REFERRAL, ENROLLMENT, AND COMPLETION IN DEVELOPMENTAL EDUCATION SEQUENCES IN COMMUNITY COLLEGES

Thomas Bailey
Dong Wook Jeong
Sung-Woo Cho

December 2008

CCRC Working Paper No. 15

Address correspondence to:

Thomas Bailey, Director
Community College Research Center
Teachers College, Columbia University
525 West 120th Street, Box 174
New York, NY 10027
tbailey@tc.edu
212-678-3091

Funding for this study was provided by Lumina Foundation for Education as part of the Achieving the Dream: Community Colleges Count initiative.

Abstract

After being assessed, many students entering community colleges are referred to one or more levels of developmental education. While the need to assist students with weak academic skills is well known, little research has examined student progression through multiple levels of developmental education and into entry-level college courses. The purpose of this paper is to analyze the patterns and determinants of student progression through sequences of developmental education starting from initial referral. We rely primarily on a micro-level longitudinal dataset that includes detailed information about student progression through developmental education. This dataset was collected as part of the national community college initiative Achieving the Dream: Community Colleges Count. The dataset has many advantages, but it is not nationally representative; therefore, we check our results against a national dataset—the National Education Longitudinal Study of 1988.

Our results indicate that only 3 to 4 out of 10 students who are referred to remediation actually complete the entire sequence to which they are referred. Most students exit in the beginning of their developmental sequence—almost half fail to complete the first course in their sequence. The results also show that more students exit their developmental sequences because they *did not enroll in* the first or a subsequent course than because they *failed* a course in which they were enrolled. We also show that men, older students, Black students, part-time students, and students in vocational programs are less likely to progress through their full remedial sequences. Finally, we provide weaker evidence that some institutional characteristics are related to a lower probability of completion of developmental education.

Table of Contents

1. Introduction

Developmental education is designed to provide students who enter college with weak academic skills the opportunity to strengthen those skills enough to prepare them for college-level coursework.[1] The concept is simple enough—students who arrive unprepared for college are provided instruction to bring them up to an adequate level. But in practice, developmental education is complex and confusing. To begin with, experts do not agree on the meaning of being "college ready." Policies and regulations governing assessment, placement, pedagogy, staffing, completion, and eligibility for enrollment in college-level credit-bearing courses vary from state to state, college to college, and program to program. The developmental education process is confusing enough simply to describe, yet from the point of view of the student, especially a student with particularly weak academic skills who has not had much previous success in school, it appears as a bewildering set of unanticipated obstacles involving several assessments, classes in more than one subject area, and sequences of courses that may require two, three, or more semesters of study before a student (often a high school graduate) is judged prepared for college-level work.

The policy deliberation and especially the research about developmental education give scant attention to this confusion and complexity. Discussions typically assume that the state of being "college ready" is well-defined, and they elide the distinction between students who need remediation and those who actually enroll in developmental courses. What is more, developmental education is often discussed without acknowledgement of the extensive diversity of services that bear that label. Any comprehensive understanding of developmental education and any successful strategy to improve its effectiveness cannot be built on such a simplistic view.

In this article, we broaden the discussion of developmental education by moving beyond consideration of the developmental *course* and focusing attention instead on the developmental *sequence*. In most colleges, students are, upon initial enrollment, assigned to different levels of

[1] Most practitioners use the term "developmental" rather than "remedial" education. In general, developmental education is taken to refer to the broad array services provided to students with weak skills, while remediation is taken to refer specifically to courses given to such students. Moreover, the term "remedial" is often considered to carry a negative connotation. This paper discusses primarily developmental classes. To simplify the exposition and to avoid the overuse of either of these two words, we use "developmental" and "remedial" interchangeably. No positive or negative connotation is intended.

developmental education on the basis of performance on placement tests.[2] Students with greater academic deficiencies are often referred to a sequence of two or more courses designed to prepare students in a step-by-step fashion for the first college-level course. For example, those with the greatest need for developmental math are expected to enroll in and pass pre-collegiate math or arithmetic, basic algebra, and intermediate algebra in order to prepare them for college-level algebra. We define the "sequence" as a process that begins with initial assessment and referral to remediation and ends with completion of the highest-level developmental course—the course that in principle completes the student's preparation for college-level studies. At times we extend the notion of "sequence" into the first-level college course in the relevant subject area, since in the end the short-term purpose of remediation is to prepare the student to be successful in that first college-level course. We examine the relationship between referral to developmental education and actual enrollment, and we track students as they progress or fail to progress through their referred sequences of remedial courses, analyzing the points at which they exit those sequences. We also analyze the demographic and institutional characteristics that are related to the completion of sequences and exits at different points along them.

We carry out this analysis using data collected as part of the Achieving the Dream: Community Colleges Count initiative. The sample includes over 250,000 students from 57 colleges in seven states. The sample is not representative of all community college students, so we check our results against an analysis using the National Education Longitudinal Study of 1988 (henceforth, NELS:88).[3] Results of that analysis are consistent with results derived from the Achieving the Dream database.

The marked contrast between *the course* and *the sequence* that we explore reveals some startling conclusions. While the majority of individual course enrollments do result in a course completion, only one third to two fifths of students referred to developmental education actually complete their entire developmental sequence. And only one fifth or fewer of those students

[2] In fall 2000, 92 percent of public two-year colleges utilized placement tests in the selection process for remediation (Parsad, Lewis, & Greene, 2003).

[3] A nationally representative sample of eighth-graders was first surveyed in the spring of 1988. A sample of these respondents was then resurveyed in four follow-ups in 1990, 1992, 1994, and 2000. On the questionnaire, students self-reported on a range of topics including: school, work, and home experiences; educational resources and support; the role in education of their parents and peers; neighborhood characteristics; educational and occupational aspirations; and other student perceptions. For the three in-school waves of data collection (when most were eighth-graders, sophomores, or seniors), achievement tests in reading, social studies, mathematics, and science were administered in addition to the student questionnaire (National Center for Education Statistics, 2003).

referred to a sequence three or more levels below college level actually complete it. And finally, about two thirds of students who fail to complete the sequence to which they were referred do so even while having passed all of the developmental courses in which they enrolled.

The remainder of this paper is organized in the following manner: In section 2 we provide some general background on the characteristics and outcomes of remediation; in section 3 we describe the Achieving the Dream and the NELS:88 databases; section 4 presents the results of the analyses on student placement and progression in developmental education; section 5 shows the results of multivariate analyses of the student and college characteristics that are related to an individual's likelihood of progressing through developmental education; section 6 summarizes the results and presents conclusions and recommendations.

2. Developmental Education Basics

More than one half of community college students enroll in at least one developmental education course during their tenure in college. In the National Postsecondary Student Aid Study of 2003-04 (NPSAS:04), 43 percent of first- and second-year students enrolled in public two-year colleges took at least one remedial course during that year (Horn & Nevill, 2006). Longitudinal data that allow a measure for the incidence of developmental education over multiple years of enrollment show even higher levels of enrollment. Attewell, Lavin, Domina, and Levey (2006) found that in the NELS:88 sample, 58 percent of community college students took at least one remedial course, 44 percent took between one and three remedial courses, and 14 percent took more than three such courses.[4] In the Achieving the Dream database, which will be described in detail below, about 59 percent of the sample enrolled in at least one developmental course.

Developmental programs absorb sizable public resources. More than 10 years ago, Breneman and Haarlow (1998) estimated that remediation cost more than $1 billion a year. A more recent study calculated the annual cost of remediation at $1.9 to $2.3 billion dollars at community colleges and another $500 million at four-year colleges (Strong American Schools, 2008). State reports cite expenditures in the tens of millions of dollars (Arkansas Department of

[4] NELS:88 is a sample of traditional college-aged students (they were all in 8th grade in 1988 and were followed until 2000).

Higher Education, n.d.; Florida Office of Program Policy Analysis and Government Accountability, 2006; Ohio Board of Regents, 2006).

The costs of remediation to the taxpayer are substantial, but the financial, psychological, and opportunity costs borne by the students themselves may be even more significant. While they are enrolled in remediation, students accumulate debt, spend time and money, and bear the opportunity cost of lost earnings. In some states, they deplete their eligibility for financial aid. Moreover, many students referred to developmental classes, most of whom are high school graduates, are surprised and discouraged when they learn that they must delay their college education and in effect return to high school. A recent survey of remedial students found that a majority believed that they were prepared for college (Strong American Schools, 2008). This can cause students to become frustrated and to give up and leave college (Rosenbaum, 2001; Deil-Amen & Rosenbaum, 2002). Many students referred to remediation try to avoid it by using loopholes and exceptions that can be found in many regulations and guidelines (Perin & Charron, 2006).

Although remediation has high costs, clearly some provision must be made for students who enter college unprepared. Proponents argue that it can be an effective tool to improve access to higher education, particularly for underprivileged populations (McCabe, 2006), while others argue that the costs of remediation, for both society and student, outweigh the benefits. The controversy about remediation has prompted some research on the effectiveness of remedial programs in preparing students for college-level courses, but given the size and significance of the developmental education function, that research is surprisingly sparse. Some studies have attempted to compare different approaches to remediation (Boylan, 2002).[5] But only a handful of studies have compared the success of students who enroll in developmental courses to the success of similar students who enroll directly in college courses. These studies generally show little positive effect, although these results are most reliable for students at the upper end of the developmental range—students who are assigned to remediation but who score near the developmental cut-off point on assessments (Bettinger & Long, 2005; Calcagno, 2007; Calcagno & Long, 2008; Martorell & McFarlin, 2007; Attewell, Lavin, Domina, & Levey, 2006).[6]

[5] Most of the research comparing different approaches to remediation show correlational rather than causal relationships.

[6] For critical analysis of the research on remediation, see Grubb (2001), Bailey and Alfonso (2005), Perin (2006), Levin and Calcagno (2008), and Bailey (in press).

What accounts for these discouraging results? Certainly one fundamental problem is that most students referred to remediation do not complete their sequences. This paper analyzes the patterns and determinants of that problem.

