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The Path Through Math:  
Course Sequences and Academic Performance  
at the Intersection of Race/Ethnicity and Gender

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**Abstract**

Using new national data from Adolescent Health and Academic Achievement (AHAA), this article examines high school math patterns for students of different race/ethnicity and gender. Compared to white males, African American and Latino males receive lower returns to taking Algebra I freshman year, reaching lower levels of the math course sequence when they begin in the same position. This pattern is not explained by academic performance, and furthermore, African American males receive less benefit from high grades. Lower returns are not observed for minority female students, suggesting that more attention to race/ethnic inequality in math among male students is needed.

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Students' academic achievement in high school has clear consequences for their lives after graduation, including their college attendance and persistence, as well as success in the labor force (Adelman, 1994; Csikszentmihalyi & Schneider, 2000; Lee & Frank, 1990). A key component of high school achievement is the completion of advanced level courses in math, as such courses expose students to cognitively demanding curriculum, offer opportunities to interact with highly skilled teachers and classmates, and provide an important educational credential on students' high school transcripts (Gamoran, Nystrand, Berends & LePore, 1995; Gamoran, 1987; Hallinan, 1996; Hallinan & Kubitschek, 1999; Lucas, 1999; Riegle-Crumb, 2003). Previous research has clearly demonstrated that math course-taking patterns are characterized by strong racial and ethnic disparities, such that African American and Latino students take fewer advanced level math courses by the end of high school compared to their white peers (Jones, Mullis, Raizen, Weiss, & Weston, 1992; Lucas, 1999; NCES, 2001). Yet much less is known about the process that leads up to this inequitable outcome. This article offers new empirical evidence about the process through which inequality emerges, by examining whether all students benefit equally from beginning high school at the key threshold of Algebra I, or whether in fact African American and Latino students remain behind their white peers in the level of math reached by the end of high school even when they start at the same place.

Additionally, while previous research has brought attention to the under-representation of African American and Latino students in advanced level math courses,

there has been much less attention to the intersection between gender and race/ethnicity (Hanson, 1996; Muller, Stage, & Kinzie, 2001). Recently, the gender gap in advanced level math course-taking has closed, such that females are now as likely to take advanced classes such as Pre-calculus and Calculus as their male peers (AAUW, 1998; Bae, Choy, Geddes, Sable, & Snyder, 2000; Xie & Shauman 2003). While this indicates clear progress for young women generally, understanding how this relates to the educational attainment of African American and Latina girls is complex, as they may equally or even outperform their male peers, at the same time that they remain behind white students of their own gender. Thus the intersection between gender and race/ethnicity with regard to course-taking warrants further attention, and is a main focus of this article.

Finally, this article examines the role of academic performance in shaping the progress of students of different genders and race/ethnic groups through the sequence of high school math courses. Course failure is potentially a major obstacle to students' attainment of advanced level math courses, regardless of their initial math course, and therefore could help to explain why minority students might not receive the same return to their math courses early in high school. Yet it is also possible that the link between performance and advanced level math course-taking is not the same for students of different genders and race/ethnic groups. Examining how grades shape the process of students' math course-taking from the beginning to the end of high school is an important part of understanding race/ethnic and gender inequality in math attainment.

To assess disparities in the process of math course-taking across high school and the role of academic performance in this process, the analyses utilize a new nationally representative educational dataset, the Adolescent Health and Academic Achievement

study (AHAA). The AHAA is a recently completed high school transcript study and a component of the National Longitudinal Study of Adolescent Health (Add Health). In contrast to other education datasets, using data from AHAA and Add Health provides the chance to examine inequality in high school during the 1990's. Specifically, I address two main questions. First, I analyze whether the benefits of beginning high school at a particular point in the sequence of high school math courses, i.e. Algebra I, are equivalent for minority students of both genders, compared to majority students. In other words, do African American and Latino students, both male and female, ultimately reach comparable level math courses as their white peers when they begin in the same course position? Second, I examine the role that academic performance plays in the process of students' math course-taking, to understand whether students from different genders and race/ethnic groups might not reach comparable levels of math despite starting in the same position because of lower grades, or whether in fact, the consequences of grades themselves vary by race/ethnicity and gender.

### ***The Path Through Math: Course Sequences***

Course-taking patterns in math can be thought of in terms of a hierarchical sequence of courses, where individual courses that are part of a larger unified subject are taught by progressive level of difficulty throughout each year of high school (Adelman, 1999; Schneider, Swanson, & Riegle-Crumb, 1998; Stevenson, Schiller, & Schneider, 1994). Previous research has documented a hierarchical math sequence categorized at the lower end by general math and beginning Algebra classes, and at the high end by advanced courses such as Trigonometry and Calculus (Stevenson, Schiller, & Schneider,

1994). Skills and concepts build on one another throughout the sequence, meaning curricula in one class must generally be mastered before students can successfully move on to the next course in the sequence.

The hierarchical nature of math course-taking and its accompanying structure of pre-requisites creates a positional advantage for those students that begin high school taking courses that are higher on the sequence (Schneider, Swanson, & Riegle-Crumb, 1998). In contrast to other subjects such as English, math offers a much less ‘open’ path, so that where a student begins the math sequence is strongly connected to how far they can reach by the end of high school (Lucas, 1999). Thus, given the same number of years of high school attendance, it follows logically that students who begin high school taking courses at the lowest level of the hierarchy are extremely unlikely to reach the same level at the end of high school as those who started at higher levels.<sup>1</sup> Specifically, if students do not begin high school taking Algebra I or Geometry, they have little chance of reaching advanced math courses such as Trigonometry and Calculus—and it is these courses that most strongly predict college attendance, both overall, and at elite postsecondary institutions (Adelman, 1999; Riegle-Crumb, 2003; Schneider, 2003).

Yet while starting at a higher position in the math sequence is a necessary step for reaching advanced courses by the end, it is not sufficient. Among students who begin high school taking the same math course, the attainment of identical trajectories is not certain. Through out the intervening high school years, a multitude of factors can operate to push students out of a position of relative advantage, and certain students may be at a higher risk of losing this initial course advantage than others. Research focusing on broadly defined academic tracks has addressed whether the course trajectories of

minority groups follow patterns similar to those of other students (see for example, Hallinan, 1996; Lucas, 1999; Lucas & Berends 2003).<sup>2</sup> In general, this research offers evidence that African American and Latino students may be more likely to ‘fall out’ of an advantaged position compared to their white peers.

In regard to the highly sequenced math courses that students take throughout high school, the issue of potentially different returns to initial math course position has clear implications for understanding educational inequality in high school, and for designing policies to reduce it. For example, if in fact African American and Latino students receive the same return to early course-taking -- such that when they begin high school in the same level of the math sequence, they subsequently reach the same level by the end of high school---, then the biggest hurdle to racial/ethnic inequality is the initial course position and the processes that led up to it. However, if these minority students do not receive the same return from beginning in a relatively high course position, then we need to focus on understanding the factors that operate throughout the years of high school that push them out of this initial position of advantage. This detailed focus on math course sequences will enable more definitive conclusions to be drawn and policies designed to promote equitable outcomes among students of different race and ethnicity.

