Draft- For Comment Only

Gender Gaps in Math and Reading Gains during Elementary and High School by Race and Ethnicity

Laura Logerfo and Austin Nichols
The Urban Institute

Duncan Chaplin
The Urban Institute/Mathematica Policy Research

September 22nd, 2006

This report was prepared with support from the Kellogg Foundation. We would like to gratefully acknowledge advice from Sara Mead at the Education Sector. Any opinions, observations, findings, conclusions, and recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the Urban Institute, Mathematica Policy Research or the Kellogg Foundation. Please direct any questions or correspondence to Duncan Chaplin at DChaplin@mathematica-mpr.com.

Abstract

Gender differences in academic achievement have long fascinated researchers and policy-makers alike. In this paper we analyze differences in math and reading test score growth rates by gender for four different race and ethnic groups—Whites, Blacks, Hispanics, and Asians and for six different time periods. Our data cover both the earliest years of education and the crucial years of adolescence. In addition, we have data covering one non-schooling period. Together these data enable us to get a very complete picture of how gender gaps evolve over the course of early elementary and high school years and how these trajectories differ by race and ethnicity. While the gender gaps are not always statistically significant, they are for 14 of 48 comparisons made and these differences are almost all during school. Finally, all of the statistically significant results suggest that males learn more math and females more reading.

Introduction

Who's smarter, girls or boys? Each year new studies appear examining if gender gaps in achievement exist, and if so, who is favored and by how much. Often this research indicates that gaps favor girls on reading and comprehension tests, and boys on math and science tests, suggesting a complicated and interesting picture that may help determine where to direct educational resources and research.

While a great deal of research stresses the importance of gender gaps in achievement (Dee, 2006, Murray 2005), Mead (2006) argues that the achievement gap between girls and boys has been greatly exaggerated. She notes that gaps by ethnicity and social class far exceed gaps by gender in size and import. In addition, American boys are performing about as well as they ever have. Girls are improving faster in math and science, but this only means that they are closing the gaps in those areas. Mead worked with data from the National Assessment of Educational Progress (NAEP), which includes results of reading and math assessments administered periodically to nationally representative cohorts of students around the ages of 9, 13, and 17. These data are useful for looking at differences between states and over time, but tell us little about how gaps develop before the age of 9.

Gaps at a point in time can be quickly swamped by a small difference in learning rates. Consequently we focus our research on rates. Some previous research, such as the work by Mead on NAEP, is based on comparisons of the performance of one cohort of students in one year (e.g. the average math scores of 9-year olds in 2004) with the performance of another cohort in another year (e.g., the average math scores of 9-year olds in 1973). While interesting, these comparisons cannot distinguish between differences in learning rates and differences in the composition of the cohorts being studied. In order to focus on learning rates we follow individual children over time.

Our data include two periods in children's lives. The first period starts in the fall of kindergarten and continues through the end of third grade (when children are typically 9-years old). The second period covers from eighth grade through twelfth grades, the critical adolescent and teenage years. In earlier work we looked at differences in test score growth rates by gender and race separately (LoGerfo et al, 2006). In this report we look at the interactions between these two characteristics.

This report is divided into three sections. First, we discuss the data and analytic methods that produce the gender gap estimates. Second, we present and explain our findings. Third and finally, we discuss the results and place them within the broader context of education policy.

Data

We use two nationally representative and longitudinal datasets, the Early Childhood Longitudinal Study—Kindergarten cohort (ECLS-K) for elementary school and the National Education Longitudinal Study of 1988 (NELS:88) for high school. ECLS-K starts with children who were kindergartners in 1998 and NELS:88 starts with eighth-graders in 1988. These students are followed throughout their elementary school and high school experiences respectively.[1]

[1] The NELS:88 dataset is refreshed at each follow-up so that their samples can be used to give representative estimates of all students in the later grades, including those who were either held back or skipped a grade and could therefore not be selected in earlier waves of data collection. These additional students are not included in our analyses.

