there was modest benefit (maximum increases in probability of .09 and .05, respectively).

Full-time students who took a developmental course, as a group, however, did improve their chances of successful Term 1 GPA/persistence to Term 2 and (to a lesser extent) Year 1 GPA/persistence to Year 2 outcomes. This result could be attributable to how institutions treat developmental course credit and grades. Most colleges offer institutional credit for developmental courses, but the credit does not typically count toward a degree (Parsad & Lewis, 2003), and the corresponding developmental course grades might or might not be used in calculating cumulative GPA. Follow-up with the two states that provided the large majority of the college outcome data for this study revealed that for one state, developmental grades were included in cumulative GPA calculations. For the other state, the inclusion/exclusion decision was institution-specific and not determined at the state level. The very high percentages of students receiving C or higher or passing grades in these courses, and the relatively high Term 1 and Year 1 cumulative GPAs, are therefore not surprising.

After the first two years, benefits associated with developmental coursework tended to decline and, in some cases, disappear. Taking developmental courses did improved full-time students' chances of achieving a 2.0, 2.5, or 3.0 cumulative GPA at graduation for students who took Arithmetic. There was also a benefit with respect to completing an Associate's degree within three years (Intermediate Algebra/College Algebra) or completing a Bachelor's degree in five or six years (Developmental English Composition and mathematics courses). To some extent these findings are consistent with those of other studies that looked at long-term college outcomes (e.g., Adelman, 1999; Calcagno & Long, 2008), which found that taking developmental coursework did not improve later college success. These studies used different

methodological approaches and college outcomes than those used here, however. The findings here illustrate the importance of taking time to degree into consideration in conducting such research, with consideration for the delayed accumulation of credit hours resulting from taking developmental coursework.

Across all subject areas and outcomes studied, Developmental Reading appeared to be least beneficial for improving the academic preparedness of entering students. For most of the institutions in this study, Developmental Reading could be taken prior to, concurrent with, or following college-level social science courses. Students who took Developmental Reading after taking college-level social science courses were excluded from the analyses, thereby limiting the numbers of students who actually took Developmental Reading. It is unclear the extent to which having all students take Developmental Reading prior to or concurrent with standard college-level social sciences coursework would change or improve these results.

The potential benefits of taking developmental coursework was also found to depend on other factors: academic preparedness, as measured by ACT Test scores; the course grade in the lower-level (developmental) course; and first-year enrollment status. The following sections address each of these factors.

The Benefit of Taking Developmental Courses Mostly Depends on the Grades Earned in Them

Consistent with findings by Perkhounkova, Noble, and Sawyer (2005) and others (Bettinger & Long, 2005a; Boatman & Long, 2010; Calcagno & Long, 2008), the benefits of taking developmental coursework depend on the grade in the developmental course. Pass/fail grades were found to be of very limited value as indicators of what students learned in the developmental course, and of students' likely success later in college. This finding may be

attributable to the very high percentages of students receiving passing grades, which would limit the extent to which students could be differentiated in terms of what they know and are able to do.

In contrast, A grades in the developmental course were associated with higher probabilities of success than expected, had students enrolled directly in the higher-level course. This finding was consistent across course pairs. We obtained a similar result for some (but not all) of the course pairs for students who earned a B or higher grade in the developmental course. The higher probabilities associated with B grades depended on ACT Test score: The benefit associated with B grades typically occurred for students with very low ACT Test scores.

The benefits associated with receiving an A or B grade in the developmental courses tended to decrease over time, paralleling the general results described earlier. For later college success outcomes, only a grade of A in the developmental course was associated with a higher probability of success than would have been expected (and then, only for a few outcomes).

The Benefit of Developmental Courses Depends on First-Year Enrollment Status

The results of this study show that full-time students are more likely than part-time students to succeed in college, regardless of the outcome being considered. Part-time students, however, appeared to derive more benefit from taking developmental courses than full-time students did. For example, part-time students benefited from taking Developmental English Composition, Elementary Algebra, and Intermediate Algebra in terms of a C or higher grade in the higher-level course. Moreover, part-time students who took a developmental course were more likely to be successful in Term 1, Year 1, and Year 2 than students with similar ACT Test scores who did not take these courses and who enrolled directly in a higher-level course. Part-time students who took Developmental English Composition, Elementary Algebra, or

Intermediate Algebra also had better chances of completing a three-year Associate's (Intermediate Algebra only) or six-year Bachelor's degree than would be expected of non-developmental students with similar ACT Test scores.

The results for full-time students, in general, did not parallel these findings. For most outcomes for full-time students, taking the developmental course did not appear to increase their long-term chances of success.

The associations between first-year enrollment status and the effectiveness of the developmental courses were interesting and unexpected. Most of the recent research on the effectiveness of developmental instruction has focused on two-year or four-year college students (but not on both), or on degree-seeking students only, or on full-time students only. Given the current trend for nontraditional (e.g., adult) students to reenroll part-time in two-year colleges, either to refresh their skills or obtain new ones, not considering part-time students when evaluating the effectiveness of developmental instruction leaves a gap in our knowledge.

The Practical Benefits of Developmental Coursework

An important consideration is the extent to which the benefits of developmental instruction are of practical value. For example, in one scenario students with lower ACT Mathematics scores who take Arithmetic before taking Elementary Algebra increase their chances of success in Elementary Algebra over what might be expected, had they enrolled directly into Elementary Algebra. However, even with this increase in probability of success, Arithmetic students still have about a 50/50 or smaller chance of earning a C or higher in Elementary Algebra (see Figure 9). In another scenario, students with very low ACT Reading scores benefit in Psychology from taking Developmental Reading if they get a grade of A in the course, but have greater than a 6 in 10 chance of succeeding in Psychology without taking the

developmental course. For either scenario, is providing developmental coursework of sufficient benefit to justify the costs of providing it? When evaluating the effectiveness of developmental instruction, researchers and policymakers need to consider both the baseline success rate for the higher-level course and the expected success rate, given developmental instruction.

The Bottom Line: Does Developmental Coursework Benefit Students?

Both two- and four-year colleges are under pressure to increase degree completion rates and to decrease developmental education on the grounds that it does not benefit students (Bettinger & Long, 2005a; Gonzales, 2012; Merisotis & Phipps, 2000; "Experts: Remedial classes need fixing," 2012; Saxon & Boylan, 2001). The basis for these findings is that students who take developmental courses are not as successful in college as students who do not need to take developmental courses. Our research confirms this finding: Developmental students as a group were not as successful in college as non-developmental students as a group, with respect to GPA/persistence over time and degree completion within a fixed time period. However, consideration of the additional time required to complete a bachelor's degree by developmental students showed that these students can complete bachelor's degrees in six years at a rate similar to or higher than that of non-developmental students in five years.

Our primary goal, however, was to investigate benefit from another perspective: Do students derive *any* benefit from taking developmental courses, in the sense that they are more successful than similar students who do not take developmental courses? We defined similarity in terms of students' readiness for college-level work, as measured by their ACT Test scores, by their enrollment status, and by the type of college in which they enrolled. We compared the conditional probability of success, given ACT Test score and enrollment status, of groups of

students who took particular developmental courses with those who took the next higher-level course.

For six-year bachelor's degree completion, the benefit was large enough to match the success of students enrolling in higher-level courses. For the other outcomes, students did benefit, but typically only if they earned an A in the developmental course. For some course pairs, students who entered the developmental course with low ACT Test scores and who earned a B in the course also derived benefit. There are a variety of explanations for these findings, only some of which could be explored here. Other considerations include the following:

- Noncognitive characteristics of students. Although prior academic achievement is a strong predictor of success in college, noncognitive characteristics are also important. Examples of such characteristics include psychosocial characteristics and behavior (principally motivation and academic discipline; see Allen & Robbins, 2010 and Allen, Robbins, & Sawyer, 2010), family environment (support and encouragement to succeed in college), and life situations (e.g., care for dependents, the need to work while in college). Noncognitive characteristics affect grades earned in high school as well as in college (Goldman & Hewitt, 1975; Goldman, Schmidt, Hewitt, & Fisher, 1974; Goldman & Widawski, 1976; Stiggins, Frisbie, & Griswold, 1989). Background characteristics (e.g., gender, race/ethnicity, family income) are also related to noncognitive characteristics (Allen & Robbins, 2010; Angrist, Lang, & Oreopoulos, 2009; Engle & Tinto, 2008; Hurtado, Laird, & Perorazio, 2010; Le, Casillas, Robbins, & Langley, 2005; Lotkowski, Robbins, & Noeth, 2004; Tym, McMillion, Barone, & Webster, 2004; Young, 2001; Zwick & Sklar, 2005).

Although the data for this study did not include measures of noncognitive characteristics, we suspect that they explain, to a large extent, developmental students' lower overall levels of success: Developmental students might be disadvantaged relative to non-developmental students in these noncognitive characteristics, and are therefore less successful in college. Noncognitive characteristics could also explain, in part, developmental students' lower test scores to begin with. Research with ACT's ENGAGE® for college students has shown the relationships between students' noncognitive characteristics and college retention, GPA, and timely degree attainment (e.g., Allen & Robbins, 2010; Allen, Robbins, & Sawyer, 2010). The research has also shown that academic discipline predicts success in Elementary Algebra (Robbins, Allen, Casillas, Peterson, & Le, 2006) and that student behaviors during the semester (participation in group work and lecture, attendance, and homework completion) predict end-of-semester knowledge (as measured by ACT COMPASS) and course success (Li, Zelenka, Buonaguidi, Beckman, Casillas, Crouse, Allen, Hanson, Acton, & Robbins, 2012).

- The degree to which developmental education extends beyond providing developmental instruction. As noted by Boylan (1995), developmental education includes providing developmental courses, but also includes advising/counseling and other services that address needs related to students' noncognitive characteristics. Support programs provide academic support for academically underprepared students, and social supports to encourage social integration at the institution (Padgett & Keup, 2011). They may include freshman orientation, first year seminars, summer bridge programs, mentoring,

advising, and counseling for selected population subgroups, course placement, and learning communities (Muraskin, 1997).

- Sustained support systems throughout college. Relatively large benefits of developmental instruction were observed in the first year of college, but declined substantively in subsequent years. One could speculate that the apparent decline in benefits from developmental instruction after the first year could be due, in part, to the lack of support systems after the first or second year. Support programs for at-risk students are typically introduced early in college (Tinto, 2004). They are also widespread; for example, in 2011 researchers from the National Resource Center for the First-Year Experience and Students in Transition reported that 87% of responding U. S. postsecondary institutions (N = 1,019) offered a first-year seminar. Of these institutions, over half had nearly all first-year students participating in the program (Padgett & Keup, 2011). In contrast, only about one-third of responding institutions had initiatives for sophomores; these initiatives typically emphasized retention, satisfaction, and student engagement (Keup, Gahagan, & Goodwin, 2010). In comparison, senior-year programs receive little attention in the literature, and studies that do exist focus on senior "capstone" experiences (Padgett & Kilgo, 2012), with little commonality in the definition of what "capstone" means (Brownell & Swaner, 2010).
- The structure and content of developmental courses. The benefits of developmental coursework also depend on the extent to which the course provides students with the skills and knowledge students need to be successful in higher-level courses. To the extent that course content is not aligned with that of higher-level courses, students are

less able to acquire the knowledge and skills they need to be successful in the higher-level course.

- The structure of course placement systems. The accuracy and benefits resulting from course placement systems rest on the measures used to make course placement decisions, the cutoff values used on those measures, and any rules established concerning their use (e.g., mandatory vs. voluntary course placement, students being allowed to take the developmental courses only before or concurrently with the associated higher-level course, etc.). For example, several students were excluded from the Developmental Reading/American History and Developmental Reading/Psychology analyses because they took the lower-level course after the higher-level course. It may be that these students would have done better in the higher-level course, had they taken the lower-level course before or concurrently with the higher-level course.
- The cost and fatigue factors associated with taking full-term developmental courses (possibly for several terms). Taking developmental courses may be too expensive, too tiring, or too frustrating for many students; they simply wear out and give up. In response, some companies have started offering targeted brush-up instruction delivered on-line (American Education Corporation, 2009; Blackboard, Inc., 2012; Pearson Education Inc., 2012; PLATO Learning, Inc., 2012; see also Tong, Saxon, Boylan, Bonham, & Smith (2012) for a detailed summary of developmental mathematics software). The software administers on-line diagnostic tests, provides instruction in the areas where deficiencies are noted, and administers a mastery test to document acquisition of the targeted knowledge and skills. This method for providing developmental instruction has obvious advantages in time, cost, and convenience to

students, but its effectiveness, like that of traditional developmental courses, needs to be studied.

We can only speculate on the extent to which these considerations influence the benefits of developmental programs. Research to confirm or refute their influences would need to incorporate data on students' noncognitive characteristics, their developmental coursework, as well as detailed information on the treatments and interventions that they participated in throughout college.

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Appendix A

Pooled Descriptive Results

Tables A-1 through A- 6

Note: All results pertaining to six-year degree completion were based on only 22 of the 35 four-year institutions in the study.

Table A-1

Summary of Student Groups for Developmental and Standard English Composition

		Student group											
		Took Developmental English Comp before Standard English Comp								Took Standard English Composition only			
		All developmental students			Developmental English Comp grade scale								
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
Predictor variable													
ACT English score		14.5	7800	57	14.7	5319	46	13.9	2163	27	20.9	72650	75
ACT Composite score		16.0	7800	57	16.2	5319	46	15.7	2163	27	20.9	72650	75
Dev. English Comp. grade; last time taken					2.87	5319	46	0.98	2163	27			
Full-time vs. part-time status		0.47	7800	57	0.36	5319	46	0.74	2163	27	0.80	72650	75
4-yr vs. 2-yr college		0.39		57	0.37		46	0.48		27	0.47		75
Outcome variable													
Type	**Level**												
Dev. English Comp. grade; first time taken	C or higher				0.94	5301	46						
	B or higher				0.67	5301	46						
	Pass							0.98	2163	27			
Standard English Comp. grade	2.0 or higher	0.70	7800	57	0.68	5319	46	0.78	2163	27	0.82	72650	75
	3.0 or higher	0.44	7800	57	0.43	5319	46	0.44	2163	27	0.66	72650	75

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Table A-1 *(continued)*

		Student group											
		Took Developmental English Comp before Standard English Comp									Took Standard English Composition only		
		All Developmental English Comp students			Developmental English Comp grade scale								
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
1st term GPA/ persist to term 2	2.0 or higher	0.73	7800	57	0.75	5319	46	0.76	2163	27	0.72	72650	75
	3.0 or higher	0.42	7800	57	0.43	5319	46	0.40	2163	27	0.42	72650	75
1st year GPA/ persist to year 2	2.0 or higher	0.54	7800	57	0.53	5319	46	0.56	2163	27	0.59	72650	75
	3.0 or higher	0.20	7800	57	0.21	5319	46	0.17	2163	27	0.32	72650	75
2nd year GPA/ persist to year 3	2.0 or higher	0.30	7800	57	0.29	5319	46	0.34	2163	27	0.43	72650	75
	3.0 or higher	0.08	7800	57	0.08	5319	46	0.07	2163	27	0.22	72650	75
Cumulative GPA at graduation/ last term	2.0 or higher	0.13	7784	57	0.13	5319	46	0.15	2147	27	0.30	57240	75
	2.5 or higher	0.11	7784	57	0.10	5319	46	0.12	2147	27	0.28	57240	75
	3.0 or higher	0.06	7784	57	0.06	5319	46	0.07	2147	27	0.20	57240	75
Assoc degree within 3 years		0.12	3878	35	0.10	3024	29	0.19	635	13	0.22	22048	40
Bach degree within 5 years		0.13	2515	43	0.11	1486	35	0.17	969	16	0.37	35292	57
Bach degree within 6 years		0.36	706	11	0.38	181	6	0.36	504	8	0.56	22317	25
Other													
No. times course was taken		1.04	7800	57	1.05	5319	46	1.01	2163	27	1.10	72650	75

Note: All statistics are pooled across institutions. The number of students with A-F and P/F grades does not sum to total number taking Developmental English because some institutions assigned grades other than A-F or P/F. The sum of the numbers of institutions associated with each grade scale exceeds the total number of institutions because some institutions assigned grades using both grade scales. Cells were left blank if the number of institutions was less than five.