### ***Math and the Intersection of Race/Ethnicity and Gender***

While race and ethnicity represent a key axis of stratification within contemporary society, such categories simultaneously intersect with other characteristics of individuals’ identities and histories that have additional implications for inequality, such as gender. Currently, there is evidence that the gender gap in high school math course-taking has

disappeared, such that overall, girls are as likely as boys to take Calculus, for example (AAUW, 1998; Bae, Choy, Geddes, Sable, & Snyder, 2000; Xie & Shauman 2003).<sup>3</sup> Until very recently, girls were under-represented in advanced math courses in high school- and the math male advantage was cited as present among all racial groups (Jones, Mullis, Raizen, Weiss, & Weston, 1992; Muller, Stage, & Kinzie, 2001; Mullis, 1993; Peng, Wright, & Hill, 1995.) Yet little attention has been paid to whether this new and more gender equitable pattern extends equally to girls of all race and ethnic groups. It is likely for example, that factors previously noted as influencing girls to leave the math/science pipeline, such as gendered stereotypes and differential socialization (Correll, 2001; Eccles, 1994; Eccles, Barber, & Jozefowicz, 1999), are still operating, perhaps with particular salience for girls in racial/ethnic minority groups, who may suffer a ‘double penalty’ as both minorities and females (Barajas & Pierce, 2001). Latinas in particular may be more responsive to stereotypes or gender norms, and to the extent that stereotypes of math as a predominantly male white field continue to operate, they may be less inclined than other females to pursue advanced courses in math (Catsambis, 1994).

However, prior research is somewhat equivocal with regard to gender differences in educational achievement among disadvantaged minority students. In fact, there is some evidence of a general trend of Latinas and African American females outperforming their male peers (Clewell & Anderson, 1991; Mickelson, 1989; Roderick, 2003). For example, Latinas have lower rates of school drop-out compared to Latino males, and both Latinas and African American females are more likely to complete a bachelor degree compared to their male peers of the same race/ethnic group (Bae, Choy, Geddes, Sable, & Snyder, 2000). Furthermore, on standardized achievement tests

administered with the National Assessment of Educational Progress (NAEP), Latinas had higher average math scores than Latino males (AAUW 1998). Finally, in some cases minority females may be more inclined towards math than their white female peers. Among adolescents, black females report more favorable attitudes towards math than white females, and higher self confidence of their math abilities (Catsambis, 1994; Mau & Domnick, 1995 ).

The complexity of the intersection between gender and race/ethnicity for students' academic outcomes has been acknowledged in prior research (Hanson, 1996; Mickelson 1989; Muller, Stage, & Kenzie, 2001). This article pays explicit attention to whether gender shapes the formation of math sequences of students of different race and ethnic groups in high school- and whether the returns to initial course positions are equivalent among different race/ethnic *and* gender groups.

### ***The Role of Student Performance in Shaping Students' Math Sequences***

Given the sequential basis of math course-taking, where continued progress is based on completion of a prior course, a students' performance in one course has clear implications for their chances of continuing onto the next. Thus, a key reason why any student, regardless of gender or race/ethnicity, might not progress as far as others in the math course sequence is having low grades. Generally speaking, the grades that students earn in high school reflect several different aspects of the process of educational attainment (Linn & Kessel, 1996). First, they represent students' ability to master the curricular material of a certain class. Yet they also capture the degree to which a student meets teacher expectations, both in terms of actual performance, and more subjectively in

terms of attitude and behavior (Farkas, Grobe, Sheehan, & Shuan, 1990; Moreno & Muller 1999). Additionally, grades reflect students' effort and engagement, as they make choices concerning how hard to work and study for a certain course, and how much effort to exert into meeting the teachers' general expectations of being a good student (Johnson, Crosnoe, & Elder 2001; Rosenbaum, 2001).

Low grades can be a major impediment to moving forward, and alternatively high grades can act as a major facilitator of moving ahead. On the extreme end, if students fail a course, they may be required to take it again before moving onward in the sequence. Even when students fail only one semester, this may function to discourage them from continuing. At the opposite end of performance, students who receive high grades clearly meet the pre-requisites for progress onto the next course in the sequence, and teachers, counselors, and parents may encourage such students more, in the presence of this tangible record of academic achievement. Additionally, while performance throughout high school is important for shaping students' trajectories, performance in the first year of high school in particular is critical (Weiss, 2001). At this crucial juncture, grades serve not only as a structural pre-requisite for continuing in the sequence, but are also likely to set the stage psychologically- in terms of students' expectations for themselves- and socially- in terms of others' perceptions and evaluations of students' abilities and potential. Recent work on Chicago schools by Roderick and Camburn (1999) underscores the importance of performance at the beginning of high school, as students who experience academic difficulty during the first few semesters of high school are unlikely to recover or improve.

With regard to differences across groups, Latino and African American students have higher rates of course failures (Roderick & Camburn, 1999) and generally receive lower grades than their white peers (Ainsworth-Darnell & Downey, 1998; Ferguson, 2001). In general, high schools girls earn higher grades compared to boys in all subjects, including math (AAUW, 1998; Mickelson 1989; Muller, 1998; NCES, 2001). This gender advantage in grades is often viewed in the context of girls' greater desire to please others, meet expectations, and generally comply to rules (Catsambis, 1994; Johnson, Crosnoe, & Elder, 2001; Xie & Shauman 2003). Yet there is little recent empirical research examining differences in academic performance across different gender and race/ethnic groups.

To the extent that grades represent the academic merit that students possess and that teachers and students themselves recognize, we might expect that other things being equal, as girls generally get higher grades in math, they will progress further in the sequence of math courses, and that as African and Latino students receive lower grades, they will not progress as far as others. Yet this logic assumes that the link between performance and course-taking functions similarly for all students, which may not in fact be the case. For example, the greater prevalence of academic failures among students in their own racial/ethnic group may lessen the psychological blow of individual failure to African American and Latino students. Alternatively, failure may reinforce negative race/ethnic stereotypes and therefore function as more of a deterrent to advanced level course-taking for these students. With regard to gender, girls of all race/ethnic groups may be more responsive to the signals that grades provide than boys, but high grades may

be more important to minority girls compared to white girls, if they are in need of more encouragement to overcome negative stereotypes of gender and race/ethnicity.

Once again, the intersection of gender and race/ethnicity is relevant to the shaping of students' math trajectories. Beginning high school with a certain level math course is only part of the battle, and may have little benefit if students do not achieve a certain level of performance. The analyses here will examine whether differences in performance can help to explain why some students ultimately reach different levels of math by the end of high school, despite starting in the same position, or alternatively, whether the consequences of academic performance are not the same for students of different genders and race/ethnicities.

### *Research Questions*

The subsequent analyses address two primary questions. First, when African American and Latino students begin high school at the same level of the math sequence, do they subsequently receive the same returns from this initial position as other students, and do these patterns differ according to gender? In other words, if these minority students begin high school in the same course position as their white peers, do they ultimately reach the same levels of the math course hierarchy by the end of high school? Second, does academic performance help to explain why students that start at comparable positions in the math sequence might not end high school in equivalent positions, or alternatively, are the consequences of performance different according to students' race/ethnicity and gender?

By addressing these questions, this article will shed light on the qualitatively different academic paths traveled by students of different race/ethnic groups and genders and how the consequences of certain fundamental aspects of the process of educational attainment- taking courses and receiving grades- may be substantively different across student groups. Additionally, by explicitly focusing on the intersection between race/ethnic inequality and gender inequality, this article makes an important contribution to previous research by offering a more detailed picture of educational disadvantage. I address both questions using new nationally representative data of recent high school cohorts from the 1990's, discussed below.

