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Preparing the Underprepared: An Analysis of Racial Disparities in Postsecondary Mathematics Remediation

Introduction

It would be difficult to overestimate the pivotal role of postsecondary remediation for higher education in the U.S. (Astin, 1998; Levin & Calcagno, 2008). As discussed in detail by Bahr (2008a), taking into account the importance of educational attainment as a predictor of socioeconomic outcomes (Kerckhoff, Raudenbush, & Glennie, 2001), remedial coursework represents a lifeline in the ascent to financial and social-structural stability for individuals who face significant deficiencies in foundational subjects (Day & McCabe, 1997; Roueche & Roueche, 1999). In fact, remediation is distinctive in higher education because, rather than sifting and sorting individuals into strata of attainment (Spring, 1976), it aims to equalize attainment between advantaged and disadvantaged groups (Roueche, Roueche, & Ely, 2001). As Bahr (2008a) explained, "remediation is, by definition, a 'remedy' intended to restore opportunity to those who otherwise may be relegated to meager wages, poor working conditions, and other consequences of socioeconomic marginalization" (p. 422).

In light of this objective, one would hope that students of historically disadvantaged and advantaged groups would benefit equally

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from remediation, advancing up to college-level proficiency in core subjects at comparable rates. Yet, this is not the case. As will be shown here, rates of successful remediation in math—the subject in which the greatest number of students require assistance (Parsad, Lewis, & Greene, 2003)—differ substantially by race. Groups that tend to be disadvantaged in math achievement generally, namely Blacks and Hispanics, also experience low rates of successful remediation.

In this study, I first quantify the racial gap in successful remediation in math, using data that address a population of first-time freshmen. I then use nested hierarchical logistic regression to test the relative and cumulative contribution to these observed racial disparities of five potential mediating variables. In addition, I test the moderating effect of college racial composition on the likelihood of successful remediation. Finally, I use hierarchical multinomial logistic regression to test the relative efficacy of remediation across racial groups.

Background

The ambiguous nature of the phrase *socioeconomic status* (SES) reminds us that the processes by which rewards are distributed in society are multidimensional and multistaged. Central to these processes are the intertwining threads of education, occupation, income, and prestige (Hauser & Warren, 1997). Educational attainment, in particular, is a powerful predictor of socioeconomic outcomes (Warren, Hauser, & Sheridan, 2002) as the formal educational system in the U.S. acts as a "sorting machine" with respect to status attainment (Spring, 1976). Stated broadly, educational credentials form a principal basis by which occupational attainment is determined, and occupational attainment is the primary determinant of income, prestige, and other characteristics of specific stratum of the socioeconomic hierarchy (Kerckhoff, 2001).

Overrepresented in the lower strata of the socioeconomic hierarchy are several historically disadvantaged racial groups, particularly Blacks and Hispanics, for whom education is a primary means of status advancement (Bailey & Morest, 2006; Kerckhoff et al., 2001). The recent 55th anniversary of the U.S. Supreme Court decision in *Brown v. Board of Education* (347 U.S. 483) highlights the importance of educational equity for rectifying longstanding racial disparities in attainment. Yet, while many gains have been made, the achievement of Blacks and Hispanics still lags behind that of Whites (Kao & Thompson, 2003).

The educational progression involves many junctures at which inequality is introduced or perpetuated. One stage of the educational sorting process that has received comparatively little empirical attention is

postsecondary remediation, commonly referred to as *developmental* or *basic skills* education (Murray, 2008; Tomlinson, 1989). As has been discussed in detail elsewhere (Bahr, 2007, 2008a), postsecondary remediation has essentially two broad objectives. The first objective is to provide the minimum levels of reading, writing, and math skills deemed essential for functional participation in a democratic society and individual sustainability in a free economy (Day & McCabe, 1997; McCabe, 2003; Phipps, 1998; Roueche et al., 2001). The second objective, which follows from the first, is to open the door to educational and economic advancement by resolving deficiencies that obstruct access to postsecondary credentials (McCusker, 1999; Tomlinson, 1989). Given the obvious impracticality of sending adults back to high school to acquire requisite skills, remediation is an indispensable bridge to postsecondary credentials over the chasm of inadequate preparation (Roberts, 1986).

The scope of remediation is as notable as its function is critical. Nationwide, nearly three in ten first-time freshmen (28%) enrolled in remedial coursework during the fall of 2000 (Parsad et al., 2003, p. 18). Nearly one in four (22%) enrolled in remedial math, while 14% enrolled in remedial writing and 11% in remedial reading. Adelman estimates that 41% of students enroll in remedial coursework at some point (2004a, p. 92), that 34% of "nonincidental" students earn credits in remedial math (2004b, p. 82), and that 18% of "nonincidental" students earn credits in remedial writing (2004b, p. 83).[1] Although comparable data that address remedial reading were not available, overall 11% of students enroll in remedial reading at some point (2004a, p. 92). Hence, it is clear that remediation plays a prominent role in higher education, and that math is the most common area of remedial need (Murray, 2008).

While Whites constitute the bulk of remedial students in an absolute sense (McCabe, 2000), Black and Hispanic students exhibit a disproportionate need for remediation. Adelman (2004a, p. 93) estimates that 62% of Blacks and 63% of Hispanics enroll in remedial coursework, compared to 36% of Whites and 38% of Asians. Concerning remedial math specifically, 46% of "nonincidental" Black students and 51% of "nonincidental" Hispanic students earn credits in remedial math, compared to 31% of Whites and 29% of Asians (Adelman, 2004b, p. 90). Consistent with these observations, a pronounced and persistent disadvantage in math achievement has been identified for Blacks and Hispanics, beginning as early as kindergarten and continuing through twelfth grade (Bali & Alvarez, 2003; Braswell, Lutkus, Grigg, Santapau, Tay-Lim, & Johnson, 2001; Farkas, 2003; Fryer & Levitt, 2004; Kao & Thompson, 2003; Riegle-Crumb, 2006). This disadvantage accrues such that, by the end of

12th grade, only 25% of Blacks and 20% of Hispanics are prepared for college-level math, compared with 39% of Whites (Rose & Betts, 2001, p. 12).

In addition to sizeable disparities in the need for remedial math assistance, the limited prior research on the topic suggests that Black and Hispanic students do not benefit as much from remediation as do Whites. For example, Dumont & Jones (1983) observed that Black students experience a disadvantage in the likelihood of completing remedial math courses. Likewise, Hagedorn and her colleagues (1999), while not addressing the possibility of a direct effect of race, identified a significant indirect disadvantage in math achievement among Black and Hispanic remedial math students. Thus, despite the importance of (and great need for) remediation in math, prior work suggests that the rewards of remedial math programs are not shared equally by all racial groups.