Table A-2

Summary of Student Groups for Arithmetic and Elementary Algebra

		Student group											
		Took Arithmetic before Elementary Algebra								Took Elementary Algebra only			
		All Arithmetic students			Arithmetic grade scale								
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
Predictor variable													
ACT Mathematics score		15.0	1128	40	15.0	932	31	14.7	196	14	15.4	11712	66
ACT Composite score		15.6	1128	40	15.6	932	31	15.5	196	14	16.3	11712	66
Arithmetic grade; last time taken					2.99	932	31	0.97	196	14			
Full-time vs. part-time status		0.24	1128	40	0.15	932	31	0.67	196	14	0.38	11712	66
4-yr vs. 2-yr college		0.20		40	0.26		31	0.14		14	0.39		66
Outcome variable													
Type	**Level**												
Arithmetic grade; first time taken	C or higher				0.92	920	31						
	B or higher				0.71	920	31						
	Pass							0.97	196	14			
Elementary Algebra grade	2.0 or higher	0.52	1128	40	0.56	932	31	0.34	196	14	0.51	11712	66
	3.0 or higher	0.36	1128	40	0.39	932	31	0.20	196	14	0.32	11712	66

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Table A-2 *(continued)*

		Student group											
		Took Arithmetic before Elementary Algebra									Took Elementary Algebra only		
					Arithmetic grade scale								
		All Arithmetic students			A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
1st term GPA/ persist to term 2	2.0 or higher	0.73	1128	40	0.77	932	31	0.57	196	14	0.55	11712	66
	3.0 or higher	0.49	1128	40	0.52	932	27	0.33	196	14	0.29	11712	66
1st year GPA/ persist to year 2	2.0 or higher	0.52	1128	40	0.54	932	27	0.45	196	14	0.38	11712	66
	3.0 or higher	0.26	1128	40	0.28	932	27	0.17	196	14	0.15	11712	66
2nd year GPA/ persist to year 3	2.0 or higher	0.21	1128	40	0.22	932	27	0.21	196	14	0.22	11712	66
	3.0 or higher	0.08	1128	40	0.08	932	27	0.09	196	14	0.06	11712	66
Cumulative GPA at graduation/ last term	2.0 or higher	0.09	1128	40	0.09	932	27	0.10	196	14	0.09	11599	61
	2.5 or higher	0.08	1128	40	0.07	932	27	0.09	196	14	0.07	11599	61
	3.0 or higher	0.05	1128	40	0.05	932	27	0.05	196	14	0.04	11599	61
Assoc degree within 3 years		0.07	817	32	0.07	640	23				0.07	5564	40
Bach degree within 5 years		0.04	182	21	0.04	174	20				0.08	4056	43
Bach degree within 6 years											0.22	1314	12
Other													
No. times course was taken		1.07	1128	40	1.08	932	31	1.02	196	14	1.22	11712	66

Note: All statistics are pooled across institutions. The number of students with A-F and P/F grades does not sum to total number taking Arithmetic because some institutions assigned grades other than A-F or P/F. The sum of the numbers of institutions associated with each grade scale exceeds the total number of institutions because some institutions assigned grades using both grade scales. Cells were left blank if the number of institutions was less than five.

Table A-3

Summary of Student Groups for Elementary and Intermediate Algebra

		Student group											
		Took Elementary Algebra before Intermediate Algebra								Took Intermediate Algebra only			
		All Elementary Algebra students			Elementary Algebra grade scale								
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
Predictor variable													
ACT Mathematics score		15.6	5235	57	15.6	4895	51	15.5	246	14	16.8	11878	67
ACT Composite score		16.6	5235	57	16.6	4895	51	16.6	246	14	18.0	11878	67
Elementary Algebra grade; last time taken					2.71	4895	51	0.94	246	14			
Full-time vs. part-time status		0.47	5235	57	0.44	4895	51	0.83	246	14	0.53	11878	67
4-yr vs. 2-yr college		0.35		57	0.35		51	0.43		14	0.43		67
Outcome variable													
Type	**Level**												
Elementary Algebra; first time taken	C or higher				0.87	4890	51						
	B or higher				0.56	4890	51						
	Pass							0.93	245	14			
Intermediate Algebra grade	2.0 or higher	0.49	5235	57	0.51	4895	51	0.07	246	14	0.51	11878	67
	3.0 or higher	0.28	5235	57	0.29	4895	51	0.05	246	14	0.33	11878	67

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Table A-3 *(continued)*

		Student group											
		Took Elementary Algebra before Intermediate Algebra									Took Intermediate Algebra only		
		All Elementary Algebra students			Elementary Algebra grade scale								
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
1st term GPA/ persist to term 2	2.0 or higher	0.75	5235	57	0.75	4895	51	0.70	246	14	0.61	11878	67
	3.0 or higher	0.42	5235	57	0.43	4895	51	0.33	246	14	0.32	11878	67
1st year GPA/ persist to year 2	2.0 or higher	0.56	5235	57	0.57	4895	51	0.41	246	14	0.46	11878	67
	3.0 or higher	0.23	5235	57	0.24	4895	51	0.12	246	14	0.19	11878	67
2nd year GPA/ persist to year 3	2.0 or higher	0.33	5235	57	0.34	4895	51	0.18	246	14	0.29	11878	67
	3.0 or higher	0.10	5235	57	0.10	4895	51	0.05	246	14	0.09	11878	67
Cumulative GPA at graduation/ last term	2.0 or higher	0.14	5205	57	0.13	4865	51	0.14	246	14	0.14	11739	67
	2.5 or higher	0.11	5205	57	0.11	4865	51	0.10	246	14	0.13	11739	67
	3.0 or higher	0.06	5205	57	0.06	4865	51	0.05	246	14	0.08	11739	67
Assoc degree within 3 years		0.12	2630	37	0.12	2412	32	.10	164	8	0.15	4105	22
Bach degree within 5 years		0.13	1735	41	0.14	1645	38	.10	63	6	0.16	4714	28
Bach degree within 6 years		0.33	561	22	0.34	504	6	.23	43	6	0.35	1394	18
Other													
No. times course was taken		1.06	5235	57	1.06	4865	51	1.03	246	14	1.24	11878	67

Note: All statistics are pooled across institutions. The number of students with A-F and P/F grades does not sum to total number taking Elementary Algebra because some institutions assigned grades other than A-F or P/F. The sum of the numbers of institutions associated with each grade scale exceeds the total number of institutions because some institutions assigned grades using both grade scales. Cells were left blank if the number of institutions was less than five.

Table A-4

Summary of Student Groups for Intermediate and College Algebra

		Student group											
		Took Intermediate Algebra before College Algebra											
		All Intermediate Algebra students			Intermediate Algebra grade scale						Took College Algebra only		
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
Predictor variable													
ACT Mathematics score		16.7	6299	60	16.7	4984	54	16.4	1142	17	20.8	33778	75
ACT Composite score		18.0	6299	60	18.0	4984	54	17.7	1142	17	21.4	33778	75
Intermediate Algebra grade; last time taken					2.76	4984	54	0.98	1142	17			
Full-time vs. part-time status		0.66	6299	60	0.60	4984	54	0.93	1142	17	0.84	33778	75
4-yr vs. 2-yr college		0.37		60	0.35		54	0.47		17	0.47		75
Outcome variable													
Type	**Level**												
Intermediate Algebra grade; first time taken	C or higher				0.89	4964	54						
	B or higher				0.59	4964	54						
	Pass							0.98	1142	17			
College Algebra grade	2.0 or higher	0.58	6299	60	0.57	4984	54	0.65	1142	17	0.66	33778	75
	3.0 or higher	0.34	6299	60	0.33	4984	54	0.41	1142	17	0.47	33778	75

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Table A-4 *(continued)*

		Student group											
		Took Intermediate Algebra before College Algebra									Took College Algebra only		
		All Intermediate Algebra students			Intermediate Algebra grade scale								
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
1st term GPA/ persist to term 2	2.0 or higher	0.82	6299	60	0.80	4984	54	0.89	1142	17	0.72	33778	75
	3.0 or higher	0.49	6299	60	0.48	4984	54	0.55	1142	17	0.44	33778	75
1st year GPA/ persist to year 2	2.0 or higher	0.64	6299	60	0.64	4984	54	0.67	1142	17	0.59	33778	75
	3.0 or higher	0.29	6299	60	0.28	4984	54	0.33	1142	17	0.34	33778	75
2nd year GPA/ persist to year 3	2.0 or higher	0.40	6299	60	0.40	4984	54	0.39	1142	17	0.42	33778	75
	3.0 or higher	0.14	6299	60	0.14	4984	54	0.16	1142	17	0.23	33778	75
Cumulative GPA at graduation/ last term	2.0 or higher	0.24	6285	60	0.20	3818	54	0.42	1142	17	0.31	33720	75
	2.5 or higher	0.21	6285	60	0.18	3818	54	0.37	1142	17	0.29	33720	75
	3.0 or higher	0.14	6285	60	0.12	3818	54	0.23	1142	17	0.22	33720	75
Assoc degree within 3 years		0.25	2718	22	0.20	1990	35	.41	607	9	0.28	9516	40
Bach degree within 5 years		0.25	2219	22	0.26	1771	40	0.36	391	7	0.38	15606	55
Bach degree within 6 years		0.51	718	11	0.38	418	8	0.56	275	7	0.57	8381	22
Other													
No. times course was taken		1.07	6299	60	1.08	4984	54	1.01	1142	17	1.10	33778	75

Note: All statistics are pooled across institutions. The number of students with A-F and P/F grades does not sum to total number taking Intermediate Algebra because some institutions assigned grades other than A-F or P/F. The sum of the numbers of institutions associated with each grade scale exceeds the total number of institutions because some institutions assigned grades using both grade scales. Cells were left blank if the number of institutions was less than five.

Table A-5

Summary of Student Groups for Developmental Reading and American History

		Student group											
		Took Developmental Reading before American History								Took American History only			
		All Developmental Reading students			Developmental Reading grade scale								
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
Predictor variable													
ACT Reading score		15.1	3573	60	14.9	1940	47	15.4	1587	24	21.6	55177	75
ACT Composite score		16.0	3573	60	15.9	1940	47	16.1	1587	24	21.0	55177	75
Developmental Reading grade; last time taken					2.75	1940	47	0.97	1587	24			
Full-time vs. part-time status		0.55	3573	60	0.28	1940	47	0.88	1587	24	0.83	55177	75
4-yr vs. 2-yr college		0.38		60	0.34		47	0.42		24	0.47		75
Outcome variable													
Type	**Level**												
Developmental Reading grade; first time taken	C or higher				0.88	1940	47						
	B or higher				0.65	1940	47						
	Pass							0.96	1557	24			
American History grade	2.0 or higher	0.54	3573	60	0.55	1940	47	0.53	1587	24	0.73	55177	75
	3.0 or higher	0.29	3573	60	0.28	1940	47	0.30	1587	24	0.51	55177	75

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Table A-5 *(continued)*

		Student group											
		Took Developmental Reading before American History									Took American History only		
		All Developmental Reading students			Developmental Reading grade scale								
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
1st term GPA/ persist to term 2	2.0 or higher	0.71	3573	60	0.70	1940	47	0.74	1587	24	0.74	55177	75
	3.0 or higher	0.40	3573	60	0.40	1940	47	0.39	1587	24	0.44	55177	75
1st year GPA/ persist to year 2	2.0 or higher	0.52	3573	60	0.52	1940	47	0.52	1587	24	0.62	55177	75
	3.0 or higher	0.19	3573	60	0.19	1940	47	0.18	1587	24	0.34	55177	75
2nd year GPA/ persist to year 3	2.0 or higher	0.31	3573	60	0.30	1940	47	0.33	1587	24	0.46	55177	75
	3.0 or higher	0.09	3573	60	0.07	1940	47	0.10	1587	24	0.24	55177	75
Cumulative GPA at graduation/ last term	2.0 or higher	0.16	3566	60	0.12	1940	47	0.21	1580	24	0.34	54978	75
	2.5 or higher	0.13	3566	60	0.10	1940	47	0.17	1580	24	0.32	54978	75
	3.0 or higher	0.07	3566	60	0.05	1940	47	0.09	1580	24	0.23	54978	75
Assoc degree within 3 years		0.13	1542	37	0.11	941	31	0.17	571	14	0.23	16463	40
Bach degree within 5 years		0.21	1397	43	0.14	567	34	0.26	811	13	0.42	27360	57
Bach degree within 6 years		0.40	619	11				0.41	592	10	0.60	18778	26
Other													
No. times course was taken		1.11	3573	60	1.15	1940	47	1.06	1587	24	1.13	55177	75

Note: All statistics are pooled across institutions. The number of students with A-F and P/F grades does not sum to total number taking Developmental Reading because some institutions assigned grades other than A-F or P/F. The sum of the numbers of institutions associated with each grade scale exceeds the total number of institutions because some institutions assigned grades using both grade scales. Cells were left blank if the number of institutions was less than five.

Table A-6

Summary of Student Groups for Developmental Reading and Psychology

		Student group											
		Took Developmental Reading before Psychology											
		All Developmental Reading students			Developmental Reading grade scale						Took Psychology only		
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
Predictor variable													
ACT Reading score		15.1	3709	59	14.9	2550	47	15.4	1102	25	21.7	51668	75
ACT Composite score		15.9	3709	59	15.9	2550	47	16.0	1102	25	21.1	51668	75
Developmental Reading grade; last time taken					2.78			0.98	1102	25			
Full-time vs. part-time status		.43	3709	59	0.28	2550	47	0.77	1102	25	0.81	51668	75
4-yr vs. 2-yr college		.39		59	0.36		47	0.52		25	0.47		75
Outcome variable													
Type	**Level**												
Developmental Reading grade; first time taken	C or higher				0.90	2080	47						
	B or higher				0.60	2080	47						
	Pass							0.97	1072	25			
Psychology grade	2.0 or higher	.59	3709	59	0.57	2550	47	0.65	1102	25	0.78	51668	75
	3.0 or higher	.35	3709	59	0.34	2550	47	0.38	1102	25	0.57	51668	75

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Table A-6 *(continued)*

		Student group											
		Took Developmental Reading before Psychology											
		All Developmental Reading students			Developmental Reading grade scale						Took Psychology only		
					A-F			P/F					
		Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.	Mean/ prop	No. of students	No. of inst.
1st term GPA/ persist to term 2	2.0 or higher	.69	3709	59	0.68	2550	47	0.73	1102	25	0.74	51668	75
	3.0 or higher	.40	3709	59	0.41	2550	47	0.40	1102	25	0.45	51668	75
1st year GPA/ persist to year 2	2.0 or higher	.49	3709	59	0.49	2550	47	0.50	1102	25	0.61	51668	75
	3.0 or higher	.18	3709	59	0.18	2550	47	0.18	1102	25	0.35	51668	75
2nd year GPA/ persist to year 3	2.0 or higher	.29	3709	59	0.28	2550	47	0.32	1102	25	0.45	51668	75
	3.0 or higher	.08	3709	59	0.07	2550	47	0.10	1102	25	0.25	51668	75
Cumulative GPA at graduation/ last term	2.0 or higher	.13	3705	59	0.10	2550	47	0.19	1098	25	0.33	51559	75
	2.5 or higher	.10	3705	59	0.08	2550	47	0.16	1098	25	0.30	51559	75
	3.0 or higher	.06	3705	59	0.04	2550	47	0.10	1098	25	0.23	51559	75
Assoc degree within 3 years		.10	1820	36	0.09	1361	30	0.14	419	12	0.20	15556	40
Bach degree within 5 years		.16	1317	45	0.10	754	39	0.23	539	11	0.42	24390	57
Bach degree within 6 years		.44	370	12	0.36	36	5	0.45	331	15	0.61	15590	24
Other													
No. times course was taken		1.10	3709	59	1.12	2550	47	1.06	1102	25	1.11	51668	75

Note: All statistics are pooled across institutions. The number of students with A-F and P/F grades does not sum to total number taking Developmental Reading because some institutions assigned grades other than A-F or P/F. The sum of the numbers of institutions associated with each grade scale exceeds the total number of institutions because some institutions assigned grades using both grade scales. Cells were left blank if the number of institutions was less than five.