### ***Data and Method***

This study uses data from two related datasets: The National Longitudinal Study of Adolescent Health (Add Health) and the new Adolescent Health and Academic Achievement Transcript Study (AHAA), the education component to the Add Health. The purpose behind the Add Health survey was to explore the health-related behaviors of adolescents in grades 7-12 and the causes of these behaviors, with an emphasis on the influence of social context. Beginning In 1994, Add Health selected a representative sample of 80 high schools and 52 “feeder” middle schools. About 200 adolescents were selected from each of the 80 pairs of schools (high school and feeder), with approximately equal numbers of males and females in each of the six grades (7-12<sup>th</sup>), resulting in a total sample of 20,745 (Bearman, Jones, & Udry, 1997). The complex longitudinal design of Add Health includes the initial student survey in 1994-95, with follow-ups in 1995 and 1996. In 2001-2002, Add Health administered a third wave of

data collection for 15,197 respondents, or 73% of the original Wave I sample. Additional information about Add Health can be found at [www.cpc.unc.edu/projects/addhealth](http://www.cpc.unc.edu/projects/addhealth).

The AHAA data set contributes major new education data to the Add Health data base. The Wave III Add Health data collection included a signed release to collect high school transcripts from all Add Health respondents. Approximately 92.9% of Wave III Add Health respondents signed a valid transcript release form (N=14,113) and the AHAA collected high school transcripts from 87% of them (N=12,258), or approximately 81% of the Wave III sample. Because of the different years during which the six nationally representative cohorts of students ( 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, and 12<sup>th</sup> graders in 1994) attended high school, the AHAA study includes high school transcripts ranging from the beginning to the end of the 1990's.

The AHAA study has completed the collection and initial coding of the high school transcripts of Add Health respondents. Each course that appeared on a student's transcript was coded with a standard coding scheme, the Classification System for Secondary Courses (CSSC), which was developed by NCES and has been used in all major transcript studies, including High School and Beyond (HSB), the National Education Longitudinal Study (NELS), and the National Assessment of Educational Progress (NAEP). Grades and credits earned were also coded to be comparable across the nation. Additional information about the AHAA study is available at [www.prc.utexas.edu/ahaa](http://www.prc.utexas.edu/ahaa).

A major advantage of using AHAA data for the analyses of race/ethnic and gender inequality in math course-taking is its recent timeframe. Given the changes in the last two decades, in regard to emerging patterns of gender equity in advanced levels of

math course-taking, increasing math requirements for graduation, and general policy efforts aimed at promoting equity in attainment- it is important to examine the more recent picture of equality in academic trajectories (see, for example, Schiller & Muller, 2000; Teitelbaum 2003). In contrast to national education datasets such as High School and Beyond (HS&B), and the National Education Longitudinal Study 88/2000 (NELS), which reflect high school attainment in the 1980's and early 1990's, the AHAA study provides a national picture of high school students throughout the decade of the 1990's.

Several filters were applied to the AHAA data to create the analytic sample appropriate for analysis here. First, I utilize data from only four cohorts, the 9<sup>th</sup> through 12<sup>th</sup> grade cohorts, as they are representative of high school students across the nation in 1994-95.<sup>4</sup> I further limit the sample to students in public schools. Third, I exclude students who dropped out of high school, to ensure that the lower levels of course-taking reached by some students at the end of high school was not due to the fact that they left school and therefore had fewer years of data.<sup>5</sup> Further, the sample includes only students with analytic weights to ensure that the data is nationally representative. These filters resulted in an analytic sample of 7101 students in 69 schools, or approximately 60% of the AHAA sample. Analysis of this data reduction indicated that the final analytic sample did not differ significantly from either the complete AHAA sample or the larger Wave III Add Health sample, with regard to demographic and academic characteristics such as race, gender, parent background, and academic performance.<sup>6</sup>

### **Dependent Variable**

*Math Course Sequence Level at the End of High School:* Using the CSSC codes referred to above, the AHAA study constructed a math sequence variable to identify the

course position of students in each year of high school, as well as the highest level of math they reached by the end of high school. The later is the dependent variable in the analyses here. As discussed earlier, because math course-taking is hierarchical and sequential, categories of courses can be arranged into an ordered categorical variable. The categories are: '1' Remedial or Basic Math; '2' General or Applied Math; '3' Pre-Algebra; '4' Algebra I; '5' Geometry; '6' Algebra II; '7' Advanced Math; '8' Pre-calculus; and '9' Calculus.<sup>7</sup>

It is important to point out that students do not necessarily have to progress through each and every level of the math sequence. Many students will begin high school at level 4, Algebra I, without ever taking courses in the lower categories. Most students follow the order of Algebra I, followed by Geometry, and then Algebra II (Schiller & Hunt, 2003). Yet after taking Algebra II, many students will progress to Pre-Calculus without taking Advanced Math, while others may have the option of proceeding directly to Calculus.

### **Independent Variables**

*Math Sequence Position at the Beginning of High School:*. To capture students' math sequence position for the first year of high school, I re-coded the math sequence variable for that year into a dichotomous variable for whether or not a student began high school taking Algebra I or a higher course. I chose this threshold because Algebra I is the most common math course taken by students in the first year of high school. Also, beginning in Algebra I or higher is considered 'on time' for reaching geometry, and subsequently Algebra II (or higher) by the end of high school, and therefore completing the sequence of courses that is required by most colleges and universities, and that also

enables students to perform well on the SAT and other math achievement tests (Adelman, 1999; Pelavin & Kane, 1990; Schiller & Hunt, 2003). For the sake of simplicity, I often refer to this variable as ‘Algebra I’, but it should be noted that approximately 25% of students with a ‘1’ on this variable began high school in a higher course. I constructed interaction terms separately by gender between the dichotomous variable for Algebra I in the first year of high school, and categories of race/ethnicity: African American, Latino, and Asian. To avoid collinearity with the main effects, the interaction terms were calculated by first centering each component variable and then multiplying them together. Variables for race/ethnicity were taken from the student surveys of Add Health.

*Math Performance Variables:* The AHAA study constructed indicators for students’ grade point average and the proportion of courses failed, both overall and for specific subjects such as math and science, based on the grades recorded on students’ high school transcripts. Because most students took courses on a semester basis, these variables are based on semester-length variables. Thus, students GPA for math in a given year represents the average of the grades they received in each semester, while the failure index measures the proportion of semesters they failed.

Using these variables, for the purposes of the analyses here I created two dichotomous variables to capture students’ math performance in the first year of high school. One variable measures whether or not the student failed one semester or more of his or her first year math course, and the other variable measures whether or not they received a “B” or higher grade point average across all semesters of math taken in year. The omitted contrast category is having a “C” or “D” average without failing a semester.

I also constructed centered interaction terms (separately by gender) between these measures of math performance and each category of race/ethnicity.

