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Racial-Ethnic Differences at the Intersection of Math Course-taking and Achievement

Catherine Riegle-Crumb[1] and Eric Grodsky[2]

Abstract

Despite increases in the representation of African American and Hispanic youth in advanced math courses in high school over the past two decades, recent national reports indicate that substantial inequality in achievement remains. These inequalities can temper one's optimism about the degree to which the United States has made real progress toward educational equity. Using data from the Education Longitudinal Study of 2002 (ELS), the authors find that the math achievement gap is most pronounced among those students who take the most demanding high school math classes, such as precalculus and calculus. The authors explore the roles of family socioeconomic status and school composition in explaining this pattern. Findings suggest that among those students reaching the advanced math high school stratum, Hispanic youth from low-income families and African American youth from segregated schools fare the worst in terms of closing the achievement gap with their white peers. The authors discuss potential explanations for the achievement differences observed and stress the need for more research that focuses explicitly on the factors that inhibit minority/majority parity at the top of the secondary curricular structure.

Keywords

math, course-taking, race-ethnicity, segregation, social class

The legitimacy of the prevailing status hierarchy among adults in the United States is predicated on equality of opportunity among children, yet evidence that minority-majority academic achievement gaps grow larger as children age and move through the school system suggests that educational opportunities are not independent of racial/ethnic and social origins (Fryer and Levitt 2006; Jencks and Phillips 1998; Neal and Johnson 1996). Although such inequalities are objectionable on moral and social justice grounds alone, these educational inequalities are also increasingly problematic from a strictly instrumental perspective. White youth as a share of the population of children in the United States have been declining since 1980 and are projected to continue to do so through 2020, while the share of youth who are of Hispanic origin will continue to increase until Hispanics account for 1 in 5 of all children in the country (Federal Interagency Forum on Child and Family Statistics 2006). In order for the United States to continue producing large numbers of highly educated and skilled workers, we must improve the educational outcomes for nonwhite youth.

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Previous research on racial/ethnic educational disparities has focused attention on minority underrepresentation in advanced classes, particularly in the subject of math, as a key marker of inequality that leads not only to a test score gap (Catsambis 1994; Dauber, Alexander, and Entwisle 1996; Lee and Bryk 1988; Mickelson and Heath 1999; Pallas and Alexander 1983) but also contributes to minority students' lower rates of college matriculation (C. Adelman 1994). Therefore, scholars of education and race continue to explore whether minority youth are given the same opportunities to reach advanced classes as their majority peers (Attewell and Domina 2008; Lucas and Berends 2007; Mickelson 2001; Noguera and Wing 2006). For example, a recent article by Kelly (2009) utilizing data from the National Education Longitudinal Study (NELS) of 1988 found that black students are much less likely to be in high-track math courses than their majority peers.[1]

In contrast, research has paid much less attention to the academic outcomes of minority students *within* advanced courses vis-à-vis their white peers. And while there is evidence that African American and Hispanic participation in higher-level courses has markedly increased, inequality in achievement stubbornly remains. For example, from 1997 to 2005, the share of disadvantaged minority students taking Advanced Placement (AP) exams almost doubled, narrowing the gap in test-taking with their white peers (U.S. Department of Education, National Center for Education Statistics 2007). However, while the exam scores of white students remained stable during this period, the average scores of minority students declined. Among Hispanic students, average scores decreased from 3.1 in 1997 to 2.5 in 2005, and the percentage of black students earning a score of 3 or higher decreased from approximately 36 percent to 29 percent. These results are consistent with a recent National Assessment of Educational Progress (NAEP) report documenting a strong increase since 1990 in the completion of advanced courses in a range of subjects by African American and Hispanic youth that is not accompanied by an increase in achievement test scores (Shettle et al. 2007). At best, trends of increasing minority representation in elite academic domains absent a parallel increase in achievement suggest only limited progress toward educational equity. At worst, such findings suggest that the advanced courses available to underrepresented youth are advanced in name but not in substance. In either case, we currently know little about the patterns and predictors of minority achievement for those students who are successful in reaching advanced classes by the end of high school.

We address two primary research questions in this article. First, are the racial/ethnic gaps in math achievement more pronounced among high school seniors who took advanced classes than among students who had not taken any math course beyond algebra 2? Second, if this is the case, then to what extent do differences in either the *levels* or the *effects* of family socioeconomic resources and school racial/ethnic composition contribute to racial/ethnic gaps in math achievement among students across different levels of mathematics course-taking? In addressing both of these questions, we consider the gap between African American and white students and between Hispanic and white students. The latter disparity has received comparatively less attention in the educational stratification literature. As growth in the Hispanic share of the population continues to outpace growth in other racial/ethnic groups, understanding the sources of the Hispanic/white achievement gap is increasingly pressing.[2]

Building on a growing body of recent research that finds that racial/ethnic inequality is often most pronounced at the high end of the achievement distribution (Gándara 2005; Hanushek and Rivkin 2006; Hedges and Nowell 1999), we expect to find that minority students in advanced math courses are actually further behind their white peers in terms of achievement than are students in lower-level classes. We argue that racial/ethnic disparities in family socioeconomic level and school racial/ethnic composition might be more consequential for academic achievement and growth at the high end of the curriculum, leading to a more pronounced test score gap there than at the lower end of the curriculum. To explore these issues, we utilize recent survey and high school transcript data from a nationally representative cohort of high school seniors available from the Education Longitudinal Study of 2002 (ELS).

BACKGROUND

Advanced Math Course-taking in High School

The hierarchical organization of high school math courses is a key mechanism of academic

stratification. A highly structured system of prerequisites that begins in middle school with algebra or prealgebra dictates that only those students who have mastered the curriculum and met teachers' expectations consistently over a period of many years are given the chance to participate in advanced math courses such as precalculus and calculus (Burkam, Lee, and Smerdon 1997; Dougherty, Mellon, and Jian 2006; Stevenson, Schiller, and Schneider 1994). Enrollment in advanced courses, particularly those beyond the critical threshold of algebra 2, substantially increases the probability that students will attend college, and in particular that they will attend a selective college or university (C. Adelman 1999; Schneider, Swanson, and Riegle-Crumb 1998). Advanced math course-taking in high school is also a strong determinant of degree completion among those who attend college (C. Adelman 1994, 1999). Equality of educational opportunity with respect to enrolling in advanced math classes is therefore an issue of consequence well beyond the walls of the high school.

The share of high school students in advanced math has dramatically increased over the past few decades. For example, the total percentage of students who took math courses above algebra 2 increased by almost 25 percentage points from 1982 to 2004 (Dalton et al. 2007). Growth in participation rates during this period was particularly pronounced among minority youth. While about 3 percent of African American and Hispanic high school graduates in the class of 1982 had completed a precalculus course, around 15 percent of African American and Hispanic youth in the class of 2004 had done so. The black/white gap in advanced course-taking narrowed by 5 percentage points during this period, decreasing from approximately 17 to 12 percentage points (Dalton et al. 2007).

The increased movement of students into higher-level math courses over the past few decades is the result of a myriad of policy recommendations and educational reforms stressing the importance of math and increasing course requirements for high school graduation (Dougherty et al. 2006). Widely disseminated results from the Third International Mathematics and Science Survey (TIMSS) in the mid-1990s made starkly apparent that the math achievement levels of our nation's students were far behind those of students in other industrialized nations. At the same time, the country's technological sector was experiencing exponential growth. These divergent trends led policymakers to turn their attention to K-12 education with a reinvigorated focus reminiscent of that seen during the years after Sputnik launched in 1957. Unlike the post-Sputnik period, however, there has been a heightened focus on minority (as well as female) youth motivated at least in part by the need to increase "America's talent pool" (National Research Council 2009). Attention to pulling in traditionally underrepresented groups was driven not only by concerns of equity but also by the demographic and economic realities the nation confronts. The future economic well-being of this country rests on a large scientifically and technologically trained labor force, and one where whites will soon comprise a minority. Thus, alongside a general emphasis toward improving educational opportunities and achievement in math there also came a particular emphasis on access and encouragement for African American and Hispanic students to pursue and excel in math.