Appendix B

Hierarchical Logistic Regression Models for Predicting Success in College

Tables B1 through B13

Note: All results pertaining to six-year degree completion were based on only 22 of the 35 four-year institutions in the study.

Table B-1

Hierarchical Logistic Regression Models for Predicting Success in Developmental Courses[1]

Developmental course	Outcome variable level	Fixed effects: Institution-level effects: Intercept	Fixed effects: Institution-level effects: Mean ACT Test score	Fixed effects: Institution-level effects: Proportion full time	Fixed effects: Student-level effects: ACT Test score	Fixed effects: Student-level effects: FT/PT status (FT=1)	Variance components: Intercept	Variance components: ACT Test score slope
Developmental English Comp	C or higher	3.047	-0.350	1.056	0.124	0.344	1.34299	0.01688
	B or higher	0.572	-0.030	-0.253	0.114	0.177	0.77141	--
	Pass	4.749	0.250	-1.324	0.031	0.283	1.21304	--
Arithmetic	C or higher	2.445	0.020	-0.125	0.182	1.001	--	--
	B or higher	0.926	0.058	-0.776	0.244	0.340	0.29519	--
	Pass							
Elementary Algebra	C or higher	2.181	0.105	0.470	0.166	0.174	0.41740	--
	B or higher	0.464	-0.122	-0.368	0.231	0.086	0.43497	--
	Pass	2.801	0.509		-0.076	0.359	--	--
Intermediate Algebra	C or higher	2.538	-0.107	0.290	0.173	1.139	0.44911	--
	B or higher	0.565	-0.039	-0.570	0.200	0.504	0.33878	--
	Pass							
Developmental Reading (before Amer. History)	C or higher	2.021	-0.596	-1.540	0.148	1.095	1.46023	--
	B or higher	0.488	-0.323	-1.114	0.116	1.047	0.71285	--
	Pass	4.224	1.169		0.126	0.821	0.93220	--
Developmental Reading (before Psychology)	C or higher	1.994	-0.517	-1.666	0.056	1.390	2.32661	--
	B or higher	0.592	-0.262	-0.966	0.088	1.022	0.83461	--
	Pass	3.847	1.110		-0.023	0.259	--	--

[1] The first time the course was taken.

Note: ACT Test scores are: English (for Developmental English Composition), Mathematics (for all mathematics courses), and Reading (for Developmental Reading). The shaded coefficients are not statistically significantly different from zero ($p > .05$ for institution-level coefficients; $p > .01$ for all student-level coefficients). Only the statistically significant ($p < .01$) variance components are listed; the non-statistically significant variance components are noted in the table as '--'. Variance components and regression coefficients for models that could not be developed are left blank.

Table B-2

Fixed Effects of Hierarchical Logistic Regression Models for Predicting Subsequent College Success after Taking Developmental and/or Standard English Composition

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT English score	Mean devel course grade	Proportion full time	Mean score by FT/PT interaction	College type (4-yr=1)	ACT English score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT interaction
All students who took Developmental English Composition before Standard English Composition											
Success in Std. English Comp	C or higher	0.835	0.088		-0.177			0.048		0.452	
	B or higher	-0.258	0.053		-0.219			0.084		0.386	
1st term GPA/ persist to term 2	2.0 or higher	1.179	0.054		-0.702		-0.424	0.002		0.916	
	3.0 or higher	-0.305	0.076		-0.421		-0.493	0.008		0.172	
1st year GPA/ persist to year 2	2.0 or higher	0.174	0.047		-0.240			0.014		0.506	
	3.0 or higher	-1.430	0.098		-0.415		-0.597	0.045		0.374	
2nd year GPA/ persist to year 3	2.0 or higher	-0.880	0.118		0.162		0.426	0.020		0.343	
	3.0 or higher	-2.508	0.119		-0.200		-0.314	0.074		0.498	
Cum. GPA at graduation/ last term	2.0 or higher	-1.982	-0.042		-0.036			0.042		1.033	
	2.5 or higher	-2.233	-0.094		-0.251			0.058		1.022	
	3.0 or higher	-2.937	0.095		0.033		-0.766	0.116		1.039	
Associate's degree within 3 years		-2.141	-0.057		-0.783			0.046		1.547	
Bachelor's degree within 5 years		-3.075	0.020		0.191		1.232	0.054		0.844	
Bachelor's degree within 6 years		-0.523	-0.075		-0.877			0.023		0.696	

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Table B-2 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT English score	Mean devel course grade	Proportion full time	Mean score by FT/PT interaction	College type (4-yr=1)	ACT English score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT interaction
Students who took Developmental English Composition (grade scale A-F) before Standard English Composition											
Success in Std. English Comp	C or higher	0.803	0.014	-0.098	-0.200			0.016	0.651	0.375	
	B or higher	-0.372	-0.003	0.203	-0.280			0.047	0.705	0.348	
1st term GPA/ persist to term 2	2.0 or higher	1.127	0.060	0.418	-0.992			-0.017	0.422	0.845	
	3.0 or higher	-0.340	0.022	0.311	-0.970			-0.012	0.498	0.120	
1st year GPA/ persist to year 2	2.0 or higher	0.146	0.088	0.007	-0.146			-0.018	0.553	0.426	
	3.0 or higher	-1.312	0.078	-0.111	-0.670		-0.715	0.008	0.879	0.364	
2nd year GPA/ persist to year 3	2.0 or higher	-0.907	0.118	-0.063	0.422		0.379	-0.016	0.483	0.245	
	3.0 or higher	-2.695	0.153	-0.303	-0.290		-0.354	0.022	0.962	0.498	
Cum. GPA at graduation/ last term	2.0 or higher	-2.135	-0.006	0.078	0.257			0.030	0.566	1.014	
	2.5 or higher	-2.409	-0.074	-0.051	-0.005			0.038	0.670	0.976	
	3.0 or higher	-3.220	0.083	-0.783	-0.357		-0.804	0.093	0.969	1.040	
Associate's degree within 3 years		-2.516	-0.053	0.508	-1.106			0.017	0.648	1.460	
Bachelor's degree within 5 years		-3.080	-0.034	-0.365	0.315		1.115	0.044	0.507	0.859	
Bachelor's degree within 6 years		-0.562	-0.667	0.300	-1.538			-0.090	0.379	1.597	

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Table B-2 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT English score	Mean devel course grade	Proportion full time	Mean score by FT/PT interaction	College type (4-yr=1)	ACT English score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT interaction
Students who took Developmental English Composition (grade scale pass/fail) before Standard English Composition											
Success in Std. English Comp	C or higher	0.945	0.278	0.613	-0.514			0.056	1.044	0.457	
	B or higher	-0.268	0.141	-0.158	-0.304			0.095	1.259	0.286	
1st term GPA/ persist to term 2	2.0 or higher	1.096	0.100		-0.120			-0.002	1.081	1.101	
	3.0 or higher	-0.570	0.085		0.346			-0.001	1.264	0.138	
1st year GPA/ persist to year 2	2.0 or higher	0.264	0.041		-0.350			0.026	1.324	0.617	
	3.0 or higher	-1.683	0.135	0.449	0.449		-0.350	0.039	2.071	0.080	
2nd year GPA/ persist to year 3	2.0 or higher	-0.959	0.162	-0.653	0.281			0.041	0.971	0.591	
	3.0 or higher										
Cum. GPA at graduation/ last term	2.0 or higher	-1.932	-0.072	-0.017	0.125			0.005	1.090	0.872	
	2.5 or higher	-2.081	-0.112	-1.217	-0.242			0.029	1.998	0.992	
	3.0 or higher										
Associate's degree within 3 years											
Bachelor's degree within 5 years		-1.741	0.114		0.199			0.043	0.452	0.880	
Bachelor's degree within 6 years		-0.660	-0.010					0.038	0.929	0.479	

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Table B-2 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT English score	Mean devel course grade	Proportion full time	Mean score by FT/PT interaction	College type (4-yr=1)	ACT English score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT interaction
Students who enrolled directly in Standard English Composition											
Success in Std. English Comp	C or higher	1.533	0.071		0.166	0.708		0.045		1.605	0.071
	B or higher	0.605	-0.001		0.700	0.730		0.087		1.197	0.074
1st term GPA/ persist to term 2	2.0 or higher	0.970	0.102					0.051		2.339	0.095
	3.0 or higher	-0.313	0.059		-0.399	-0.129	-0.620	0.087		1.457	0.098
1st year GPA/ persist to year 2	2.0 or higher	0.225	0.083		-0.036	0.314		0.043		1.684	0.083
	3.0 or higher	-0.829	-0.001		0.550	0.277	-0.287	0.102		1.322	0.101
2nd year GPA/ persist to year 3	2.0 or higher	-0.780	0.046		1.213	0.599	0.683	0.026		1.421	0.072
	3.0 or higher	-1.674	-0.019		1.489	0.544	0.472	0.094		1.229	0.091
Cum. GPA at graduation/ last term	2.0 or higher	-1.132	-0.014		1.109	0.234		0.052		1.655	0.058
	2.5 or higher	-1.242	-0.015		0.925	0.131		0.066		1.636	0.058
	3.0 or higher	-1.646	-0.046		0.619	0.130		0.098		1.630	0.059
Associate's degree within 3 years		-1.024	0.110		1.852			0.062		1.784	
Bachelor's degree within 5 years		-2.093	0.109				1.051	0.056		1.973	0.068
Bachelor's degree within 6 years		-0.406	0.147		1.328			0.064		1.843	

Note: Shaded coefficients were not significantly different from zero ($p > .05$ for institution-level effects; $p > .01$ for all student-level main and interaction effects).

Table B-3

Variance Components of Hierarchical Logistic Regression Models for Predicting Subsequent Academic Success after Taking Developmental English Composition and/or Standard English Composition

Outcome variable			
Type	Level	Intercept	ACT Test score slope
All students who took Developmental English Composition before Standard English Composition			
Success in Std. English Comp	C or higher	0.08929	--
	B or higher	0.17946	--
1st term GPA/persist to term 2	2.0 or higher	0.17750	--
	3.0 or higher	0.17946	--
1st year GPA/persist to year 2	2.0 or higher	0.06308	0.00263
	3.0 or higher	0.10110	--
2nd year GPA/persist to year 3	2.0 or higher	0.05090	--
	3.0 or higher	0.07516	--
Cum. GPA at graduation/ last term	2.0 or higher	0.27496	--
	2.5 or higher	0.23989	--
	3.0 or higher	0.14624	--
Associate's degree within 3 years		0.35980	--
Bachelor's degree within 5 years		0.11281	--
Bachelor's degree within 6 years		--	--
Students who took Developmental English Composition (grade scale A-F) before Standard English Composition			
Success in Std. English Comp	C or higher	0.08636	--
	B or higher	0.15723	--
1st term GPA/persist to term 2	2.0 or higher	0.29191	--
	3.0 or higher	0.20817	--
1st year GPA/persist to year 2	2.0 or higher	0.11910	--
	3.0 or higher	0.12688	--
2nd year GPA/persist to year 3	2.0 or higher	0.10767	--
	3.0 or higher	0.08441	--
Cum. GPA at graduation/ last term	2.0 or higher	0.19937	--
	2.5 or higher	0.18813	--
	3.0 or higher	--	--
Associate's degree within 3 years		0.41048	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years		--	--

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Table B-3 *(continued)*

Outcome variable			
Type	Level	Intercept	ACT Test score slope
Students who took Developmental English Composition (grade scale pass/fail) before Standard English Composition			
Success in Std. English Comp	C or higher	--	--
	B or higher	--	--
1st term GPA/persist to term 2	2.0 or higher	0.14632	--
	3.0 or higher	0.09210	--
1st year GPA/persist to year 2	2.0 or higher	--	--
	3.0 or higher	--	--
2nd year GPA/persist to year 3	2.0 or higher	0.12661	--
	3.0 or higher		
Cum. GPA at graduation/ last term	2.0 or higher	0.58299	--
	2.5 or higher	0.50159	--
	3.0 or higher		
Associate's degree within 3 years			
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years		--	--
Students who enrolled directly in Standard English Composition			
Success in Std. English Comp	C or higher	0.15645	0.00056
	B or higher	0.15480	0.00065
1st term GPA/persist to term 2	2.0 or higher	0.61474	0.00039
	3.0 or higher	0.17222	0.00047
1st year GPA/persist to year 2	2.0 or higher	0.10664	0.00022
	3.0 or higher	0.07340	0.00080
2nd year GPA/persist to year 3	2.0 or higher	0.10692	0.00085
	3.0 or higher	0.07767	0.00194
Cum. GPA at graduation/ last term	2.0 or higher	0.25533	0.00045
	2.5 or higher	0.23284	0.00047
	3.0 or higher	0.23373	0.00052
Associate's degree within 3 years		0.15930	--
Bachelor's degree within 5 years		0.12857	0.00067
Bachelor's degree within 6 years		0.13163	0.00049

Note: Statistically significant ($p < .01$) variance components are listed. Non-statistically significant variance components are noted in the table as '--' and were not included in the final models. Variance components for models that could not be developed are left blank.