*Background Individual Variables:* Additional background variables in the analyses come from Add Health. Parent education level is an ordinal variable ranging from ‘1’ for parents who receive a high school diploma or less to ‘4’ for parents who receive a college diploma or higher. The higher education level of a student’s parents is used. I also include controls for family structure (intact two-parent family vs. other) and family income (logged). For students who were missing values for income, I assigned them the sample mean and included a control flag for these students. Additionally, I also included flags for to control on students’ cohort (9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, or 12<sup>th</sup> graders in 1994). None of the flags for imputed mean or cohort were statistically significant in any of the analyses conducted, and therefore are not shown in the tables here.<sup>8</sup>

*Method:* In addition to descriptive techniques, the analyses here are conducted with hierarchical linear modeling (HLM). This method accounts for the clustering of students within schools, and computes robust standard errors that account for correlated error terms for students within the same school. While some other statistical packages such as STATA also deal effectively with clustering within schools, hierarchical models partition the variance of the dependent measures separately into the different levels of analysis. HLM also allows school characteristics to be controlled in the models.

The analyses begin with descriptive statistics to examine variation by race/ethnicity and gender for the variables of interest. This includes the dependent variable of highest math course reached by the end of high school, and the key independent variables of initial math position and early academic performance in math.

Subsequently, I turn to the results of hierarchical linear models to examine differences in returns to initial math position by race/ethnicity and gender. Finally, I present results of hierarchical linear models that test whether academic performance helps to explain the association between initial and final positions in the math course sequence, or whether alternatively, performance does not have uniform effects on course-taking for all student groups. Separate models are conducted for male and female students, to clearly discern the math course-taking patterns of different race/ethnic groups for each gender.

### ***Results***

Table 1 displays percents of the highest math course students reached by the end of high school, separately for each gender and race/ethnic group. This variable will be subsequently used as the dependent variable in subsequent analyses. As observed from the table, there is no male advantage in the percentage of students who reach the most academically elite levels of math, which includes Advanced Math, Pre-Calculus and Calculus. Generally, at the end of high school, this segment of the math sequence can be characterized as gender equitable within each race/ethnic group. The exception to this trend is that both white and African American female students have significantly higher levels of representation than their male peers in the one category of Pre-calculus.<sup>9</sup>

TABLE 1 ABOUT HERE

Race/ethnic differences remain however, and within both genders. White students of both genders have significantly higher representation than African American and

Latino students of the same gender in the elite math categories (Advanced Math, Pre-Calculus, and Calculus). Thus, recent data from the new AHAA study confirms previously found trends of stratification in high school course-taking by race and ethnicity.

Table 2 displays percentages by gender and race/ethnicity for the distribution of students taking Algebra I (or higher) in their first year of high school. In all categories of race/ethnicity, girls display slightly higher representations than their male peers. However, this gender difference, or female advantage, is statistically significant only among white students. Within each gender group, white and Asian students have significantly higher levels of representation in Algebra I compared to African American and Latino students of the same gender. These students trail behind their white and Asian peers by at least 15% in each gender, indicating that there is a considerable degree of inequality at the beginning of high school.

#### TABLE 2 ABOUT HERE

Table 2 also displays descriptive statistics by gender and race/ethnic category for the distribution of students' grades in their first year math course. Failure rates are significantly higher among African American and Latino students, compared to their white and Asian peers of the same gender. Approximately twenty percent of all male African American and Latino students fail their freshman year math course, with slightly less of their female peers exhibiting a similar disadvantage. This is part of a general pattern of lower failures for all female students compared to their male peers of the same

race/ethnicity, but this gender difference is statistically significant only among white students. Failure rates are significantly lowest among Asian students of both genders.

A corresponding pattern is observed for high grades. Within each gender, the percentage of African American and Latino students with high grades is significantly lower than the percentage for whites. Additionally, well over fifty percent of Asian students of both genders receiving an ‘A’ or ‘B’ in their first year math course, which is significantly greater than any other race/ethnic group. And while females of every group appear to have higher grades than their corresponding male peers, this gender advantage is significant only among white students.

In sum, these bivariate descriptive analyses indicate race/ethnic disadvantage among both genders at the beginning and the end of high school. African American and Latino male and female students begin high school at lower levels of the math sequence, and remain at lower levels at the end of high school. In the next section, I examine if holding this initial disparity in math course position constant, there are equal benefits to taking Algebra I or higher the first year of high school for students of different race/ethnic and gender groups. Finally, I examine whether lower returns might be due to levels of academic performance, or whether alternatively, the consequences of performance are themselves different across student gender and race/ethnic groups.

### **Results of HLM**

*Examining the Returns to Algebra I:* Table 3 displays the results of HLM analyses, performed separately by gender, predicting the highest math course taken by the end of high school.<sup>10</sup> Controlling on the other variables in the models, there are no significant main effects for African American or Latino students of either gender,

compared to white students. Asian students of both genders reach significantly higher levels of math. Taking Algebra I or higher in the first year of high school has a strong effect on the level of math attained by senior year. This is consistent with prior research on math course-taking, and confirms the hierarchical and sequential nature of math in high school. The higher students start in the math sequence, the higher they finish.

### TABLE 3 ABOUT HERE

Yet the results in Model 1 also indicate that the returns to Algebra I are not equal for all male students. The effect of taking Algebra I is significantly lower for both African American and Latino males students, compared to white students. This pattern is unique to male students. For female students in Model 2, there are no significant effects of the race/ethnic interactions with Algebra I, and tests between the coefficients in the male and female models confirm that they are significantly different. Therefore, for female students, the returns to Algebra I do not differ according to race/ethnicity. If a female African American or Latino student does take Algebra I, she receives the same advantage as her white female peers in terms of reaching a higher level of math by the end of high school.

Although the primary focus of this article is how race/ethnicity and gender shape the math course trajectories of individuals from the beginning to the end of high school, prior research indicates the importance of considering the influence of school characteristics on students' achievement (see for example, Pong 1998, Van Houtte, 2004). Thus, I also conducted Level 2 models where the slopes for the interaction

between race/ethnicity and Algebra I course-taking (at Level 1) are the dependent variable, and the independent variables are characteristics of schools, including size, location, racial composition of the student body, and the average educational background of students' parents in the school. None of these school characteristics had significant effects, indicating that the differential returns to Algebra I for male students of different race/ethnic groups do not vary according to these aspects of the school context.<sup>11</sup>

In summary, there are clear gender differences in the role that race/ethnicity plays in the benefits of early math course position. The results in Table 2 indicated that African American and Latino females are in fact significantly under-represented in Algebra I at the beginning of high school compared to white females. Yet Table 3 indicates that those minority females who do take Algebra 1 receive the same benefits. For African American and Latino males however, the disadvantage appears to be twofold: lower initial position, and lower returns even when the initial position is equal.

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#### FIGURE 1 ABOUT HERE

To better understand the magnitude of this particular disadvantage for African American and Latino males, Figure 1 graphically displays the lower returns to Algebra I for these male students compared to white males as observed in Table 3. The figure shows the predicted level of the math sequence by the end of high school for separately by race/ethnic group for male students who begin in Algebra I. These values are calculated for male students with average levels of parent education and income who

come from intact families. Although I also calculate the predicted returns to Algebra I for Asian male students, it should be noted that there are not statistically different returns to Algebra I for these students compared to white male students.

As seen in the figure, the lower returns to initial math position for African American and Latino males are apparent. The difference between African American and white males is .4, or almost half of a sequence level, and the difference between Latino and white males is .3. For African American male students of otherwise average background, this translates into a predicted math sequence level of 6.6 at the end of high school. Similarly, Latino males have a predicted math sequence of 6.7. Thus, both groups have predicted levels lower than the threshold for Advanced Math. This is in contrast to white males, who have a predicted level of 7 on the math sequence, indicating that when they take Algebra I, they will on average reach Advanced Math by the end of high school.