This Study

In this study, I explore racial differences in one particular remedial outcome, namely successful remediation in math, defined as the receipt of a passing grade in a college-level math course (Bahr, 2007; Boylan & Saxon, 1999). I focus specifically on remediation in community colleges because these institutions constitute the principal venue in which remediation occurs (Adelman, 2004b; Day & McCabe, 1997; Parsad et al., 2003; Perin & Charron, 2006).

At the outset, it is clear that any racial disparities in mathematics preparation and achievement may be attributed to a number of well-documented expressions of socioeconomic inequality, such as academic tracking, lower levels of parental capital, and the poorer quality of primary and secondary schools in neighborhoods characterized by a high percentage of minorities (e.g., Brayboy, Castagno, & Maughan, 2007; Condron & Roscigno, 2003; Darling-Hammond, 1995; Kao & Thompson, 2003; Lucas & Good, 2001; Orr, 2003; Roscigno, 1998). Thus, race itself is not a *cause* of the disparities; rather, it is the many correlated facets of inequality that lead to lower preparation and achievement among historically disadvantaged racial groups.

However, socioeconomic inequality, as a distal cause, does not lend itself readily to intervention in the postsecondary institution, a critical juncture at which to leverage change in educational inequalities (Hallinan, 2001). Generally speaking, only the proximal causes, or mediating mechanisms, of disparate educational outcomes are accessible to intervention in the postsecondary institution. Consequently, illumination of

the mechanisms that mediate the relationship between race and remedial outcomes would expand our understanding of the process of remediation and facilitate timely institutional intervention.

Here, I test a number of potential mediating mechanisms of racial differences in the likelihood of successful remediation, including depth and breadth of remedial need, performance in first math, academic goal, and enrollment patterns. In addition, I test the moderating effect of racial context. Prior findings concerning racial context, which are summarized by Bahr (2008b), suggest that institutions that have high concentrations of minority students tend to offer more supportive environments to students of disadvantaged racial groups than do institutions that have low concentrations of minority students (Chavous, Harris, Rivas, Helaire, & Green, 2004; Fries-Britt & Turner, 2002; Hagedorn, Chi, Cepeda, & McLain, 2007; Pascarella & Terenzini, 2005), although findings on this point are not entirely conclusive (e.g., Pascarella, Smart, & Stoecker, 1989; Wassmer, Moore, & Shulock, 2004). Finally, I test the relative efficacy of remediation across racial groups. The findings of the few recent, large-scale, multi-institutional tests of the efficacy of remediation indicate that skill-deficient students who remediate successfully experience academic outcomes that are comparable to those of students who are college-prepared (e.g., Attewell, Lavin, Domina, & Levey, 2006; Bahr, 2008a, 2010; Bettinger & Long, 2004). However, it remains to be determined if the efficacy of remediation holds across various important subgroups of students. As it pertains to this study, I seek to determine whether the major racial/ethnic groups reap similar benefits from remediating in math.

Data & Methods

Data

I employ data collected by the Chancellor's Office of California Community Colleges. The Chancellor's Office collects data each term from all of the community colleges in California. These data constitute a census of California's community college students and include transcripts, demographics, financial aid awards, credential awards, and a variety of other information. In addition, the database is cross-referenced against the enrollment records of all California public four-year postsecondary institutions and the National Student Clearinghouse database in order to identify students who transferred to public and private four-year institutions, both in-state and out-of-state (Bahr, Hom, & Perry, 2005). These data have been utilized in a number of prior studies that address postsecondary remediation either directly or indirectly (e.g., Bahr, 2007, 2008a, 2008b, 2009b).

I selected for this analysis the fall 1995 cohort of first-time college freshmen who enrolled in any of California's 104 semester-based community colleges ($N = 167{,}982$).[2] I observed the records of these students across *all* semester-based colleges (regardless of the first institution of attendance) for six years, through the spring term of 2001, and retained those whose first nonvocational math course was remedial in nature ($N = 70{,}078$).[3] Of these, I retained the students of the four most numerous racial groups—White, Black, Hispanic, and Asian—who constitute 91.6% of this subset ($N = 64{,}170$). I then dropped the 1.6% of students whose records were missing valid data on sex, age, or the tracking ID variable, resulting in a final analytical cohort of 63,147 students. Finally, in 2003, I refreshed the data with information concerning credential awards and transfers to four-year institutions through the spring term of 2003.

Dependent Variables

Remediation in math is structured around a series of courses of successively greater skill that lead up to the minimum expected skill of new college freshmen. To categorize math courses in these data, I used course catalogs to determine the skill-level of each math course (both credit and non-credit) in which any member of the first-time freshmen cohort enrolled at any time during the observation period. I then collapsed these math courses into five categories: basic arithmetic, pre-algebra, beginning algebra, intermediate algebra/geometry, and college-level math, the latter of which includes all math courses of a skill-level equal to, or greater than, college algebra. I ignored nonsubstantive math courses (e.g., math labs) and vocational math, except when a given vocational course was part of the remedial sequence or otherwise categorized as college-level.

The goal of remediation is realized when a student, beginning with a course that is appropriate to his or her level of preparation, navigates the sequence of increasingly advanced courses and completes a college-level course in that subject. Hence, the first outcome of interest is the attainment of college-level math skill, defined as the successful completion (A, B, C, D, or Credit) of a college-level math course within six years of first enrollment.

In addition, I test the relative efficacy of remediation across racial subcategories. Although a variety of dependent variables have been employed in tests of the efficacy of remediation (for a detailed discussion, see Bahr, 2008a), one of the most robust is students' long-term attainment (Grubb, 2001). Within the context of the community college, two expressions of attainment are readily measurable: the award of a creden-

tial and transfer to a four-year institution. Likewise, two categories of credentials are available: associate degrees and certificates, of which the former typically is considered a higher-level credential than is the latter. When combined with the possibility of transfer, a five-category nominal measure of attainment may be derived. This measure indicates the highest credential earned (if any) by a student and whether or not the student transferred to a four-year institution. The five categories of this measure are as follows: no credential and no transfer, terminal certificate, terminal associate's degree with or without a certificate, upward transfer without a credential, and upward transfer with a credential.

Independent Variables

I consider five potential mediators of the relationship between race and successful remediation, including degree of math deficiency, level of English competency (a key measure of *breadth* of remedial need), performance in first math, student's primary academic goal, and student's enrollment patterns. Both math deficiency and English competency are set to the skill-level of a student's first course in that subject, and each is treated as a set of dummy variables. English courses were categorized in a process similar to that of math. In particular, I collapsed English courses into five categories: remedial reading, remedial writing, English-as-a-Second-Language (ESL), college-level English, and no English coursework.