Room at the Top . . . but Equity?

As noted previously, the push to give minority youth access to advanced math courses has increased the numbers of African American and Hispanic students taking such classes nationwide. Yet improved access is a necessary but insufficient component for providing equal educational opportunities for all youth. Without levels of achievement comparable to those of their white peers, minority students taking the most advanced high school math courses remain in a position of disadvantage. In fact, we suggest that minority students in advanced math courses in high school may trail their white counterparts in achievement test scores *to an even greater degree* than do students in lower-level courses. We explore whether the achievement gap among those taking advanced courses is more pronounced than at lower levels of the curriculum due to majority-minority disparities in two key factors: family socioeconomic background and school racial/ethnic composition. Additionally, while most past research has focused on how differences in *levels* of these resources contribute to differences in academic achievement (Catsambis 1994; Lucas 1999; Oakes 1990; Stevenson et al. 1994), some work suggests racial/ethnic differences in the magnitude of the *association* between these attributes and academic achievement.

In the following sections, we discuss the extant literature on the relationship between family

socioeconomic background, school racial/ethnic composition, and students' patterns of achievement. We begin by briefly discussing how each set of factors influences racial/ethnic patterns of achievement in general. We then consider why racial/ethnic disparities in these family and school resources might contribute more to achievement gaps among those students at the advanced end of the high school math curriculum than to gaps among those completing less rigorous courses of study. Finally, we discuss why we might expect to observe differential returns of both socioeconomic background and school composition for the achievement of minority students in advanced math classes compared to their majority peers.

Socioeconomic background. Social class differences in students' families account for a substantial portion of the achievement gap between majority and minority youth, as African American and Hispanic parents have historically had lower levels of education, occupational status, and income compared to whites (Hedges and Nowell 1999). The rich existing literature on how socioeconomic background contributes to student achievement has pointed to several different mechanisms for this transmission of advantage. More advantaged parents tend to have greater familiarity with the educational system, thus providing their children with information of higher quality and certitude that subsequently enables their children to apply themselves more successfully than their less advantaged peers to their academic work (Morgan 2002, 2005). More advantaged parents have also historically had higher educational and occupational aspirations for their children than less advantaged parents, and these aspirations contribute directly to variation in academic achievement (Sewell, Haller, and Ohlendorf 1970). Socioeconomic advantage may operate through more subtle developmental pathways as well. Children of middle- and upper-class parents, for example, learn at an early age to communicate verbally and nonverbally in ways that are rewarded in school (Bourdieu and Passeron 1990; Hart and Risley 1995), affecting a sense of entitlement in their interactions with their teachers (Lareau 2003).

Socioeconomic differences between white and minority students may be particularly important with regard to students' achievement at the high end of the course-taking distribution. For example, parents with baccalaureate or advanced degrees tend to feel more comfortable than less educated parents confronting school personnel about their child's education, including obtaining access to advanced courses and requesting timely and detailed information about their child's academic progress and needs (Lareau 2000). They are also more likely to be able to assist their children with coursework and homework or acquire the assistance of others to help if necessary (Baker and Stevenson 1986; Davies 2004). Thus, while differences in the resources that families of different social origins have at their disposal are likely contributors to the achievement gap for students at all levels of the math curriculum, such class disparities may be even more pronounced or magnified in their academic implications for students taking advanced courses such as precalculus.

In addition to differences in levels of socioeconomic resources, the effects of social origins may vary considerably across racial/ethnic groups. There is evidence suggesting the academic achievement of African American youth, and to a lesser extent Hispanic youth, is less sensitive to parental education and other aspects measures of socioeconomic status than the achievement levels of white youth (Gosa and Alexander 2007; Grodsky, Kalogrides, and Siebens 2007; Lubienski 2002). For example, analyzing NAEP reading test scores, a report by the College Board (1999) found that the black-white test score gap was indeed largest among youth with college educated parents.

While the reasons for such disparities are unclear, Gosa and Alexander (2007) offer several candidate explanations in their review of the literature. For example, African American families in the upper and middle class possess less wealth than similarly positioned whites and are more likely to spend their financial and other resources to help support extended kin who are less well off. They and others also speculate that the greater socioeconomic heterogeneity of African American neighborhoods compared to white neighborhoods may work to attenuate the association between parent socioeconomic status and academic achievement. Even among relatively advantaged African Americans, median neighborhood income and housing values are lower than for comparable whites (Alba, Logan, and Stults 2000; Massey and Denton 1993), and the share of neighborhood households in poverty is greater (R. Adelman 2004). As a result of greater intrafamilial and neighborhood variation in socioeconomic status,

more advantaged African American students have greater exposure to poor and working-class peers than do more advantaged white students (Patillo-McCoy 1999), and may therefore have less access to community reinforcement of the academic norms and attitudes typically associated with higher levels of socioeconomic attainment. Furthermore, while indicators such as highest degree attained and yearly income are typical markers of a family's access to social and economic resources, they nevertheless fail to capture important distinctions such as the selectivity of the postsecondary institution parents attended or the social networks to which parents have access, both of which are mechanisms through which parents can transmit advantage to their children and areas where minority parents may be further disadvantaged (Kim and Schneider 2005; Massey and Fischer 2006; McNeal 1999). This dilution of middle-class advantage among African Americans (and potentially among Hispanics) may lead to less beneficiary outcomes for these youth compared to their white peers, particularly in advanced math classes where the curriculum becomes the most demanding and academic effort as well as academic support from parents and peers assume greater levels of importance.

Racial/ethnic composition. Although findings vary to some extent, past research generally shows that youth attending schools with a higher share of minority students tend to have lower levels of academic achievement as measured by scores on standardized tests (Linn and Welner 2007). A primary argument for the relationship between school segregation and achievement focuses on differences in the quantity and quality of school resources available to students. The resource argument was most famously evaluated and rejected by Coleman and his colleagues (1966), and a spate of subsequent studies reinforced their conclusion that schools' economic resources were not the cause of inequality in achievement between minority and majority youth (G. Borman and Dowling 2006). More recent studies, however, present strong evidence to the contrary, particularly with regard to characteristics of teachers (Jencks and Phillips 1998). Teachers in schools with high percentages of African American and Hispanic students have fewer years of experience, are less likely to be fully credentialed, and are more likely to be teaching out of their field(s) of expertise, particularly in math, than teachers in predominately white schools (Clotfelter, Ladd, and Vigdor 2005; Darling-Hammond 2001; Mickelson and Heath 1999). Some studies suggest that teachers expect less in terms of ability and performance from students in high-concentration minority schools (Delpit 1992; Flores 2007; Ream 2003). Thus, to the extent that school segregation exposes minority students to less qualified teachers who expect less from them, their achievement is likely to suffer.

A specific aim of the present study is to determine whether the racial/ethnic composition of schools contributes more to explaining the gap between minority and majority students at the high end of the math course-taking spectrum in high school compared to the lower end. We propose that the negative effect of school segregation on achievement test scores of minority youth may increase with the assumed demand of their academic courses. Schools that serve a large share of minority students may lack the instructional resources, such as highly qualified teachers, needed to provide opportunities to learn for their most advanced students. Teachers and staff in high-minority schools are likely to be focused instead on ensuring that less academically successful students meet the necessary achievement thresholds to avoid sanctions (Booher-Jennings 2005). This emphasis may further serve to discourage the educational efforts of those students taking advanced courses in predominantly minority schools.