Table B-4

Fixed Effects of Hierarchical Logistic Regression Models for Predicting Subsequent College Success after Taking Arithmetic and/or Elementary Algebra

Outcome variable		Institution-level effects					Student-level effects		
Type	Level	Intercept	Mean ACT Math score	Mean devel course grade	Proportion full time	College type	ACT Math score	Devel course grade	FT/PT status (FT=1)
All students who took Arithmetic before taking Elementary Algebra									
Success in Elem. Algebra	C or higher	-0.290	0.465				0.162		0.348
	B or higher	-0.884	0.221				0.274		0.123
1st term GPA/ persist to term 2	2.0 or higher	0.685	0.086		-1.885	-1.466	0.074		1.049
	3.0 or higher	-0.133	-0.214		-1.456		0.083		0.254
1st year GPA/ persist to year 2	2.0 or higher	-0.008	0.026		-0.996		0.008		0.660
	3.0 or higher	-1.176	-0.252		-1.073		0.083		0.084
2nd year GPA/ persist to year 3	2.0 or higher	-1.349	0.117		-0.059		-0.002		0.305
	3.0 or higher	-2.447	-0.173		-0.285		0.193		0.556
Cum. GPA at graduation/ last term	2.0 or higher	-2.663	0.396		-0.534		0.079		1.456
	2.5 or higher	-2.791	0.310		-0.572		0.118		1.366
	3.0 or higher	-3.245	-0.038		-0.989		0.355		1.239
Associate's degree within 3 years		-2.906	0.420				0.212		0.943
Bachelor's degree within 5 years		-3.170	-0.002		-0.403	0.029	0.104		1.104
Bachelor's degree within 6 years									

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Table B-4 (*continued)*

Outcome variable		Institution-level effects					Student-level effects		
Type	Level	Intercept	Mean ACT Math score	Mean devel course grade	Proportion full time	College type	ACT Math score	Devel course grade	FT/PT status (FT=1)
Students who took Arithmetic (grade scale A-F) before Elementary Algebra									
Success in Elem. Algebra	C or higher	0.220	0.136	-0.218	-0.522		0.092	0.617	0.748
	B or higher	-0.617	-0.073	-0.368	-0.947		0.231	0.852	0.488
1st term GPA/ persist to term 2	2.0 or higher	1.142	-0.019	0.320	-0.704		0.036	0.487	1.063
	3.0 or higher	0.125	-0.471	0.119	-0.394		0.064	0.427	-0.050
1st year GPA/ persist to year 2	2.0 or higher	0.212	-0.069	-0.397	-0.661		-0.009	0.422	0.642
	3.0 or higher	-0.902	-0.581	-0.108	-0.108		0.026	0.586	-0.049
2nd year GPA/ persist to year 3	2.0 or higher	-1.219	-0.060	-0.348	-0.139		0.006	0.224	0.354
	3.0 or higher	-2.483	-0.418	-0.242	-0.317		0.182	0.539	0.475
Cum. GPA at graduation/ last term	2.0 or higher	-2.601	0.294	-0.062	-0.188		0.080	0.309	1.400
	2.5 or higher	-2.733	0.196	-0.189	-0.319		0.111	0.366	1.292
	3.0 or higher	-3.315	-0.098	-0.220	-0.593		0.308	0.724	1.044
Associate's degree within 3 years		-2.785	-0.077	-0.168			0.181	0.374	1.281
Bachelor's degree within 5 years		-3.018	0.270	-0.074	0.980		0.079	0.152	1.002
Bachelor's degree within 6 years									

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Table B-4 (*continued)*

Outcome variable		Institution-level effects					Student-level effects		
Type	Level	Intercept	Mean ACT Math score	Mean devel course grade	Proportion full time	College type	ACT Math score	Devel course grade	FT/PT status (FT=1)
Students who took Arithmetic (grade scale pass/fail) before Elementary Algebra									
Success in Elem. Algebra	C or higher								
	B or higher								
1st term GPA/ persist to term 2	2.0 or higher	0.605	-0.580		-1.904		0.051	0.946	1.063
	3.0 or higher								
1st year GPA/ persist to year 2	2.0 or higher	-0.165	0.228		-1.218		-0.129	1.231	0.554
	3.0 or higher								
2nd year GPA/ persist to year 3	2.0 or higher								
	3.0 or higher								
Cum. GPA at graduation/ last term	2.0 or higher								
	2.5 or higher								
	3.0 or higher								
Associate's degree within 3 years									
Bachelor's degree within 5 years									
Bachelor's degree within 6 years									

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Table B-4 (*continued)*

Outcome variable		Institution-level effects					Student-level effects		
Type	Level	Intercept	Mean ACT Math score	Mean devel course grade	Proportion full time	College type	ACT Math score	Devel course grade	FT/PT status (FT=1)
Students who enrolled directly in Elementary Algebra									
Success in Elem. Algebra	C or higher	-0.582	0.241		-1.034		0.236		0.759
	B or higher	-1.304	0.066		-1.136		0.311		0.546
1st term GPA/ persist to term 2	2.0 or higher	-0.085	-0.033		-1.865		0.051		1.492
	3.0 or higher	-1.167	-0.058		-1.337	-0.683	0.063		0.803
1st year GPA/ persist to year 2	2.0 or higher	-0.821	0.206		-1.234		0.048		0.984
	3.0 or higher	-2.025	0.289		-1.067		0.103		0.644
2nd year GPA/ persist to year 3	2.0 or higher	-1.603	0.197		-0.392		0.019		0.845
	3.0 or higher	-2.946	0.204		-0.527		0.099		0.910
Cum. GPA at graduation/ last term	2.0 or higher	-2.705	0.478		-0.262		0.067		1.211
	2.5 or higher	-2.921	0.521		-0.345		0.086		1.248
	3.0 or higher	-3.458	0.450		-0.355		0.147		1.377
Associate's degree within 3 years		-2.904	0.320		-0.906		0.079		1.736
Bachelor's degree within 5 years		-3.938	0.059		-1.281	1.420	0.149		1.460
Bachelor's degree within 6 years		-1.013	0.544		-1.333		0.083		1.117

Note: Shaded coefficients were not significantly different from zero ($p > .05$ for institution-level effects; $p > .01$ for all student-level main and interaction effects).

Table B-5

Variance Components of Hierarchical Logistic Regression Models for Predicting Subsequent Academic Success after Taking Arithmetic and/or Elementary Algebra

Outcome variable			
Type	Level	Intercept	ACT Test score slope
All students who took Arithmetic before Elementary Algebra			
Success in Elementary Algebra	C or higher	0.49421	--
	B or higher	0.35677	--
1st term GPA/persist to term 2	2.0 or higher	0. 17576	--
	3.0 or higher	0.09754	--
1st year GPA/persist to year 2	2.0 or higher	--	--
	3.0 or higher	0. 15184	--
2nd year GPA/persist to year 3	2.0 or higher	--	--
	3.0 or higher	--	--
Cum. GPA at graduation/ last term	2.0 or higher	--	--
	2.5 or higher	--	--
	3.0 or higher	--	--
Associate's degree within 3 years		--	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years			
Students who took Arithmetic (grade scale A-F) before Elementary Algebra			
Success in Elementary Algebra	C or higher	0. 12691	--
	B or higher	0. 27294	--
1st term GPA/persist to term 2	2.0 or higher	0. 10343	--
	3.0 or higher	--	--
1st year GPA/persist to year 2	2.0 or higher	--	--
	3.0 or higher	--	--
2nd year GPA/persist to year 3	2.0 or higher	--	--
	3.0 or higher	--	--
Cum. GPA at graduation/ last term	2.0 or higher	--	--
	2.5 or higher	--	--
	3.0 or higher	--	--
Associate's degree within 3 years		0. 22884	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years			

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Table B-5 *(continued)*

Outcome variable			
Type	Level	Intercept	ACT Test score slope
Students who took Arithmetic (grade scale pass/fail) before Elementary Algebra			
Success in Elementary Algebra	C or higher		
	B or higher		
1st term GPA/persist to term 2	2.0 or higher	--	--
	3.0 or higher		
1st year GPA/persist to year 2	2.0 or higher	--	--
	3.0 or higher		
2nd year GPA/persist to year 3	2.0 or higher		
	3.0 or higher		
Cum. GPA at graduation/ last term	2.0 or higher		
	2.5 or higher		
	3.0 or higher		
Associate's degree within 3 years			
Bachelor's degree within 5 years			
Bachelor's degree within 6 years			
Students who enrolled directly in Elementary Algebra			
Success in Elementary Algebra	C or higher	2.18399	--
	B or higher	1.67714	0.01145
1st term GPA/persist to term 2	2.0 or higher	0.48859	--
	3.0 or higher	0.35618	--
1st year GPA/persist to year 2	2.0 or higher	0.36947	--
	3.0 or higher	0.39166	--
2nd year GPA/persist to year 3	2.0 or higher	0.23418	--
	3.0 or higher	0.27330	--
Cum. GPA at graduation/ last term	2.0 or higher	0.38943	--
	2.5 or higher	0.33374	--
	3.0 or higher	0.26062	--
Associate's degree within 3 years		0.40382	--
Bachelor's degree within 5 years		0.20929	--
Bachelor's degree within 6 years		--	--

Note: Statistically significant ($p < .01$) variance components are listed. Non-statistically significant variance components are noted in the table as '--' and were not included in the final models. Variance components for models that could not be developed are left blank.

Table B-6

Fixed Effects of Hierarchical Logistic Regression Models for Predicting Subsequent College Success after Taking Elementary and/or Intermediate Algebra

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Math score	Mean devel course grade	Prop. full time	Mean grade by score interaction	College type	ACT Math score	Devel course grade	FT/PT status (FT=1)	Grade by score interaction
All students who took Elementary Algebra before Intermediate Algebra											
Success in Inter. Algebra	C or higher	-0.277	0.150		-1.149			0.126		0.239	
	B or higher	-1.108	-0.047		-0.971			0.205		0.199	
1st term GPA/ persist to term 2	2.0 or higher	1.095	0.173		-1.277			0.023		0.744	
	3.0 or higher	-0.267	-0.053		-0.984		-0.670	0.026		0.287	
1st year GPA/ persist to year 2	2.0 or higher	0.145	0.208		-0.857			-0.016		0.445	
	3.0 or higher	-1.302	-0.041		-0.728		-0.686	0.056		0.267	
2nd year GPA/ persist to year 3	2.0 or higher	-0.822	0.377		-0.569		0.391	-0.051		0.398	
	3.0 or higher	-2.315	0.268		-0.816			0.025		0.616	
Cum. GPA at graduation/ last term	2.0 or higher	-1.980	0.773		-0.401			-0.045		0.895	
	2.5 or higher	-2.213	0.734		-0.489			-0.021		0.933	
	3.0 or higher	-2.813	0.563		-0.718			0.060		1.018	
Associate's degree within 3 years		-2.167	0.349		-1.393			-0.056		1.490	
Bachelor's degree within 5 years		-3.069	0.449		-0.870		1.593	0.074		0.867	
Bachelor's degree within 6 years		-0.204	0.342		-1.492			-0.065		0.483	

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Table B-6 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Math score	Mean devel course grade	Prop. full time	Mean grade by score interaction	College type	ACT Math score	Devel course grade	FT/PT status (FT=1)	Grade by score interaction
Students who took Elementary Algebra (grade scale A-F) before Intermediate Algebra											
Success in Inter. Algebra	C or higher	0.111	-0.028	-0.128	-0.016			0.044	0.837	0.215	
	B or higher	-1.085	0.007		-0.210			0.107	1.100	0.176	
1st term GPA/ persist to term 2	2.0 or higher	1.229	0.302	0.181	-1.326			-0.008	0.343	0.810	
	3.0 or higher	-0.235	0.250	0.235	-1.081			-0.026	0.484	0.294	
1st year GPA/ persist to year 2	2.0 or higher	0.252	0.253	-0.019	-0.674			-0.059	0.354	0.487	
	3.0 or higher	-1.346	0.262	0.260	-0.539			-0.026	0.705	0.270	
2nd year GPA/ persist to year 3	2.0 or higher	-0.698	0.163	-0.312	-0.302			-0.094	0.334	0.457	
	3.0 or higher	-2.425	0.390	0.362	-0.694	-0.153		-0.119	0.798	0.628	0.092
Cum. GPA at graduation/ last term	2.0 or higher	-2.051	0.876	-0.268	-0.417			-0.077	0.367	0.949	
	2.5 or higher	-2.301	0.875	-0.278	-0.507			-0.074	0.468	0.993	
	3.0 or higher	-3.059	0.734	-0.094	-0.583			-0.008	0.723	1.054	
Associate's degree within 3 years		-2.174	0.281	-0.243				-0.082	0.356	0.774	
Bachelor's degree within 5 years		-3.019	0.469	-0.591	-0.801		1.527	0.030	0.376	0.919	
Bachelor's degree within 6 years		-0.901	-1.442					-0.034	0.497	0.289	

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Table B-6 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Math score	Mean devel course grade	Prop. full time	Mean grade by score interaction	College type	ACT Math score	Devel course grade	FT/PT status (FT=1)	Grade by score interaction
Students who took Elementary Algebra (grade scale pass/fail) before Intermediate Algebra											
Success in Inter. Algebra	C or higher										
	B or higher										
1st term GPA/ persist to term 2	2.0 or higher	0.918	0.235		1.655			-0.050	1.192	0.476	
	3.0 or higher	-0.584	0.147	-0.164	1.355			0.034	2.390	0.365	
1st year GPA/ persist to year 2	2.0 or higher	-0.427	-0.273	0.167				0.010	1.147	-0.303	
	3.0 or higher	-2.192	-0.678	-1.332	1.251			0.156	1.149	-0.309	
2nd year GPA/ persist to year 3	2.0 or higher										
	3.0 or higher										
Cum. GPA at graduation/ last term	2.0 or higher										
	2.5 or higher										
	3.0 or higher										
Associate's degree within 3 years											
Bachelor's degree within 5 years											
Bachelor's degree within 6 years											

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Table B-6 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Math score	Mean devel course grade	Prop. full time	Mean grade by score interaction	College type	ACT Math score	Devel course grade	FT/PT status (FT=1)	Grade by score interaction
Students who enrolled directly in Intermediate Algebra											
Success in Inter. Algebra	C or higher	-0.311	0.731		-1.665			0.135		1.271	
	B or higher	-1.066	0.652					0.188		1.045	
1st term GPA/ persist to term 2	2.0 or higher	0.431	0.329		-1.964			0.035		1.845	
	3.0 or higher	-0.827	0.154		-1.747			0.059		1.097	
1st year GPA/ persist to year 2	2.0 or higher	-0.305	0.268		-1.353			0.026		1.330	
	3.0 or higher	-1.579	0.221		-1.383			0.115		1.101	
2nd year GPA/ persist to year 3	2.0 or higher	-1.169	0.324		-0.655		0.597	0.010		1.091	
	3.0 or higher	-2.391	0.282		-0.417			0.103		0.770	
Cum. GPA at graduation/ last term	2.0 or higher	-2.003	0.395		-0.703			0.023		1.421	
	2.5 or higher	-2.148	0.375		-0.818			0.042		1.391	
	3.0 or higher	-2.735	0.459		-1.190			0.073		1.498	
Associate's degree within 3 years		-1.910	0.080		-0.535			0.038		1.282	
Bachelor's degree within 5 years		-2.944	0.313		-1.349		1.138	0.023		1.526	
Bachelor's degree within 6 years		-1.300	0.137					0.075		1.293	

Note: Shaded coefficients were not significantly different from zero ($p > .05$ for institution-level effects; $p > .01$ for all student-level main and interaction effects).

Table B-7

Variance Components of Hierarchical Logistic Regression Models for Predicting Subsequent Academic Success after Taking Elementary and/or Intermediate Algebra

Outcome variable			
Type	Level	Intercept	ACT Test score slope
All students who took Elementary Algebra before Intermediate Algebra			
Success in Intermediate Algebra	C or higher	0.66402	--
	B or higher	0.45276	--
1st term GPA/persist to term 2	2.0 or higher	0.27417	--
	3.0 or higher	0.18496	--
1st year GPA/persist to year 2	2.0 or higher	0.15100	--
	3.0 or higher	0.22901	--
2nd year GPA/persist to year 3	2.0 or higher	0.06322	--
	3.0 or higher	0.17924	--
Cum. GPA at graduation/ last term	2.0 or higher	0.16752	--
	2.5 or higher	0.15910	--
	3.0 or higher	--	--
Associate's degree within 3 years		--	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years		--	--
Students who took Elementary Algebra (grade scale A-F) before Intermediate Algebra			
Success in Intermediate Algebra	C or higher	0.09910	--
	B or higher	0.16935	--
1st term GPA/persist to term 2	2.0 or higher	0.26032	--
	3.0 or higher	0.16679	--
1st year GPA/persist to year 2	2.0 or higher	0.11219	--
	3.0 or higher	0.14733	--
2nd year GPA/persist to year 3	2.0 or higher	0.03658	--
	3.0 or higher	--	--
Cum. GPA at graduation/ last term	2.0 or higher	0.19697	--
	2.5 or higher	0.16410	--
	3.0 or higher	0.14685	--
Associate's degree within 3 years		--	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years		--	--

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Table B-7 *(continued)*

Outcome variable			
Type	Level	Intercept	ACT Test score slope
Students who took Elementary Algebra (grade scale pass/fail) before Intermediate Algebra			
Success in Intermediate Algebra	C or higher		
	B or higher		
1st term GPA/persist to term 2	2.0 or higher	--	--
	3.0 or higher	0.28277	--
1st year GPA/persist to year 2	2.0 or higher	--	--
	3.0 or higher	--	--
2nd year GPA/persist to year 3	2.0 or higher		
	3.0 or higher		
Cum. GPA at graduation/ last term	2.0 or higher		
	2.5 or higher		
	3.0 or higher		
Associate's degree within 3 years			
Bachelor's degree within 5 years			
Bachelor's degree within 6 years			
Students who enrolled directly in Intermediate Algebra			
Success in Intermediate Algebra	C or higher	1.32347	--
	B or higher	1.09427	--
1st term GPA/persist to term 2	2.0 or higher	0.23359	0.00643
	3.0 or higher	0.21292	--
1st year GPA/persist to year 2	2.0 or higher	0.16626	--
	3.0 or higher	0.17327	--
2nd year GPA/persist to year 3	2.0 or higher	0.12994	--
	3.0 or higher	0.06741	--
Cum. GPA at graduation/ last term	2.0 or higher	0.34037	--
	2.5 or higher	0.32218	--
	3.0 or higher	0.29119	--
Associate's degree within 3 years		0.26264	--
Bachelor's degree within 5 years		0.12104	--
Bachelor's degree within 6 years		0.62077	--

Note: Statistically significant ($p < .01$) variance components are listed. Non-statistically significant variance components are noted in the table as '--' and were not included in the final models. Variance components for models that could not be developed are left blank.