Of the three remaining mediators, academic goal is a self-reported measure of a student's primary objective, collected at the time of application, which I collapsed into ten nominal categories and which I treated as a set of dummy variables. Likewise, grade in first math course includes ten nominal attributes and is treated as a set of dummy variables. Finally, the set of variables that measure aspects of enrollment patterns includes persistence, enrollment inconsistency, and delay of first math (i.e., math procrastination), all of which are treated as continuous and centered on their respective grand means. Persistence is operationalized as the number of terms (including summer terms, but excluding winter intersessions) in which a student enrolled in courses from fall 1995 through spring 2001. Enrollment inconsistency is operationalized as the percentage of terms in which a given student did not enroll in courses from fall 1995 through the last term that the student was observed in the system. Delay of first math is operationalized as the term number of first math enrollment (e.g., *fall 1995* = 1; *spring 2001* = 17).

While all of the potential mediating variables are measured at the student-level, the moderating variables are measured at the level of the college. Specifically, I include three variables that address the percentage

(logged to approximate normality) of the fall 1995 first-time freshmen cohort at a given college who are Black, Hispanic, and Asian, respectively.

Additionally, I incorporate five student-level controls and four college-level controls. The student-level controls include a dummy variable for sex, age at college entry (centered on the grand mean), and three variables that, taken together, serve as proxies of SES (Calcagno, Crosta, Bailey, & Jenkins, 2007; Koski & Levin, 1998): a dummy variable that indicates receipt of a fee waiver during the first year, a dummy variable that indicates receipt of any grants during the first year, and a continuous variable that indicates the total value of any grants received during the first year (grand mean centered). Among the four college-level controls, I include an indicator of the average SES of the student body: the percentage of first-time freshman who received a fee waiver in the first year of attendance. I also include three measures of the goal orientation of the student body: the percentage of first-time freshmen who indicated a primary objective of transfer, an academic associate's degree, or a vocational credential, respectively.[4]

Methods of Analysis

I used nested two-level hierarchical logistic regression (Raudenbush & Bryk, 2002) to analyze natural variation in the probability of remediating successfully in math within six years of initial enrollment. In total, I estimated eight nested models that are specified as follows.

$$\ln\left(\frac{P_{ij}}{1-P_{ij}}\right) = \beta_{0j} + \beta_{1j}(Black)_{ij} + \beta_{2j}(Hispanic)_{ij} + \beta_{3j}(Asian)_{ij} + \beta_{kj}(Student\ Level\ Variables)_{ij}$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\%Black)_j + \gamma_{02}(\%Hispanic)_j + \gamma_{03}(\%Asian)_j + \gamma_{0m}(College\ Level\ Variables)_j + \varepsilon_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\%Black)_j + \varepsilon_{1j}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}(\%Hispanic)_j + \varepsilon_{2j}$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}(\%Asian)_j + \varepsilon_{3j}$$

$$\beta_{kj} = \gamma_{k0} + \varepsilon_{kj}$$

A related model is used to test the relative efficacy of remediation across racial groups. Specifically, I use two-level hierarchical multinomial logistic regression (Raudenbush & Bryk, 2002) to analyze natural variation in the probability of each of the five categories of attainment detailed earlier. Although the outcome differs, the model is comparably

specified, except that a dichotomous indicator of successful remediation in math and three multiplicative interactions of race and successful remediation are added to the student-level equation.

Analysis

Exploring the Relationship between Race and Remediation

The ameliorative objectives of remediation imply that rates of successful remediation should be equal across categories of race, but prior research gives reasons to suspect otherwise. To explore this incongruity, I present in Table 1 a series of bivariate analyses of the likelihood of remediating in math by race and selected student-level variables. In Table 2, I present bivariate analyses of the distribution of selected student-level variables across categories of race. Together, these tables facilitate a preliminary investigation of some of the relationships of interest here.

TABLE 1

Frequency Distributions of Selected Student-Level Variables and Bivariate Analyses of the Likelihood of Remediating Successfully in Math within Six Years of First Enrollment ($N_{students}$ = 63,147)

	N	% of Cohort	% Remediated
Race			
White	28,890	45.75	28.99
Black	6,840	10.83	11.75
Hispanic	21,255	33.66	20.28
Asian	6,162	9.76	33.69
Math Deficiency			
Intermediate algebra/geometry	13,509	21.39	50.31
Beginning algebra	23,796	37.68	26.52
Pre-algebra	10,382	16.44	13.44
Basic arithmetic	15,460	24.48	6.88
English Competency			
College-level English	16,215	25.68	39.81
Remedial writing	30,234	47.88	22.97
Remedial reading	4,476	7.09	15.19
English-as-a-second-language	5,472	8.67	24.31
No English	6,750	10.69	2.31
Academic Goal			
Transfer	12,672	20.07	37.30
Transfer + AS/AA	26,808	42.45	27.76
AS/AA	4,255	6.74	12.69
Vocational AS/AA	1,891	2.99	9.57
Vocational certificate	1,247	1.97	9.46
Other job-related	5,268	8.34	10.59

TABLE 1 (*Continued*)

Frequency Distributions of Selected Student-Level Variables and Bivariate Analyses of the Likelihood of Remediating Successfully in Math within Six Years of First Enrollment ($N_{students}$ = 63,147)

	N	% of Cohort	% Remediated
Abstract	2,914	4.61	20.62
Remediation	1,538	2.44	10.27
Undecided	6,038	9.56	19.03
Not reported	516	0.82	17.44
First Math Grade			
A	8,321	13.18	43.80
B	9,275	14.69	40.83
C	9,876	15.64	34.53
D	4,533	7.18	23.27
F	7,675	12.15	11.77
Withdrawal	15,739	24.92	11.24
Credit	3,463	5.48	17.27
No credit	1,823	2.89	7.08
Ungraded/unreported	2,442	3.87	11.02
Persistence (Terms Enrolled)			
1–2	9,699	15.36	0.74
3–5	16,326	25.85	6.95
6–8	16,137	25.55	30.76
9–11	12,878	20.39	43.35
12–14	6,742	10.68	46.62
15–17	1,365	2.16	49.01
Enrollment Inconsistency (%)			
< 20.1	22,275	35.27	29.52
20.1–40.0	21,017	33.28	31.18
40.1–60.0	12,287	19.46	17.27
60.1–80.0	6,270	9.93	4.75
> 80.0	1,298	2.06	1.23
Delay of First Math			
Fall 95–Spring 96	45,322	71.77	26.27
Summer 96–Spring 97	9,022	14.29	25.37
Summer 97–Spring 98	3,951	6.26	20.40
Summer 98–Spring 99	2,280	3.61	16.45
Summer 99–Spring 00	1,463	2.32	10.32
Summer 00–Spring 01	1,109	1.76	3.43

Note. Chi-square tests of independence indicate statistically significant relationships ($p \leq 0.001$) between the likelihood of sccessful remediation in math and each of the independent variables noted in the table above.