3. Achieving the Dream Initiative: Data Description

Achieving the Dream: Community Colleges Count is a multiyear, national initiative to help community college students succeed, with a particular emphasis on economically disadvantaged students and students of color.[7] As of 2008, 19 funders and over 80 colleges in 15 states participated in the initiative. One of its most important goals is helping participating colleges and accompanying state agencies to build "a culture of evidence"—to gather, analyze, and make better use of data to foster fundamental change in the education practices and operations of community colleges for the purpose of improving student outcomes. The Achieving the Dream initiative collects longitudinal records for all first-time credential-seeking students in specified cohorts at all of the colleges participating in the initiative, including data on cohorts starting two years before the college entered the initiative. These cohorts will be tracked for the life of the initiative (at least six years for participating colleges) and possibly beyond. The dataset includes student demographics, enrollment information, the number of credits accumulated, and the receipt of any degrees or certificates. It also includes detailed information on referral to developmental education; enrollment and completion of remedial courses in reading, writing, and mathematics; and enrollment and completion of "gatekeeper" courses—the first college-level courses corresponding to the developmental subject fields.[8] The initiative started in 2004 with five participating states: Florida, New Mexico, North Carolina, Texas, and Virginia. Twenty-seven colleges were chosen from those states. Each had student populations that were at least 38 percent Pell grant recipients or 54 percent Black, Hispanic, or Native American. In 2005 and 2006, 31 colleges from Connecticut, Ohio, Pennsylvania, Washington,

[7] For more information, see www.achievingthedream.org.

[8] Colleges are asked to choose their own "gatekeeper" courses. Gatekeeper courses are formally defined in the data gathering instructions to the colleges as the first college-level courses the student must take after remediation. These may be different for students enrolled in different programs within one institution. For example, a student enrolled in a medical program may have a different math requirement than a student in a business program.

and Texas joined the initiative.[9] Although subsequently 26 colleges in eight states joined the initiative, we use data only from those who joined in 2004, 2005, or 2006, because we have at least three years of post-enrollment data on students from those colleges.

Table 1 describes institutional characteristics of 57 Achieving the Dream colleges in fall 2004.[10] We retrieved the data from the Integrated Postsecondary Education Data System (IPEDS) to compare Achieving the Dream colleges with national and state public two-year institutions. The first column represents national public two-year colleges, the second column represents public two-year colleges in Achieving the Dream states, and the third represents the colleges included in the sample. Compared to the national and state samples, Achieving the Dream colleges serve substantially higher proportions of Black and Hispanic students. Achieving the Dream colleges also enroll a larger number of students per college, and they make noticeably smaller instructional expenditures per fulltime-equivalent enrollment (FTE). They are also more likely to be located in urban areas. Thus the Achieving the Dream sample more closely represents an urban, low-income, and minority student population than do community colleges in the country as a whole. The sample therefore characterizes an important sub-group of community colleges, but when possible we check our results against the national NELS:88 sample.

[9] These second- and third-round colleges include three open-admission, four-year institutions in Texas. However, these institutions were not included in our analysis.

[10] One of the first 27 colleges dropped out of the initiative, so the sample consists of 26 colleges from the initial group, and 31 that joined in 2005 and 2006.

Table 1:
Characteristics of Achieving the Dream colleges

Variables	Public Two-year (Nation)	Public Two-year (Achieving the Dream states[1])	Achieving the Dream Colleges[2]
Percent of Black students	14.22 (17.02)	14.13 (13.31)	16.56 (11.84)
Percent of Hispanic students	8.54 (13.67)	12.07 (17.07)	22.39 (20.71)
Fulltime-equivalent enrollments (FTE)	2,114.2 (2,142.2)	2,150.7 (2,216.8)	6,609.5 (3,350.6)
Percent of students receiving federal financial aid	43.94 (18.71)	41.41 (17.34)	38.45 (14.52)
Average amount of federal financial aid received per FTE (in dollars)	2,708.2 (637.5)	2,646.3 (633.4)	2,878.98 (465.61)
Instructional expenditures per FTE (in dollars)	5,261.5 (20,987)	5,025.6 (12,675)	3,339.47 (848.90)
Location: Urban	39.47%	48.99%	80.94%
Suburban	23.72%	21.14%	14.77%
Rural	36.81%	29.87%	4.29%
Fulltime retention rate (fall 2003 to fall 2004)	57.73% (13.85)	56.30% (13.56)	57.61% (6.50)
Observations (N)	1,169	307	57

Note: Standard deviations for continuous variables are in parentheses.
[1] Achieving the Dream states include Connecticut, Florida, Ohio, New Mexico, North Carolina, Pennsylvania, Texas, Virginia, and Washington.
[2] For the purpose of comparison, we excluded three four-year institutions from the Achieving the Dream colleges.

The Achieving the Dream database we used for this study was derived from 256,672 first-time credential-seeking students who began their enrollment in fall 2003 to fall 2004 in 57 colleges that provided detailed information on developmental education. We followed their enrollments in remediation through the summers of 2006 and 2007—three academic years. For simplicity, we focused on two common developmental education subjects: math and reading. The database contains information on student gender, race/ethnicity, age at entry, full- or part-time enrollment, major, and all remedial courses taken and the grades earned in those courses. One unique aspect of this dataset, particularly important for our purposes, is that it includes a

variable indicating whether students were referred to developmental education and, for those who were referred, the level to which they were referred.[11]

As previously discussed, for the purpose of comparison and to assess the extent to which our analysis is representative, we also used a national micro-level data taken from NELS:88 that includes transcript information on remediation. The NELS transcripts allowed us to track students through their developmental sequences, but the dataset does not indicate whether students were referred to remediation.

4. Student Progression Through Developmental Education

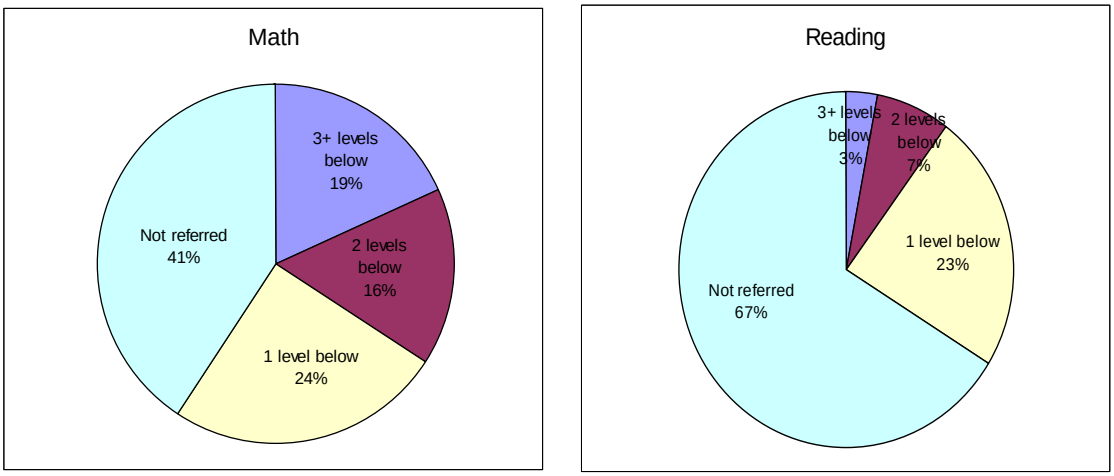
4.1 Student placement in developmental education

Most Achieving the Dream colleges use a placement test and/or academic records to place beginning students into developmental education. Based on their performance on the test/records, many individuals are referred to a sequence of developmental courses. The Achieving the Dream database classifies all beginning students into four groups for each type of developmental education: students referred to 1) no developmental education, 2) developmental education one level below the entry-level college course, 3) two levels below, and 4) three or more levels below. Some students are thus expected to finish three or more developmental courses before enrolling in college-level classes. Figure 1 shows the distribution of students referred to different levels by subject. Fifty-nine percent of students were referred to developmental math: 24 percent to one level below entry-level college, 16 percent to two levels below, and 19 percent to three or more levels below. Far fewer students—only 33 percent—were referred to reading remediation: 23 percent, 7 percent, and 3 percent into the respective three levels.[12]

[11] Participating institutions were given the following instructions on how to determine whether a student should be considered referred to remedial math or reading: "Student was referred for remedial needs in mathematics [reading]. Remedial courses are instructional courses designed for students deficient in the general competencies necessary for a regular postsecondary curriculum and educational setting. The student can be referred through a counselor, a developmental office, etc." Institutions with multiple levels of remedial education were asked to report the level to which the student was initially referred.

[12] A sequence of developmental reading courses might include pre-college reading, textbook mastery, and college textbook material.

Figure 1:
Referral to Different Levels of Developmental Education among Achieving the Dream Students



It is important to note that different colleges provide different numbers of levels of developmental education. In fall 2000, public two-year colleges reported to offer, on average, 3.6 remedial courses in math while offering 2.7 courses in reading. Among the 53 Achieving the Dream colleges in the sample that provided information on remedial math offerings, 35 offer three or more levels of remedial math, 9 offer two levels, and 9 offer one level. Among the 51 such colleges that provided information on remedial reading offerings, 20 offer three or more levels of remedial reading, 20 offer two levels, and 11 offer one level (see Table 2).

Table 2:
Developmental Course Offerings and Student Referrals of Achieving the Dream Colleges

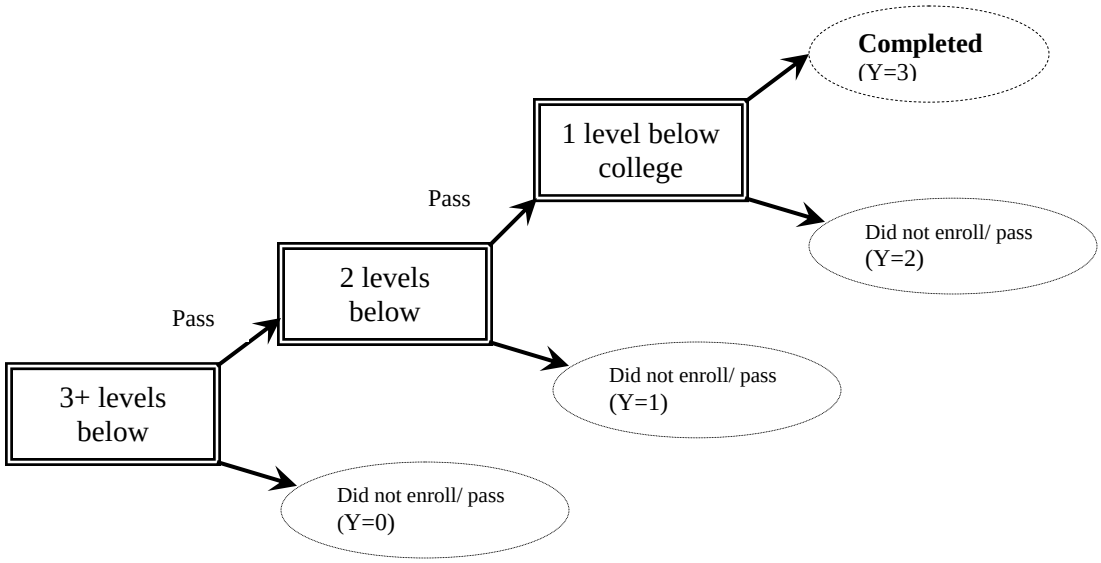
Developmental course offerings	Number of Colleges	Level of Developmental Education to which Students Are Referred				Number of students (N)
		3+ levels below	2 levels below	1 level below	Not referred	
Math						
One level	9			50.9%	49.2%	29,714
Two levels	9		29.6%	17.4%	53.0%	22,381
Three or more levels	35	32.9%	18.1%	16.2%	32.8%	89,495
Reading						
One level	11			39.4%	60.6%	22,361
Two levels	20		10.7%	20.3%	69.0%	28,015
Three or more levels	20	8.3%	8.8%	16.6%	66.4%	27,773

Note: Among 57 Achieving the Dream colleges, 4 and 6 provided no information on developmental education in math and reading, respectively.