Yet while the resource argument may be well suited to explain why the academic trajectories of higher-achieving students are constrained by segregation, it is perhaps less suited to explain a pattern noted in several recent studies. Namely, the achievement levels of academically strong minority students appear to be more sensitive to racial/ethnic composition than the achievement levels of similar white students (Hanushek and Rivkin 2006; Hoxby and Weingarth 2006; K. M. Borman et al. 2004). For example, Hanushek and Rivkin (2006) find that school segregation has a more detrimental effect on the growth in achievement between third and eighth grade of initially high-scoring African American students than comparable white students. In fact, Hanushek and Rivkin (2006) report that high-achieving white students are not impacted one way or the other by attending high-minority schools while African American students are harmed by doing so.

Social-psychological explanations more specifically address why the negative effects of segregation on achievement could be concentrated on minority youth. Most notably, Fordham and Ogbu (1986) argued that high-minority schools contribute to the development of an oppositional peer culture where students reject academic norms of effort, engagement, and performance as "acting white," which subsequently leads to underachievement.[3] Recent studies undermine the distinctly racial dimension of oppositional culture, offering evidence that antischool attitudes and behaviors are widespread among minority and white youth alike (Ainsworth-Darnell and Downey 1998; Harris and Robinson 2007; Morgan and Mehta 2004) and across schools varying widely in their racial/ethnic composition (Cook and Ludwig 1998; Tyson 2002; Tyson, Darity, and Castellino 2005). For example, Kelly (2007) found no evidence that antischool norms were more prevalent in predominantly black classrooms and concluded that lack of school engagement is not the mantle of any one particular racial/ethnic group, but rather a characteristic common to all students with weak prior academic skills. Based on the existing research, it therefore seems unlikely that oppositional culture underlies the association between school segregation and academic achievement; moreover, it has little to offer in terms of explaining why high-achieving minority students may be the most susceptible to the negative consequences of segregation.

Perhaps a more relevant explanation for such patterns is stereotype threat. Specifically, minority students who strongly identify with mathematics (or academics more generally) may fail to perform to their potential on an assessment due to anxiety or distraction caused by invoking a negative performance stereotype regarding the academic performance of minority students (Sackett, Hardison, and Cullen 2004; Steele 1997; Steele and Aronson 1998). As we would generally expect, students in advanced math classes to have a relatively strong attachment to academics, it seems logical that minority students in classes such as calculus and precalculus might be the most vulnerable to such threats. To the extent that white students are overrepresented in the most demanding classes even within high-minority schools (Tyson et al. 2005), stereotype threat might well inhibit the academic performance of African American and perhaps Latino students. On the other hand, racial/ethnic stereotypes of inferior academic performance might be less salient in schools with a high minority concentration.

Given the limitations of the data on which we base this research, we can only speculate about the ultimate causes of any association between segregation and academic achievement that we observe. It is beyond the scope of this study to adjudicate between arguments about the negative social-psychological consequences of segregation on one hand and the negative consequences of insufficient financial, structural, and human resources on the other. Instead, a primary focus of our analyses is to discern whether minority students taking the most advanced math courses are the ones most negatively affected by attending highly segregated schools.

The Temporal Dimension of the Achievement Gap

As learning new skills and gaining new knowledge in mathematics is necessarily cumulative, the lower relative achievement levels of African American and Hispanic students at the end of high school reflect both recent and more distal inequalities in their opportunity to learn. Phillips, Crouse, and Ralph (1998) find that approximately one half of both the reading and math test score gap between blacks and whites at the end of high school is attributable to the comparatively lower skill levels of blacks in elementary school. Yet achievement disparities emerge and continue to grow during secondary school even once one conditions on initial school readiness. Therefore, in this article we distinguish between racial/ethnic differences in learning over the latter two years of high school and cumulative racial/ethnic differences in academic achievement by estimating models with and without controls for prior academic achievement.

Neither growth models nor cross-sectional models alone sufficiently capture the disparities in achievement we seek to explain. The cross-sectional models allow us to consider the long-run associations of social class and school composition with achievement disparities at different levels of mathematics course-taking. Confining our attention to changes in knowledge over the last two years of high school would ignore the extent to which the inequalities born by black and Hispanic students have compounded over the primary and secondary years. On the other hand, analyses that condition on prior achievement lead to an

estimate of the net contribution of social class and segregation to achievement during the later years of high school, accounting for the fact that both are likely tied to students' achievement at earlier time points in their educational trajectories. Therefore, by estimating models with and without controls for prior academic achievement, we can better discern whether and when family social background and school composition exert their influence on the majority-minority achievement gap among advanced and nonadvanced students.

DATA

We base our analyses on a nationally representative sample of students who were high school sophomores in 2002 and participated in the ELS. Subsequent follow-ups were conducted in 2004, when most students were seniors, and 2006. We restricted our analytic sample to students in public schools, as course-taking requirements and options vary significantly across school sector (Coleman, Kilgore, and Hoffer 1982). We further restrict our sample to students who had complete transcript information available during the latter two years of high school.

We draw primarily on data collected from students, their parents, and school administrators. Students completed achievement tests in math and reading as sophomores and math as seniors. Additionally, students' high school transcripts were collected and coded using the Classification of Secondary School Course (CSSC) codes. These were developed by the National Center for Education Statistics (NCES) and used in prior transcript studies such as the National Education Longitudinal Study of 1988 (NELS). Using the CSSC codes, we constructed a dichotomous measure of the highest level of math that students reached by the end of high school. Students in *advanced math* completed at least one course beyond algebra 2, including trigonometry, AP statistics, precalculus, or calculus. While algebra 2 is generally considered the math threshold for college admission, students who take courses beyond algebra 2 score higher on entrance examinations and have greater likelihoods of attending college in general (and more selective colleges and universities in particular), as well as graduating from college, than students who meet but do not exceed the algebra 2 threshold (C. Adelman 1999). We divide our sample into two strata based on whether or not students completed any math course beyond algebra 2 and conduct separate analyses for each group. Stratifying students by this dichotomous indicator of course level reduces but does not eliminate heterogeneity in students' curricular exposure in math. Therefore, we include a dichotomous indicator of whether advanced students reached calculus and whether nonadvanced students took courses beyond the basic or general math levels.

Our dependent variable is student's senior year math achievement test score, scaled as the number of items the student would have answered correctly had he or she taken the complete mathematics test (based on the student's IRT scale score). The ELS math tests consist of multiple test forms varying in average difficulty. Students in the base year all took a routing test and, based on the outcome of that assessment, were given one of three assessment batteries (low, medium, and high difficulty). Assignment to 12th-grade forms was based on performance on the 10th-grade assessments for students who participated in both the base year and first follow-up (Ingels et al. 2007).

The independent variables in our analyses are taken from the 10th-grade surveys. We distinguish among Hispanic, African American, and non-Hispanic white students based on students' self-reports. We excluded Asian students and those who identified as Native American or other from our analyses. To capture the socioeconomic status of the student's family, we include indicators for both parental education level and family income from the ELS parent questionnaire.[4] Parental education is the highest level of education attained by either of the student's parents, ranging from the lowest value of 1 for those with less than a high school degree to the highest value of 8 for those with an advanced degree. To measure family income, we recoded the original ordinal indicator by taking the midpoint of each income category and estimating the midpoint of the highest category via a modified Pareto formula (Hout 2004; also see Table A.1 in the appendix for complete information on the coding of this and all other variables in the analyses; online appendix available at http://soe.sagepub.com/supplemental).[5] To capture the potentially deleterious effects of school segregation on achievement, we include a measure of the percentage of the student body that is either African American or Hispanic. This information

comes from the Common Core of Data (CCD) via the school survey in ELS. Additionally, because we are interested in evaluating the contributions of differences in levels *and* associations of family socioeconomic background and school composition to the majority-minority achievement gap, we construct interaction terms between students' race-ethnicity and parental education, family income, and school composition.