In this report we focus on differences by gender and ethnicity. We used four categories for ethnicity: white, Black, Hispanic, and Asian.[2]

Participants in these studies took a battery of tests in reading and mathematics at the start of their relevant school transition. The elementary school children were tested five times starting in the first term of kindergarten and ending three years later. The high school students were tested three times starting in eighth-grade, typically the last grade before high school, and ending four years later. Results from this report indicate how much students learned during the intervals between test administrations.

Reading. Reading questions tapped basic skills, from letter recognition and the link between letters and sounds to vocabulary and reading comprehension. Because more children than expected performed close to the ceiling on the spring K reading assessment, NCES increased the number and difficulty of questions covered by the assessment item pool used for the first grade exams (NCES, 2002). Changes between the first and third grade rounds included adding more advanced questions about literal inference, extrapolation, and evaluation.

The NELS:88 reading tests posed questions about reading passages that varied in length from a single paragraph to a half-page. The tests measured skills in reading comprehension, literal inference, and critical evaluation, which represent an extension of the skills tapped by the ECLS-K tests. In the follow-up test administrations students were given more difficult forms of the exams depending on their performance on the earlier tests. The high difficulty form was differentiated from the low difficulty form by including more complex texts taken from social studies and science.

Math. In ECLS-K math questions tapped skills in conceptual knowledge, procedural knowledge, and problem solving. Items range from asking children to identify numbers to solving simple multiplication and division problems. The assessment pools included the same number and difficulty of questions in kindergarten and first grade. More difficult items were added in third grade. These additional items measure skills in geometry and spatial sense, data analysis, probability and statistics, and basic algebraic functions (NCES, 2004).

At the secondary level, the NELS:88 tenth and twelfth grade math tests had three forms of difficulty, again administered based on previous performance. All levels of the test tapped skills in arithmetic, similar to the skills found on the ECLS-K tests. The average and high difficulty level tests tapped skills in algebra and geometry. The high difficulty level tests included pre-calculus questions and/or analytic geometry questions.

Achievement gain. Our outcome – achievement gain – can be measured using a number of metrics, all of which are based on points on the tests. The points are not the actual number right on the assessment as administered, but rather the number that item response theory (IRT) predicts the student would have answered correctly if s/he had been administered all the questions in the item pools. There was not sufficient time for the students to respond to all of the items. Thus, at a test administration, a student was administered only a subset of items that corresponded to their grade level and skill level as estimated by an initial set of routing items.

The IRT model adjusts for the possibility that students are guessing (NCES, 2005), so the score is more accurate than a pure sum of correct responses. This IRT process allows each student's

[2] Pacific Islanders, Native Americans, and those reporting a mixed background are omitted due to small sample sizes.

performance to be put on a common scale at each point in time, and over time and thus facilitates the quantification of learning rates.

Analytic Method

Differences in school exposure – testing time gaps. In large-scale studies, participants cannot all be administered cognitive assessments on the same day. Instead, assessments occur over a span of at least two and sometimes four months. This means that students have different levels of school exposure before they take their assessments. And because school exposure is positively correlated with test performance, models must adjust for these differences. We model test scores as a function of the time before a given assessment. In other words, each time parameter measures from the beginning of the school year to the date of the test[3], both of which are individually variable.[4] Thus by including these time measures, the models account for the variable amount of time spent in each grade, or school exposure. The coefficients for these parameters estimate the amount of learning during that time period.

The elementary school analyses model test scores as a function of the intervals between five points in time: beginning of kindergarten, end of kindergarten, beginning of first grade, end of first grade, and end of third grade. The total span of time covered is around 287 days or 9.5 months per grade on average. The summer between kindergarten and first grade lasts around 78 days, or about 2.5 months. The time spent between the end of first grade and the third grade assessment date averages 691 days or 23 months.