TABLE 2

Distributions (Percentages and Means) of Selected Student-Level Variables by Race ($N_{students}$ = 63,147)

	White	Black	Hispanic	Asian
Math Deficiency				
Intermediate algebra/geometry	25.97%	11.46%	14.96%	33.12%
Beginning algebra	40.89%	30.54%	35.50%	38.10%
Pre-algebra	15.76%	17.25%	18.57%	11.41%
Basic arithmetic	17.38%	40.75%	30.97%	17.36%
English Competency				
College-level English	36.43%	17.84%	17.43%	12.40%
Remedial writing	42.21%	54.88%	56.99%	34.25%
Remedial reading	5.68%	10.09%	8.41%	5.79%
English-as-a-second-language	3.85%	2.08%	7.86%	41.35%
No English	11.83%	15.12%	9.31%	5.21%
Academic Goal				
Transfer	21.55%	16.49%	18.19%	23.58%
Transfer + AS/AA	44.58%	43.89%	39.97%	39.47%
AS/AA	6.52%	7.03%	6.94%	6.70%
Vocational AS/AA	2.70%	2.95%	3.30%	3.36%
Vocational certificate	1.92%	1.87%	1.94%	2.48%
Other job-related	6.60%	12.47%	10.23%	5.44%
Abstract	4.52%	3.98%	5.33%	3.28%
Remediation	1.60%	3.63%	2.64%	4.33%
Undecided	9.17%	7.16%	10.60%	10.50%
Not reported	0.85%	0.53%	0.86%	0.86%
First Math Grade				
A	15.34%	6.64%	9.91%	21.58%
B	16.19%	9.52%	13.52%	17.41%
C	16.01%	12.56%	16.26%	15.17%
D	7.27%	6.92%	7.40%	6.28%
F	11.83%	13.96%	12.99%	8.80%
Withdrawal	23.20%	34.30%	25.96%	19.02%
Credit	4.72%	5.56%	6.25%	6.31%
No credit	2.16%	3.54%	3.82%	2.32%
Ungraded/unreported	3.27%	7.02%	3.88%	3.10%
Persistence				
Mean number of enrolled terms	6.607	5.866	7.030	7.736
Enrollment Inconsistency				
Mean % of nonenrolled terms	31.466	32.709	31.298	24.981
Delay of First Math				
Mean term of first math	2.873	3.049	3.029	2.728

Note. Chi-square tests of independence indicate statistically significant relationships ($p \leq 0.001$) between race and math deficiency, English competency, academic goal, and first math grade. Likewise, one-way analysis of variance indicates statistically significant relationships ($p \leq 0.001$) between race and persistence, enrollment inconsistency, and delay of first math. For each of the first four independent variables (i.e., math deficiency, English competency, academic goal, first math grade), each racial column sums to 100%.

Large and statistically significant racial differences in the likelihood of remediating successfully are evident in Table 1 ($\chi^2 = 1394$; $p < 0.001$). Specifically, the odds of remediating for White students are 3.1 times the odds for Black students and 1.6 times that of Hispanic students. The odds of remediating for Asian students are 1.2 times the odds for White students, which is consistent with prior findings of a generalized Asian advantage in math (Kao & Thompson, 2003; Rose & Betts, 2001). Overall, rates of successful remediation are quite low: less than one student in four (24.6%) completed a college-level math course successfully within six years of first enrollment.[5]

Rates of successful remediation also vary significantly by all of the mediating variables, and statistically significant differences are observed in the distributions of these mediating variables across categories of race. Generally speaking, the relationships presented in Tables 1 and 2 are consistent with expectations concerning the mediating role of the proposed intervening variables. For example, math skill deficiency at college entry is strongly related to the likelihood of successful remediation, and substantial differences in initial math skill deficiency are observed across the categories of race. To illustrate, slightly more than half (50.3%) of students who entered college at the highest level of remedial math skill (intermediate algebra or geometry) remediated successfully, compared with about one in fifteen students (6.9%) who entered college at the lowest level of remedial math skill (arithmetic). In turn, more than one-quarter (26.0%) of White students entered college at the highest level remedial math skill, compared with about one in nine Black students (11.5%) and one in seven Hispanic students (15.0%). In contrast, slightly more than one in six White students (17.4%) entered college at the lowest level of remedial math skill, while about two-fifths (40.8%) of Black students and one-third (31.0%) of Hispanic students did so. Thus, one may surmise from these observations that degree of math deficiency at college entry likely contributes strongly to racial differences in successful remediation.

The relationships between race, performance in first math, and successful remediation are similarly strong. For example, more than two-fifths (43.8%) of students who achieved a grade of *A* in their first math course went on to remediate successfully, while less than one-eighth of students who achieved a grade of F, or who withdrew, remediated successfully (11.8% and 11.2%, respectively). In turn, White students were more than twice as likely as were Black students to achieve a grade of A (15.3% vs. 6.6%), while Black students were nearly 1.4 times as likely as White students to achieve a grade of F or to withdraw (48.3% vs. 35.0%). Accordingly, one may anticipate that performance in first math, like degree of math deficiency, contributes strongly to racial differences in successful remediation.

However, two exceptions regarding the mediating variables must be noted. First, Asians exhibit the highest rate of remediation, yet they also exhibit the highest rate of enrollment in ESL coursework, which suggests that Asians are excelling in math despite average disadvantages in English. Second, although persistence is associated positively with successful remediation, Hispanics exhibit greater average persistence than do Whites but a lower rate of successful remediation.

Towards Explaining the Racial Gaps in Successful Remediation

I present in Table 3 the estimated net effects of race on the likelihood of successful remediation across a series of nested two-level hierarchical logistic regression models. Two variables emerge as particularly important mediators of the Black-White disparity in successful remediation, namely math skill deficiency and grade in first math. To elaborate, in the baseline model (Model 0) the odds of remediating are 154% greater for Whites than for Blacks. This differential changes little in Model 1 and 2. However, with the introduction of math skill deficiency in Model 3, the White advantage decreases markedly to 105%. Similarly, with the introduction of first math grade, the White advantage declines from 91% (Model 5) to 49% (Model 6). Average differences in English competency (Model 4) contribute modestly to the Black-White differential, while differences in goals (Model 5) and enrollment patterns (Model 7) appear to be effectively inconsequential.

The Hispanic-White disparity follows a somewhat comparable pattern to that of the Black-White disparity. Math skill deficiency (Model 3) and first math grade (Model 6) contribute strongly to the Hispanic-White disparity. Similarly, as with the Black-White gap, the contribution of average differences in English competency (Model 4) is small, and the contribution of differences in goals (Model 5) is trivial. However, unlike the Black-White disparity, controlling for enrollment patterns (Model 7) increases the Hispanic-White gap from zero to a 20% advantage for Whites in the odds of successful remediation. This latter finding, while inconsistent with the pattern observed for the Black-White differential, is consistent with the earlier observation that Hispanics remediate at a lower rate than one would anticipate given their superior average persistence (Tables 1 and 2).