4.2 Student progression through developmental education

As we have pointed out, students can be referred to multiple levels of developmental education. In principle, only those who passed the course into which they were originally referred can pursue a higher-level developmental course.[13] Figure 2 depicts a model of student progression in developmental education for students who are referred to developmental courses that are three or more levels below college-level. Such individuals have many opportunities to exit their sequence. If we consider Y to be a student's ultimate outcome (Y), then there are four possible results for Y: 1) student did not enroll in or pass the course(s) three or more levels below college-level (Y = 0),[14] 2) student completed the course(s) three or more levels below but did not enroll in or pass the course two levels below (Y = 1), 3) student completed the course two levels below but did not enroll in or pass the course one level below (Y = 2), and 4) student completed the highest-level developmental course (Y = 3).

Figure 2:
Model of Student Progression in Developmental Education



[13] In reality, some students enroll in a higher level of remediation without taking the course to which they were originally referred. At some colleges, individuals are allowed to re-take the placement test. Based on their new test scores, students can be re-placed into a higher level of developmental education or even directly into a college-level course.

[14] For our analysis, course completion is defined as earning a "D" or better in the course.

Not surprisingly, developmental education completion rates are negatively related to the number of levels to which a student is referred. Of those students in our Achieving the Dream sample in need of remediation one level below college-level (see Figure 3 and Table 3), only 44 percent and 48 percent completed developmental math and reading, respectively.[15] Of those referred to two levels below college-level, only 29 percent and 36 percent completed math and reading remediation, respectively.[16] The corresponding figures are 16 percent and 22 percent for those referred to three or more levels below college-level. When aggregating across the levels (not shown in Figure 3 or Table 3), only 31 percent of students referred to math remediation and 44 percent referred to reading remediation completed their sequences within three years.

Table 3:
In-Order Enrollment, Pass, and Completion Rates in
Developmental Courses of Students in Achieving the Dream Colleges

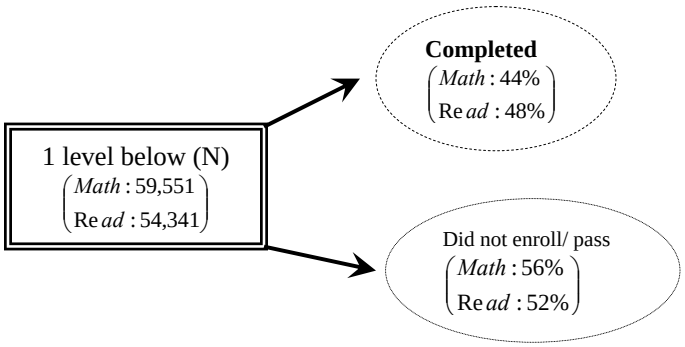
Course		*Referred to Math Remediation*			*Referred to Reading Remediation*		
Level	Enroll/pass	3+ levels below	2 levels below	1 level below	3+ levels below	2 levels below	1 level below
3+ levels below	Not enrolled	18.6%			34.7%		
	Not passed	24.8%			12.6%		
	[Sub-total]	[43.4%]			[47.3%]		
2 levels below	Not enrolled	15.8%	26.7%		14.0%	27.6%	
	Not passed	11.5%	21.3%		4.1%	14.8%	
	[Sub-total]	[27.3%]	[48.0%]		[18.1%]	[42.4%]	
1 level below	Not enrolled	7.3%	13.1%	38.0%	8.1%	14.8%	38.4%
	Not passed	5.9%	10.0%	17.6%	4.1%	6.6%	13.2%
	[Sub-total]	[13.2%]	[23.1%]	[55.6%]	[12.2%]	[21.4%]	[51.6%]
	Completed	16.1%	28.9%	44.4%	22.4%	36.3%	48.4%
	Observations	43,886	38,153	59,551	6,825	16,983	54,341

[15] For simplicity, throughout the paper, individuals in need of remediation at colleges having only one level are treated the same as those in need of remediation one level below college-level at institutions having two or three or more developmental levels. Of course, there may be differences in student characteristics among these groups, but for analytic purposes, all the individuals in these groups have only a single transition to pass through.

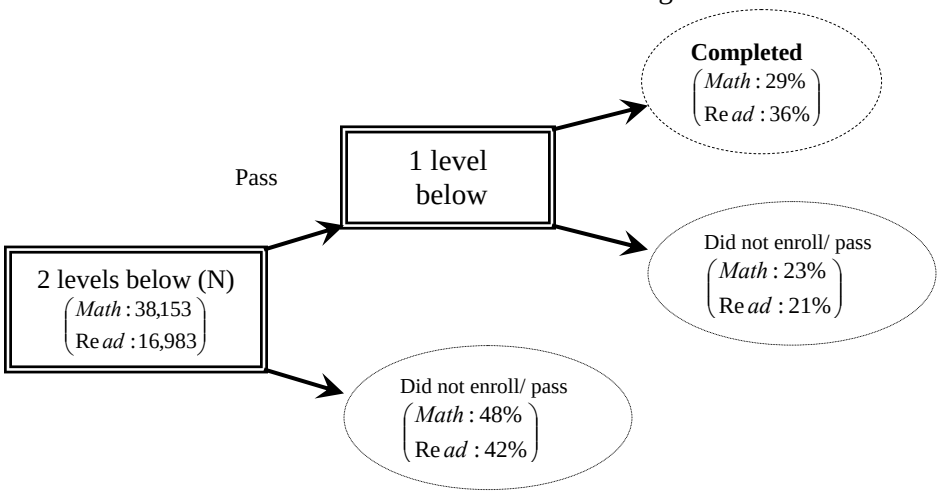
[16] Individuals referred to remediation two levels below college-level are treated the same regardless of the number of developmental levels offered by college (see previous footnote for rationale).

Figure 3:
In-Order Completion of Developmental Courses among Achieving the Dream Students

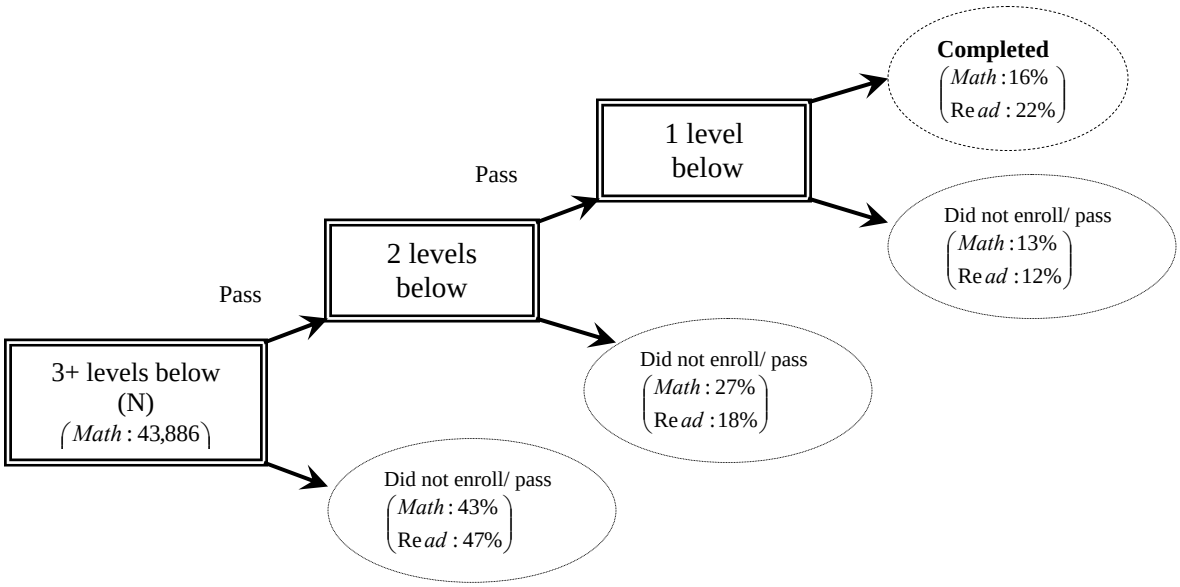
A. Those referred to 1 level below college



B. Those referred to 2 levels below college



C. Those referred to 3+ levels below college



While fewer than half of students in the sample who were referred to remediation completed their sequences, many of those never even finished the first course to which they were referred. Figure 3 indicates that between 40 and 50 percent of students referred to two and to three or more levels below college-level in both reading and math did not complete their first developmental course. Across all levels of remediation, we see that approximately one half of all developmental students did not finish the first course to which they were referred, for both math and reading. This indicates that most exits in developmental education occur in or before the first course.

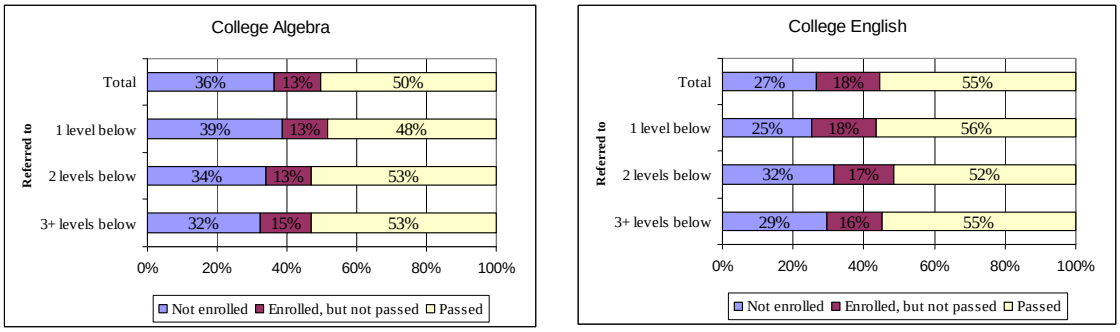
So far we have focused on students who did not complete particular courses, but this group is made up both of students who never enrolled in such courses to begin with as well as those who enrolled in but failed to complete or pass them. Table 3 differentiates between these two groups. Focusing on the first course to which a student is referred, we see that among those who did not complete that course (in each case of one-level-below, two-levels-below, or three-or-more-levels-below), more students did not complete it simply because they did not enroll in it than because they failed the course or dropped out of it after having enrolled.