The differential returns to Algebra I for African American and Latino males compared to white males are therefore not only statistically significant, but substantively so. Recent research by Adelman (1999) indicates that while taking Algebra II by the end of high school does increase the chances of going to college compared to those who do not, the crucial threshold in predicting college matriculation is reaching a course *beyond* Algebra II. The implications of the differential race/ethnic returns to initial course position observed here are that, on average, white male students who begin high school taking Algebra I will successfully reach a critical course position by the end of school, while African American and Latino students will not. Thus, the reduced benefits of initial course position offered to minority male students signal not only stratification in

the high school years, but inequality that has tangible consequence for success after high school.

*Considering Academic Performance:* The next analyses examines the role of early student performance, to determine whether the lower returns to Algebra I for male African American and Latino compared to white male students are due in part to lower grades, or whether in fact the consequences of grades are not the same for all students.

#### TABLE 4 ABOUT HERE

Table 4 displays the results of HLM analyses that include measures for failure and high grades in math during the first year of high school, and interaction terms between these performance variables and categories of race/ethnicity.<sup>13</sup> Beginning with the model for male students, the results indicate that even after taking into account academic performance, the lower returns to Algebra I for African American and Latino males are virtually unchanged. The interaction between race/ethnic group and Algebra I remains negative and statistically significant for these students.

Overall, it is clear from the main effects that failure has a strong negative effect on the level of the math sequence reached by the end of high school, and receiving high grades early in high school has a strong positive effect. Thus, to the extent that minority male students are more likely to fail and less likely to receive high grades in their first year, they will reach lower levels of math by the end of high school. Nevertheless, this does not explain the fact that African American and Latino males who begin high school in Algebra I receive lower returns from doing so than their white peers.

Additionally, the interaction effects for male students also reveal lower returns for African American male students who receive an 'A' or 'B' in their initial math course. The positive effect of high grades on the math sequence level is significantly lower for these students compared to their white peers. Therefore, earning high grades does not have the same beneficial consequences for African American males as it does for white males.

It should be noted that the interaction terms displayed here do not account for the level of the math course a student took in their first year of high school. Additional three-way interaction terms (race/ethnicity \* performance \* Algebra 1) were computed for both failure and high grades, and added to the model. These interaction terms tested whether the effect of failure and high grades differed according to whether or not the student took Algebra I, and whether this differed by race/ethnicity. None of the interaction terms were statistically significant. Thus, the effects of failure for male students of different race/ethnic groups does not vary according to their initial math course, nor does the lower return to high grades for African American males differ based on whether they begin high school in Algebra I or in a lower course.

Table 4 also displays a parallel model for female students. The main effects for failure and high grades are comparable for female students and male students. However, the interaction term for failure of African American female students is positive and statistically significant. While failure generally decreases the level of math that female students attain by the end of high school, it has less of a negative effect for African American females compared to white females. This suggests a somewhat greater resiliency of African American females to academic difficulties and discouragement in

math, and again suggests that the meaning and consequences of grades are not uniform across all student groups.

### ***Discussion and Conclusion***

This paper examined the high school math course-taking trajectories of high school students of different race/ethnic groups and genders using nationally representative data from the 1990's. While much has been written focusing on patterns or disparities based on one distinction or the other, there has been little work that specifically focuses on the intersection of gender and race/ethnicity. The analyses in this paper clearly reveal that race/ethnicity does not shape math course-taking in identical ways for male and female students. Yet in the midst of a continuing focus in academic research on gender inequality in math, and the recent media attention on that topic, the story here is not specifically one of feminine disadvantage. Instead, this article focuses much needed attention on the particularly disadvantaged position of African American and Latino males in a core high school subject.

While African American and Latino students of both genders generally start high school in lower math courses compared to their white peers, for minority female students, this appears to be the primary hurdle to reaching comparable levels of math as white female students by the end of high school. It is, of course, important not to downplay this initial obstacle. The lower percentages of African American and Latino females who begin high school taking Algebra I is a real and tangible problem with clear negative consequences, given the strong connection between early and ultimate levels of math

courses taken. The positive side of the story is that when these female students do begin high school in Algebra I, they receive the same return to this initial course position.

The same cannot be said for African American and Latino males. Like their female peers, they are less likely to begin high school in Algebra I. Yet their disadvantage does not end there, but is exacerbated by the lower returns they receive compared to their white male peers even when they take Algebra I. The reduced benefits that African American and Latino students receive from their initial math course are substantial, and can have clear implications for their lives after high school. As shown in Figure 1, unlike their white male peers, these male students will on average fall short of a critical math course-taking threshold for college matriculation. Therefore, the inequalities in math course-taking trajectories shown here signal inequality that exists in high school, but also suggest a primary mechanism through which opportunities for postsecondary attendance are stratified by race/ethnicity.

The role of academic performance was also considered here as a potentially strong reason why some students might not progress as far as others, even when they begin high school at the same position. Yet the results indicated that the patterns of inequality in math sequence level at the end of high school cannot be explained away as the result of early performance. Instead, the analyses further revealed that just as the benefits of early course-taking do not accrue equally to all students, neither do the benefits of early performance. Specifically, African American males have lower returns from high grades in math at the beginning of high school. From this perspective, African American males are the most severely restricted from getting ahead in high school math.

One interpretation of the results presented here is that African American males are more impervious to the feedback about their performance that grades provide. The reduced effect of failure on the final math sequence level observed for African American females compared to white females could potentially be interpreted in a similar manner. Generally, minority students may be less responsive to institutional feedback, whether positive or negative. Ogbu (1978; 2003) offered the notion of oppositional culture, suggesting that when African American students perceive that they will receive lower returns to their educational investments or will not receive equal treatment, they proactively reject the dominant educational goals of schools. Such explanations could help explain why both African American and Latino students receive lower grades, why these minority male students do not ultimately reach the same level of math when they begin at the same initial position as their white male peers, and even why African American males receive less of a benefit from higher grades. In other words, the traditional math trajectory may be perceived as part of a system in which they are unlikely to succeed, and thus rejected.

Yet the evidence for oppositional culture is equivocal, as others have suggested that rather than downplaying educational priorities, in fact minority students display more positive attitudes towards school and education (see for example, Ainsworth-Darnell & Downey, 1998; Horvat & Lewis, 2003; Mickelson, 1990). Recent research finds that rather than rejecting prevailing educational norms, minority students may feel uncomfortable and unsupported in an academically intense environment that is dominated by white students (Yonezawa, Wells, and Serna, 2002), but respond favorably to high teacher expectations (Gutierrez, 2000). The analyses here are limited to examining

academic indicators, and therefore did not consider the role of social-psychological factors. Future research could help shed more light on the patterns observed here.

Additionally, it is important to note that interpretations that suggest that African American and Latino males may somewhat willingly choose to reject the opportunity for high levels of math course-taking, whether because of perceived lower returns or other factors, should not overshadow the finding that the academic course-taking hierarchy does not serve minority males equal to others. The prevailing academic structure of the public high school fails to provide the same benefits to African American and Latino males as it does to other groups. Therefore, the onus of responsibility must not be shifted to the shoulders of individuals in the midst of clear structural and systemic inequality. Clearly, more work is needed to determine the critical factors in the public educational system, as well as the broader society, that displace African American and Latino males from a position of advantage.