We adjust for two dimensions of prior academic preparation: students' cumulative grade point average (GPA) in math at the end of their sophomore year of high school (based on the grades reported on students' high school transcripts) and students' score on the math achievement test administered by ELS during the 10th-grade year and scaled to be directly comparable to the senior year math assessment score. Models excluding prior academic achievement capture the cumulative process of racial/ethnic inequality while models conditioning on prior academic achievement estimate student learning between 10th and 12th grade. Finally, we adjust each model for student's gender, as well as generational status (indicating whether or not the student is first generation). Missing values are imputed.[6]

Plan of analyses. We begin by presenting the means and standard deviations of our dependent and independent variables by race/ethnicity and math stratum. Next, we estimate separate regression models by math stratum to examine racial/ethnic gaps in 12th-grade math achievement and the extent to which they are accounted for by family socioeconomic resources and school racial/ethnic composition. In addition to models exploring the average effects of these predictors, we also estimate models that include interaction terms to evaluate potential differences in the effects of socioeconomic origins and school racial/ethnic composition for African American and Hispanic students relative to white students. Finally, we estimate models of achievement growth between 10th and 12th grade by controlling for 10th-grade test scores and math GPA. Because of the clustered nature of the data and our interest in estimating school effects, we estimate two-level random effects models with students nested in schools.[7]

RESULTS

Descriptive analyses. Over half (55 percent) of the white seniors in our study complete at least one advanced math course. For black students, the corresponding percentage is smaller (48 percent).[8] Of the three groups, Hispanic students have the lowest percentage; approximately one in three Hispanics complete an advanced math class (37 percent). This confirms that while minority youth have made significant inroads to increase their representation in elite high school courses, they nevertheless remain underrepresented.

Table 1 shows descriptive statistics by race/ethnicity and math stratum for our analytic sample. We denote statistically significant group differences by a superscripted letter in each cell of the table. We find that white students in the advanced math stratum have significantly higher average levels of 12th-grade math achievement than black students (B) and Hispanic students (H). A significant white advantage in test scores is also apparent among those in the nonadvanced math stratum. However, in response to our first research question, the magnitude of the majority-minority achievement gap appears larger for advanced math students. The black-white test score gap in the advanced stratum is over 13 points (or around one standard deviation) and the Hispanic-white gap slightly over 8 points (or around three-quarters of a standard deviation). In comparison, respective gaps in the nonadvanced stratum are just over 7 and almost 6 points. Subsequent tests confirm that the majority-minority gap in the advanced stratum is significantly greater than that observed in the nonadvanced stratum.[9] Minority students who have persevered to reach advanced math courses are no nearer to closing the achievement gap with their white peers than less accomplished students; in fact they are, relatively speaking, further behind. Our subsequent multivariate analyses will focus on explaining how differences in levels and associations of family social class and school racial/ethnic composition contribute to this more pronounced inequity among those who reach advanced math courses.

Returning to the descriptive statistics displayed in Table 1, as one might expect, those in the advanced math stratum generally have significantly higher means on academic and family background measures compared to students of the same racial/ethnic group who fail to advance beyond algebra 2.[10] Among students in the advanced math stratum, white students are significantly more likely to take calculus than black and

Table 1. Means and Standard Deviations

	Advanced math stratum			Nonadvanced math stratum		
	White	Black	Hispanic	White	Black	Hispanic
12th-grade math test score	58.19[BH]	44.85[H]	49.89	41.92[BH]	34.57[H]	35.95
SD	11.64	12.92	13.69	12.01	9.77	11.02
Female	0.53[H]	0.55	0.58	0.47[B]	0.52	0.49
SD	0.50	0.49	0.49	0.50	0.49	0.50
First-generation immigrant	0.02[BH]	0.04[H]	0.22	0.01[BH]	0.03[H]	0.25
SD	0.16	0.19	0.41	0.12	0.16	0.43
Course-taking (advanced = calculus; nonadvanced = basic/remedial math)	0.26[BH]	0.11[H]	0.18	0.07	0.06	0.06
SD	0.44	0.31	0.38	0.26	0.25	0.24
Parental education level	4.96[BH]	4.54[H]	3.77	3.97[H]	4.02[H]	3.18
SD	1.90	2.01	2.14	1.89	1.83	1.95
Family income (in $10,000 units)	7.83[BH]	5.05	4.98	5.62[BH]	3.92	3.87
SD	5.68	4.59	4.27	4.19	3.71	3.27
Math grade point average	2.64[BH]	1.90[H]	2.28	1.80[BH]	1.43[H]	1.52
SD	0.79	0.84	0.89	0.81	0.77	0.83
10th-grade math test score	45.62[BH]	34.78[H]	38.51	34.71[BH]	27.70[H]	28.91
SD	9.20	10.22	10.78	9.84	7.87	9.01
Percentage minority in school	15.60[BH]	57.24[H]	51.88	14.25[BH]	53.17	53.89
SD	17.78	30.75	30.85	17.83	29.22	30.26
N	2,930	630	510	2,375	680	850

B indicates that mean is significantly different than the Black mean within the same math stratum (advanced or nonadvanced), $p < .05$. H indicates that mean is significantly different than the Hispanic mean within the same math stratum, $p < .05$.
Source: Educational Longitudinal Study (ELS) 2002–2004.

Hispanic youth. With regard to racial/ethnic differences in family socioeconomic resources, white students in advanced math come from families with significantly higher levels of parental education and income compared to African American and Hispanic students. We observe a similar but less pronounced pattern of racial/ethnic inequality in family resources among nonadvanced students. Differences in family income between white students and their black and Hispanic course-taking peers are significant, but among those in the nonadvanced stratum, majority-minority differences in parental education level are significant only between white and Hispanic students. As would be expected, significantly fewer black and white students than Hispanic students are first-generation immigrants. One-quarter of Hispanic students in the sample report being born outside of the United States.

Turning to measures of academic preparation, at both levels of course-taking, we find that white students have significantly higher grade point averages in math and higher 10th-grade math test scores than black and Hispanic students. Like differences in social origins, differences in prior grades and test scores are larger among students in advanced courses. For example, while black students in nonadvanced math trail their white peers by less than half a grade point, the gap among advanced students is three-fourths of a grade point.