This phenomenon continues as students move through subsequent levels of remediation in their sequences. As shown in Table 3, at each level, there are more students who did not show up for the next-level course (after having successfully completed the previous course in the sequence) than there are those who enrolled in but did not pass the course.

In Figure 4 we simplify the results presented in Table 3. Regardless of the level of remediation referred to, sequence non-completers are classified into only two groups: 1) those who exited the sequence because they did not enroll in one of their developmental courses, and 2) those who exited because they enrolled in but did not pass one of their developmental courses. These bar charts reaffirm the conclusion that more students did not complete sequences because of non-enrollment than because of failure to complete courses in which they were enrolled. There are some important insights to gain from this figure. First, it shows that those students referred to one level below college-level (in both reading and math) who actually enrolled have a high probability of completing their sequence (in this case, just one course). For these students, who are at the higher end of the developmental range, non-enrollment accounts for two thirds to three fourths of all non-completion. This fact raises the question: Why do students who appear to have a higher probability of completing their sequences fail to enroll at similar rates as those

referred to lower levels? Second, while for math, non-enrollment still accounts for more than half of those who did not complete their sequences, course failures and drop-outs are relatively more important than they are for reading. Finally, non-enrollment is particularly severe for those referred to reading remediation three or more levels below college-level. Almost three fifths of students referred to this lowest level of developmental education in our sample did not enroll in any reading developmental course within three years of entering the sample.

Figure 4:
Gatekeeper Enrollment and Completion among Achieving the Dream Students Developmental Education Completers



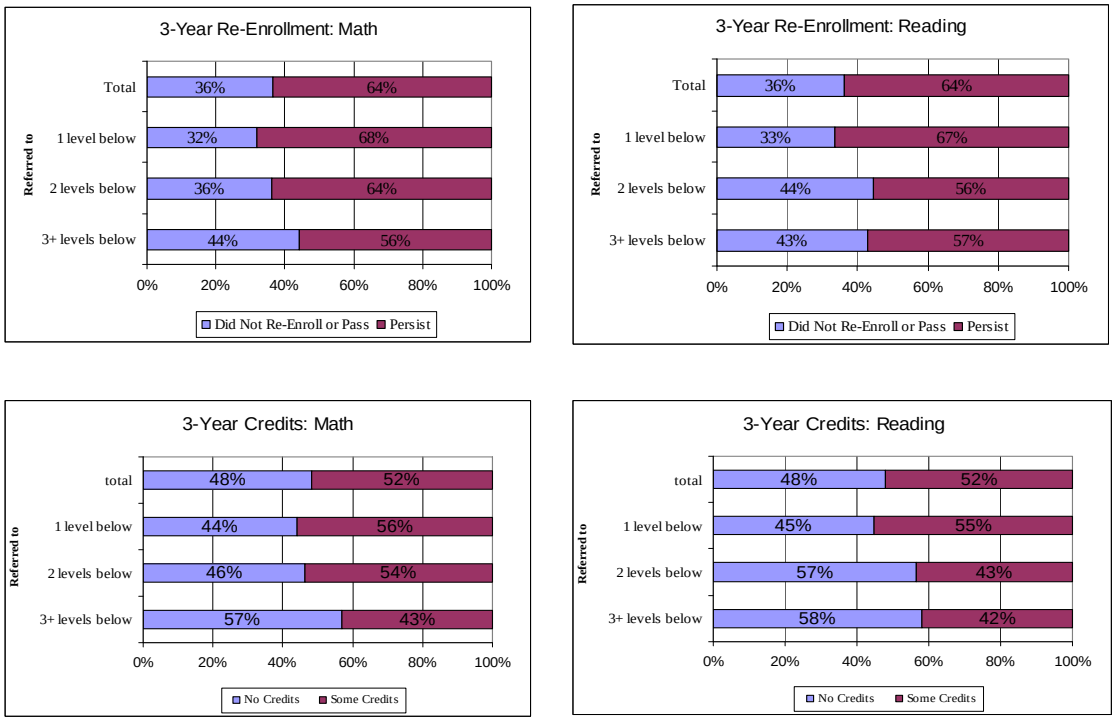
Note: Gatekeeper courses are defined as the first college-level courses the student must take after remediation. These may be different for students enrolled in different programs even within the same institution.

What happens to students who either never enroll in their first developmental course or enroll in but fail to pass that course?[17] Critics of developmental education argue that either the prospect or the experience of remediation discourages students who therefore give up and leave college. Data displayed in Figure 5 are at least consistent with that argument. More than one third of students referred to either math or reading remediation who did not complete their first developmental course did not enroll in any course—either remedial or college-level—in a subsequent semester within the three-year tracking period. These numbers rise to more than two fifths for students assigned to the lowest levels of remediation. The figure also shows that about one half of students referred to either math or reading remediation who did not complete their

[17] In most colleges, students are required to take the sequence of courses to which they are referred before they are eligible for college-level courses, but in some states and colleges, remediation is voluntary. In 75 percent of public two-year colleges, students are in principle required to take remedial courses to which they are referred while the remaining 25 percent are recommended by colleges to take those courses (Parsad, Lewis, & Greene, 2003).

first remedial course did not earn a college-level credit in any subject in a subsequent semester within three years.[18]

Figure 5:
Math and Reading Development Education Outcomes among Achieving the Dream First Students Who Did Not Complete Their First Developmental Course



Note: The sample includes all those who did not complete their first developmental education course. 3-Year Re-Enrollment indicates whether a student enrolls in any college-level course in a semester subsequent to the semester in which they were scheduled to take their first developmental course. These measures exclude those who transfer or fully complete within three years.

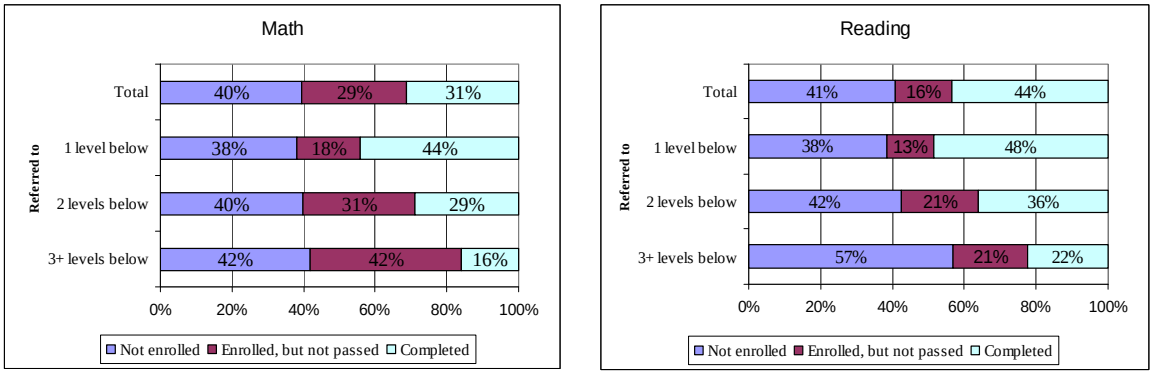
Viewed from a more positive perspective, this does mean that about half of the students who did not complete their first remedial course did go on to earn college-level credits. This is either because developmental education was not mandatory or because they enrolled in college courses in fields in which they were not referred to remediation.

We now extend the analysis to include the first college-level course in the relevant subject area. We have already seen that 31 percent of students referred to math remediation and 44 percent referred to reading remediation complete their developmental sequences within three

[18] For consistency with the enrollment rates, the data in the figure do not include students' first-term records, so we are not considering any credits or enrollments during the semester in which they were expected to take their first developmental course.

years. Of those, how many passed the first college-level course during that time period? These results are displayed in Figure 6. When reporting their data, the Achieving the Dream colleges are asked to choose a "gatekeeper" course for math, reading, and writing (see footnote 8 for a definition of gatekeeper courses). Colleges then report on enrollments and completions of these courses for their students.

Figure 6:
Enrollment and Progression Patterns among Achieving the Dream Students



First, more than half of those who completed their sequences did go on to pass a gatekeeper course. And this share was remarkably similar in both reading and math, regardless of the original level of remediation to which students were referred. One interpretation of this similarity is that completing a full developmental sequence does allow students with very weak skills to catch up to those with stronger skills—students referred to courses three or more levels below college-level do as well in their first college course as those who tested into the highest level of remediation.[19]

Of course the data displayed in Figure 4 also suggest that almost one half of those who complete their sequences do not go on and pass the first college-level course. What this means is that only 15 percent of all students referred to math remediation pass a college-level math course within three years, and about 20 percent of students referred to reading developmental education pass an English gatekeeper course within that period. Moreover, the pattern of non-completion of

[19] Nevertheless, as we can tell from Figure 3, very few of the weakest students even complete their sequence, so it may be that those who do complete are exceptional individuals. This might explain their relative success rather than the effects of their instruction.

gatekeeper courses in our sample is similar to the corresponding pattern for developmental courses. Among those who did not complete the gatekeeper course, between two thirds and three fourths simply did not enroll.

4.3 National Education Longitudinal Study of 1988

In the remainder of this section, we provide a comparison to the Achieving the Dream data by using a national micro-level dataset taken from NELS:88. One of the key advantages that NELS provides is the inclusion of more extensive information than the Achieving the Dream database on student characteristics. But there are disadvantages: the data refer to a period about 10 years before the Achieving the Dream data era, NELS does not indicate whether a student was referred to developmental education, and the sample is much smaller. In 2000, the National Center for Education Statistics (NCES) collected the NELS:88 fourth follow-up survey respondents' college transcripts from approximately 3,200 postsecondary institutions. This set of transcripts is referred to as the Postsecondary Transcript Study (PETS) of 2000.[20] Our analytic sample consists of 3,410 students who started postsecondary education at community college and whose transcripts are available.[21] Table 4 contrasts demographic characteristics of the NELS and Achieving the Dream samples. Summary statistics indicate that Black and Hispanic populations are significantly over-represented in the Achieving the Dream sample.[22] This over-representation may reflect the selection process under which colleges serving a high proportion of minority students were chosen to participate in Achieving the Dream. But it also reflects general changes in the demographic characteristics of community college students. In the past decade, there has been a significant increase in the proportion of minority populations attending community colleges: from 10.0 percent in 1990 to 13.6 percent in 2003 for Black and from 8.1 percent to 14.4 percent for Hispanics over the same period (Snyder, Tan, & Hoffman, 2006). The table also shows that the NELS students are on average four years younger at college entry than the

[20] In 1988, 24,599 eighth graders were selected for the NELS sample that was followed up four times (in 1990, 1992, 1994, and 2000). In the end, 12,144 individuals survived the base-year and four follow-up surveys. Attewell, Lavin, Domina, and Levey (2006) provide a detailed description of the NELS data for their analysis on developmental education.