The Asian-White disparity follows a similar pattern. Controlling for math deficiency (Model 3) and first math grade (Model 6) reduces the Asian advantage. This advantage increases slightly with the introduction of English competency (Model 4), which is consistent with the earlier observation than Asians remediate at a higher rate than one would anticipate given their lower average English competency. Controlling for

TABLE 3

Net Racial Differences in the Likelihood of Successful Remediation in Math, as Estimated via Two-Level Hierarchical Logistic Regression ($N_{students}$ = 63,147; $N_{colleges}$ = 104)

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Coefficients[a]								
Black (vs. White)	–0.931***	–0.946***	–0.925***	–0.720***	–0.631***	–0.648***	–0.402***	–0.399***
	(0.057)	(0.064)	(0.064)	(0.063)	(0.065)	(0.065)	(0.067)	(0.077)
Hispanic (vs. White)	–0.365***	–0.345***	–0.360***	–0.172***	–0.124***	–0.111**	0.005	–0.182***
	(0.035)	(0.035)	(0.035)	(0.036)	(0.037)	(0.036)	(0.037)	(0.042)
Asian (vs. White)	0.317***	0.288***	0.306***	0.099	0.143*	0.131*	0.029	–0.152*
	(0.050)	(0.058)	(0.059)	(0.060)	(0.057)	(0.058)	(0.059)	(0.062)
Odds Ratios[b]								
White vs. Black	2.54	2.58	2.52	2.05	1.88	1.91	1.49	1.49
White vs. Hispanic	1.44	1.41	1.43	1.19	1.13	1.12	1.00	1.20
White vs. Asian	0.73	0.75	0.74	0.91	0.87	0.88	0.97	1.16
Variables Included	race	Model 0 + college variables	Model 1 + sex, age, and proxies of SES	Model 2 + math deficiency	Model 3 + English competency	Model 4 + academic goal	Model 5 + first math grade	Model 6 + enrollment patterns

Notes. [a]Standard errors are provided in parentheses.

[b]An odds ratio of 1 indicates no difference between the two groups that are being compared.

*$p \leq 0.05$ **$p \leq 0.01$ ***$p \leq 0.001$

academic goal (Model 5) contributes very little to the Asian-White gap, while controlling for enrollment patterns (Model 7) reverses the relationship: net of other variables, Whites experience a 16% advantage over Asians in the odds of successful remediation. This indicates that Asians, like Hispanics, remediate at a lower rate than is anticipated given their superior enrollment patterns (Tables 1 and 2).

Exploring the Direct Effects of the Mediating Variables

In order to examine more closely the effects of the mediating variables, I present in Table 4 all of the student-level effects for the complete model (Model 7). An examination of Table 4 reveals two strongly influential variables, the effects of which remain robust despite controls for other variables. Not surprisingly, the first of these is degree of math deficiency: as initial math skills decline, the probability that a student will remediate successfully drops sharply. Additionally, the only other explanatory variable to approach the predictive power of math deficiency is student's performance in first math, which is strongly and positively associated with successful remediation.

TABLE 4

Estimated Student-Level Effects (College-Level Effects Not Shown) for the Complete Model (Model 7) of Successful Remediation in Math ($N_{students}$ = 63,147; $N_{colleges}$ = 104)

	Coefficient	*SE*	Δp[a]
Race			
Black (vs. White)	–0.399***	0.077	–0.061
Hispanic (vs. White)	–0.182***	0.042	–0.026
Asian (vs. White)	–0.152*	0.062	–0.021
Sex			
female (vs. male)	0.065*	0.033	0.009
Age			
years	–0.028***	0.003	–0.004
Proxies of SES			
Received fee waiver (vs. not)	–0.233***	0.041	–0.034
Received one or more grants (vs. not)	–0.072	0.065	–0.010
Value of grants received (x10^3 $)	0.082***	0.022	0.011
Math Deficiency			
Beginning algebra (vs. int. alg/geom)	–1.220***	0.036	–0.231
Pre-algebra (vs. int. alg/geom)	–2.231***	0.060	–0.479
Basic arithmetic (vs. int. alg/geom)	–2.850***	0.081	–0.607
English Competency			
Remedial writing (vs. college-level)	–0.377***	0.032	–0.057
Remedial reading (vs. college-level)	–0.609***	0.060	–0.099
ESL (vs. college-level)	–0.681***	0.066	–0.113
No English (vs. college-level)	–1.694***	0.095	–0.348

TABLE 4 (*Continued*)

Estimated Student-Level Effects (College-Level Effects Not Shown) for the Complete Model (Model 7) of Successful Remediation in Math ($N_{students}$ = 63,147; $N_{colleges}$ = 104)

	Coefficient	*SE*	Δp[a]
Academic Goal			
Transfer + AS/AA (vs. transfer only)	–0.271***	0.033	–0.040
AS/AA (vs. transfer only)	–1.046***	0.074	–0.191
Vocational AS/AA (vs. transfer only)	–1.367***	0.096	–0.267
Vocational certificate (vs. transfer only)	–1.310***	0.114	–0.253
Other job-related (vs. transfer only)	–0.797***	0.069	–0.136
Abstract (vs. transfer only)	–0.247**	0.079	–0.036
Remediation (vs. transfer only)	–0.677***	0.080	–0.112
Undecided (vs. transfer only)	–0.508***	0.054	–0.080
Not reported (vs. transfer only)	–0.549***	0.110	–0.088
First Math Grade			
B (vs. A)	–0.410***	0.043	–0.063
C (vs. A)	–0.928***	0.046	–0.164
D (vs. A)	–1.713***	0.055	–0.353
F (vs. A)	–2.297***	0.070	–0.494
Withdrawal (vs. A)	–2.303***	0.053	–0.495
Credit (vs. A)	–0.647***	0.080	–0.106
No credit (vs. A)	–2.064***	0.168	–0.439
Ungraded/unreported (vs. A)	–1.842***	0.085	–0.385
Persistence			
Semester terms	0.318***	0.005	0.038
Enrollment Inconsistency			
% of semester terms	–0.016***	0.001	–0.002
Delay of First Math			
Semester terms	–0.119***	0.005	–0.017

Notes. [a]The comparison predicted probability is 0.841. The "comparison student" for the purpose of calculating Δp is one who has characteristics equal to the excluded categories of all discrete variables and the means of all continuous variables except the variable that measures the dollar value of grants received, which was set to zero.
*$p \leq 0.05$ **$p \leq 0.01$ ***$p \leq 0.001$

Of the remaining variables, English competency has a smaller direct effect than do math deficiency or first math grade. However, the observed effect of English competency is consistent with prior work that indicates that deficiencies in multiple subjects decrease the likelihood of remediating successfully (Bahr, 2007; McCabe, 2000; Weissman, Silk, & Bulakowski, 1997). Concerning the measure of academic goal, students who are pursuing vocational goals and other goals that terminate in the community college have a somewhat lower likelihood of remediating, relative to students who are seeking transfer exclusively. Finally, the direct effects of the variables that address enrollment patterns are in

the expected directions: longer delays of first math enrollment and increasing inconsistency of enrollment are associated negatively with the likelihood of remediating, while persistence is associated positively. Of the three, persistence exhibits the strongest effect even after accounting for differences in scales of measurement.