Table B-8

Fixed Effects of Hierarchical Logistic Regression Models for Predicting Subsequent College Success after Taking Intermediate and/or College Algebra

Outcome variable		Institution-level effects							Student-level effects				
Type	Level	Interc.	Mean ACT Math score	Mean devel course grade	Prop. full time	Mean grade by score inter.	Mean score by FT/PT inter.	College type (4 yr=1)	ACT Math score	Devel course grade	FT/PT status (FT=1)	Grade by score inter.	Score by FT/PT inter.
All students who took Intermediate Algebra before College Algebra													
Success in College Algebra	C or higher	0.368	0.005		-0.376				0.116		0.474		
	B or higher	-0.693	0.033		-0.163				0.166		0.417		
1st term GPA/ persist to term 2	2.0 or higher	1.685	0.400		-0.746				0.021		1.027		
	3.0 or higher	0.030	0.285		-0.771				0.034		0.364		
1st year GPA/ persist to year 2	2.0 or higher	0.599	0.306		-0.651				-0.006		0.645		
	3.0 or higher	-0.851	0.204		-0.748				0.083		0.590		
2nd year GPA/ persist to year 3	2.0 or higher	-0.534	0.306		-0.333			0.762	-0.042		0.350		
	3.0 or higher	-1.843	0.119		-0.083				0.040		0.402		
Cum. GPA at graduation/ last term	2.0 or higher	-1.179	0.352		0.283				0.014		0.953		
	2.5 or higher	-1.355	0.335		0.238				0.030		0.958		
	3.0 or higher	-1.919	0.329		-0.186				0.073		1.273		
Associate's degree within 3 years		-1.096	-0.091		0.309				0.008		1.065		
Bachelor's degree within 5 years		-2.319	0.431		-0.334			1.285	0.036		1.098		
Bachelor's degree within 6 years		-0.024	0.448						0.024		0.469		

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Table B-8 *(continued)*

Outcome variable		Institution-level effects						Student-level effects					
Type	Level	Interc.	Mean ACT Math score	Mean devel course grade	Prop. full time	Mean grade by score inter.	Mean score by FT/PT inter.	College type (4 yr=1)	ACT Math score	Devel course grade	FT/PT status (FT=1)	Grade by score inter.	Score by FT/PT inter.
Students who took Intermediate Algebra (grade scale A-F) before College Algebra													
Success in College Algebra	C or higher	0.304	0.155	0.173	-0.603				0.061	0.665	0.383		
	B or higher	-0.934	0.145	-0.093	-0.440				0.098	0.980	0.319		
1st term GPA/ persist to term 2	2.0 or higher	1.476	0.473	-0.178	-1.433				-0.012	0.338	0.943		
	3.0 or higher	-0.134	0.387	0.318	-1.391				-0.006	0.487	0.289		
1st year GPA/ persist to year 2	2.0 or higher	0.482	0.426	-0.288	-0.909	-0.023			-0.047	0.297	0.595	0.059	
	3.0 or higher	-1.103	0.395	-0.017	-1.186				0.015	0.724	0.529		
2nd year GPA/ persist to year 3	2.0 or higher	-0.626	0.372	-0.651	-0.371			0.683	-0.085	0.299	0.316		
	3.0 or higher	-2.146	0.272	-0.573	-0.319				-0.029	0.724	0.352		
Cum. GPA at graduation/ last term	2.0 or higher	-1.469	0.495	-0.428	-0.317				-0.031	0.304	0.958		
	2.5 or higher	-1.708	0.505	-0.248	-0.510				-0.009	0.389	0.987		
	3.0 or higher	-2.342	0.536	-0.190	-0.976				0.026	0.568	1.295		
Associate's degree within 3 years		-1.421	0.018	-0.551	-0.352				-0.047	0.363	0.976		
Bachelor's degree within 5 years		-2.313	0.494	-0.807	-0.428			1.019	-0.011	0.312	1.115		
Bachelor's degree within 6 years		-0.172	0.326	-0.890					-0.035	0.236	0.132		

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Table B-8 *(continued)*

Outcome variable		Institution-level effects							Student-level effects				
Type	Level	Interc.	Mean ACT Math score	Mean devel course grade	Prop. full time	Mean grade by score inter.	Mean score by FT/PT inter.	College type (4 yr=1)	ACT Math score	Devel course grade	FT/PT status (FT=1)	Grade by score inter.	Score by FT/PT inter.
Students who took Intermediate Algebra (grade scale pass/fail) before College Algebra													
Success in College Algebra	C or higher	0.762	-0.783						0.101	1.860	0.061		
	B or higher	-0.159	-0.867		-0.989				0.148	3.043	-0.024		
1st term GPA/ persist to term 2	2.0 or higher	1.901	0.723		0.813				0.021	1.943	1.254		
	3.0 or higher	0.007	0.245		0.487				0.006	2.652	0.238		
1st year GPA/ persist to year 2	2.0 or higher	0.562	0.451		0.247				0.028	0.957	0.760		
	3.0 or higher	-0.802	0.069						0.093	1.621	0.198		
2nd year GPA/ persist to year 3	2.0 or higher	-0.497	0.325		0.451				-0.012	0.671	0.043		
	3.0 or higher												
Cum. GPA at graduation/ last term	2.0 or higher	-0.666	0.574		-0.614				0.051	0.945	0.609		
	2.5 or higher	-1.039	0.924		1.268				0.027	2.452	0.466		
	3.0 or higher												
Associate's degree within 3 years		-0.463	-0.300	-0.834	1.103				0.039	1.096	1.746		
Bachelor's degree within 5 years		-0.746	0.807		-1.506				0.097	0.705	0.693		
Bachelor's degree within 6 years		0.060	1.085		-1.376				0.124	0.092	1.012		

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Table B-8 *(continued)*

Outcome variable		Institution-level effects						Student-level effects					
Type	Level	Interc.	Mean ACT Math score	Mean devel course grade	Prop. full time	Mean grade by score inter.	Mean score by FT/PT inter.	College type (4 yr=1)	ACT Math score	Devel course grade	FT/PT status (FT=1)	Grade by score inter.	Score by FT/PT inter.
Students who enrolled directly in College Algebra													
Success in College Algebra	C or higher	0.808	-0.176		0.500		0.289		0.132		1.321		0.115
	B or higher	-0.080	-0.210		0.746		0.258		0.174		1.088		0.100
1st term GPA/ persist to term 2	2.0 or higher	1.000	-0.056						0.074		2.784		0.079
	3.0 or higher	-0.269	-0.141		-1.399		-0.491		0.122		1.950		0.103
1st year GPA/ persist to year 2	2.0 or higher	0.271	0.052		-0.023		0.058		0.057		2.062		0.066
	3.0 or higher	-0.730	-0.103		0.673		0.055	-0.277	0.123		1.890		0.099
2nd year GPA/ persist to year 3	2.0 or higher	-0.783	0.058		0.229		0.179	0.962	0.015		1.696		0.100
	3.0 or higher	-1.597	-0.066		0.886		0.250	0.626	0.083		1.684		0.099
Cum. GPA at graduation/ last term	2.0 or higher	-0.989	-0.075		1.476		0.187		0.041		1.996		0.086
	2.5 or higher	-1.100	-0.076		1.289		0.171		0.055		2.000		0.077
	3.0 or higher	-1.457	-0.126		0.927		0.081		0.098		2.000		0.089
Associate's degree within 3 years		-1.083	-0.129						0.038		2.074		
Bachelor's degree within 5 years		-1.896	0.036					1.076	0.063		2.409		
Bachelor's degree within 6 years		-0.255	0.079		1.952				0.062		2.342		

Note: Shaded coefficients were not significantly different from zero ($p > .05$ for institution-level effects; $p > .01$ for all student-level main and interaction effects).

Table B-9

Variance Components of Hierarchical Logistic Regression Models for Predicting Subsequent Academic Success after Taking Intermediate and/or College Algebra

Outcome variable			
Type	Level	Intercept	ACT Test score slope
All students who took Intermediate Algebra before College Algebra			
Success in College Algebra	C or higher	0.19164	--
	B or higher	0.27598	--
1st term GPA/persist to term 2	2.0 or higher	0.37449	--
	3.0 or higher	0.27595	--
1st year GPA/persist to year 2	2.0 or higher	0.09423	--
	3.0 or higher	0.16734	--
2nd year GPA/persist to year 3	2.0 or higher	0.07159	--
	3.0 or higher	0.07084	--
Cum. GPA at graduation/ last term	2.0 or higher	0.36044	--
	2.5 or higher	0.34729	--
	3.0 or higher	0.37808	--
Associate's degree within 3 years		0.16667	--
Bachelor's degree within 5 years		0.13578	--
Bachelor's degree within 6 years		0.22006	--
Students who took Intermediate Algebra Algebra (grade scale A-F) before College Algebra			
Success in College Algebra	C or higher	0.12159	--
	B or higher	0.20628	--
1st term GPA/persist to term 2	2.0 or higher	0.32706	--
	3.0 or higher	0.18251	--
1st year GPA/persist to year 2	2.0 or higher	0.12773	--
	3.0 or higher	0.09869	--
2nd year GPA/persist to year 3	2.0 or higher	0.07690	--
	3.0 or higher	0.07878	--
Cum. GPA at graduation/ last term	2.0 or higher	0.33498	--
	2.5 or higher	0.31125	--
	3.0 or higher	0.38553	--
Associate's degree within 3 years		--	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years		--	--

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Table B-9 *(continued)*

Outcome variable			
Type	Level	Intercept	ACT Test score slope
Students who took Intermediate Algebra (grade scale pass/fail) before College Algebra			
Success in College Algebra	C or higher	0.40227	--
	B or higher	0.51184	--
1st term GPA/persist to term 2	2.0 or higher	0.23230	--
	3.0 or higher	0.24585	--
1st year GPA/persist to year 2	2.0 or higher	0.07408	--
	3.0 or higher	0.18071	--
2nd year GPA/persist to year 3	2.0 or higher	0.23449	--
	3.0 or higher		
Cum. GPA at graduation/ last term	2.0 or higher	0.19205	--
	2.5 or higher	--	--
	3.0 or higher		
Associate's degree within 3 years			
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years		--	--
Students who enrolled directly in College Algebra			
Success in College Algebra	C or higher	0.15507	0.00099
	B or higher	0.17354	--
1st term GPA/persist to term 2	2.0 or higher	0.51557	0.00155
	3.0 or higher	0.19374	--
1st year GPA/persist to year 2	2.0 or higher	0.05665	--
	3.0 or higher	0.04190	--
2nd year GPA/persist to year 3	2.0 or higher	0.07098	0.00205
	3.0 or higher	0.03416	0.00347
Cum. GPA at graduation/ last term	2.0 or higher	0.22364	0.00105
	2.5 or higher	0.20803	0.00114
	3.0 or higher	0.21877	--
Associate's degree within 3 years		0.20977	--
Bachelor's degree within 5 years		0.07946	--
Bachelor's degree within 6 years		0.05865	--

Note: Statistically significant ($p < .01$) variance components are listed. Non-statistically significant variance components are noted in the table as '--' and were not included in the final models. Variance components for models that could not be developed are left blank.

Table B-10

Fixed Effects of Hierarchical Logistic Regression Models for Predicting Subsequent College Success after Taking Developmental Reading and/or American History

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Reading score	Mean devel course grade	Prop. full time	Mean score by FT/PT inter.	College type (4-yr=1)	ACT Reading score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT inter.
All students who took Developmental Reading before American History											
Success in American History	C or higher	0.107	0.049		-0.871			0.057		0.663	
	B or higher	-1.021	0.094		-1.031			0.049		0.700	
1st term GPA/ persist to term 2	2.0 or higher	1.074	0.068		-1.639			0.043		1.100	
	3.0 or higher	-0.349	-0.026		-1.132			0.043		0.457	
1st year GPA/ persist to year 2	2.0 or higher	0.054	0.087		-1.057	0.159		0.041		0.794	0.092
	3.0 or higher	-1.590	-0.084		-1.230	0.522		0.039		0.843	0.082
2nd year GPA/ persist to year 3	2.0 or higher	-0.931	0.172		-1.039		0.509	0.048		0.768	
	3.0 or higher	-2.542	0.171		-1.031			0.084		1.025	
Cum. GPA at graduation/ last term	2.0 or higher	-1.949	0.216		-0.634			0.045		1.163	
	2.5 or higher	-2.215	0.227		-0.599			0.058		1.167	
	3.0 or higher	-3.013	0.234		-0.942			0.069		1.434	
Associate's degree within 3 years		-2.073	-0.151		-1.234			0.062		1.546	
Bachelor's degree within 5 years		-2.053	0.294		0.116			0.046		0.949	
Bachelor's degree within 6 years		-1.363	0.236					0.045		0.995	

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Table B-10 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Reading score	Mean devel course grade	Prop. full time	Mean score by FT/PT inter.	College type (4-yr=1)	ACT Reading score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT inter.
Students who took Developmental Reading (grade scale A-F) before American History											
Success in American History	C or higher	-0.068	-0.385	0.044	-0.640			0.009	0.485	0.527	
	B or higher	-1.300	-0.359	-0.042	-1.223			0.008	0.479	0.574	
1st term GPA/ persist to term 2	2.0 or higher	0.914	-0.208	-0.038	-1.921			0.019	0.622	0.666	
	3.0 or higher	-0.511	-0.177	-0.192	-1.485			-0.000	0.643	0.040	
1st year GPA/ persist to year 2	2.0 or higher	-0.062	0.118	-0.103	-1.256			-0.019	0.662	0.587	
	3.0 or higher	-2.019	-0.123	0.074	-1.647			-0.020	0.842	0.529	
2nd year GPA/ persist to year 3	2.0 or higher	-1.071	0.168	-0.266	-1.052		0.545	0.018	0.656	0.581	
	3.0 or higher	-3.202	0.124	-0.369	-1.064			0.016	1.193	0.752	
Cum. GPA at graduation/ last term	2.0 or higher	-2.458	0.200	0.111	-0.991			0.020	0.622	1.110	
	2.5 or higher	-2.851	0.141	0.197	-0.984			0.021	0.738	1.125	
	3.0 or higher	-3.691	-0.142	0.025	-1.472			0.045	0.705	1.296	
Associate's degree within 3 years		-3.036	0.134	0.542	-1.925			0.047	0.736	1.536	
Bachelor's degree within 5 years		-3.568	0.142	0.021	-1.109		1.829	0.064	0.651	0.786	
Bachelor's degree within 6 years											