[21] Given the fact that transcript data were retrieved from a restricted-use source, all sample size numbers are rounded to the nearest 10 throughout the paper in accordance with the NCES policy regarding confidentiality. Transcripts are limited to a three-year period of observation in an effort to be consistent with the Achieving the Dream sample.

[22] Even the NELS sample does not represent the entire community college student population at that time because of individuals who delayed postsecondary education after high school.

Achieving the Dream students. In contrast to NELS, the Achieving the Dream sample includes older students who entered college perhaps many years after high school.

Table 4:
Demographic Characteristics of Achieving the Dream and NELS Students

Characteristics	Achieving the Dream College Students	NELS Students[1]
Female	56.2%	55.0%
White	49.5%	68.1%
Black	16.6%	7.1%
Hispanic	22.4%	15.9%
Other	8.2%	8.9%
Age at college entry	23.6	19.1
	(8.48)	(1.75)
Observations	256,672	3,410

Note: Standard deviations for continuous variables are in parentheses.
[1]The sample consists of individuals who were enrolled in community college soon after high school and whose college transcripts are provided by their institutions. The sample does not include older students.

College transcript records taken from PETS contain information on student enrollment and performance in developmental education courses. From these course-by-course and term-by-term records, we were able to identify a set of developmental math courses[23] that students ever enrolled in: 1) pre-collegiate math or arithmetic, 2) basic algebra, and 3) intermediate algebra.[24] Table 5 presents NELS students' first-time math course enrollment, whether developmental or college-level.[25] Among the 3,410 NELS students, 25.3, 16.2, and 12.4 percent enrolled for their first math course in pre-collegiate math, basic algebra, and intermediate algebra, respectively. Almost 26 percent enrolled in a college-level course. The remaining 20.3 percent did not enroll in any math course during their college career.

[23] The NELS transcripts only identify one reading/English course as remedial, so we were not able to use NELS to analyze progression through a sequence of developmental reading courses.
[24] NCES considers intermediate algebra a pre-college course even though in a small number of cases, students are granted additive credits for the course (Snyder, Tan, & Hoffman, 2006). In this paper, we consider intermediate algebra to be a developmental course.
[25] The length of time for transcript observation for each student is three years from the start of postsecondary education.

Table 5:
Type of First Enrollment in a Math Course for NELS Students

Enrollment / Assignment	All students	Never enrolled in a math course	*First Enrolled Math Course*			
			Pre-collegiate math	Basic Algebra, Plane Geometry	Intermediate Algebra[1]	College-level math course
Enrollment	3,400[2]	690	860	550	420	880
	[100%]	[20.3%]	[25.3%]	[16.2%]	[12.4%]	[25.9%]
Assignment	3,400	-	1,100	720	520	1,060
	[100%]	-	[32.4%]	[21.2%]	[15.3%]	[31.2%]

Notes: To be consistent with the Achieving the Dream sample, only student transcripts that captured three years or less of a student's academic performance were used. For the purposes of assignment, a student's 12th grade math scores were used for imputation.
[1]In this paper we consider Intermediate Algebra to be a developmental course.
[2]Ten observations were dropped from the original sample of 3410 due to missing data.

NELS does not indicate whether a student was referred to developmental education. In order to compare the present analysis to our analysis of the Achieving the Dream data, we estimated the need for developmental education among NELS students using 12th grade standardized math test scores. Specifically, we used an imputation technique (Royston, 2004) to predict whether a student would be in need of developmental instruction in math. We first treated individuals with no math enrollment as if they had missing values for their first-time math courses.[26] A univariate technique based solely on the individuals' 12th grade math test scores was then employed to estimate the course into which they would have been placed had they taken a math course.[27] Given the ordinal nature of the variable, an ordered logit regression was used in the imputation. In order to carry out this analysis, we assumed that students who actually enrolled in developmental and college-level math courses were referred to those courses. We then used the relationship between the 12th grade math score and enrollment in the different math courses to predict, for the 20.3 percent who did not enroll in any math course, which course they would have been referred to given their 12th grade test score. As a result of imputation, the proportions of students in need of pre-collegiate math, basic algebra, and intermediate algebra increase from 25.3, 16.2, and 12.4 percent to 32.4, 21.2, and 15.3 percent, respectively. In other

[26] We created a categorical variable that takes a value of 0 for students in no need of developmental math, 1 for those in need of intermediate algebra, 2 for those in need of basic algebra, and 3 for those in need of pre-collegiate math or arithmetic.
[27] In this study, we used the STATA command "uvis" to impute missing values of the first-time math course variable from complete data in the 12th grade math test score. From implementation, for a given missing value of the categorical variable, the imputed value is selected to minimize the mean absolute difference in the logit of the predicted value probability between the non-missing observation and the target-missing observation. For more detail, consult Royston (2004).

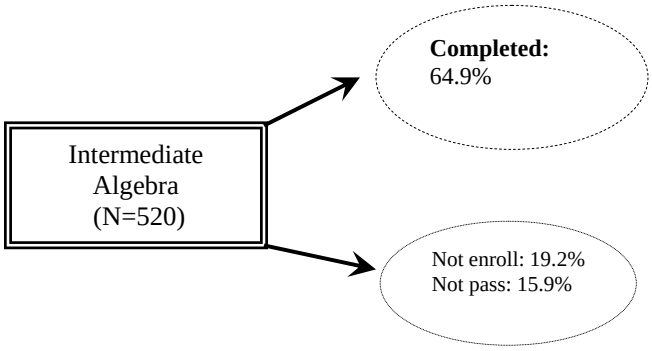
words, 69 percent of community college students in the NELS sample are predicted to have been referred to developmental education in math while only 54 percent actually enrolled.[28] For the Achieving the Dream college students, 59 percent were referred to math developmental education while only 42 percent enrolled.

Figure 7 describes the NELS students' progression through developmental education in math. We first observe that few students whom we estimate to be in need of remediation actually completed their full sequences. For example, only 10.1 percent of those with test scores indicating that they needed pre-collegiate math enrolled in and passed all three courses in the sequence: pre-collegiate math, basic algebra, and intermediate algebra. The corresponding figures are only 23.8 percent for individuals in need of basic algebra and 64.9 for those in need of intermediate algebra. It is not surprising that the greater the developmental need that individuals had, the less likely they are to have completed all developmental education. When aggregating the data across the course levels, we see that only one third of developmental students completed all of their necessary courses in math. This is very close to the same percentage as the corresponding Achieving the Dream students (31 percent). Among those completers, two out of three are reported to have enrolled in and passed at least one college-level math course. As was the case with the Achieving the Dream developmental education completers, the percent of NELS completers who passed a college-level course is similar across the three levels of developmental need: 50.5, 57.7, and 59.2 percent for those with a demonstrated need for pre-collegiate math, basic algebra, and intermediate algebra, respectively. Approximately 28 percent of all developmental education completers (regardless of first enrollment) did not even attempt to take any college-level math courses.

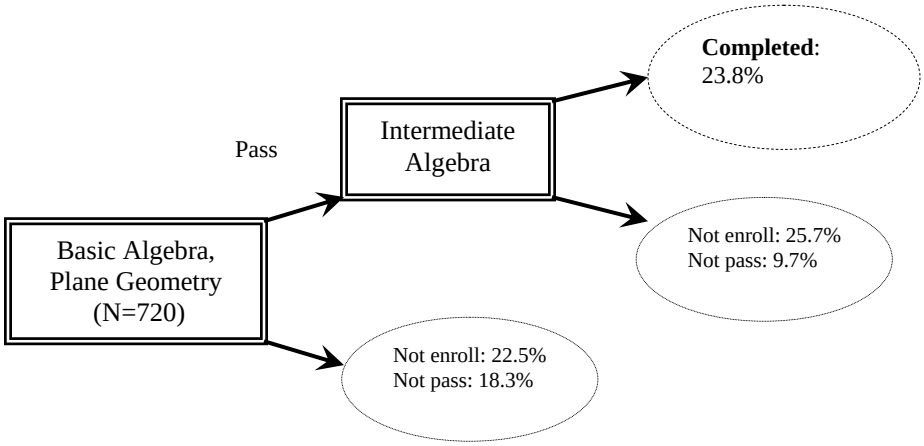
[28] It should be noted that some colleges provide intermediate algebra as remedial while others offer it as college-level.

Figure 7:
In-Order Completion of Developmental Math Courses among NELS Students Estimated to be Referred to Various Levels

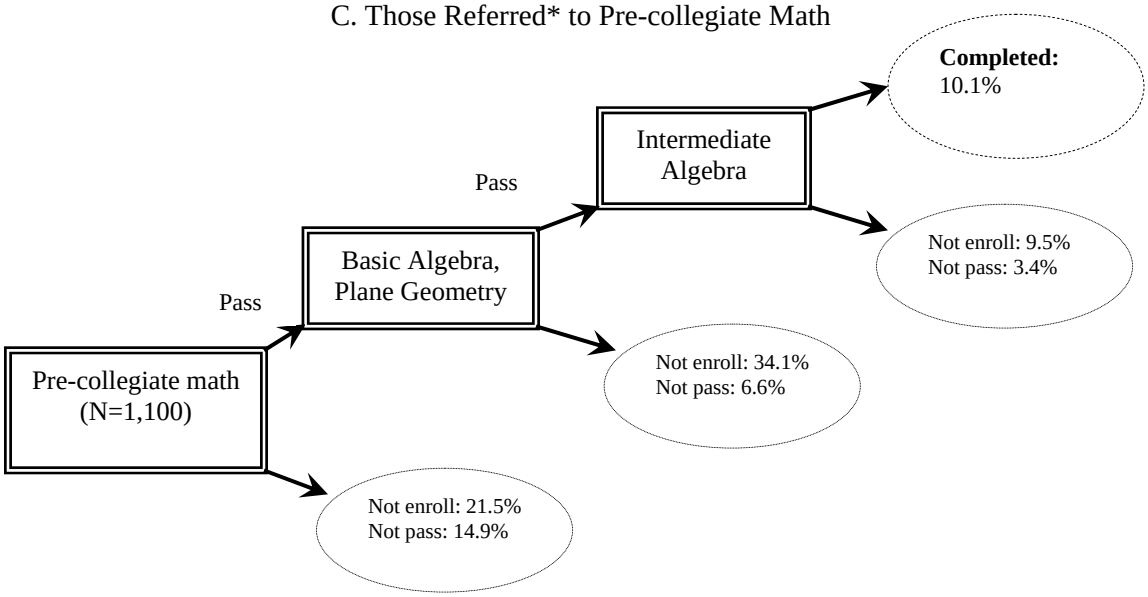
A. Those Referred* to Intermediate Algebra



B. Those Referred* to Basic Algebra, Plane Geometry



C. Those Referred* to Pre-collegiate Math



* For the NELS analysis we estimate these referrals.