On average, white students in our sample attend a school that is approximately 15 percent minority. African American and Hispanic students attend schools whose average composition is over half minority. Finally we note that there are some significant differences in family resources and individual academic histories between African American and Hispanic students. In both advanced and nonadvanced strata, black students have higher levels of parental education than their Hispanic peers, yet they also have lower levels of prior academic preparation. Additionally, compared to Hispanic students, black students in the

Table 2. Regression Analyses Predicting 12th-Grade Math Scores for Students in Advanced Math Stratum (Unstandardized Coefficients with Standard Errors)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Black	−11.884***	−9.913***	−9.462***	−10.398***	−9.007***	−6.824***	0.902
SE	0.580	0.512	0.501	1.155	1.190	1.514	0.931
Hispanic	−7.803***	−6.230***	−4.959***	−7.055***	−5.575***	−6.513***	−1.214
SE	0.619	0.562	0.555	1.140	1.175	1.527	0.938
Female		−2.912***	−2.855***	−2.838***	−2.831***	−2.829**	−1.678***
SE		0.318	0.312	0.312	0.311	0.311	0.199
First-generation immigrant		−1.849**	−1.596*	−1.307	−1.285	−1.304	−0.362
SE		0.754	0.741	0.746	0.744	0.744	0.462
Calculus		13.184***	12.413***	12.404***	12.376***	12.373***	3.905***
SE		0.391	0.387	0.387	0.386	0.386	0.263
Parental education level			0.885***	0.895***	0.898***	0.899***	0.192**
SE			0.089	0.108	0.108	0.108	0.067
Family income			0.168***	0.105**	0.108***	0.108***	0.051*
SE			0.033	0.036	0.036	0.036	0.022
Black × Parental Education Level				−0.234	−0.266	−0.306	−0.185
SE				0.240	0.240	0.240	0.150
Hispanic × Parental Education Level				0.066	0.006	0.029	−0.188
SE				0.248	0.248	0.249	0.154
Black × Family Income				0.348***	0.317**	0.286**	0.075
SE				0.101	0.101	0.101	0.063
Hispanic × Family Income				0.307**	0.261*	0.288*	0.201**
SE				0.118	0.118	0.120	0.075
Percentage minority in school					−0.045***	−0.034**	−0.004
SE					0.009	0.013	0.007
Black × Percentage Minority in School						−0.042*	−0.032**
SE						0.020	0.011
Hispanic × Percentage Minority in School						0.009	0.009
SE						0.020	0.012
Math grade point average							1.906***
SE							0.144
10th-grade math test							0.874***
SE							0.013
Constant	58.087***	56.195***	50.749***	51.204***	52.133***	51.956***	11.908***
SE	0.318	0.349	0.527	0.593	−0.622	0.640	0.614
Variance (constant)	23.766	19.749	15.302	15.379	14.597	14.318	2.202
Variance (residual)	122.788	93.051	90.621	90.232	90.042	90.063	36.141

$N = 4{,}070$.
Source: Educational Longitudinal Study (ELS) 2002–2004.
*$p < .05$. **$p < .01$. ***$p < .001$.

advanced stratum attend schools with a higher percentage of minority students.

Multivariate regression analyses. Tables 2 and 3 present the results of separate regression analyses predicting 12th-grade math test score by math stratum. In addition to controls specified in the table, each model includes random school effects. We discuss the results for students completing advanced math courses first (Table 2) and then the results for students who take nonadvanced math courses (Table 3).

The racial/ethnic achievement gap among students in the advanced math stratum. In the first model for Table 2, we see again the large test gaps between African American and Hispanic students and white students who complete advanced mathematics courses. Comparing results of model 1 to the group means in Table 1, we find that racial/ethnic gaps are attenuated when taking account of the variation in mean achievement of the schools our sample members attend (i.e., conditioning for school random effects). The attenuation is greater for the

Table 3. Regression Analyses Predicting 12th-Grade Math Scores for Students in NonaAdvanced Math Stratum (Unstandardized Coefficients with Standard Errors)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Black	−7.042***	−6.865***	−6.441***	−5.760***	−4.806***	−5.494***	−1.175
SE	0.523	0.502	0.500	1.156	1.188	1.413	0.860
Hispanic	−5.744***	−5.272***	−4.512***	−5.109***	−3.932***	−2.719*	−0.008
SE	0.495	0.506	0.503	0.987	1.043	1.294	0.787
Female		−2.175***	−2.053***	−2.054***	−2.041***	−2.041***	−0.889***
SE		0.346	0.343	0.343	0.343	0.343	0.211
First-generation immigrant		−2.094**	−1.762***	−1.668*	−1.592*	−1.547*	−0.038
SE		0.753	0.746	0.751	0.750	0.750	0.458
Low math		−13.564***	−13.074***	−13.101***	−13.181***	−13.225***	−4.347***
SE		0.696	0.689	0.690	0.689	0.689	0.436
Parental education level			0.465***	0.544***	0.548***	0.547***	0.132
SE			0.096	0.124	0.124	0.124	0.076
Family income			0.295***	0.240***	0.243***	0.243***	0.048
SE			0.046	0.056	0.056	0.056	0.034
Black × Parental Education				−0.299	−0.283	−0.295	−0.033
SE				0.263	0.263	0.263	0.160
Hispanic × Parental Education				−0.135	−0.193	−0.233	0.112
SE				0.235	0.235	0.237	0.144
Black × Family Income				0.104	0.072	0.089	0.092
SE				0.128	0.128	0.129	0.079
Hispanic × Family Income				0.245	0.216	0.199	0.082
SE				0.131	0.131	(0.132	0.080
Percentage minority in school					−0.029***	−0.023	0.003
SE					0.008	(0.013	0.008
Black × Percentage Minority in School						0.009	0.010
SE						0.020	0.012

(continued)

Table 3. (continued)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Hispanic × Percentage Minority in School						−0.024	−0.018
SE						0.019	0.011
Math grade point average							0.783***
SE							0.137
10th-grade math test							0.940***
SE							0.012
Constant	41.808***	43.836***	40.221***	40.225***	40.691***	40.614***	7.815***
SE	0.272	0.318	0.506	0.588	0.602	0.620	0.556
Variance (constant)	7.046	8.017	6.575	6.464	5.949	6.015	1.965
Variance (residual)	123.808	110.784	109.135	109.192	109.229	109.15	40.530

$N = 3{,}900$.
Source: Educational Longitudinal Study (ELS) 2002–2004.
*$p < .05$. **$p < .01$. ***$p < .001$.

black-white achievement gap (about 11 percent) than it is for the Hispanic-white achievement gap (about 6 percent). This differential is likely driven by greater segregation of blacks than Hispanics across schools and potentially lower average achievement levels in the schools attended by the average black student compared to the average Hispanic student (a point to which we return in the following).

We add indicators for gender, immigrant status, and calculus course-taking in model 2. The first two are significantly and negatively associated with test score, while the last is positively so. The advanced math achievement gap between white students and their minority peers decreases by approximately 15 percent to 20 percent from that observed in model 1; additional analyses without gender or generational status included confirms that this attenuation is mostly due to racial/ethnic differences in calculus participation. In model 3, we adjusted for differences in levels of family socioeconomic resources; with the inclusion of these measures the magnitude of the achievement gap between African American students and their white peers is reduced by about 5 percent. In contrast, the mean achievement difference between Hispanic and white students is reduced by 20 percent.

We evaluate potential differences in the associations between social class background and academic achievement across racial/ethnic groups in model 4. While we find no evidence of differential returns to parental education, we do find significant differences in the achievement returns to family income by race/ethnicity. These differences run opposite to the effects anticipated by Gosa and Alexander (2007) and others who have written on the black middle class. In fact, the effects of family income for Hispanic and African American students are about four times what they are for non-Hispanic white students, holding constant parental education, immigrant status, gender, and calculus enrollment. Subsequent calculations indicate that among advanced students, test score gaps are most pronounced among those from the lowest family income. For example, at one standard deviation below the pooled average family income, the black/white gap is almost 11 points, and the Hispanic/white gap is about 6 points. At one standard deviation above the mean on family income, the black/white gap is reduced to approximately 7 points and the Hispanic/white gap to 3 points. Thus, contrary to our expectations, we do not find evidence that minority students in advanced classes benefit less than their white peers from higher levels of social class. Rather, their achievement levels suffer comparably more than white students from lower levels of family income.