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Table B-10 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Reading score	Mean devel course grade	Prop. full time	Mean score by FT/PT inter.	College type (4-yr=1)	ACT Reading score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT inter.
Students who took Developmental Reading (grade scale pass/fail) before American History (P/F)											
Success in American History	C or higher	0.098	0.127	0.640	-1.221			0.082	1.025	0.427	
	B or higher	-0.977	0.163	0.368	-1.243			0.065	0.507	0.473	
1st term GPA/ persist to term 2	2.0 or higher	1.135	0.041	1.931	-1.240			0.037	0.858	1.237	
	3.0 or higher	-0.321	0.010	0.868	-1.016			0.048	0.993	0.721	
1st year GPA/ persist to year 2	2.0 or higher	0.050	0.171	0.040	-1.690	-0.876		0.065	1.156	0.650	0.115
	3.0 or higher	-1.669	0.140	0.161				0.072	2.182	0.667	
2nd year GPA/ persist to year 3	2.0 or higher	-0.852	0.178	-1.141	-1.372		0.612	0.045	0.924	0.594	
	3.0 or higher										
Cum. GPA at graduation/ last term	2.0 or higher	-1.562	0.256		-0.915			0.044	0.499	0.717	
	2.5 or higher	-1.870	0.231		-0.596			0.064	1.704	0.611	
	3.0 or higher										
Associate's degree within 3 years											
Bachelor's degree within 5 years		-1.757	0.287					0.036	0.200	0.852	
Bachelor's degree within 6 years		-0.983	0.230					0.050	-0.297	0.828	

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Table B-10 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Reading score	Mean devel course grade	Prop. full time	Mean score by FT/PT inter.	College type (4-yr=1)	ACT Reading score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT inter.
Students who enrolled directly in American History											
Success in American History	C or higher	1.040	0.089		0.503	0.229	-0.642	0.067		1.061	0.044
	B or higher	0.075	0.009		0.987	0.257	-0.527	0.086		0.859	0.051
1st term GPA/ persist to term 2	2.0 or higher	0.940	-0.126		-0.289	0.706		0.046		2.057	0.067
	3.0 or higher	-0.245	-0.054		-0.586	0.084		0.070		1.346	0.071
1st year GPA/ persist to year 2	2.0 or higher	0.214	0.052		0.327	0.560		0.035		1.478	0.056
	3.0 or higher	-0.748	0.003		0.041	0.199		0.080		1.278	0.066
2nd year GPA/ persist to year 3	2.0 or higher	-0.699	0.096		1.037	0.419	0.541	0.018		1.179	0.050
	3.0 or higher	-1.592	0.013		1.391	0.388	0.521	0.074		1.180	0.059
Cum. GPA at graduation/ last term	2.0 or higher	-0.960	0.052		0.539	0.161		0.036		1.465	0.049
	2.5 or higher	-1.073	0.045		0.520	0.166		0.046		1.455	0.050
	3.0 or higher	-1.481	0.012		0.527	0.187		0.070		1.489	0.050
Associate's degree within 3 years		-0.982	0.103		0.086			0.044		1.607	
Bachelor's degree within 5 years		-1.737	0.149		0.195		0.854	0.034		1.699	0.048
Bachelor's degree within 6 years		-0.284	0.112		1.973	0.480		0.032		1.598	0.051

Note: Shaded coefficients were not significantly different from zero ($p > .05$ for institution-level effects; $p > .01$ for all student-level main and interaction effects).

Table B-11

Variance Components of Hierarchical Logistic Regression Models for Predicting Subsequent Academic Success after Taking Developmental Reading and/or American History

Outcome variable			
Type	Level	Intercept	ACT Test score slope
All students who took Developmental Reading before American History			
Success in American History	C or higher	0.31065	--
	B or higher	0.30331	--
1st term GPA/persist to term 2	2.0 or higher	0.35721	--
	3.0 or higher	0.28639	--
1st year GPA/persist to year 2	2.0 or higher	0.09287	--
	3.0 or higher	0.22655	--
2nd year GPA/persist to year 3	2.0 or higher	--	--
	3.0 or higher	--	--
Cum. GPA at graduation/ last term	2.0 or higher	0.28860	--
	2.5 or higher	0.24864	--
	3.0 or higher	0.25181	--
Associate's degree within 3 years		0.33096	--
Bachelor's degree within 5 years		0.26682	--
Bachelor's degree within 6 years		--	--
Students who took Developmental Reading (grade scale A-F) before American History			
Success in American History	C or higher	0.26340	--
	B or higher	0.27164	--
1st term GPA/persist to term 2	2.0 or higher	0.54123	--
	3.0 or higher	0.34897	--
1st year GPA/persist to year 2	2.0 or higher	0.14352	--
	3.0 or higher	0.27511	--
2nd year GPA/persist to year 3	2.0 or higher	--	--
	3.0 or higher	--	--
Cum. GPA at graduation/ last term	2.0 or higher	0.20955	--
	2.5 or higher	0.22620	--
	3.0 or higher	0.16866	--
Associate's degree within 3 years		0.39419	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years			

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Table B-11 *(continued)*

Outcome variable			
Type	Level	Intercept	ACT Test score slope
Students who took Developmental Reading (grade scale pass/fail) before American History			
Success in American History	C or higher	0.14183	--
	B or higher	0.19479	--
1st term GPA/persist to term 2	2.0 or higher	0.14484	--
	3.0 or higher	0.19109	--
1st year GPA/persist to year 2	2.0 or higher	--	--
	3.0 or higher	0.34642	--
2nd year GPA/persist to year 3	2.0 or higher	--	--
	3.0 or higher		
Cum. GPA at graduation/ last term	2.0 or higher	--	--
	2.5 or higher	--	--
	3.0 or higher		
Associate's degree within 3 years		--	
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years		--	--
Students who enrolled directly in American History			
Success in American History	C or higher	0.12638	0.00124
	B or higher	0.15353	0.00097
1st term GPA/persist to term 2	2.0 or higher	0.88759	0.00033
	3.0 or higher	0.22461	0.00056
1st year GPA/persist to year 2	2.0 or higher	0.27408	0.00037
	3.0 or higher	0.07790	0.00062
2nd year GPA/persist to year 3	2.0 or higher	0.12855	0.00063
	3.0 or higher	0.05523	0.00140
Cum. GPA at graduation/ last term	2.0 or higher	0.27720	0.00035
	2.5 or higher	0.24357	0.00035
	3.0 or higher	0.22552	0.00048
Associate's degree within 3 years		0.25289	--
Bachelor's degree within 5 years		0.11045	--
Bachelor's degree within 6 years		0.10999	0.00024

Note: Statistically significant ($p < .01$) variance components are listed. Non-statistically significant variance components are noted in the table as '--' and were not included in the final models. Variance components for models that could not be developed are left blank.

Table B-12

Fixed Effects of Hierarchical Logistic Regression Models for Predicting Subsequent College Success after Taking Developmental Reading and/or Psychology

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Reading score	Mean devel course grade	Prop. full time	Mean score by FT/PT inter.	College type (4 yr=1)	ACT Reading score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT inter.
All Students who took Developmental Reading before Psychology											
Success in Psychology	C or higher	0.317	0.087		-0.389		-0.428	0.059		0.829	
	B or higher	-0.790	-0.027		-0.826			0.063		0.726	
1st term GPA/ persist to term 2	2.0 or higher	0.881	0.022		-1.522			0.045		1.184	
	3.0 or higher	-0.379	0.020		-0.981			0.030		0.408	
1st year GPA/ persist to year 2	2.0 or higher	-0.109	0.123		-0.896			0.032		0.783	
	3.0 or higher	-1.683	0.107		-1.212		-0.526	0.034		0.886	
2nd year GPA/ persist to year 3	2.0 or higher	-1.012	0.194		-0.441		0.376	0.032		0.586	
	3.0 or higher	-2.647	0.144		-0.697			0.081		0.904	
Cum. GPA at graduation/ last term	2.0 or higher	-2.179	0.191		-0.066			0.021		1.149	
	2.5 or higher	-2.408	0.173		0.053			0.032		1.112	
	3.0 or higher	-3.106	0.149		-0.227			0.056		1.358	
Associate's degree within 3 years		-2.363	0.187		-0.537			0.059		1.520	
Bachelor's degree within 5 years		-2.999	0.203		0.215		1.117	0.012		0.655	
Bachelor's degree within 6 years		-1.016	0.147					0.034		0.849	

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Table B-12 *(continued)*

Outcome variable		Institution-level effects					Student-level effects			
Type	Level	Intercept	Mean ACT Reading score	Mean devel course grade	Prop. full time	Mean score by FT/PT inter.	College type (4 yr=1)	ACT Reading score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT inter.
Students who took Developmental Reading (grade scale A-F) before Psychology											
Success in Psychology	C or higher	0.289	0.185	-0.329	-0.243		-0.622	0.032	0.562	0.604	
	B or higher	-0.793	-0.132	-0.359	-0.289			0.031	0.619	0.491	
1st term GPA/ persist to term 2	2.0 or higher	0.695	0.089	0.293	-1.509			0.020	0.645	0.687	
	3.0 or higher	-0.602	-0.046	0.288	-1.124			0.005	0.637	0.014	
1st year GPA/ persist to year 2	2.0 or higher	-0.152	0.175	-0.066	-0.701			-0.009	0.671	0.460	
	3.0 or higher	-2.084	-0.181	0.163	-1.710			-0.024	0.885	0.645	
2nd year GPA/ persist to year 3	2.0 or higher	-0.982	0.098	-0.303	-0.037		0.355	0.007	0.625	0.327	
	3.0 or higher	-3.248	-0.018	-0.525	-0.923			0.037	1.154	0.792	
Cum. GPA at graduation/ last term	2.0 or higher	-2.586	-0.119	0.140	0.032			0.002	0.659	0.937	
	2.5 or higher	-2.819	-0.116	-0.142	-0.080			-0.015	0.809	0.952	
	3.0 or higher	-3.781	-0.113	-0.004	-0.806			0.024	0.997	1.201	
Associate's degree within 3 years		-2.881	0.350	0.030	-0.483			0.032	0.689	1.158	
Bachelor's degree within 5 years		-2.811	-0.450	-0.269	1.326		1.027	-0.020	0.549	0.645	
Bachelor's degree within 6 years											

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Table B-12 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Reading score	Mean devel course grade	Prop. full time	Mean score by FT/PT inter.	College type (4 yr=1)	ACT Reading score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT inter.
Students who took Developmental Reading (grade scale pass/fail) before Psychology											
Success in Psychology	C or higher	0.577	0.004		-0.401			0.097	2.022	0.734	
	B or higher	-0.557	0.039		-1.359			0.088	1.099	0.601	
1st term GPA/ persist to term 2	2.0 or higher	1.106	0.021		-0.687			0.052	2.116	1.544	
	3.0 or higher	-0.385	0.029	1.319	-0.446			0.032	1.908	0.682	
1st year GPA/ persist to year 2	2.0 or higher	0.011	0.099		-0.737			0.057	1.873	0.763	
	3.0 or higher	-1.546	0.092		-1.178			0.062	1.415	0.731	
2nd year GPA/ persist to year 3	2.0 or higher										
	3.0 or higher										
Cum. GPA at graduation/ last term	2.0 or higher	-1.830	0.259	-0.645	-0.002			0.018	1.360	0.960	
	2.5 or higher										
	3.0 or higher										
Associate's degree within 3 years		-1.685	0.195		-0.620			0.063	0.708	1.750	
Bachelor's degree within 5 years											
Bachelor's degree within 6 years											

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Table B-12 *(continued)*

Outcome variable		Institution-level effects						Student-level effects			
Type	Level	Intercept	Mean ACT Reading score	Mean devel course grade	Prop. full time	Mean score by FT/PT inter.	College type (4 yr=1)	ACT Reading score	Devel course grade	FT/PT status (FT=1)	Score by FT/PT inter.
Students who enrolled directly in Psychology											
Success in Psychology	C or higher	1.374	-0.012		-0.316	-0.051		0.071		1.090	0.050
	B or higher	0.386	-0.046		0.301	-0.042		0.089		0.826	0.046
1st term GPA/ persist to term 2	2.0 or higher	0.961	0.010					0.051		2.012	0.067
	3.0 or higher	-0.224	0.016		-1.632			0.077		1.272	0.076
1st year GPA/ persist to year 2	2.0 or higher	0.198	0.121		-0.876	0.276		0.036		1.426	0.054
	3.0 or higher	-0.783	0.021		0.004	0.287		0.084		1.232	0.062
2nd year GPA/ persist to year 3	2.0 or higher	-0.782	0.103		0.181	0.357	0.580	0.022		1.152	0.046
	3.0 or higher	-1.617	0.045		1.017	0.401	0.523	0.077		1.141	0.054
Cum. GPA at graduation/ last term	2.0 or higher	-1.077	0.007		1.461	0.478		0.042		1.469	0.042
	2.5 or higher	-1.182	0.018		1.194	0.425		0.049		1.492	0.042
	3.0 or higher	-1.562	-0.010		1.147	0.436		0.076		1.548	0.037
Associate's degree within 3 years		-1.131	0.120		0.365			0.045		1.505	
Bachelor's degree within 5 years		-1.870	0.147		0.297		0.868	0.049		1.777	
Bachelor's degree within 6 years		-0.216	0.200		-0.612			0.044		1.638	

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Note: Shaded coefficients were not significantly different from zero ($p > .05$ for institution-level effects; $p > .01$ for all student-level main and interaction effects).

Table B-13

Variance Components of Hierarchical Logistic Regression Models for Predicting Subsequent Academic Success after Taking Developmental Reading and/or Psychology

Outcome variable			
Type	Level	Intercept	ACT Test score slope
All students who took Developmental Reading before Psychology			
Success in Psychology	C or higher	0.24388	0.00363
	B or higher	0.47088	--
1st term GPA/persist to term 2	2.0 or higher	0.44383	--
	3.0 or higher	0.30596	--
1st year GPA/persist to year 2	2.0 or higher	0.04918	--
	3.0 or higher	0.16624	--
2nd year GPA/persist to year 3	2.0 or higher	0.06595	--
	3.0 or higher	--	--
Cum. GPA at graduation/ last term	2.0 or higher	0.18723	--
	2.5 or higher	0.15626	--
	3.0 or higher	0.13265	--
Associate's degree within 3 years		0.28092	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years		--	--
Students who took Developmental Reading (grade scale A-F) before Psychology			
Success in Psychology	C or higher	0.20358	--
	B or higher	0.46950	--
1st term GPA/persist to term 2	2.0 or higher	0.68297	--
	3.0 or higher	0.41632	--
1st year GPA/persist to year 2	2.0 or higher	0.06196	--
	3.0 or higher	0.24331	--
2nd year GPA/persist to year 3	2.0 or higher	--	--
	3.0 or higher	0.19738	--
Cum. GPA at graduation/ last term	2.0 or higher	0.17500	--
	2.5 or higher	--	--
	3.0 or higher	--	--
Associate's degree within 3 years		0.39011	--
Bachelor's degree within 5 years		--	--
Bachelor's degree within 6 years			

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Table B-13 *(continued)*

Outcome variable			
Type	Level	Intercept	ACT Test score slope
Students who took Developmental Reading (grade scale pass/fail) before Psychology			
Success in Psychology	C or higher	0.62343	--
	B or higher	0.62160	--
1st term GPA/persist to term 2	2.0 or higher	0.21356	--
	3.0 or higher	0.13496	--
1st year GPA/persist to year 2	2.0 or higher	--	--
	3.0 or higher	--	--
2nd year GPA/persist to year 3	2.0 or higher		
	3.0 or higher		
Cum. GPA at graduation/ last term	2.0 or higher	0.12779	--
	2.5 or higher		
	3.0 or higher		
Associate's degree within 3 years		--	--
Bachelor's degree within 5 years			
Bachelor's degree within 6 years			
Students who enrolled directly in Psychology			
Success in Psychology	C or higher	0.14657	0.00038
	B or higher	0.20649	0.00052
1st term GPA/persist to term 2	2.0 or higher	0.97216	0.00029
	3.0 or higher	0.21932	--
1st year GPA/persist to year 2	2.0 or higher	0.16210	0.00040
	3.0 or higher	0.08610	0.00060
2nd year GPA/persist to year 3	2.0 or higher	0.14003	0.00056
	3.0 or higher	0.06113	0.00135
Cum. GPA at graduation/ last term	2.0 or higher	0.24036	0.00039
	2.5 or higher	0.21407	--
	3.0 or higher	0.21331	0.00046
Associate's degree within 3 years		0.20930	--
Bachelor's degree within 5 years		0.11092	0.00023
Bachelor's degree within 6 years		0.10643	--

Note: Statistically significant ($p < .01$) variance components are listed. Non-statistically significant variance components are noted in the table as '--' and were not included in the final models. Variance components for models that could not be developed are left blank.