As was the case with the Achieving the Dream students, many developmental students in the NELS sample did not finish the first course in their sequence. More than a third of individuals estimated to be in need of pre-collegiate math failed to pass that course. The equivalent numbers are 40.8 percent for students in need of basic algebra and 35.1 percent for those in need of intermediate algebra. More than half of those non-completers never enrolled in the first course of their sequences throughout all of their tracked college years. This is very similar to analogous results from the Achieving the Dream data: 58.0 percent of the students who did not complete their first developmental math course failed to do so because they did not enroll, not because they tried and failed or dropped out. It is again not completing the first remedial course, or the failure to enroll in that first course, that often prevents these students from the possibility of completing their developmental sequences. Even for those who finished the first course in their sequences, many never enrolled in the next level. For example, of those with the greatest developmental need, 63.6 percent enrolled in and passed pre-collegiate math, but almost half of those who passed did not show up for the next course in the sequence, basic algebra. For those in need of basic algebra, the corresponding figures are 59.2 percent who enrolled in and passed that course and 25.7 percent who did not go on to enroll in intermediate algebra. Two out of three of those developmental students who did not complete their full sequences of math courses never actually failed one of those courses. They did not finish their sequences either because they never enrolled in any developmental math course or because they failed to enroll in a subsequent course after having successfully completing the previous course.

In summary, the NELS data confirm the basic story that emerges from the Achieving the Dream analysis: 1) only a minority of students who need developmental education complete their full sequence of developmental courses; 2) many never pass their first developmental course in their sequence, and 3) a majority of those students who do not complete their full sequence of courses fail to do so because they do not enroll in their initial course or a subsequent course, not because they fail or drop out of any of the courses they attempt.

5. The Determinants of Developmental Progression: Multivariate Analysis

In this section, we use the concept of a developmental sequence to analyze the determinants of educational outcomes for remedial students. Our analysis so far has shown that many students drop out of their developmental education sequences. But there is considerable variation in these outcomes among students who are referred to the same remedial level. Can we identify student or institutional characteristics that are related to a higher likelihood of reaching intermediate points in a sequence, of completing the sequence, and of moving successfully into college-level courses?

In the following analysis we supplement the individual-level data from Achieving the Dream with institution-level data from the Achieving the Dream and the IPEDS databases to conduct a multivariate analysis that allows us to differentiate the relationships between individual and institutional factors and student progress through developmental education.

5.1 Empirical model

To simplify our analysis, we used a definition of developmental progression based on the step-by-step character of the remedial sequence. As we illustrated in Figure 1, developmental students are expected to enroll in and pass single or multiple developmental courses depending upon their placement. For those who are referred to the lowest level (three or more levels below college-level) of developmental education, their achieved outcome can be categorized into one of the following four options: 1) Y = 0, those who did not pass the third level (three or more levels below college level); 2) Y = 1, those who passed the third level but did not progress any further; 3) Y = 2, those who passed the second level, but not the first level; and 4) Y = 3, those who completed the entire sequence. The last three outcomes (Y = 1, 2, 3) are observed for those referred to two levels below while the last two (Y = 2, 3) are observed for those referred to one level below.

Compared to a binary definition of developmental education completion, the concept of a sequence allows us to treat non-completers differently depending on where they stop. For example, among individuals referred to three levels below college, those who finished the first course but not the next level (Y = 1) are presumed to be more successful in developmental education than those who did not even finish the first course (Y = 0). Consequently, we use an

ordered logit regression. In this approach the ordinal variable is conceived of as the discrete realizations of an underlying continuous random variable, Y^*, indicating the degree to which the student completed developmental education. The unobservable Y^* can be expressed as a linear function of covariates X: $Y^* = \beta' X + \varepsilon$. The observed categorical variable, Y, is derived from unknown cut-off points ($\alpha_0, \alpha_1, \ldots, \alpha_j$) in the distribution of Y^*: $Y = j$ if $\alpha_{j-1} \leq Y^* < \alpha_j$. Let the probability of Y = j be Prob($Y = j$). Then, the proportional odds model is:

$$\frac{\Pr ob(Y \leq j)}{\Pr ob(Y > j)} = \exp(\alpha_j - \beta' X)$$

where Prob($Y \leq j$) denotes the probability of having at most j^{th} level of developmental completion and Prob($Y > j$) denotes the probability of having above the level j. The parameter β represents the relationship between the covariate and the dependent variable. In this model, the association is assumed not to be the same for every category j. The regression coefficient β_l for a particular explanatory variable is the logarithm of odds ratio for the dependent variable, holding others constant. To simplify the interpretation of the results, we transformed the raw coefficients into odds ratios.

5.2 Empirical specifications

We hypothesized that success in developmental education depends on student demographics, college characteristics, and state-specific effects. Student demographics include gender, race/ethnicity, age at entry, cohort year, intensity of first-term enrollment, major studied, developmental need in other subjects, and socioeconomic background. Gender, race/ethnicity, age, and cohort differences are commonly identified as determinants of postsecondary outcomes (Choy, 2002; Pascarella & Terenzini, 2005). Working while enrolled and attending part time are also associated with lower probability of retention and graduation. Students who major in academic areas including liberal arts are expected to succeed in developmental education at a higher rate than those studying vocational areas. As a measure of pre-college ability, we added a dummy variable indicating whether the student was in need of remediation in other subjects.

We also used college-level variables from IPEDS to account for the influence of institutional characteristics on a student's likelihood of progressing through developmental education. College characteristics include school location, size, proportion of full-time students and minorities, tuition, average amount of federal aid received per FTE, instructional expenditure

per FTE, and certificate orientation. College location, size, and student body demographics are commonly entered as covariates in the literature on student success in college (Bailey, Calcagno, Jenkins, Leinbach, & Kienzl, 2006). For example, students at large and urban colleges serving mainly minorities and economically disadvantaged populations are found to persist and/or graduate at lower rates than their counterparts. We included tuition as a cost of college attendance that is presumed to have a negative relationship with course completion. As a proxy for students' financial need, we entered the amount of financial aid received by students in the college per FTE. College resources devoted to instruction are expected to help students succeed in developmental education. In addition, certificate-oriented colleges may not stress developmental education as much as degree-oriented colleges. To control for certificate orientation, we included a dummy indicating whether the college awarded more certificates than associate degrees. Finally, we introduced into the analysis state-specific fixed effects to control for differences in state policy or funding systems that might influence outcomes for developmental students.

5.3 Results

Table 6 presents summary statistics of the Achieving the Dream college sample by level of developmental education to which they were referred. Regardless of the subject, female, young, Black, and Hispanic students tended to need more levels of developmental education. Full-timers were determined to have less need for developmental education than part-timers. Individuals studying in vocational areas tended to have more need for remediation than those studying in non-vocational areas. It is not surprising that students with a demonstrated developmental need for a particular subject tended to be referred to developmental education in the other subject. Finally, developmental students with greater need were more likely to enroll in colleges that were urban, large, certificate-oriented, and serving high proportions of minority students, particularly Hispanic and economically disadvantaged populations.

Table 6:
Summary Characteristics of Achieving the Dream Students

Variables	Developmental Math Referred To				Developmental Reading Referred To			
	Not referred	1 level below	2 levels below	3+ levels below	Not referred	1 level below	2 levels below	3+ levels below
Student Demographics								
Cohort 2004	0.516	0.503	0.488	0.496	0.501	0.507	0.517	0.531
Female	0.530	0.555	0.580	0.615	0.550	0.576	0.604	0.567
Age	24.98 (9.78)	21.82 (6.57)	22.42 (7.12)	23.34 (7.74)	24.44 (9.15)	21.40 (6.17)	22.26 (7.23)	22.37 (7.13)
White	0.548	0.473	0.473	0.335	0.550	0.374	0.263	0.145
Black	0.141	0.190	0.222	0.179	0.135	0.228	0.309	0.141
Hispanic	0.185	0.244	0.203	0.426	0.215	0.295	0.314	0.588
Other race/ethnicity	0.125	0.093	0.102	0.06	0.101	0.103	0.113	0.126
Full-time study in the 1st term	0.505	0.589	0.577	0.504	0.529	0.576	0.525	0.497
Major studied: vocational	0.349	0.327	0.349	0.312	0.327	0.307	0.343	0.357
Referred to math dev. ed.	0	1	1	1	0.440	0.838	0.871	0.891
Referred to reading dev. ed.	0.123	0.493	0.421	0.59	0	1	1	1
College Characteristics								
Urban (=1)	0.760	0.760	0.853	0.884	0.790	0.758	0.843	0.865
Suburban (=1)	0.184	0.206	0.091	0.075	0.159	0.199	0.096	0.105
Rural (=1)	0.056	0.034	0.056	0.041	0.051	0.043	0.062	0.029
Small: 5,000 or less (=1)	0.259	0.221	0.258	0.245	0.277	0.208	0.264	0.264
Medium: 5,001-10,000 (=1)	0.138	0.112	0.089	0.107	0.133	0.102	0.088	0.173
Large: 10,000 or more (=1)	0.603	0.667	0.653	0.648	0.590	0.690	0.648	0.563
Offer 1 level of dev. ed. (=1)	0.294	0.499	0	0	0.227	0.411	0	0
Offer 2 levels of dev. ed. (=1)	0.258	0.139	0.369	0	0.411	0.337	0.571	0
Offer 3 levels of dev. ed. (=1)	0.448	0.362	0.631	1	0.362	0.252	0.429	1
Percentage of full-time students	22.71 (17.95)	24.49 (17.75)	22.72 (17.99)	26.73 (18.33)	23.72 (17.93)	23.19 (18.31)	21.36 (18.56)	35.55 (10.12)
Percentage of Black students	18.28 (12.77)	17.69 (11.85)	18.36 (11.83)	11.89 (9.36)	16.44 (11.64)	17.16 (11.55)	19.51 (16.28)	9.28 (9.53)
Percentage of Hispanic students	19.47 (18.39)	22.08 (19.60)	17.45 (17.91)	35.71 (26.59)	22.09 (20.40)	23.57 (20.79)	24.33 (24.84)	49.89 (24.14)
Tuition ($1000)	1.70 (0.67)	1.60 (0.55)	1.66 (0.66)	1.28 (0.43)	1.59 (0.61)	1.58 (0.58)	1.73 (0.81)	1.24 (0.25)
Average federal aid received/FTE	2.78 (0.62)	2.64 (0.79)	2.95 (0.40)	3.03 (0.40)	2.82 (0.57)	2.66 (0.80)	2.99 (0.41)	3.01 (0.45)
Instructional expenditure/FTE	3.53 (5.17)	3.21 (2.17)	3.87 (4.99)	3.84 (6.06)	3.55 (4.11)	3.58 (6.78)	3.86 (5.56)	3.57 (0.92)
Certificate-orientation (=1)	0.024	0.029	0.030	0.059	0.033	0.025	0.052	0.084
Observations (N)	97,678	59,551	38,153	43,886	151,597	54,341	16,983	6,825

Note: Standard deviations for continuous variables are in parentheses. Of the 256,672 Achieving the Dream students in the sample, data on developmental math are missing for 42,088 students and on developmental reading for 45,452 students.