The secondary school analyses follow the same procedure but use the intervals between just three testing times—the springs of eighth grade, tenth grade, and twelfth grade**.** In NELS:88 most test dates occurred within a small time from of about 2 to 4 months (standard deviations equal to 1 and 2) and in regular intervals of about 24 months.[5]

Metrics for results. Findings are reported in two metrics, both of which should facilitate interpretation. Learning or growth rates are reported in points per day, per month, and per time period. These metrics represent the most easily understood and familiar approach. We also present findings for differences in learning rates in units of standard deviations, or effect sizes. Effect sizes measure the magnitude of a relationship and can be compared across tests with different point ranges. We divide average growth rates in each period by the standard deviation of scores from the assessment at the beginning of the period, measured at the start of the period. This makes expected gains comparable across different test designs.

Proficiency index. We also present several graphs to show gender differences in learning rates. These graphs chart average male and female learning rates across time and benchmark gains against skill

---

[3] In NELS:88, there are no dates for the start and end of school years. We assumed June 1, 1988 for the end of eighth grade and June 1, 1990 for the end of tenth grade.

[4] For example, for assessments in kindergarten, the amount of time in the first and third grades equals zero. This changes as the assessment time changes so that by third grade, the times in kindergarten and first grade are set (those grades are already completed and spanned a fixed amount of time, approximately 286 days, including weekends). However, the time in third grade before the assessment does not equal a full year, because at the third grade assessment, third grade is not yet completed.

[5] Exact test dates are not available for the base year of NELS:88 but are available for the first and second follow-ups. In order to calculate the elapsed time between tests, we impute the base year test date with the median test date for the base year of April 1, 1988. If the test dates were missing for the first or second follow-ups, we imputed them with the median test dates of March 20, 1990 and February 27, 1992, respectively.

proficiencies that correspond to point gains on the assessments. The point where a student's score corresponds to a 50% probability of mastery of a topic or skill set is the ability level at which children are learning the topic at the fastest rate. We refer to this type of proficiency as the current level of achievement for a student with this score. For example, a child in the ECLS-K study with a math score of 43.84 has a 50% chance of being proficient on the topic labeled "ADD/SUBTRACT." From this, we can plausibly say that students with scores in the vicinity of 44 are learning to add and subtract. The next such level "MULTIPLY/DIVIDE" occurs at an IRT score of 67.32, so students in the vicinity of 67 are learning to multiply and divide. Gradations of ability between these two milestones (in the range from 44 to 67 points) cannot be tied to specific named skills, but the milestones offer a means to measure increases in an essentially arbitrary test score metric using familiar concepts. The following table provides the key to converting test scores to proficiency scores.

TABLE A1. SKILLS BEING LEARNED AT SPECIFIED IRT SCORE LEVELS – ECLS-K
(Assumes 50% Proficiency Level Corresponds to Point of Maximal Learning Speed)

Math Skills	
IRT Score	Proficiency Type
10.05	1-COUNT, NUMBER, SHAPE
18.71	2-RELATIVE SIZE
28.46	3-ORDINALITY, SEQUENCE
43.84	4-ADD/SUBTRACT
67.32	5-MULTIPLY/DIVIDE
91.29	6-PLACE VALUE
104.41	7-RATE & MEASUREMENT

Reading Skills	
IRT Score	Proficiency Type
21.41	1-LETTER RECOGNITION
30.73	2-BEGINNING SOUNDS
36.08	3-ENDING SOUNDS
51.03	4-SIGHT WORDS
68.87	5-WORD IN CONTEXT
91.63	6-LITERAL INFERENCE
112.98	7-EXTRAPOLATION
124.59	8-EVALUATION

TABLE A2. SKILLS BEING LEARNED AT SPECIFIED IRT SCORE LEVELS – NELS:88
(Assumes 50% Proficiency Level Corresponds to Point of Maximal Learning Speed)

Math Skills	
IRT Score	Proficiency Type
15.59	1-COMPREHENSION, INCLUDING LEVEL OF DETAIL
30.65	2-SIMPLE INFERENCES AND UNDERSTAND ABSTRACT CONCEPTS
43.30	3-COMPLEX INFERENCE AND EVALUATE JUDGMENTS

Reading Skills	
IRT Score	Proficiency Type
22.82	1-SINGLE OPERATIONS WITH WHOLE NUMBERS
37.24	2-FRACTIONS, DECIMALS, POWERS, AND ROOTS
46.21	3-SIMPLE PROBLEM SOLVING
57.73	4-INTERMEDIATE LEVEL MATH CONCEPTS
73.55	5-MULTI-STEP PROBLEM SOLVING AND ADVANCED MATH