The Moderating Effect of College Racial Composition

The test of the moderating effects of college racial composition in Model 7, the results of which are presented separately in Table 5, produced findings that appear to be inconsistent with deductions drawn from the literature. At first glance, the findings seem to suggest that Black students in predominantly Black colleges are slightly more likely to remediate successfully than are Black students in predominantly non-Black colleges, which would be consistent with the literature (e.g., Pascarella & Terenzini, 2005). However, this race-specific effect (for Black students) of the concentration of Black students is balanced by an average disadvantage for students of all races who enroll in predominantly Black community colleges. As a result, the likelihood of successful remediation for Black students effectively does not vary with the concentration of Black students in the college, while the likelihood of successful remediation for White, Hispanic, and Asian students declines as the concentration of Black students increases. Although the absolute size of this curvilinear relationship is difficult to interpret due to the transformation and centering of the variable, further analyses (not shown) indicate that the predicted probability of successful remediation for a White student varies from 0.78 (100% Black student body) to 0.87 (0% Black) when all other continuous variables are set to their respective means (except the dollar value of grants received, which was set to zero) and all categorical variables are set to the excluded categories.

As a point of comparison, however, the reader should keep in mind that the effect on the probability of successful remediation of beginning college with the poorest math skills (basic arithmetic), compared with beginning college with the highest-level remedial math skills (intermediate algebra or geometry), is nearly eight times as large as even the greatest possible effect of the concentration of Black students (i.e., the effect of 100% Black vs. 0% Black). To illustrate, the predicted probability of successful remediation for a White student who begins college in intermediate algebra or geometry is 0.84, while the probability of successful remediation for his/her counterpart who begins college in arithmetic is 0.23, net of controls.

The effect of Hispanic concentration directly counters deductions drawn from the literature. While the concentration of Hispanics does *not*

TABLE 5

Estimated College-Level Effects (Student-Level Effects Not Shown) for the Complete Model (Model 7) of Successful Remediation in Math ($N_{students}$ = 63,147; $N_{colleges}$ = 104)

	Coefficient	*SE*	Δp[a]
Race			
Black (vs. White)	–0.399***	0.077	–0.061
Hispanic (vs. White)	–0.182***	0.042	–0.026
Asian (vs. White)	–0.152*	0.062	–0.021
College Racial Composition			
Direct Effect of % Black (logged)	–0.135***	0.027	–0.019
Direct Effect of % Hispanic (logged)	0.029	0.037	0.004
Direct Effect of % Asian (logged)	0.054	0.029	0.007
Race-Specific Effect of % Black (logged) for Blacks	0.139*	0.059	0.018
Race-Specific Effect of % Hispanic (logged) for Hispanics	–0.218***	0.059	–0.031
Race-Specific Effect of % Asian (logged) for Asians	–0.013	0.056	–0.002
College SES Composition			
Direct Effect of % of Students Receiving Fee Waiver	0.003	0.002	0.000
College Goal Composition			
Direct Effect of % of Students Seeking Upward Transfer	–0.006*	0.003	–0.001
Direct Effect of % of Students Seeking Associate Degree	0.001	0.003	0.000
Direct Effect of % of Students Seeking Job-Related Goal	–0.004	0.003	0.000

Notes. [a] The comparison predicted probability is 0.841. The "comparison student" for the purpose of calculating Δp is one who has characteristics equal to the excluded categories of all discrete variables and the means of all continuous variables except the variable that measures the dollar value of grants received, which was set to zero.
*$p \leq 0.05$ ***$p \leq 0.001$

have a significant direct effect on students generally, Hispanic students who enroll in colleges that serve a disproportionately Hispanic student body are somewhat *less* likely to remediate than are their counterparts in colleges that serve relatively few Hispanics. The predicted probability of successful remediation for a Hispanic student varies from 0.77 (100% Hispanic) to 0.89 (0% Hispanic) when all other continuous variables are set to their respective means (except the dollar value of grants received, which was set to zero) and all categorical variables are set to the excluded categories.

Testing the Efficacy of Remediation across Categories of Race

As the last stage of this analysis, I sought to determine if students of the four major racial groups reap similar benefits from remediating successfully in math. The results, which are presented in Table 6, reveal only two significant racial differences in the beneficial effects of remediating successfully. Although remediating successfully in math is strongly and

positively associated with the likelihood of transferring without a credential (versus neither completing a credential nor transferring), and while Black students experience a general advantage over Whites in the likelihood of transferring without a credential (net of controls), Black students do not gain as much from remediating in math as do White students. Similarly, although remediating successfully is positively associated with the likelihood of completing a terminal credential, Asian students do not gain as much from remediating as do Whites.

Discussion

A number of noteworthy findings emerged from this analysis. First, there are sizeable racial gaps in the likelihood of successful remediation in math: just as with other expressions of math achievement in the U.S., Blacks and Hispanics face significant disadvantages in the likelihood of successful remediation. Second, racial disparities in successful remediation in math largely are a product of racial differences in math skill at college entry and performance in first math. Third, college racial concentration appears to play at least a small role in the likelihood of successful remediation, but one that varies across racial groups. Finally, overall, students of the four major racial groups reap similar benefits from remediating successfully.

The mediating role of math skill at college entry in the race-remediation relationship is of particular interest here both for its magnitude and for its implications. The fact that Blacks and Hispanics begin the remedial math sequence with substantially greater average deficiencies than do Whites and Asians points to an accumulation of mathematics disadvantage accrued in earlier educational experiences (Bali & Alvarez, 2003; Braswell et al., 2001; Farkas, 2003; Fryer & Levitt, 2004; Kao & Thompson, 2003; Riegle-Crumb, 2006). Small racial gaps in math achievement that are observed as early as kindergarten widen over time such that, by college, Black and Hispanic remedial math students enroll disproportionately in arithmetic, while Whites and Asians enroll disproportionately in intermediate algebra or geometry. This finding is distressing in that it reveals that the well-documented racial stratification in math achievement in the U.S. persists even into the lowest echelon of postsecondary math (remedial math) and contributes to racial disparities in outcomes. Thus, racial stratification in math skill acquisition is exacerbated, rather than alleviated, in the remedial sequence, in complete opposition to the underlying intent.