Now let us turn to the question of what determines developmental progression. Table 7 shows the results from the ordered logit regression for each group of students referred to a particular level of remediation. We first observe that there are substantial individual-specific differences in developmental progression. Female students tended to have significantly higher odds of progressing through developmental math education than their male counterparts. The results indicate that the odds of females passing to a higher level of developmental education were 1.53 to 1.56 times (depending on the level) as large as the odds for males, holding other factors constant. The corresponding figures for developmental reading range from 1.52 to 1.77. Older students tended to have lower odds of passing to a higher developmental level than their younger counterparts. It is noteworthy that the odds of Black students passing to a higher level of developmental math were 0.67 to 0.96 times the odds of their White peers. The equivalent numbers vary from 0.86 to 1.09 for developmental reading. In contrast, there is no indication that Hispanic students had lower odds of developmental progression than their White peers. We also observe that both the intensity of first-term enrollment (whether the student attends full-time or part-time) and the type of major are related to the odds of developmental progression. The odds of passing to a higher level of developmental math were 1.50 to 1.68 times as large when individuals studied on a full-time basis. These numbers are very similar to those for reading. The results also indicate that the odds of finishing a higher level in developmental math were lower (0.61–0.77) when studying in vocational areas. Individuals with a demonstrated developmental need for reading seem to have had lower odds of progressing through developmental math. In sum, men, Black students, and those attending part time or studying in a vocational area had lower odds of progressing through their developmental sequences. Black students had particularly low odds when they were referred to developmental math at two or three or more levels below college-level. The gender effect is strong throughout the entire sequence for both math and reading, but the negative effect of age applies mostly to reading.

Table 7:
Odds Ratios Estimated from Ordered Logit Regressions for Achieving the Dream Students

Variables	Developmental Math Referred To			Developmental Reading Referred To		
	3+ levels below	2 levels below	1 level below	3+ levels below	2 levels below	1 level below
Cohort 2004	0.966	1.044	0.949	1.297	1.019	1.051
	(0.034)	(0.051)	(0.056)	(0.230)	(0.084)	(0.086)
Female	1.561**	1.535**	1.527**	1.768**	1.706**	1.519**
	(0.063)	(0.088)	(0.069)	(0.176)	(0.057)	(0.071)
Age	0.995	0.996	0.988**	0.976**	0.990*	0.978**
	(0.003)	(0.003)	(0.003)	(0.006)	(0.005)	(0.004)
Black	0.669**	0.753**	0.906	0.864	0.866*	1.105
	(0.027)	(0.050)	(0.059)	(0.118)	(0.058)	(0.068)
Hispanic	1.125	1.196	1.108**	1.048	1.167	1.094
	(0.092)	(0.155)	(0.039)	(0.070)	(0.127)	(0.121)
Other race/ethnicity	1.258**	1.172*	1.277**	1.130	1.249	1.359*
	(0.078)	(0.093)	(0.099)	(0.186)	(0.172)	(0.207)
Fulltime study in the 1st term	1.502**	1.684**	1.681**	1.531**	1.744**	1.672**
	(0.096)	(0.112)	(0.062)	(0.179)	(0.126)	(0.081)
Major studied: vocational	0.609**	0.668**	0.771**	0.710**	0.776**	0.885
	(0.043)	(0.028)	(0.067)	(0.076)	(0.053)	(0.067)
Referred to math/reading dev.	0.764**	0.947	0.921	1.273	0.878	1.094
	(0.041)	(0.085)	(0.074)	(0.308)	(0.089)	(0.165)
Suburban (=1)	0.786	0.550	0.656	0.313	0.778	0.870
	(0.121)	(0.169)	(0.272)	(0.198)	(0.221)	(0.440)
Rural (=1)	0.831	0.989	0.974	0.633	0.607	1.025
	(0.128)	(0.256)	(0.232)	(0.162)	(0.187)	(0.289)
Small: 5,000 or less (=1)	0.768	0.770	0.709	0.433**	0.697	0.783
	(0.142)	(0.191)	(0.141)	(0.029)	(0.129)	(0.191)
Medium: 5,001-10,000 (=1)	0.474**	1.060	1.358	0.518	0.637*	1.163
	(0.067)	(0.249)	(0.429)	(0.273)	(0.131)	(0.381)
Percentage full-time students	0.990	0.980**	0.989	1.012	0.996	0.996
	(0.006)	(0.005)	(0.009)	(0.007)	(0.005)	(0.009)
Percentage Black students	1.010	0.987*	0.990	0.955	0.998	0.974
	(0.011)	(0.006)	(0.008)	(0.025)	(0.005)	(0.016)
Percentage Hispanic students	1.013	1.008*	1.005	0.990	1.009*	0.991
	(0.005)	(0.004)	(0.007)	(0.012)	(0.004)	(0.008)
Tuition (in $1000 units)	0.530*	0.985	0.854	0.395	1.270	0.764
	(0.124)	(0.199)	(0.185)	(0.241)	(0.224)	(0.218)
Average federal aid received / FTE	0.977	0.938	0.954	1.022	0.813	0.822
	(0.159)	(0.104)	(0.091)	(0.173)	(0.093)	(0.098)
Instructional expenditure / FTE	0.997	0.999	1.000	0.746	0.996	1.001
	(0.004)	(0.003)	(0.007)	(0.113)	(0.002)	(0.003)
Certificate-orientation (=1)	0.576	0.470*	0.538	0.736	0.659	0.384**
	(0.201)	(0.168)	(0.183)	(0.119)	(0.189)	(0.137)
Offer 2 levels of dev. ed.		0.721	1.282		0.720	1.710
		(0.185)	(0.460)		(0.141)	(0.688)
Offer 3 levels of dev. ed.			1.089			1.627
			(0.262)			(0.717)
Log likelihood	-42727.39	-36238.18	-47398.89	-8020.23	-15942.93	-32079.64
Chi-Squared	40241.93	6186.68	2918.56	1694.61	10110.64	3790.55
Observations	35189	32151	49865	6762	15504	44749

Note: Standard errors adjusted for college clusters are in parentheses. * Significant at 5 percent, ** significant at 1 percent. State dummies are commonly included in the regressions.

The table also shows that institution-level variables—in particular, college size, student composition, and certificate orientation—are important for developmental progression even after adjusting for individual demographics. The results indicate that the odds of passing to a higher level of math remediation were 0.71 to 0.77 times as large when students attended small colleges. The corresponding figures range from 0.43 to 0.78 for reading. There seem to be similar associations between students at mid-size and large colleges. We also observe that student composition has some influence on the odds of progressing through developmental education. Individuals at institutions serving high proportions of Black and economically disadvantaged students (measured by receipt of federal aid) generally have lower odds of passing to a higher level of remediation than their peers at colleges serving low proportions of this population. Tuition level seems to matter as well, particularly for individuals referred to the lowest levels of developmental education. Lastly, the results indicate that the odds of finishing a higher level of developmental education were lower (0.47–0.58) when students enrolled in certificate-oriented colleges.

5.4 Robustness of the results and limitations of the analysis

Potential analytic problems may derive from the fact that our analysis depends on crude measures of individuals and institutions available in the Achieving the Dream and IPEDS databases. For example, we did not include any measures of individual-level socioeconomic background that are presumed to be important determinants of developmental progression. Fortunately, the Achieving the Dream database includes students' residential ZIP codes, from which we can derive socioeconomic measures from outside sources. Specifically, we exploited the 2000 Census to obtain two ZIP code-level measures of socioeconomic background: neighbors' income and educational attainment. But more than 20 percent of the Achieving the Dream sample had no or incomplete ZIP code information. These observations were therefore dropped from the sample for this analysis. Nonetheless, the results from the ordered logit regressions with the two socioeconomic measures are very similar to those presented in Table 6. As expected, neighborhood income and educational attainment were positively related to the odds of developmental progression.

Another possible problem is related to the assumption that the associations between the independent variables and the dependent variable are constant across the transitions through

developmental levels. This assumption is required for the use of the ordered logit model. A particular covariate may have different relations with developmental progression depending on the transition, category *j*. In order to address this issue, we ran a set of generalized ordered logit regressions, the so-called generalized threshold model (Maddala, 1983), where the odds ratios are allowed to vary across the ordinal categories. We observed some differences in the odds ratios for several variables across the categories; nevertheless, the results for each category are qualitatively similar to those presented in Table 6.

A final specific concern is that the ordered logit model does not take full advantage of the sequential nature of developmental progression. A student's progression toward a high level of remediation is predicated on the student's success in the previous level. We used a sequential response model (Maddala, 1983; Amemiya, 1985) that estimates probabilities of passing different transitions. At each transition, individuals determine whether to drop out or continue developmental education. Basically, the sequential model is analogous to a discrete time hazard rate model in duration analysis that estimates the probability of exit at a particular time conditional on survival. For simplicity, we assumed that the probability of passing a given transition is conditionally independent of passing previous transitions; in other words, all transitions are considered a conditionally independent series of binary processes. The results from the sequential logit regressions suggest that there are some differences in the estimated odds ratios across the transitions, but they are also qualitatively similar to those presented in Table 6.

Lastly, we point out that our multivariate analysis is exploratory, not definitive. It shows the relationships between the covariates and the developmental outcome. It is difficult to make causal inferences from the results due to multiple sample selections at transitions. There may be unobserved individual-specific heterogeneity that is correlated with student success in the previous and current transitions.

6. Conclusion

In this article we have focused attention on the sequence of developmental courses. What does the concept of a sequence help us learn?