## NOTES

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<sup>1</sup> Additionally, the math sequence actually begins taking shape in middle school, where many students take pre-algebra or algebra as eighth graders, and then continue into high school having met these pre-requisites for higher level courses.

<sup>2</sup> Students within a given track often take different levels of courses for different subjects, such that their track designation does not reflect the potential complexity of course-taking patterns (Lucas, 1999; Schneider, Swanson, & Riegle-Crumb, 1998). Thus, while acknowledging the insights of previous work on tracks, the particular focus of this article is to offer a concrete and tangible picture of racial/ethnic stratification in math course-taking from the beginning to the end of high school.

<sup>3</sup> While the gender gap in advanced math course-taking has closed, the gender gap in math achievement test scores remains, although this gap has also shrunk over time and does not emerge among recent cohorts until the end of high school (see for example, Leahey and Guo 2001).

<sup>4</sup> In fact, the design of Add Health entailed that each cohort sample is nationally representative. For example, the 9<sup>th</sup> graders sampled in Add Health are a representative sample of all 9<sup>th</sup> graders nationwide in 1994-95.

<sup>5</sup> This is consistent with previous research on race/ethnic differences in course-taking. See for example, Hallinan 1996.

<sup>6</sup> Results of this analysis are available from the author upon request.

<sup>7</sup> The category of Advanced Math includes Statistics and Probability, Algebra III, and Finite Math. In addition to courses by the same name, the category for Pre-calculus includes Trigonometry and Elementary Analysis.

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<sup>8</sup> Full results available from the author upon request.

<sup>9</sup> Although Asian and Latina females also have higher percentages than their male peers in Pre-Calculus, these differences are not statistically significant based on t-tests.

<sup>10</sup> The coefficients in the models are un-centered, and therefore in their natural metric. Additionally, the coefficients for Asian, students' cohort, and the flag for imputed income are fixed across models. Analysis of variance of the dependent variable using HLM reveals that for female students, twelve percent of the variance in the highest course reached in the math sequence by the end of high school occurs between schools, and for male students, sixteen percent of the variance occurs between schools. It is clear that overall, there is substantially more stratification of math course-taking within schools rather than across them.

<sup>11</sup> Full results available upon request from the author.

<sup>12</sup> Additional analyses not shown here included interaction terms for race, algebra I, and level of parent education. The results revealed that the lower returns observed for the Latino and African American male students do not vary according to the degree of parental education.

<sup>13</sup> Coefficients for Asian, students' cohort, the flag for imputed income, and the interaction terms between race/ethnicity and grades are fixed.

**Table 1: Highest Math Course Taken by End of High School by Race/Ethnicity and Gender**

	<i>Males</i>				<i>Females</i>			
	<i>White</i>	<i>AA*</i>	<i>Latino</i>	<i>Asian</i>	<i>White</i>	<i>AA*</i>	<i>Latino</i>	<i>Asians</i>
Remedial/basic	1%	1%	1%	0%	1%	1%	1%	0%
Genera/applied	3%	2%	3%	1%	2%	2%	2%	0%
Pre-Algebra	3%	6%	6%	4%	2%	2%	4%	3%
Algebra I	11%	15%	18%	8%	9%	11%	14%	8%
Geometry	14%	19%	23%	9%	13%	18%	21%	11%
Algebra II	23%	28%	24%	23%	25%	29%	27%	18%
Advanced Math	7%	9%	6%	5%	7%	9%	6%	7%
Pre-calculus	26%	14%	14%	24%	31%	22%	20%	28%
Calculus	12%	6%	6%	25%	12%	6%	6%	25%
<b>N</b>	1868	569	608	363	2000	786	598	309

Note: Percents are weighted; \* AA refers to African American Students

**Table 2: Descriptive Statistics for Students' First Year Math Course-taking and Performance in High School by Race/Ethnicity and Gender**

	<i>Algebra I (or higher)</i>	<i>Failure</i>	<i>High Grades</i>
<b><i>Males</i></b>			
White	73%	11%	42%
African American	56%	18%	25%
Latino	56%	18%	33%
Asian	69%	5%	54%
<b><i>Females</i></b>			
White	80%	7%	53%
African American	65%	14%	28%
Latino	64%	14%	35%
Asian	75%	4%	69%

Note: Percents are weighted; N= 3408 for males and N=3693 for females.

**Table 3: The Effects of Initial Course Position on the Highest Math Course Taken by the End of High School: Regression Coefficients from HLM**

	<b>Males</b>	<b>Females</b>
<i>Student Background</i>		
African American	-.142	-.134
Latino	.044	-.102
Asian	.692***	.849***
Parent education level	.292***	.220***
Family income	.062	.044
Intact family	.365***	.309***
<i>Initial Course Position</i>		
Algebra I or higher (9 <sup>th</sup> grade)	2.41***	2.11***
Interaction: African American * Algebra I	-.767**	-.223
Interaction: Latino * Algebra I	-.925***	-.297
Interaction: Asian * Algebra I	-.503	-.395
Intercept (U0)	3.10****	3.91***
<b>-2 Log Likelihood Variance Components</b>		
Level 2 Intercept (U0)	1.29	.800
African American	.179	.131
Latino	.092	.149
Parent Education Level	.049	.056
Family Income	.065	.067
Intact Family	.149	.143
Algebra I or higher	.699	.311
African American * Algebra I	1.36	.588
Latino * Algebra I	.595	.417
Level 1 (R)	1.47	2.04

\*p<.05; \*\*p<.01; \*\*\*p<.001

Note: N= 3408 for males, N=3693 for females, with Level 2 N=69 public high schools.