Appendix C

Differences in Estimated Probabilities of Success for All Students and by Developmental Course Grade

Tables C1 through C 6

Note: All results pertaining to six-year degree completion were based on only 22 of the 35 four-year institutions in the study.

Table C-1

Differences between Estimated Probabilities of Longer-Term College Outcomes for Students who Enrolled in Developmental/ Standard English Composition and those who Enrolled in only Standard English Composition, for All Students and by Developmental English Composition Grade

		Difference between probability associated with lower-level course and probability associated with higher-level course											
Outcome		All students in lower-level course			Students with an A grade in lower-level course			Students with a B grade in lower-level course			Students with a C grade in lower-level course		
Type	Level	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.
Success in higher-level course	C or higher	-0.06	-0.07	-0.07	0.10	0.06	0.02	0.00	-0.04	-0.08	-0.14	-0.18	-0.22
	B or higher	-0.03	-0.05	-0.07	0.19	0.13	0.07	0.01	-0.04	-0.09	-0.14	-0.21	-0.26
1st term GPA/ persist to term 2	2.0 or higher	0.20	0.14	0.08	0.25	0.19	0.14	0.21	0.14	0.09	0.14	0.08	0.03
	3.0 or higher	0.23	0.15	0.06	0.36	0.28	0.19	0.24	0.16	0.06	0.12	0.04	-0.05
1st year GPA/ persist to year 2	2.0 or higher	0.15	0.09	0.03	0.28	0.22	0.16	0.16	0.10	0.04	0.03	-0.03	-0.09
	3.0 or higher	0.07	0.04	-0.01	0.36	0.30	0.22	0.16	0.10	0.02	0.02	-0.04	-0.12
2nd year GPA/ persist to year 3	2.0 or higher	0.04	0.02	0.00	0.18	0.15	0.11	0.06	0.03	0.00	-0.03	-0.07	-0.10
	3.0 or higher	0.01	0.00	-0.02	0.16	0.13	0.08	0.04	0.01	-0.04	-0.02	-0.05	-0.09
Cum. GPA at graduation/ last term	2.0 or higher	-0.03	-0.05	-0.07	0.11	0.07	0.02	0.00	-0.04	-0.08	-0.07	-0.11	-0.16
	2.5 or higher	-0.05	-0.07	-0.08	0.09	0.05	0.01	0.09	0.05	0.01	-0.02	-0.06	-0.10
	3.0 or higher	-0.02	-0.03	-0.04	0.05	0.07	0.08	0.05	0.07	0.08	-0.02	-0.03	-0.05
Associate's degree within 3 years		0.01	-0.03	-0.08	0.10	0.06	0.01	-0.01	-0.06	-0.10	-0.09	-0.13	-0.18
Bachelor's degree within 5 years		-0.03	-0.05	-0.08	0.05	0.03	0.00	0.01	-0.02	-0.04	-0.02	-0.05	-0.07
Bachelor's degree within 6 years		0.15	0.09	0.03	0.40	0.34	0.28	0.31	0.26	0.20	0.22	0.16	0.10

Note: Shaded cells correspond to course grade regression coefficients that are not statistically significantly different from zero ($p > .01$). Cells are left blank for models that could not be developed. Percentiles (Pctl.) correspond to the 5th and 95th percentiles of ACT English scores of students who took the lower-level course. Differences for a Passing grade ranged from -0.06 (P5) to -0.05 (P95) for a C or higher grade in Standard English Composition (median=-0.06), from -0.06 (P5) to -0.08 (P95) for a B or higher in Standard English Composition (median=-0.07), and from 0.15 (P5) to 0.03 (P95) for a 2.0 or higher Year 1 GPA/persist to Year 2 (median=0.09).

Table C-2

Differences between Estimated Probabilities of Longer-Term College Outcomes for Students who Enrolled in Arithmetic/Elementary Algebra and those who Enrolled in only Elementary Algebra, for All Students and by Arithmetic Grade

		Difference between probability associated with lower-level course and probability associated with higher-level course											
Outcome		All students in lower-level course			Students with an A grade in lower-level course			Students with a B grade in lower-level course			Students with a C grade in lower-level course		
Type	Level	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.
Success in higher-level course	C or higher	0.09	0.06	0.03	0.53	0.42	0.31	0.42	0.31	0.20	0.27	0.17	0.05
	B or higher	0.05	0.06	0.06	0.37	0.40	0.39	0.17	0.19	0.19	0.03	0.02	-0.01
1st term GPA/ persist to term 2	2.0 or higher	0.15	0.13	0.11	0.27	0.24	0.22	0.23	0.20	0.18	0.17	0.14	0.12
	3.0 or higher	0.22	0.20	0.17	0.33	0.31	0.28	0.23	0.20	0.17	0.12	0.10	0.07
1st year GPA/ persist to year 2	2.0 or higher	0.21	0.19	0.17	0.36	0.33	0.31	0.27	0.25	0.23	0.18	0.15	0.13
	3.0 or higher	0.13	0.10	0.07	0.29	0.27	0.24	0.16	0.14	0.11	0.06	0.03	0.01
2nd year GPA/ persist to year 3	2.0 or higher	-0.01	-0.01	-0.01	0.08	0.08	0.08	0.03	0.03	0.03	-0.01	-0.01	-0.01
	3.0 or higher	0.01	0.02	0.05	0.12	0.10	0.09	-0.06	-0.07	0.02	-0.06	-0.07	-0.09
Cum. GPA at graduation/ last term	2.0 or higher	0.07	0.06	0.05	0.15	0.14	0.12	0.10	0.08	0.07	0.05	0.04	0.02
	2.5 or higher	0.07	0.05	0.04	0.14	0.13	0.11	0.14	0.13	0.11	0.08	0.07	0.05
	3.0 or higher	-0.01	0.01	0.05	0.02	0.06	0.12	0.02	0.06	0.12	-0.01	0.00	0.03
Associate's degree within 3 years		-0.08	-0.05	-0.02	0.07	0.07	0.07	0.02	0.02	0.02	-0.03	-0.03	-0.03
Bachelor's degree within 5 years		0.04	0.04	0.04	0.07	0.07	0.07	0.06	0.06	0.06	0.04	0.04	0.04
Bachelor's degree within 6 years													

Note: Shaded cells correspond to course grade regression coefficients that are not statistically significantly different from zero ($p > .01$). Cells are left blank for models that could not be developed. Percentiles (Pctl.) correspond to the 5th and 95th percentiles of ACT Mathematics scores of students who took the lower-level course.

Table C-3

Differences between Estimated Probabilities of Longer-Term College Outcomes for Students who Enrolled in Elementary Algebra/ Intermediate Algebra and those who Enrolled in only Intermediate Algebra, for All Students and by Elementary Algebra Grade

		Difference between probability associated with lower-level course and probability associated with higher-level course											
Outcome		All students in lower-level course			Students with an A grade in lower-level course			Students with a B grade in lower-level course			Students with a C grade in lower-level course		
Type	Level	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.
Success in higher-level course	C or higher	-0.06	-0.07	-0.07	0.34	0.27	0.21	0.17	0.10	0.03	-0.04	-0.10	-0.17
	B or higher	-0.04	-0.04	-0.04	0.31	0.30	0.26	0.06	0.03	0.00	-0.10	-0.15	-0.21
1st term GPA/ persist to term 2	2.0 or higher	0.03	0.03	0.03	0.11	0.11	0.11	0.07	0.07	0.07	0.02	0.02	0.02
	3.0 or higher	0.10	0.07	0.05	0.26	0.24	0.21	0.15	0.12	0.09	0.03	0.00	-0.03
1st year GPA/ persist to year 2	2.0 or higher	0.01	0.01	0.01	0.18	0.15	0.13	0.11	0.08	0.05	0.02	0.00	-0.03
	3.0 or higher	0.01	-0.03	-0.07	0.24	0.21	0.16	0.08	0.05	0.01	-0.03	-0.07	-0.11
2nd year GPA/ persist to year 3	2.0 or higher	0.04	0.02	-0.01	0.22	0.17	0.12	0.13	0.09	0.04	0.05	0.01	-0.03
	3.0 or higher	0.04	0.02	0.00	0.17	0.15	0.13	-0.08	0.02	0.02	-0.08	-0.10	-0.12
Cum. GPA at graduation/ last term	2.0 or higher	-0.03	-0.03	-0.03	0.05	0.05	0.05	-0.01	-0.01	-0.01	-0.07	-0.07	-0.07
	2.5 or higher	-0.01	-0.02	-0.03	0.08	0.07	0.06	0.08	0.07	0.06	0.00	-0.01	-0.02
	3.0 or higher	0.00	-0.01	-0.02	0.08	0.07	0.06	0.08	0.07	0.06	0.00	-0.01	-0.02
Associate's degree within 3 years		-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.05	-0.05	-0.05	-0.09	-0.09	-0.09
Bachelor's degree within 5 years		-0.03	-0.03	-0.03	0.02	0.02	0.02	-0.01	-0.01	-0.01	-0.04	-0.04	-0.04
Bachelor's degree within 6 years		0.18	0.18	0.18	0.14	0.14	0.14	0.02	0.02	0.02	-0.09	-0.09	-0.09

Note: Shaded cells correspond to course grade regression coefficients that are not statistically significantly different from zero ($p > .01$). Cells are left blank for models that could not be developed. Percentiles (Pctl.) correspond to the 5th and 95th percentiles of ACT Mathematics scores of students who took the lower-level course.

Table C-4

Differences between Estimated Probabilities of Longer-Term College Outcomes for Students who Enrolled in Intermediate Algebra/College Algebra and those who Enrolled in only College Algebra, for All Students and by Intermediate Algebra Grade

Outcome		Difference between probability associated with lower-level course and probability associated with higher-level course											
		All students in lower-level course			Students with an A grade in lower-level course			Students with a B grade in lower-level course			Students with a C grade in lower-level course		
Type	Level	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.
Success in higher-level course	C or higher	0.05	0.03	0.02	0.28	0.20	0.13	0.14	0.07	0.00	-0.02	-0.09	-0.16
	B or higher	0.03	0.03	0.02	0.29	0.26	0.22	0.06	0.03	-0.02	-0.10	-0.15	-0.21
1st term GPA/ persist to term 2	2.0 or higher	0.18	0.15	0.11	0.20	0.17	0.14	0.17	0.14	0.10	0.13	0.09	0.06
	3.0 or higher	0.25	0.19	0.12	0.35	0.29	0.22	0.23	0.17	0.10	0.11	0.05	-0.02
1st year GPA/ persist to year 2	2.0 or higher	0.16	0.13	0.09	0.19	0.17	0.15	0.13	0.11	0.09	0.06	0.04	0.02
	3.0 or higher	0.09	0.08	0.06	0.29	0.24	0.19	0.12	0.07	0.01	-0.02	-0.06	-0.12
2nd year GPA/ persist to year 3	2.0 or higher	0.07	0.06	0.04	0.20	0.14	0.09	0.12	0.07	0.01	0.05	0.00	-0.05
	3.0 or higher	0.03	0.01	-0.01	0.12	0.10	0.08	-0.12	-0.13	-0.03	-0.12	-0.14	-0.17
Cum. GPA at graduation/ last term	2.0 or higher	0.04	0.02	-0.01	0.07	0.05	0.02	0.01	-0.02	-0.04	-0.05	-0.07	-0.09
	2.5 or higher	0.04	0.01	-0.01	0.08	0.05	0.03	0.08	0.05	0.03	0.00	-0.02	-0.05
	3.0 or higher	0.05	0.03	-0.01	0.11	0.09	0.05	0.11	0.09	0.05	0.02	0.00	-0.04
Associate's degree within 3 years		0.06	0.04	0.03	0.09	0.08	0.06	0.01	0.00	-0.02	-0.06	-0.07	-0.09
Bachelor's degree within 5 years		0.00	-0.02	-0.03	0.06	0.04	0.03	0.02	0.00	-0.01	-0.02	-0.03	-0.05
Bachelor's degree within 6 years		0.11	0.08	0.05	0.12	0.08	0.05	0.06	0.03	-0.01	0.00	-0.03	-0.06

Note: Shaded cells correspond to course grade regression coefficients that are not statistically significantly different from zero ($p > .01$). Cells are left blank for models that could not be developed. Percentiles (Pctl.) correspond to the 5th and 95th percentiles of ACT Mathematics scores of students who took the lower-level course. Differences for a Passing grade ranged from 0.18 (P5) to 0.11 (P95) for a 2.0 or higher GPA/persist to Term 2 (median=0.15).

Table C-5

Differences between Estimated Probabilities of Longer-Term College Outcomes for Students who Enrolled in Developmental Reading/American History and those who Enrolled in only American History, for All Students and by Developmental Reading Grade

Outcome		Difference between probability associated with lower-level course and probability associated with higher-level course											
		All students in lower-level course			Students with an A grade in lower-level course			Students with a B grade in lower-level course			Students with a C grade in lower-level course		
Type	Level	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.
Success in higher-level course	C or higher	-0.07	-0.08	-0.09	0.10	0.03	-0.04	0.00	-0.08	-0.15	-0.12	-0.20	-0.27
	B or higher	-0.03	-0.08	-0.14	0.11	0.01	-0.10	0.00	-0.10	-0.21	-0.09	-0.19	-0.30
1st term GPA/ persist to term 2	2.0 or higher	0.13	0.11	0.08	0.23	0.18	0.13	0.16	0.10	0.05	0.05	-0.01	-0.06
	3.0 or higher	0.17	0.09	0.00	0.28	0.20	0.11	0.12	0.04	-0.05	-0.02	-0.10	-0.19
1st year GPA/ persist to year 2	2.0 or higher	0.01	0.05	0.09	0.26	0.21	0.16	0.12	0.07	0.02	-0.04	-0.09	-0.14
	3.0 or higher	-0.01	-0.02	-0.04	0.17	0.10	0.01	0.01	-0.06	-0.15	-0.09	-0.16	-0.25
2nd year GPA/ persist to year 3	2.0 or higher	0.00	0.02	0.04	0.22	0.19	0.17	0.06	0.03	0.01	-0.08	-0.10	-0.13
	3.0 or higher	-0.01	-0.02	-0.02	0.14	0.10	0.05	-0.01	-0.05	-0.10	-0.07	-0.10	-0.15
Cum. GPA at graduation/ last term	2.0 or higher	-0.04	-0.08	-0.12	0.05	0.01	-0.03	-0.06	-0.10	-0.14	-0.13	-0.17	-0.21
	2.5 or higher	-0.04	-0.09	-0.13	0.04	0.00	-0.05	0.04	0.00	-0.05	-0.07	-0.11	-0.16
	3.0 or higher	-0.03	-0.07	-0.12	0.02	-0.03	-0.08	0.02	-0.03	-0.08	-0.05	-0.09	-0.14
Associate's degree within 3 years		-0.04	-0.08	-0.12	0.02	-0.02	-0.06	-0.10	-0.13	-0.18	-0.16	-0.20	-0.24
Bachelor's degree within 5 years		0.03	0.01	-0.02	-0.03	-0.06	-0.08	-0.08	-0.10	-0.13	-0.10	-0.13	-0.15
Bachelor's degree within 6 years		-0.11	-0.15	-0.20	-0.39	-0.44	-0.48	-0.39	-0.44	-0.48	-0.39	-0.44	-0.48

Note: Shaded cells correspond to course grade regression coefficients that are not statistically significantly different from zero ($p > .01$). Cells are left blank for models that could not be developed. Percentiles (Pctl.) correspond to the 5th and 95th percentiles of ACT English scores of students who took the lower-level course. Differences for a Passing grade ranged from -0.02 (P5) to 0.02 (P95) for a 2.0 or higher Year 1 GPA/persist to Year 2 (median=0.00).