It is unclear, however, why students at the bottom of the remedial math hierarchy have such a low probability of completing the remedial

TABLE 6

Estimated Effects of Math Status, Race, and the Multiplicative Interaction of Race and Math Status on a Five-Category Nominal Measure of Attainment, as Estimated via Two-Level Hierarchical Multinomial Logistic Regression ($N_{students}$ = 63,147; $N_{colleges}$ = 104)[ab]

	Comparison Category: No Credential and No Transfer	Certificate Only	Associate's Degree with or without Certificate	Transfer without Credential	Transfer with Credential
Math Status					
Remediated Successfully (vs. Not)		–0.598***	0.928***	2.348***	3.484***
		(0.169)	(0.071)	(0.063)	(0.076)
Race					
Black (vs. White)		–0.332*	–0.264*	0.332***	0.191
		(0.141)	(0.107)	(0.077)	(0.145)
Hispanic (vs. White)		–0.143	–0.339***	–0.246***	–0.400***
		(0.081)	(0.066)	(0.058)	(0.091)
Asian (vs. White)		–0.031	0.095	–0.091	–0.455**
		(0.150)	(0.114)	(0.109)	(0.172)
Interactions					
Black * Remediated Successfully		–0.122	0.136	–0.497**	–0.036
		(0.545)	(0.191)	(0.156)	(0.195)
Hispanic * Remediated Successfully		–0.151	–0.189	–0.131	0.141
		(0.250)	(0.110)	(0.100)	(0.112)
Asian * Remediated Successfully		0.115	–0.739***	0.110	0.050
		(0.268)	(0.149)	(0.121)	(0.182)

Note. [a]Standard errors are provided in parentheses.

[b]Statistical controls for the following variables were included in this model: sex, age, three proxies of SES, math deficiency at college entry, English competency at college entry, academic goal, performance in first math, persistence, enrollment inconsistency, delay of first math, a college-level measure of the percentage of students who received a fee waiver in the first year, three college-level measures of the goal orientation of the student body, and three college-level measures of racial composition, the latter of which are entered into the model both as direct effects and as cross-level interactions with the corresponding student-level dummy variables for race.

*$p \leq 0.05$ **$p \leq 0.01$ ***$p \leq 0.001$

sequence. Bahr (2008a) discussed a number of possible explanations that are supported by the literature, including the tendency for underprepared students to view college attendance as a personal educational "experiment" (Dougherty & Hong, 2006; Rosenbaum, 2001), students' discouragement at the prospect of taking courses that do not result in credit towards a degree or count towards transfer (McCusker, 1999), and the stigma of placement in low-ability groups (Hadden, 2000; Maxwell, 1997). Of note, the latter two explanations are contradicted by Deil-Amen and Rosenbaum's (2002) finding of a shift in community colleges toward "stigma-free" remediation that tends to hide from underprepared students their remedial status. Ultimately, however, the underlying cause of the low rate of remediation among the poorest-skilled students remains uncertain. This is a critically important topic for future studies to consider, and one that may be approached effectively through qualitative research methods. One might envision, for example, a series of intensive interviews and focus groups that seek to understand *why* so many students who begin the remedial math sequence at, or near, the bottom of the mathematics hierarchy fail so often to complete it.

A related question that has been raised in prior work (Bahr, 2007), but that remains unanswered, should be echoed here. In particular, it is not clear what specific mechanisms connect math deficiency and performance in first math (as predictors) to successful remediation (as an outcome). One might speculate that students who have the poorest skills, and those who perform poorly in first math, simply "drop out" or "stop out" at higher rates than their better prepared and better performing counterparts. Alternatively, or in conjunction, one might speculate that poorly prepared and poor performing students are more likely to switch to alternative academic trajectories that do not require college-level math competency (e.g., vocational degrees or certificates).

The evidence presented here, and that presented in prior studies based on these same data (Bahr, 2007, 2008a), supports neither of these speculations. Concerning the former, the direct effects of math skill deficiency and performance in first math remain quite strong despite the introduction of statistical controls for persistence and enrollment inconsistency. In fact, although not shown in the tables presented here, the direct effects of both math skill deficiency and first math grade on the likelihood of successful remediation *grew* in absolute size after the introduction of the measures of enrollment patterns (Model 7). If poorly prepared and poor-performing students were simply "dropping out" or "stopping out" at a higher rate, one would anticipate finding the reverse: the magnitude of these direct effects would decrease following the introduction of controls for enrollment patterns. Thus, the evidence suggests that poorly

prepared and poor-performing students are *not* simply dropping out of college, although they are remediating at a *much lower* rate than better prepared and better-performing students.

In future studies, it would be useful to examine more closely the relationships between initial skill deficiency, performance in first math, enrollment patterns, and the highest level of math skill attained. One hypothesis that could be explored is that students who begin college at a lower rung of the remedial math ladder may discontinue their ascent to college-level math skill "mid-climb," or they may impeded by the combined effect of a late start in math and the length of time that a student reasonably may remain in college (given various exogenous factors, such as the need to obtain full-time employment). Bahr's (2009b) approach to modeling students' *rate of progress* through the remedial math sequence may prove particularly useful in investigating these questions.

Concerning the latter speculation (i.e., goal switching), Bahr (2008a) demonstrated that the single most likely outcome for remedial math students who do *not* remediate successfully is neither the completion of a community college credential nor upward transfer to a four-year institution. Consequently, although evidence of goal switching among community college students has been presented (e.g., Pascarella, Wolniak, & Pierson, 2003; Voorhees & Zhou, 2000), it does not appear to be the case that unsuccessful remedial math students are exchanging goals that necessitate college-level math proficiency for goals that do not require such proficiency.

One other set of student-level effects warrants further discussion, namely the residual direct effects of race on successful remediation. Although the mediating variables that were examined here explained much of the racial gap in successful remediation, statistically significant differences remain. The largest of these differences—between Black and White students—is a gap of 0.06 in the predicted probability of successful remediation. Thus, although substantially smaller after controlling for the mediating variables, the residual effect of race is not inconsequential. One possible explanation for these remaining differences is that the measures of math and English skill at college entry that were employed here do not capture completely any racial differences in academic preparation. This explanation speaks to a notable weakness of these data, namely that they do not include measures of general academic preparation such as performance on standardized exams (e.g., college entrance exams, matriculation exams) or performance/preparation in high school. Consequently, a replication of this study that employs controls for general academic preparation may prove informative.