In models 5 and 6, we add measures of school percentage minority and the interaction of percentage minority and race/ethnicity. Net of student social background, the effect of percentage minority is negative and significant, indicating that achievement levels of all students are lower in schools with higher minority composition (model 5).[11] This effect is very small in magnitude; a 10 percentage point increase in percentage minority is associated with a 0.4 point decline in math test scores (approximately 3 percent of a standard deviation). Yet consistent with past literature, the negative association between percentage minority and achievement is stronger for African American students than it is for white students, with African American students experiencing a decline of about eight-tenths of a point for each third of a point experienced by whites (as seen in model 6). This is not the case for Hispanic students; the conditional association between percentage minority and academic achievement for Hispanic and non-Hispanic white students is statistically and substantively indistinguishable. Subsequent calculations indicate that by accounting for both main and interaction effects of school composition in model 6, the average black/white test gap among advanced students is reduced by approximately 20 percent, from a gap of about nine points when social class was taken into account, to a reduced gap of just over seven points. The average Hispanic/white gap (conditioned on social class and calculated from model 4) is reduced by only 10 percent.

Finally, model 7 includes measures of prior academic preparation. Results from this model reflect how variation in the independent variables contributes to variation in student *learning* between the 10th and 12th grades rather than variation in *achievement* at a single point in time.[12] Although the socioeconomic background coefficients decline in magnitude, parental education and family income continue to contribute to academic achievement over the final two years of high school. Evidence for differential contributions of social background across racial/ethnic groups is mixed. The income interaction for African American students is very close to 0 and

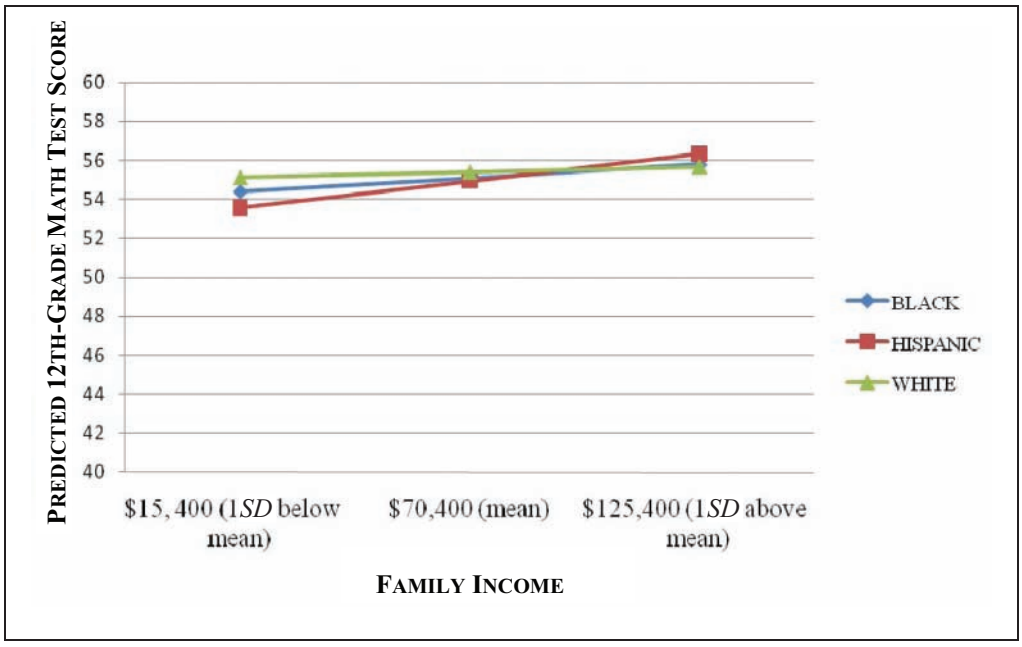

Figure 1. Effect of family income on 12th grade achievement among students in advanced math stratum (net of students' academic background)

no longer significant, but the returns to family income for Hispanic students are about five times as much as those for white students. As seen in Figure 1, Hispanic students at higher levels of family income actually enjoy a slightly higher predicted test score than comparable whites net of differences in prior achievement and other covariates. At one standard deviation above the mean, Hispanic students have a predicted test score that is about half a point higher than whites.

Also in model 7, the main effect for percentage minority approaches 0 and is not significant in our final model, suggesting that the amount white and Hispanic students in advanced math classes learn between 10th and 12th grade is virtually unaffected by variation in school racial/ethnic composition. This is not the case for African American students, who appear to learn slightly less between 10th and 12th grade in schools with a high minority concentration. Comparing the association between percentage minority and academic achievement for African American students in models 6 and 7, it appears that about 50 percent of the effect of minority student concentration for African American students occurs between the 10th and 12th grades.[13] As seen in Figure 2, while the predicted achievement scores of white and Hispanic students remain unchanged as the percentage minority in the school increases, the predicted test scores of blacks begin to decline as the minority school composition increases upward from 20 percent. Although modest in magnitude, this divergence in achievement trajectories is troubling and consistent with the assertion that African American students taking more demanding math courses in highly segregated environments simply are not learning the same material as their white and African American counterparts in less racially isolated schools. This disparity, although slight, is nevertheless indicative of the deleterious effect of school segregation that remains even after family resources and prior academic preparation are taken into account.

The racial/ethnic achievement gap among students in the nonadvanced math stratum. Table 3 presents the results of regression analyses parallel to those presented in Table 2 for students who have not reached any course beyond algebra 2 by the end of high school. As mentioned previously, in model 1, we see that racial/ethnic differences in achievement for students in the nonadvanced stratum are smaller than the differences for similar students in more demanding courses. The

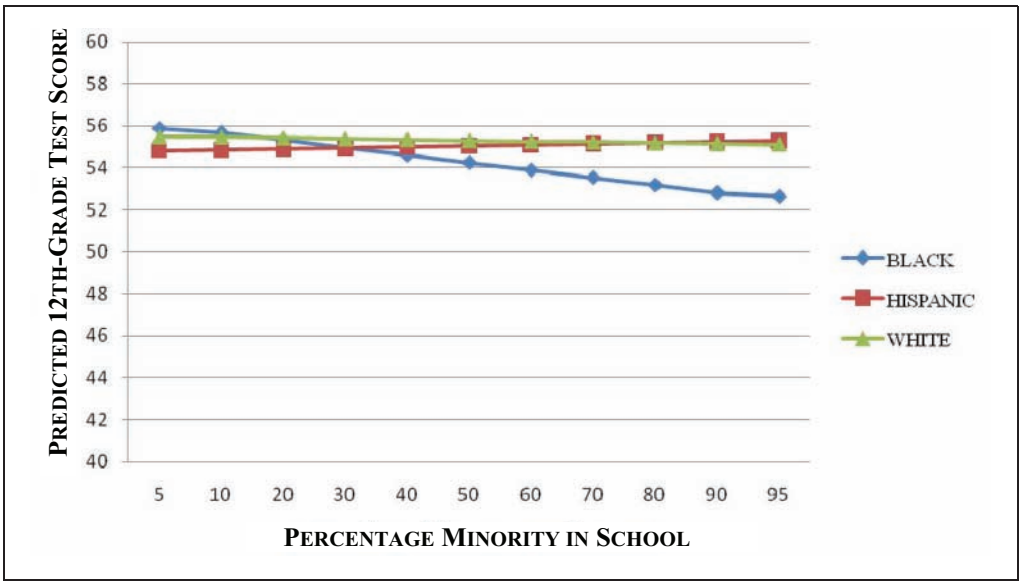

Figure 2. Effect of school racial/ethnic composition on 12th grade achievement among students in advanced math stratum (net of students' academic background)

coefficients are slightly smaller than the gaps in achievement tests showed in Table 1.

We find in model 2 that the inclusion of gender, immigrant status, and remedial math participation (all of which are negatively and significantly associated with test score) does not contribute to much reduction in the average majority/minority gap. Parental education and income significantly predict test scores (model 3), and the coefficients for black and Hispanic are reduced, but more so for Hispanic than for black students (approximately 14 percent for Hispanics and only 6 percent for blacks). Additional *t*-tests reveal that the coefficient for parental education level observed in Table 2 for advanced students is significantly larger than it is here for nonadvanced students. We allow for differential effects of social origin measures across racial/ethnic groups in model 4. In contrast to students in the advanced math stratum, the association between social origins and math achievement among students completing less demanding math courses appears uniform across racial/ethnic groups.