Table C-6

Differences between Estimated Probabilities of Longer-Term College Outcomes for Students who Enrolled in Developmental Reading/Psychology and those who Enrolled in only Psychology, for All Students and by Developmental Reading Grade

Outcome		Difference between probability associated with lower-level course and probability associated with higher-level course											
		All students in lower-level course			Students with an A grade in lower-level course			Students with a B grade in lower-level course			Students with a C grade in lower-level course		
Type	Level	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.	5th Pctl.	Median	95th Pctl.
Success in higher-level course	C or higher	-0.04	-0.05	-0.06	0.13	0.06	0.00	0.03	-0.04	-0.10	-0.10	-0.17	-0.23
	B or higher	-0.03	-0.07	-0.10	0.20	0.10	0.00	0.04	-0.05	-0.15	-0.10	-0.19	-0.29
1st term GPA/ persist to term 2	2.0 or higher	0.14	0.11	0.09	0.22	0.16	0.11	0.13	0.07	0.03	0.00	-0.05	-0.10
	3.0 or higher	0.19	0.11	0.02	0.27	0.19	0.10	0.11	0.03	-0.06	-0.03	-0.11	-0.19
1st year GPA/ persist to year 2	2.0 or higher	0.06	0.05	0.03	0.24	0.19	0.14	0.09	0.04	-0.01	-0.08	-0.13	-0.17
	3.0 or higher	-0.01	-0.07	-0.15	0.19	0.13	0.06	0.02	-0.04	-0.12	-0.08	-0.14	-0.22
2nd year GPA/ persist to year 3	2.0 or higher	0.05	0.02	-0.01	0.21	0.19	0.16	0.06	0.03	0.01	-0.07	-0.09	-0.12
	3.0 or higher	-0.01	-0.01	-0.02	0.13	0.10	0.05	-0.01	-0.04	-0.08	-0.06	-0.09	-0.14
Cum. GPA at graduation/ last term	2.0 or higher	-0.03	-0.06	-0.10	0.04	0.00	-0.04	-0.07	-0.10	-0.14	-0.13	-0.16	-0.20
	2.5 or higher	-0.04	-0.07	-0.11	0.06	0.02	-0.02	0.06	0.02	-0.02	-0.06	-0.10	-0.14
	3.0 or higher	-0.02	-0.05	-0.10	0.05	0.01	-0.03	0.05	0.01	-0.03	-0.04	-0.08	-0.12
Associate's degree within 3 years		-0.03	-0.06	-0.10	0.01	-0.02	-0.05	-0.08	-0.12	-0.15	-0.14	-0.18	-0.21
Bachelor's degree within 5 years		-0.05	-0.07	-0.09	0.04	0.02	-0.01	-0.02	-0.04	-0.07	-0.06	-0.08	-0.10
Bachelor's degree within 6 years		-0.04	-0.08	-0.13	-0.41	-0.46	-0.50	-0.41	-0.46	-0.50	-0.41	-0.46	-0.50

Note: Shaded cells correspond to course grade regression coefficients that are not statistically significantly different from zero ($p > .01$). Cells are left blank for models that could not be developed. Percentiles (Pctl.) correspond to the 5th and 95th percentiles of ACT English scores of students who took the lower-level course. Differences for a Passing grade ranged from -0.07 (P5) to -0.02 (P95) for a C or higher grade in Psychology (median=0.03), from -0.07 (P5) to -0.03 (P95) for a 2.0 or higher Term 1 GPA/persist to Term 2 (median=-0.05), and from 0.17 (P5) to 0.06 (P95) for a 2.0 or higher Year 1 GPA/persist to Year 2 (median=0.11).

Appendix D

Estimated Probabilities of Success for Full- and Part-Time Students

Tables D1 through D 6

Note: All results pertaining to six-year degree completion were based on only 22 of the 35 four-year institutions in the study.

Table D-1

Estimated Probabilities of Longer-Term College Outcomes for Students who enrolled in Developmental and Standard English Composition, by Full-Time/Part-Time Status

Outcome variable		Estimated probability	
Type	Level	PT	FT
All students who enrolled in Developmental and Standard English Composition			
Dev. English Comp. grade; first time taken	C or higher	0.95	0.96
	B or higher	0.62	0.66
	Pass	0.99	0.99
Std. English Composition grade	C or higher	0.65	0.75
	B or higher	0.39	0.49
1st term GPA/persist to term 2	2.0 or higher	0.68	0.84
	3.0 or higher	0.38	0.47
1st year GPA/persist to year 2	2.0 or higher	0.48	0.61
	3.0 or higher	0.17	0.23
2nd year GPA/persist to year 3	2.0 or higher	0.26	0.33
	3.0 or higher	0.06	0.10
Cum. GPA at graduation/ last term	2.0 or higher	0.08	0.19
	2.5 or higher	0.06	0.16
	3.0 or higher	0.03	0.08
Associate's degree within 3 years		0.05	0.21
Bachelor's degree within 5 years		0.04	0.05
Bachelor's degree within 6 years		0.30	0.46
Students who enrolled directly in Standard English Composition			
Std. English Composition grade	C or higher	0.56	0.86
	B or higher	0.41	0.70
1st term GPA/persist to term 2	2.0 or higher	0.28	0.80
	3.0 or higher	0.18	0.49
1st year GPA/persist to year 2	2.0 or higher	0.24	0.63
	3.0 or higher	0.13	0.36
2nd year GPA/persist to year 3	2.0 or higher	0.13	0.37
	3.0 or higher	0.06	0.19
Cum. GPA at graduation/ last term	2.0 or higher	0.09	0.33
	2.5 or higher	0.08	0.31
	3.0 or higher	0.05	0.21
Associate's degree within 3 years		0.08	0.34
Bachelor's degree within 5 years		0.02	0.15
Bachelor's degree within 6 years		0.13	0.49

Note: Shaded cells correspond to full-time/part-time regression coefficients that are not statistically significantly different from zero ($p > .01$). Cells are left blank for models that could not be developed.

Table D-2

Estimated Probabilities of Longer-Term Outcomes for Students who enrolled in Arithmetic and Elementary Algebra, by Full-Time/Part-Time Status

Outcome variable		Estimated probability	
Type	Level	PT	FT
All students who enrolled in Arithmetic and Elementary Algebra			
Arithmetic grade; first time taken	C or higher	0.90	0.96
	B or higher	0.70	0.77
	Pass		
Elementary Algebra grade	C or higher	0.41	0.49
	B or higher	0.29	0.31
1st term GPA/persist to term 2	2.0 or higher	0.61	0.81
	3.0 or higher	0.45	0.52
1st year GPA/persist to year 2	2.0 or higher	0.46	0.62
	3.0 or higher	0.23	0.25
2nd year GPA/persist to year 3	2.0 or higher	0.19	0.25
	3.0 or higher	0.07	0.12
Cum. GPA at graduation/ last term	2.0 or higher	0.05	0.17
	2.5 or higher	0.04	0.15
	3.0 or higher	0.03	0.09
Associate's degree within 3 years		0.04	0.10
Bachelor's degree within 5 years		0.03	0.09
Bachelor's degree within 6 years			
Students who enrolled directly in Elementary Algebra			
Elementary Algebra grade	C or higher	0.30	0.47
	B or higher	0.18	0.28
1st term GPA/persist to term 2	2.0 or higher	0.34	0.70
	3.0 or higher	0.19	0.34
1st year GPA/persist to year 2	2.0 or higher	0.23	0.45
	3.0 or higher	0.09	0.16
2nd year GPA/persist to year 3	2.0 or higher	0.13	0.25
	3.0 or higher	0.04	0.08
Cum. GPA at graduation/ last term	2.0 or higher	0.04	0.12
	2.5 or higher	0.03	0.10
	3.0 or higher	0.02	0.07
Associate's degree within 3 years		0.03	0.14
Bachelor's degree within 5 years		0.01	0.05
Bachelor's degree within 6 years		0.19	0.42

Table D-3

Estimated Probabilities of Longer-Term Outcomes for Students who enrolled in Elementary and Intermediate Algebra, by Full-Time/Part-Time Status

Outcome variable		Estimated probability	
Type	Level	PT	FT
All students who enrolled in Elementary and Intermediate Algebra			
Elementary Algebra grade; first time taken	C or higher	0.89	0.91
	B or higher	0.60	0.62
	Pass	0.93	0.95
Intermediate Algebra grade	C or higher	0.40	0.46
	B or higher	0.23	0.27
1st term GPA/persist to term 2	2.0 or higher	0.68	0.82
	3.0 or higher	0.40	0.47
1st year GPA/persist to year 2	2.0 or higher	0.48	0.59
	3.0 or higher	0.19	0.24
2nd year GPA/persist to year 3	2.0 or higher	0.27	0.35
	3.0 or higher	0.07	0.12
Cum. GPA at graduation/ last term	2.0 or higher	0.08	0.18
	2.5 or higher	0.07	0.15
	3.0 or higher	0.04	0.09
Associate's degree within 3 years		0.05	0.20
Bachelor's degree within 5 years		0.03	0.07
Bachelor's degree within 6 years		0.39	0.51
Students who enrolled directly in Intermediate Algebra			
Intermediate Algebra grade	C or higher	0.27	0.57
	B or higher	0.17	0.36
1st term GPA/persist to term 2	2.0 or higher	0.37	0.79
	3.0 or higher	0.20	0.42
1st year GPA/persist to year 2	2.0 or higher	0.27	0.58
	3.0 or higher	0.10	0.26
2nd year GPA/persist to year 3	2.0 or higher	0.15	0.34
	3.0 or higher	0.06	0.12
Cum. GPA at graduation/ last term	2.0 or higher	0.06	0.21
	2.5 or higher	0.05	0.18
	3.0 or higher	0.03	0.12
Associate's degree within 3 years		0.07	0.21
Bachelor's degree within 5 years		0.02	0.10
Bachelor's degree within 6 years		0.12	0.33

Table D-4

Estimated Probabilities of Longer-Term Outcomes for Students who enrolled in Intermediate and College Algebra, by Full-Time/Part-Time Status

Outcome variable		Estimated probability	
Type	Level	PT	FT
All students who enrolled in Intermediate Algebra before College Algebra			
Intermediate Algebra grade ; first time taken	C or higher	0.86	0.95
	B or higher	0.56	0.68
	Pass		
College Algebra grade	C or higher	0.51	0.63
	B or higher	0.28	0.37
1st term GPA/persist to term 2	2.0 or higher	0.73	0.88
	3.0 or higher	0.45	0.54
1st year GPA/persist to year 2	2.0 or higher	0.54	0.69
	3.0 or higher	0.22	0.34
2nd year GPA/persist to year 3	2.0 or higher	0.32	0.40
	3.0 or higher	0.11	0.15
Cum. GPA at graduation/ last term	2.0 or higher	0.14	0.30
	2.5 or higher	0.12	0.26
	3.0 or higher	0.06	0.18
Associate's degree within 3 years		0.14	0.32
Bachelor's degree within 5 years		0.05	0.13
Bachelor's degree within 6 years		0.42	0.53
Students who enrolled directly in College Algebra			
College Algebra grade	C or higher	0.42	0.73
	B or higher	0.27	0.52
1st term GPA/persist to term 2	2.0 or higher	0.21	0.81
	3.0 or higher	0.13	0.51
1st year GPA/persist to year 2	2.0 or higher	0.19	0.64
	3.0 or higher	0.09	0.39
2nd year GPA/persist to year 3	2.0 or higher	0.10	0.37
	3.0 or higher	0.05	0.21
Cum. GPA at graduation/ last term	2.0 or higher	0.06	0.34
	2.5 or higher	0.06	0.31
	3.0 or higher	0.04	0.24
Associate's degree within 3 years		0.06	0.32
Bachelor's degree within 5 years		0.02	0.18
Bachelor's degree within 6 years		0.10	0.53

Table D-5

Estimated Probabilities of Longer-Term Outcomes for Students who enrolled in Developmental Reading and American History, by Full-Time/Part-Time Status

Outcome variable		Estimated probability	
Type	Level	PT	FT
All students who enrolled in Developmental Reading before American History			
Developmental Reading grade ; first time taken	C or higher	0.81	0.93
	B or higher	0.48	0.72
	Pass	0.98	0.99
American History grade	C or higher	0.43	0.60
	B or higher	0.20	0.33
1st term GPA/persist to term 2	2.0 or higher	0.61	0.83
	3.0 or higher	0.35	0.46
1st year GPA/persist to year 2	2.0 or higher	0.40	0.60
	3.0 or higher	0.11	0.23
2nd year GPA/persist to year 3	2.0 or higher	0.20	0.36
	3.0 or higher	0.04	0.11
Cum. GPA at graduation/ last term	2.0 or higher	0.07	0.19
	2.5 or higher	0.05	0.15
	3.0 or higher	0.02	0.08
Associate's degree within 3 years		0.05	0.20
Bachelor's degree within 5 years		0.07	0.16
Bachelor's degree within 6 years		0.13	0.28
Students who enrolled directly in American History			
American History grade	C or higher	0.54	0.77
	B or higher	0.34	0.55
1st term GPA/persist to term 2	2.0 or higher	0.32	0.78
	3.0 or higher	0.20	0.49
1st year GPA/persist to year 2	2.0 or higher	0.27	0.61
	3.0 or higher	0.14	0.37
2nd year GPA/persist to year 3	2.0 or higher	0.16	0.38
	3.0 or higher	0.07	0.20
Cum. GPA at graduation/ last term	2.0 or higher	0.10	0.33
	2.5 or higher	0.09	0.30
	3.0 or higher	0.06	0.23
Associate's degree within 3 years		0.09	0.33
Bachelor's degree within 5 years		0.04	0.19
Bachelor's degree within 6 years		0.17	0.50

Table D-6

Estimated Probabilities of Longer-Term Outcomes for Students who enrolled in Developmental Reading and Psychology, by Full-Time/Part-Time Status

Outcome variable		Estimated probability	
Type	Level	PT	FT
All students who enrolled in Developmental Reading before Psychology			
Developmental Reading grade ; first time taken	C or higher	0.80	0.94
	B or higher	0.54	0.76
	Pass	0.98	0.98
Psychology grade	C or higher	0.49	0.69
	B or higher	0.25	0.41
1st term GPA/persist to term 2	2.0 or higher	0.59	0.83
	3.0 or higher	0.37	0.46
1st year GPA/persist to year 2	2.0 or higher	0.39	0.59
	3.0 or higher	0.11	0.24
2nd year GPA/persist to year 3	2.0 or higher	0.22	0.34
	3.0 or higher	0.05	0.11
Cum. GPA at graduation/ last term	2.0 or higher	0.07	0.18
	2.5 or higher	0.05	0.15
	3.0 or higher	0.02	0.09
Associate's degree within 3 years		0.05	0.19
Bachelor's degree within 5 years		0.04	0.07
Bachelor's degree within 6 years		0.20	0.37
Students who enrolled directly in Psychology			
Psychology grade	C or higher	0.62	0.83
	B or higher	0.43	0.63
1st term GPA/persist to term 2	2.0 or higher	0.34	0.79
	3.0 or higher	0.22	0.50
1st year GPA/persist to year 2	2.0 or higher	0.28	0.61
	3.0 or higher	0.14	0.36
2nd year GPA/persist to year 3	2.0 or higher	0.15	0.36
	3.0 or higher	0.07	0.20
Cum. GPA at graduation/ last term	2.0 or higher	0.09	0.31
	2.5 or higher	0.08	0.29
	3.0 or higher	0.06	0.22
Associate's degree within 3 years		0.09	0.30
Bachelor's degree within 5 years		0.04	0.18
Bachelor's degree within 6 years		0.18	0.53

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