Regarding the influence on institutional racial context, my findings indicate that Black students who attend disproportionately Black colleges gain no benefit, but suffer no detriment, in terms of the likelihood of achieving college-level math skill, relative to their counterparts in colleges that enroll fewer Black students. On the other hand, non-Black students who enroll in disproportionately Black colleges experience a reduced likelihood of remediating successfully. On the surface, this appears to inconsistent with some prior work concerning the effect of institutional racial composition (e.g., Pascarella & Terenzini, 2005).

One possible interpretation of this unexpected relationship revolves around characteristics of colleges that are correlated with institutional racial composition. In particular, it may be that the negative effect of the concentration of Black students on the chances of non-Black students is a consequence of other correlated college-level characteristics that tend, on average, to depress the likelihood of remediating in math. While several college-level controls were employed here, many other institutional characteristics that are correlated with institutional racial composition might be considered. A follow-up study that tests the effect of the concentration of Black students while controlling for a comprehensive set of potential suppressing college-level variables may find a positive effect of Black concentration for Black students (in place of the net zero effect found here), even as the negative effect for non-Black students disappears. That is, a more comprehensive set of college-level controls may result in an upward (positive) shift in the effect of concentration of Black students across all racial groups (i.e., from negative to zero for non-Black students, and from zero to positive for Black students). Additionally, it may be useful to explore, through qualitative research methods, any differences between predominantly Black community colleges and predominantly non-Black community colleges in terms of services and academic support provided to historically disadvantaged racial groups.

On the other hand, the negative effect of Hispanic concentration on Hispanic students' chances of remediating is more difficult to interpret. This finding may be contrasted with some prior work that suggests that Hispanic students benefit academically from a "critical mass" of Hispanics (e.g., Hagedorn et al., 2007). Yet, it parallels work presented by Wassmer, Moore, and Shulock (2004) concerning the effect of Hispanic composition on institutional transfer rates, and work by Bahr (2008b), using the same data employed in this study, on the effect of Hispanic composition on the effect of advising on Hispanic students' hazard of transfer. Thus, the findings presented here affirm that something unexpected is occurring with regard to the concentration of Hispanic students, although it is not yet clear what it is that is occurring. While fur-

ther work is needed to explore these relationships, the findings of this study do add to important ongoing work on "minority-serving institutions" (e.g., Li & Carroll, 2007; Santiago, 2008), of which community colleges receive unduly little empirical attention (Maxwell & Shammas, 2007).

Finally, the finding of relatively few significant racial differences in the benefits of remediating successfully is encouraging. This indicates that, although Black and Hispanic students face substantial obstacles in the likelihood of remediating successfully, those who attain college-level math skill experience outcomes (e.g., credential completion, transfer) that are comparable to those successful White and Asian students. In other words, mathematics remediation appears to be relatively equally effective across racial lines.

Conclusion

Postsecondary remediation differs from virtually every other aspect of the U.S. postsecondary educational system. While most of the postsecondary educational system serves to sort individuals into strata of attainment, remediation is designed as a lifeline to educationally marginalized populations. It is intended to be a bridge of educational opportunity for those who would otherwise be shunted off the path of economic stability into a wilderness of dead-end jobs, poor health care, limited housing opportunities, and a myriad of other social ills.

In this study, I quantified sizeable racial differences in rates successful remediation in math. While more than one-quarter of White remedial math students and one-third of Asians attain college-level math skill within six years, only one-fifth of Hispanic and one-ninth of Black students do so. My findings indicate that Black and Hispanic students, who are represented disproportionately in the groups that have the lowest math achievement from kindergarten through high school, carry this disadvantage forward into remedial math, the lowest echelon of postsecondary mathematics. The rate of successful remediation for students who have the poorest math skills is abysmal. Consequently, the remedial math sequence, rather than reducing racial disparities in math achievement, instead further amplifies these disparities. These racial gaps in successful remediation are exacerbated all the more by the overrepresentation of Blacks and Hispanics among students who perform poorly in first math, as a weak showing in first math appears to dissuade students from the pursuit of college-level math skill. However, Whites, Blacks, Hispanics, and Asians who remediate successfully in math experience favorable long-term academic outcomes at comparable rates, so the picture painted here is not without hope.

In light of these findings, it is critically important that we identify points of intervention to increase both the overall success rate of students and the racial equity of remediation. In that regard, my findings suggest several plausible avenues for investigation and intervention. First, targeted institutional intervention for "at risk" students, defined by the concurrence of severe deficiencies in both math and English, may increase overall rates of successful remediation and decrease racial disparities in successful remediation. Second, targeted intervention of "low performers" in first math also may contribute both to global improvement in outcomes and to greater racial equity. Third, additional research should be directed at exploring the alternative academic trajectories of students who drop out of the remedial math sequence, but persist in college. Fourth, further empirical attention should be given to the role of college racial concentration in the students' academic outcomes, particularly the outcomes of Black and Hispanic students. Fifth, the role of academic advising in guiding students who face skill deficiencies should be expanded, as prior research indicates that academic advising has an unequivocally positive effect on the likelihood that skill-deficient students will remediate successfully and attain other positive outcomes (Bahr, 2008b). Finally, researchers, policy makers, and administrators might explore the possibility of initiating comprehensive intervention programs that incorporate a number of the features described here, much like Florida State University's *CARE* program (Carey, 2008), to determine if an integrated approach to intervention may yield the best outcomes among skill-deficient students.

Notes

[1]*Nonincidental* refers to those postsecondary students who earned more than 10 college credits (Adelman, 2004a, p. v). The reader should note that the exclusion from these statistics of so-called *incidental* postsecondary students results in an underestimation of actual participation in remedial coursework. This is a particularly important point to consider in light of Adelman's (2004a, p. 36–37) observation that *incidental* postsecondary students exhibit a disproportionately high level of underpreparation for college-level coursework, compared with those postsecondary students who ultimately are classified as *nonincidental*.

[2]Note that, at the beginning of the observation period defined for this study, there were 107 distinct community colleges in California, of which 104 were semester-based. There are now 110 community colleges, of which 107 are semester-based.

[3]Given the comparatively high rate of lateral transfer between community colleges that is exhibited by students (Bahr, 2009a), the tracking of students' progress across all of the semester-based colleges in the California community college system represents an important strength of this paper.

[4]The reader should note that the one college-level variable that is, perhaps, most important in a study such as this one—the approach to remedial education that is employed by a given college (e.g., McMillan, Parke, & Lanning, 1997)—is not available in these data.

[5]Note that, while the rate of successful remediation in math is dismal, it would be lower still if this figure included students who were advised to enroll in remedial math coursework (on the basis of initial basic skills assessment) but elected not to do so. On the other hand, the reader should be reminded that these data include both credit and noncredit courses. Consequently, the low rate of successful remediation noted here may be more accurate than that which is suggested by studies that exclude noncredit coursework.

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