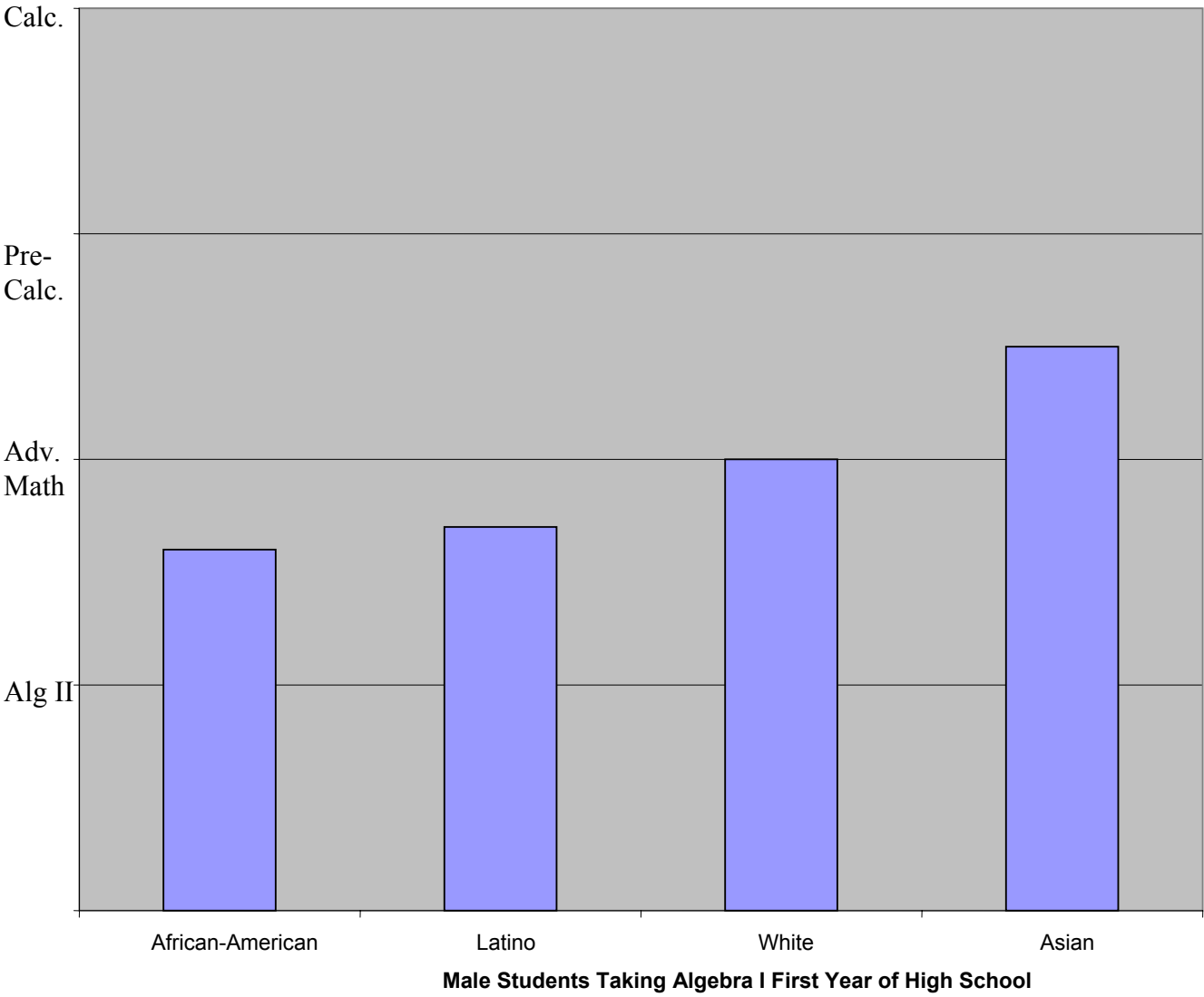
**Table 4: The Effects of Academic Performance on the Highest Math Course Taken by the End of High School: Regression Coefficients from HLM**

	<b>Males</b>	<b>Females</b>
<i>Student Background</i>		
African American	-.054	-.054
Latino	.095	.030
Asian	.463**	.602***
Parent Education Level	.262***	.172***
Family income	.024	.059
Intact Family	.280***	.154**
<i>Initial Course Position</i>		
Algebra I or higher (9 <sup>th</sup> grade)	2.31***	2.07***
Interaction: African American * Algebra I	-.734**	-.113
Interaction: Latino * Algebra I	-.731***	-.151
Interaction: Asian * Algebra I	-.645	.025
<i>Academic Performance</i>		
Failure in 9 <sup>th</sup> grade math course	-.643***	-.763***
Interaction: African American * Failure	-.055	.559**
Interaction: Latino * Failure	.081	.330
Interaction: Asian * Failure	-.143	.399
High grade in 9 <sup>th</sup> grade math course	.827***	.913***
Interaction: African American * High grade	-.363**	-.047
Interaction: Latino * High grade	-.355	-.103
Interaction: Asian * High grade	.206	-.110
Intercept (U0)	3.186***	3.75***
<b>-2 Log Likelihood Variance Components</b>		
Level 2 Intercept (U0)	2.21	.955
African American	.132	.153
Latino	.219	.177
Parent Education Level	.055	.036
Family Income	.131	.146
Intact Family	.126	.109
Algebra I or higher	.689	.372
African American * Algebra I	1.45	.477
Latino * Algebra I	.726	.261
Failure in 9 <sup>th</sup> grade math course	.494	.250
High grade in 9 <sup>th</sup> grade math course	.181	.131
Level 1 (R)	1.19	2.05

\*p<.05; \*\*p<.01; \*\*\*p<.001;

Note: N= 3408 for males, N=3693 for females, with Level 2 N=69 public high schools.

Figure 1: Predicted Values for Level of Math Sequence by the End of High School for Male Students by Race/Ethnicity



## Works Cited

Ainsworth-Darnell, James and Douglas Downey. 1998. "Assessing the oppositional culture explanation for racial/ethnic differences in school performance". *American Sociological Review*, 63, 536-553.

Adelman, Clifford. 1994. *Answers in the tool box: Academic intensity, attendance patterns, and bachelor's degree attainment*. U.S. Department of Education, Office of Educational Research and Improvement.

Adelman, Clifford. 1999. *Postsecondary attainment, attendance, curriculum, and performance: Selected results from the NELS:88/2000 Postsecondary Education Transcript Study (PETS), 2000*. U.S. Department of Education, Institute of Education Sciences, NCES 2003-394.

American Association of University Women. 1998. *Gender gaps: Where schools still fail our children*. Washington, DC: American Association of University Women Educational Foundation.

Barajas, Heidi and Jennifer Pierce. 2001. "The significance of race and gender in school success among Latinas and Latinos in college". *Gender and Society*, 15, 859-878.

Bae, Yupin, Susan Choy, Claire Geddes, Jennifer Sable, and Thomas Snyder. 2000. *Trends in gender equity for girls and women*. NCES 2000-030. Washington, D.C: U.S. Department of Education, National Center for Education Statistics.

Bearman, Peter S., Jo Jones, and Richard J. Udry. 1997. *The National Longitudinal Study of Adolescent Health: Research Design*. University of North Carolina at Chapel Hill: Carolina Population Center.

Catsambis, Sophia. 1994. "The path to math: gender and racial-ethnic differences in mathematics participation from middle school to high school". *Sociology of Education*, 67, 199-215.

Clewell, Beatriz, and Bernice Anderson. 1991. *Women of color in mathematics, science, and engineering: A review of the literature*. Washington, DC: Center for Women Policy Studies.

Correll, Shelley. 2001. "Gender and the career choice process: The role of biased self-assessments." *American Journal of Sociology*, 106, 1691-1730.

Csikszentmihalyi, Mihaly and Barbara Schneider. 2000. *Becoming adult: How teenagers prepare for the world of work*. New York: Basic Books.

Eccles, Jacquelynne. 1994. "Understanding women's educational and occupational choices: applying the Eccles et al. model of achievement-related choices." *Psychology of Women Quarterly* 18, 585-609.

Eccles, Jacquelynne, Bonnie Barber, and Debra Jozefowicz. 1999. "Linking gender to educational, occupational, and recreational choices: applying the Eccles et al. model of achievement-related choices." In W. Swann, J. Langlois, & L. Gilbert (Eds.), *Sexism and stereotypes in modern society: The gender science of Janet Taylor Spence* (pp 153-192). Washington, DC: American Psychological Association.

Farkas, George, Robert Grobe, Daniel Sheehan, and Yuan Shuan. 1990. "Cultural resources and school success: gender, ethnicity, and poverty groups within an urban school district." *American Sociological Review*, 67, 148-55.

Ferguson, Ronald. 2001. "A diagnostic analysis of black-white GPA disparities in Shaker Heights, Ohio." *Brookings Papers on Education Policy* 2001, 347-414.

Gamoran, Adam. 1987. "The stratification of high school learning opportunities." *Sociology of Education*, 60, 61-77.