First of all, a focus on the sequence makes immediately clear the daunting task confronting many of the nearly two thirds of all community college students who are referred to developmental education at least in one area. Students arriving with weak academic skills can face semesters of work before they can in effect start college—at least in relevant areas. This developmental "obstacle course" presents students with many opportunities to step out of their sequences, and students in large numbers take those opportunities. Between one third and two fifths of students referred to remediation complete their sequences. Among students referred to math remediation three or more levels below college-level—fully one fifth of all students in the more than 250,000 students in the Achieving the Dream sample—only 16 percent completed their math sequences within 3 years, and fewer than 10 percent of that group passed a college-level math course within that period.

Moreover, colleges tend to lose their developmental students early in the sequence. About one half of all students in the sample referred to developmental education failed to finish the first course in their sequence. And failure to complete the first course to which they were referred marked the end of the college experience for many students (at least for the three-year period for which we tracked students). More than one third of all students who did not finish the first developmental course in their sequence never enrolled in a college course in a subsequent semester at their initial college within three years. For students assigned to remediation three or more levels below college-level in both math and reading, the share who never enrolled in another course rises to more than two fifths.

Analysis of developmental sequences also makes clear that many students who exit their sequences do so even though they have passed all of the courses in which they enrolled. More students leave their sequences because they did not enroll either in their first or a subsequent remedial course than because they failed a course in which they were enrolled. This pattern extends into the first college-level course: among developmental completers in the sample, those

who enrolled in a gatekeeper course had a good chance of passing it, but about 30 percent did not enroll in such a course within the three-year period of the study.

Our analyses of the individual and institutional characteristics that are related to successful student progression through developmental education reinforce some conclusions that apply to community college student success in general. We found that men, Black students, occupational students, and students attending part time had a lower probability of progressing through their sequences than women, White students, academic students, and full-time students.[29]

Differentiating between the various transition points within developmental sequences reveals some interesting insights. First, Black students with very weak academic skills—those referred to remediation two or three or more levels below college-level—were particularly at risk of exiting their sequences. Likewise, for those students with very weak math skills, also having weak reading skills was particularly problematic for getting through their first developmental math course. Generally, older students had a lower probability of completing their sequences, but for math, the advantage for younger students only emerges for students referred to the highest-level remedial course. This may indicate that younger students at the higher end of the developmental range may simply need some review to catch up, while older students, who are further away from their high school math experience, may face deeper problems.

Some institutional factors show some relationship to progression at some points in the sequences, but individual characteristics have a stronger relationship to outcomes than do institutional characteristics. The dominance of individual characteristics is also revealed in analyses of community college graduation rates (Calcagno, Bailey, Jenkins, Kienzl, & Leinbach, 2007). Although this seems to suggest that colleges have little effect on developmental outcomes, the institutional variables available from IPEDS for this analysis do not include information on the types of programs and policies such as pedagogic approaches, counseling strategies, or innovative ways of organizing remediation that we would like to have been able to test.

But this analysis of remedial sequences does suggest three broad implications for college practice. First, for one half of students referred to developmental education, colleges are not

[29] We should emphasize that these results indicate relationships between characteristics and developmental outcomes. We have not been able to control for all possible alternative explanations, so the factors that we examine may not be the cause of the outcomes that we observe. Nevertheless, our results stand up under alternative models and specifications and are consistent with the developmental education research literature.

succeeding in getting those students through their developmental sequences and successfully through the first relevant college-level course. Given that, it is not surprising that evaluations find that "developmental education," defined as either having been referred to or having enrolled in any developmental course, has little effect. Colleges are not holding on to students long enough for the remedial "treatment" to have an influence. Given these low completion rates, community colleges in general need to consider fundamental changes in their approaches to remediation—modest improvements will not solve much of the problem.

Second, colleges lose their developmental students early in the sequences, in many cases, before they enroll in the first course. This suggests a need for a major effort to counsel and guide students perhaps even before their initial assessment. Many strategies are now being used to strengthen the early experience of community college students. These include "student success" courses or learning communities for first-year students. Contextualized developmental courses that quickly connect remedial instruction to a student's occupational interests also seem promising. Alternatively, a college might offer students an opportunity to take appropriately designed occupational courses before subjecting them to remedial instruction.

Yet many potential students may become discouraged or lost before they even get a chance to be influenced by first semester initiatives. Policies that reach back to students in high school, such as early warning testing to make clear to students the academic deficiencies that they have, dual enrollment programs to acclimate students to college, and intensive summer pre-college programs to solidify students' commitment to college and to quickly push them past initial roadblocks, all seem like promising programs.

Third, we have emphasized that more students fail to complete developmental sequences because they never enroll in their first or a subsequent course than because they drop out of or fail to pass a course in which they are enrolled. This insight suggests a wide variety of possible approaches. Certainly the types of initiatives suggested above in our discussion of the early and pre-college experience would be helpful here. In addition, perhaps colleges should combine two or three levels of instruction into one longer, more intensive course. At the very least, concerted efforts should be made to encourage students who complete one course in their sequence to go on to the next. This might involve abandoning the semester schedule to prevent gaps between courses, or registering and scheduling students for the next course in a sequence while they are still in the previous course. An additional approach might involve enrolling more upper-level

developmental students directly into college-level courses and using the resources saved by having fewer developmental courses to provide extra help or tutoring or perhaps supplemental instruction in the college-level course.

As it stands now, developmental education sequences must appear confusing, intimidating, and boring to many students entering community colleges. And so far, developmental education has at best shown limited success. But if the nation is to increase its college-educated workforce, it will have to do so by strengthening the skills of the millions of students in community college developmental programs. That progress can only be made if we understand, simplify, and improve the complex developmental sequences that confront so many students.

References

Amemiya, T. (1985). *Advanced econometrics*. Cambridge: Harvard University Press.

Arkansas Department of Higher Education. (n.d.). *2003–04 Arkansas academic cost accounting system: A strategic management tool for higher education planning and campus decision-making.* AR: Author.

Attewell, P., Lavin, D., Domina, T., & Levey, T. (2006). New evidence on college remediation. *Journal of Higher Education*, *77*(5), 886–924.

Bailey, T. (in press). Challenge and opportunity: Rethinking the role and function of developmental education in community college. *New Directions for Community Colleges.*

Bailey, T., & Alfonso, M. (2005). *Paths to persistence: An analysis of research on program effectiveness at community colleges*. Indianapolis: Lumina Foundation for Education.

Bailey, T., Calcagno, J. C., Jenkins, D., Leinbach, T., & Kienzl, G. (2006). Is Student-Right-To-Know all you should know? An analysis of community college graduation rates. *Research in Higher Education*, *47*(5), 491–519.

Bettinger, E., & Long, B. (2005). *Addressing the needs of under-prepared college students: Does college remediation work?* (NBER Working Paper No. 11325). Cambridge, MA: National Bureau of Economic Research.

Boylan, H. (2002). *What works: A guide to research-based best practices in developmental education.* Boone, NC: Appalachian State University, Continuous Quality Improvement Network with the National Center for Developmental Education.

Breneman, D. W., & Haarlow, W. N. (1998). Remedial education: Costs and consequences. *Fordham Report*, *2*(9), 1–22.

Calcagno, J. C. (2007). *Evaluating the impact of developmental education in community colleges: A quasi-experimental regression-discontinuity design*. Unpublished doctoral dissertation, Columbia University, Teachers College, New York.

Calcagno, J. C., Bailey, T., Jenkins, D., Kienzl, G. and Leinbach, T. (2007). Community college student success: What institutional characteristics make a difference. *Economics of Education Review* (in press), available at doi:10.1016/j.econedurev.2007.07.003.

Calcagno, J. C., & Long, B. (2008). *The impact of postsecondary remediation using a regression discontinuity approach: Addressing endogenous sorting and noncompliance* (NCPR Working Paper). New York: National Center for Postsecondary Research.

Choy, S. P. (2002). *Access and persistence: Findings from 10 years of longitudinal research on students.* Washington, DC: American Council on Education, Center for Policy Analysis.

Deil-Amen, R., & Rosenbaum, J. (2002). The unintended consequences of stigma-free remediation. *Sociology of Education*, *75*(3), 249–268.

Florida Office of Program Policy Analysis and Government Accountability. (2006). *Steps can be taken to reduce remediation rates; 78% of community college students, 10% of university students need remediation* (OPPAGA Report No. 06-40). FL: Author.

Grubb, N. (2001). *From black box to Pandora's box: Evaluating remedial/developmental education*. New York: Columbia University, Teachers College, Community College Research Center.

Horn, L., & Nevill, S. (2006). *Profile of undergraduates in U.S. postsecondary education institutions: 2003–04: With a special analysis of community college students* (NCES 2006-184). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Levin, H. & Calcagno, J. C. (2008). Remediation in the community college: An evaluator's perspective, *Community College Review, 35*(3),181-207.

Maddala, G. (1983). *Limited dependent and qualitative variables in econometrics*. Cambridge, MA: Cambridge University Press.

Martorell, P., & McFarlin, I. (2007). *Help or hindrance? The effects of college remediation on academic and labor market outcomes.* Unpublished manuscript.

McCabe, R. (2006). *No one to waste: A report to public decision makers and community college leaders*. Washington, DC: American Association of Community Colleges.

National Center for Education Statistics. (2003). *National Education Longitudinal Study: 1988-2000 Data files and electronic codebook system. Base year through fourth follow-up ECB/CD-ROM*. Washington, DC: U.S. Department of Education, Institute of Education Sciences.

Ohio Board of Regents. (2006). *Costs and consequences of remedial course enrollment in Ohio public higher education: Six-year outcomes for fall 1998 cohort*. OH: Author.

Parsad, B., Lewis, L., & Greene, B. (2003). *Remedial education at degree-granting postsecondary institutions in fall 2000* (NCES 2004-010). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Pascarella, E. T., & Terenzini, P. T. (2005). *How college affects students,* Vol. 2*: A third decade of research*. San Francisco: Jossey-Bass.

Perin, D. (2006). Can community colleges protect both access and standards? The problem of remediation. *Teachers College Record, 108*(3), 339–373.

Perin, D., & Charron, K. (2006). “Lights just click on every day.” In T. Bailey & V. S. Morest (Eds.), *Defending the community college equity agenda* (pp. 155–194). Baltimore: The Johns Hopkins University Press.

Rosenbaum, J. (2001). *Beyond college for all.* New York: Russell Sage Foundation.

Royston, P. (2004). Multiple imputation of missing values. *Stata Journal, 4*(3), 227–241.

Snyder, T. D., Tan, A. G., & Hoffman, C. M. (2006). *Digest of education statistics 2005* (NCES 2006-030). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Strong American Schools. (2008). *Diploma to Nowhere.* Retrieved October 8, 2008, from http://www.edin08.com/