In model 5, we introduce measures of school racial/ethnic composition. We find that segregation is negatively associated with math achievement and mediates a small share of the racial/ethnic achievement gaps. The net association between minority concentration and mathematics achievement is about half of what it is for students taking advanced classes. Interaction terms in model 6 suggest that the negative effects of minority student concentration may be born more by Hispanics (−0.024), but none of the segregation terms attain statistical significance in that model. Thus, the negative effects of segregation on achievement appear to occur primarily among students in advanced-level math courses. Finally, in model 7, with the introduction of the indicators of students' prior academic preparation, the racial/ethnic gap in achievement among nonadvanced students becomes statistically indistinguishable from zero. Additionally, neither parental education nor family income is statistically significant a predictor of learning over the final two years of high school.

DISCUSSION

In this article, we explore racial/ethnic differences in math achievement among high school students completing different levels of mathematics course work. We find that the mathematics achievement gap, particularly for African American and white youth, is most pronounced among students completing the most demanding courses.

Additionally, the processes leading to racial/ethnic differences in mathematics achievement seem contingent on the level of mathematics courses (advanced vs. not) students complete. We also observe interesting differences in the factors that contribute to the Hispanic/white gap and to the black/white gap in test scores among advanced math students.

With regard to social origin, we find some evidence that differences in levels of income and parental education contribute more to the Hispanic/white test score gap among students in the advanced math stratum than among those in the nonadvanced stratum. Among the latter group (those who fail to take any math beyond algebra 2), racial/ethnic differences in parental education and family income account for 16 percent of the Hispanic/white achievement gap (calculated by comparing average gaps from model 2 to model 4); yet among those who complete at least one math class more demanding than algebra 2, we find that differences in social origins account for a larger share of the Hispanic/white difference in math achievement (about 27 percent). Social class differences appear less consequential with regard to black/white achievement differences, accounting for less than 10 percent of the test score gap, both among those taking advanced courses and those not.

Minority parents appear just as effective as white parents in translating the advantages of high levels of social class to their children's achievement in advanced math classes, if not more so. The minority/majority test score gap among students reaching courses beyond algebra 2 is widest among those students with the lowest levels of family income and narrows considerably as income level increases. This pattern applies to students' 12th-grade math achievement for both minority groups. Yet while high levels of parental income yield greater returns for learning between the 10th and 12th grade for Hispanic youth than for white youth, African American and white students enjoy virtually identical returns to income during this time (as seen in Figure 1). Interestingly, we observe no racial/ethnic difference in the returns to socioeconomic status among those students in the nonadvanced math course-taking stratum.

Our findings differ from previous studies suggesting that minority parents may face differential obstacles in translating their social class advantage to their children (Gosa and Alexander 2007; Grodsky et al. 2007; Lubienski 2002). One plausible explanation for these divergent findings is that more advantaged minority youth are simply less likely to take advanced math courses than more advantaged white youth. Once enrolled in those courses, however, minority youth see the same achievement benefits of higher socioeconomic levels as white students. Subsequent analyses of our data offer some support for this assertion. Black and Hispanic students at higher levels of parental education have a significantly lower probability of being in the advanced math stratum than similarly privileged white students. For example, white students whose parents have a master's degree have a predicted probability of .67 for being in advanced math, compared to a probability of .57 for black students and .48 for Hispanic students from similarly educated families (see Appendix Table A.1 for results). Such patterns may be due to the advice or actions of school personnel, or minority/white differences in preferences for advanced math, or information or ability to advocate for inclusion in such courses (Kelly 2009). Our results in Table 2 showing the relative test score advantage of low-income white students are also consistent with the notion that whites sometimes enjoy advantages that are relatively independent of their social background, a possibility to which we return in the following.

In addition to considering how social class background contributes to racial/ethnic test score gaps among advanced students, we also consider the role of the compositional characteristics of the schools that students attend. We find that school segregation contributes to racial/ethnic differences in mathematics achievement for African American students enrolled in advanced math courses, who experience more than twice as much of a decline in mean test scores as whites for each percentage point increase in the share of minority students attending their high schools. Furthermore, while the association between minority concentration and growth in mathematics achievement over the last two years of high school is not statistically significant for white and Hispanic students, it remains negative and significant for African American students even after adjusting for 10th-grade math scores.

What drives the association between school segregation and African American student achievement at the high end of the math curriculum, and why are white students in high concentration minority schools not similarly affected?

Our study is limited in its ability to clearly discern the mechanisms driving such patterns. As mentioned earlier, the deleterious effects of school segregation are typically attributed to school resources (including the presence of qualified teachers), the economic status of the other families of students who attend the school, or the oppositional culture of minority youths as evidenced by their antischool behavior and attitudes (Downey 2008). In additional analyses, we attempted to account for each of these factors using the limited indicators available to us in ELS.[14] These controls fail to attenuate the negative effects of school segregation on the achievement of black youth enrolled in advanced high school math courses. Yet perhaps with more refined indicators, such as teachers' scores on achievement tests, or evidence of their substantive or pedagogical training, or more detailed survey items that better capture the potential onus of "acting white" for black students, our results might differ.

Additionally, we are limited in our ability to understand the extent to which stereotype threat contributes to the black-white achievement gap among advanced students. Experimental studies are especially well suited to the task of discerning the extent to which stereotypes of inferior academic ability are cued for black students in a testing situation (Inzlicht and Ben-Zeev 2000). Observational data on the racial/ethnic composition of the advanced math classrooms in which students were enrolled might better capture the likelihood for minority students to be deterred by stereotypes. While school-level data may be suggestive, the composition of the most elite spaces in any school is apt to be more privileged (and in this case more white) than the school as a whole. We hope that future studies will collect these classroom-level data.

Finally, another possibility that is difficult to test empirically is that there is a privilege to whiteness that defies social space. Even (and perhaps especially) in high-minority environments, teachers may expect more from white students than they do from African American students, as race functions to signal social status even within schools. Ethnographic research provides some support for this assertion. For example, Morris (2005) finds that teachers attribute a higher socioeconomic status to white students within a high minority school. This (mis)attribution leads teachers to hold higher expectations for white students than for black students. Bettie (2002) reports similar findings, consistent with Lareau and Horvat's (1999) argument that being white is a form of cultural capital within schools.

Due to data limitations, our attempts at explaining the negative effects of school segregation on the achievement of black youth in advanced math courses remains speculative for the time being. Beyond the omission of items that would more precisely measure stereotype threat, the racial/ethnic composition of the classroom, or the potentially disparate experiences of white and minority students in the same classes, the outcome measure is less than ideal. Tests in ELS are quite sensibly calibrated to produce optimal measures of mathematics knowledge across the full range of American high school students. Despite the use of multiple test forms, only about 10 percent of the items in the senior year ELS math assessment are designed to measure advanced topics such as precalculus and analytic geometry (Bozick and Ingels 2008). The limited coverage of advanced math hinders the reliability of the dependent variable for the upper end of the achievement distribution, possibly resulting in conservative estimates of the negative effects of segregation on achievement for black students in advanced classes.

Despite limitations, our results reveal a troubling paradox with regard to black students' opportunities to learn. Kelly (2009) finds that black students have less access to high-track math classes when they attend integrated schools, where the limited slots available are likely to be filled by white students. However, our study suggests that the greater access to advanced math courses enjoyed by minority students in a highly segregated environment may not be accompanied by commensurate gains in math knowledge.