Gamoran, Adam, Martin Nystrand, Mark Berends, Paul C. LePore. 1995. "An Organizational Analysis of the Effects of Ability Grouping." *American Education Research Journal*, 32, 687-715.

Garet, Michael and Brian Delany. 1988. "Students, courses, and stratification." *Sociology of Education*, 61, 61-77.

Gutierrez, Rochelle. 2000. "Advancing African American, Urban Youth in Mathematics: Unpacking the Success of One Math Department." *American Journal of Education*, 109, 63-112.

Hallinan, Maureen. 1996. "Track mobility in secondary school." *Social Forces*, 74, 983-1002.

Hallinan, Maureen and Warren Kubitschek. 1999. "Curriculum differentiation and high school achievement." *Social Psychology of Education*, 3, 41-62.

Hanson, Sandra. 1996. *Lost talent: Women in the sciences*. Philadelphia: Temple University Press.

Horvat, Erin and Kristine Lewis 2003. "Reassessing the 'burden of acting White': The importance of peer groups in managing academic success." *Sociology of Education*, 76, 265-280.

Johnson, Monica, Robert Crosnoe, and Glen Elder. 2001. "Students' attachment and academic engagement: The role of race and ethnicity." *Sociology of Education*, 74, 318-340.

Jones, Lee, Ina Mullis, Senta Raizen, Iris Weiss, and Elizabeth Weston. 1992. *The 1990 science report card*. Washington, D.C.: Educational Testing Service.

Kilgore, Sally and William Pendleton. 1993. "The organizational context of learning: framework for understanding the acquisition of knowledge." *Sociology of Education*, 66, 63-87.

Lee, Valerie and Kenneth Frank. 1990. "Students' characteristics that facilitate the transfer from two-year to four-year colleges." *Sociology of Education*, 63, 178-193.

Linn, Marcia and Cathy Kessel. 1996. Grades or scores: Predicting future college mathematics performance. *Educational Measurement: Issues and Practice*, 15, 10-14.

Lucas, Samuel R. 1999. *Tracking inequality: Stratification and mobility in American high schools*. Columbia: Teachers College Press.

Lucas, Samuel R. and Mark Berends. 2002. "Sociodemographic diversity, correlated achievement, and de facto tracking." *Sociology of Education*, 75,, 328-348.

Lucas, Samuel R and Aaron D. Good. 2001. "Race, class, and tournament track mobility." *Sociology of Education*, 74, 139-156.

Mau, Wei-Cheng, and Margaret Domnick. 1995. "Characteristics of Female Students Who Aspire to Science and Engineering or Homemaking Occupations." *Career Development Quarterly*, 4, 323-338.

Mickelson, Roslyn A. 1989. "Why does Jane read and write so well? The anomaly of women's achievement." *Sociology of Education*, 62, 47-63.

Mickelson, Roslyn A. 1990. "The attitude-achievement paradox among black adolescents." *Sociology of Education*, 63, 44-61.

Moreno, Susan and Chandra Muller. 1999. "Success and Diversity: The Transition through First-Year Calculus in the University." *American Journal of Education*, 108, 30-58.

Muller, Patricia, Frances Stage, and Jillian Kinzie. 2001. "Science achievement growth trajectories: understanding factors related to gender and racial-ethnic differences in precollege science achievement." *American Educational Research Journal*, 38, 981-1012.

Muller, Chandra. 1998. "Gender differences in parental involvement and adolescents' math achievement." *Sociology of Education*, 71, 336-356.

Mullis, Ina, John Dossey, Eugene Owen, and Gary Phillips. 1993. *NAEP 1992 math report card for the nation and for the states*. Washington, D.C. : Government Printing Office.

National Center for Education Statistics (NCES). 2001. *The 1998 high school transcript study tabulations: comparative data on credits earned and demographics for 1998, 1994, 1990, 1987, and 1982 high school graduates*. Washington D.C.: United States Department of Education, Office of Educational Research and Improvement (NCES 2001-498).

Ogbu, John. 1978. *Minority education and caste: The American system in cross-cultural perspective*. New York: Academic Press.

Ogbu, John. 2003. *Black American students in an affluent suburb: A study of academic disengagement*. Mahwah, N.J. L. Erlbaum Associates.

Pallas, Aaron and Karl Alexander. 1983. "Sex differences in quantitative SAT performance: new evidence on the differential coursework hypothesis." *American Educational Research Journal*, 20, 165-182.

Pelavin, Sol, and Michael Kane. 1990. *Changing the odds: factors increasing access to college*. New York: College Board Publications.

Peng, Samuel, D. Wright, and Susan Hill. 1995. *Understanding racial-ethnic differences in secondary school science and mathematics*. Washington, DC: U.S. Government Printing Office (NCES 95-710).

Pong, Suet-Ling. 1998. "The School Compositional Effect of Single Parenthood on 10th-Grade Achievement." *Sociology of Education* 71, 24-42.

Roderick, Melissa and Eric Camburn. 1999. "Risk and recovery from course failure in the early years of high school." *American Educational Research Journal*, 36, 303-343.

Roderick, Melissa. 2003. "What's happening to the boys? Early high school experiences and school outcomes among African American male adolescents in Chicago." *Urban Education*, 38, 538-607.

Riegle-Crumb, Catherine. 2003. "Strategies for success: Transitions from high school to postsecondary." *Presented at the American Education Research Association Annual Meeting* (Chicago, IL).

Rosenbaum, James. 2001. *Beyond college for all: Career paths for the forgotten half*. New York: Russell Sage Foundation.

Schneider, Barbara. 2003. Strategies for success: High school and beyond. In D. Ravitch (Ed.), *Brookings Papers on Education Policy*. Brookings Institution Press.

Schneider, Barbara, Christopher Swanson, and Catherine Riegler-Crumb. 1998. Opportunities for learning: course sequences and positional advantages. *Social Psychology of Education*, 2, 25-53.

Schiller, Kathryn and Donald Hunt. 2003. "Accumulated disadvantages: Racial and social class differences in high school mathematics course trajectories." *Presented at the American Education Research Association Annual Meeting* (Chicago, IL).

Schiller, Kathryn and Chandra Muller. 2000. "External Examinations and Accountability, Educational Expectations, and High School Graduation." *American Journal of Education*, 108, 73-103.

Stevenson, David, Kathryn Schiller, and Barbara Schneider. 1994. "Sequences of opportunities for learning." *Sociology of Education*, 67, 184-198.

Teitelbaum, Peter. 2003. "The influence of high school graduation requirement policy in mathematics and science on student course-taking patterns and achievement." *Educational Evaluation and Policy Analysis*, 25, 31-58.

Van Huette, Meke. 2004. "Tracking Effects on School Achievement: A Quantitative Explanation in Terms of the Academic Culture of School Staff." *American Journal of Education*, 110, 354-389.

Weiss, Christopher. 2002. "Difficult Starts: Turbulence in the School Year and Its Impact on Urban Students' Achievement." *American Journal of Education*, 109, 196-227.

Xie, Yu and Kimberlee Shauman. 2003. *Women in science: Career processes and outcomes*. Cambridge: Harvard University Press.

Yonezawa, Susan, Amy Stuart Wells and Irene Serna. 2002. "Choosing tracks: "Freedom of choice" in detracking schools." *American Educational Research Journal*, 39, 37-68.