CONCLUSION

Racial/ethnic differences in academic achievement remain of central concern in both educational policy and research on social stratification. In this article we move beyond previous work on aggregate test score differences to focus on differences among students in the different strata of high school math course-taking. Our motivation for doing so is twofold. First, we agree with Ferguson (1998), Hedges and Nowell (1999), and others who have argued that gaps at the top

of the academic achievement distribution have not been adequately studied in the past, particularly in light of the relatively modest changes in the minority-majority achievement gap over time for high-achieving students. Second, from a purely instrumental perspective, students who complete advanced mathematics courses in high school are more likely than other students to attend college and complete a four-year college degree (C. Adelman 1994, 1999). By focusing on students in the upper stratum of the secondary math curriculum, we focus on those students most likely to replace today's managers, professionals, and civic and business leaders.

While our analyses reveal that minority students in advanced classes fall further behind the achievement of their white peers (relatively speaking) than students completing only lower level classes, our results (as shown in Table 1) are also consistent with prior research demonstrating that being in advanced math classes improves mathematics achievement for all students (Attewell and Domina 2008; Dauber et al. 1996; Gamoran and Hannigan 2000; Mickelson and Heath 1999). The differential achievement returns to advanced math classes for racial/ethnic groups that we document should not overshadow the academic benefits that minority students in such classes receive when compared to those not participating in advanced math. To the extent that black and Hispanic students still have disproportionately low rates of representation in these classes, equality of opportunity to learn is inhibited (Kelly 2009). Our results simply take the stratification of learning a step further, showing that equality of course participation may not be enough.

Finally, we note that the effects of social origin and school composition on students' learning between 10th and 12th grade are relatively modest. One might then view these results more optimistically as a sign that things are not as bad as they might be. Alternatively, one might reasonably expect that increasing access to advanced-level courses for minority youth would be the best strategy for attaining equity in racial/ethnic achievement patterns. The fact that minority youth who successfully persevered to reach advanced math courses are actually further behind their white peers, relatively speaking, is indeed troubling from this perspective, as is evidence that this gap is more pronounced for black students in segregated schools and Hispanic students from low-income families. As a nation we have taken great strides in the past few decades toward providing equality of educational opportunities to minority youth. Nonetheless, our analyses suggest that below the surface patterns of mathematics course participation, inequalities remain.

AUTHORS' NOTE

Opinions reflect those of the authors and do not necessarily reflect those of the granting agencies.

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NOTES

1. Throughout the text, we alternate usage of the words *black* and *African American*, given the prevalence of both terms in the sociological and educational literatures.
2. We recognize that the Hispanic population in the United States is a very heterogeneous one. Prior research indicates that achievement patterns among Hispanic youth may vary both by generational status and country of origin and that obstacles to educational attainment may likewise vary (Kao and Tienda 1995; Oropesa and Landale 2009; Schmid 2001). It is nevertheless apparent that educational differences between white and Hispanic students are generally much larger in magnitude than the within-group differences observed among Hispanic youth (Wotjkiewicz and Donato 1995). While an in-depth consideration of the variation in predictors of educational achievement within the Hispanic student population is outside of the scope of this study, we do control for students' generational status in all analytic models. In exploratory analyses we also controlled on country of origin, but the overwhelming majority of Hispanic students in the sample are of Mexican origin and this indicator was never significant.
3. For a review of this literature, see Downey (2008).
4. In exploratory analyses, we also included indicators for intact family structure, language spoken at home, and educational expectations. These

variables did not change any of the primary results here and in many cases were not statistically significant predictors. We therefore chose the more parsimonious model presented here.

5. In models not shown, we coded parental education and family income as dummy variables. The coefficients demonstrate linearity in the conditional relationship between social origin measures and math achievement and are substantively similar to those we present here.
6. The Education Longitudinal Study of 2002 (ELS) data include imputed values (via sequential hot deck imputation) for certain key variables, including test scores, family income, and parental education (Ingels et al. 2007). We therefore used these imputed values in our analyses. The percentage of cases in our analytic sample imputed for these variables includes 23 percent for family income, 9 percent for parental education level, and 12 percent for math test scores. For other missing data for variables not imputed by ELS, we used the "impute" command in Stata that organizes cases by patterns of missing data and then runs regressions to determine predicted values. (We also explored using mean substitution and multiple imputation to compensate for item nonresponse. The results we present are robust to these alternative approaches.) The percentage missing for these other variables was as follows: generational status: 13 percent; math grade point average: 12 percent; and percentage minority in school: 3 percent.
7. We estimate all models in Stata and show unweighted estimates (with sample sizes rounded to the nearest 10 in compliance with Institute of Education Sciences regulations). Stata is not able to accommodate weights in the mixed models of the sort we estimate. Weighted estimates for other (single-level) models we produce are substantively identical to those we show here. This is not surprising since we adjust for the characteristics on which student oversampling was based (race/ethnicity) and restrict our analysis to students in public schools, thereby implicitly conditioning on school stratum as well (Winship and Radbill 1994). We also ran our models using hierarchical linear modeling (HLM). The results were comparable to those reported here.
8. Percentages can be calculated using the group sample sizes (*N*s) reported in Table 1.
9. Pooled models with race by math stratum interactions predicting 12th-grade test score confirm that both the black-white gap and the Hispanic-white gap are significantly larger among students in the advanced math stratum compared to the nonadvanced stratum.
10. There are only three exceptions to this trend. For African American students, the proportions of females in both the advanced and nonadvanced math groups are not statistically different. Also, among Hispanic students, there is not a statistically significant difference in the proportion of students from intact families between students in the two math groups. Finally, the percentage minority in the school does not differ between Hispanic students in advanced and nonadvanced math; however, for both black and white students, students in the advanced stratum attend schools with a statistically significantly higher percentage minority composition compared to those in the nonadvanced stratum.
11. In preliminary analyses, we first ran models with school racial-ethnic composition variables (both main effects and interactions with student race-ethnicity) that did not include the indicators of family socioeconomic background, thereby allowing us to see the gross contribution of school segregation to the black-white and Hispanic-white test gap. The coefficients for school racial-ethnic composition were very similar to those shown here in models 5 and 6.
12. We also experimented with estimating change score models, taking grade 12 – grade 10 test score as the dependent variable. Results were the same as those reported here (with the coefficient for 10th-grade test scores approaching unity).
13. Net of other attributes, model 6 suggests that African American students lose 0.076 points for each additional percentage point in the share of students at their school who are African American or Hispanic (0.034 + 0.042). If we confine our attention to achievement growth over the final two years of high school (model 7), we see that African American students lose 0.036 points for each additional percentage point in the share of students at their school who are African American or Hispanic.
14. For oppositional culture indicators, we created a mean scale of how important it was to the student's friends to attend classes regularly, study, get good grades, finish high school, and continue past high school. We also included measures of the importance of good grades and how frequently the student got into trouble at school. These measures are consistent with those used by Harris and Robinson (2007) in their study of oppositional culture, but arguably do not capture key aspects of oppositional cultural theory, such as the degree to which minority students perceive that their future opportunities will be constrained by their race (Harris 2008). For teacher quality, we included measures of whether the student's 10th-grade math teacher was new to teaching, new to the school, certified, had a degree in math, and had taken five or more math courses in college. Ideally, we would have data for students' 11th- and 12th-grade math teachers, namely, those who are instructing the advanced courses in which minority students are trailing their white peers.

Finally, we also included measures of the percentage of the student body eligible for free or reduced-price lunch and school means for family income and parental education level. None of these indicators reduced the Black × Percentage Minority coefficient observed in model 7 for the advanced math stratum in either size or significance. These results are available upon request from the first author.

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