Linear models. To account for different rates of learning across students, we construct growth curve models, with growth varying by time period in a piecewise fashion (e.g., in ECLS-K, Fall-K to Spring-K; Fall-1 to Spring-1, etc.). Models are two-level hierarchical models, with testing times nested within students. Level-1 represents testing times, with analyses weighted by precision weights to account for measurement error. Level-2 represents individual students, weighted to ensure generalizability of the sample (the inverse of the probability of being selected for the sample). We report findings from these models with robust standard errors. The model's equations are:

Level 1

$$Y_{ti} = \pi_{0i} + \pi_{1i}\, a_{ti} + e_{ti}$$

Y_{ti} = observed status at time t for individual i
π_{0i} = growth trajectory parameter for subject i at time 0
a_{ti} = amount of time passed at time t for person i
e_{ti} = error term

Level 2

$$\pi_{0i} = \beta_{00} + \Sigma\beta_{0q}X_{qi} + r_{0i}$$

$$\pi_{1i} = \beta_{00} + \Sigma\,\beta_{1q}X_{qi} + r_{0i}$$

π_{0i} = initial status at time 0, constant term
π_{1i} = growth rate for person i over the time period; the expected change during this time
β_{0q} = the effect of X_q on the growth parameter
X_q = an individual background measure (e.g., gender, race/ethnicity)
r_{0i} = random effect with mean of 0, assumed to be normally distributed

These hierarchical models allow the initial level and learning rate of each student to have a common component and an individual random component. Ignoring this feature, the models are essentially a linear regression of scores on the lengths of time spent in various parts of the educational system at the point the score is measured. The estimated constant in such a model is the initial score when entering kindergarten or at the end of eighth grade, and the coefficients on time variables are growth rates of scores in points per day during the relevant spans of time (see Logerfo et al, 2006 for more details).

Our samples consist primarily of students with test scores in most waves of the data. However, some test score data are missing and the missing data rates vary by race and across waves meaning that for some subjects and subgroups, changes over time may be driven by changes in the composition of the test takers. In particular, large fractions of Asians and Hispanics did not take the reading tests in the early elementary school, starting with 30 percent of Hispanics and 23 percent of Asians in the fall of kindergarten and going down to less than 2 percent of each of these groups by the end of 3rd grade. This occurred in large part because students who could not speak English well were not asked to take the test. Thus, changes in their performance in reading could be driven by changes in the composition of who took the tests. In contrast, less than four percent of whites or blacks missed the reading test in any year. The situation in math is somewhat better in that only Asians missed taking the test at a high

rate with about 23 percent not taking the math test in the fall of kindergarten. No other group had more than 2 percent missing the test in any wave.

In NELS the data are only missing for about 3 percent of the 8th and 10th grade samples. In 12th grade, however, test scores are missing for about 18 percent of the sample. Test scores are more likely to be missing for those with low initial test scores, low-income students, and blacks. To help alleviate possible problems caused by missing data dropouts and students who were retained in grade were excluded from the analysis sample. Nonetheless, the growth grades in grades 10-12 may be biased, especially for blacks.

Results

We first explore gender differences in reading then turn to gender differences in mathematics. For each subject, results are broken out by gender alone and by gender with race. Elementary school results are presented first, followed by secondary school results.

Gender Differences in Reading

Gender Alone

Elementary school. Female students begin kindergarten with higher reading scores than male students, as shown in Table 1. At the start of kindergarten, girls are predicted to score nearly a point higher on the reading assessment. During both kindergarten and during first grade girls gain more than boys (0.015 SD per month in kindergarten; and 0.009 SD per month in first grade). Interestingly girls do not make more gain relative to boys while out of school during the summer between kindergarten and first grade or after the first grade. Nevertheless, due to the initial differences and their higher growth rates during the school year in kindergarten and again in first grade, girls finish third grade with an average reading score nearly 4 points higher than boys.

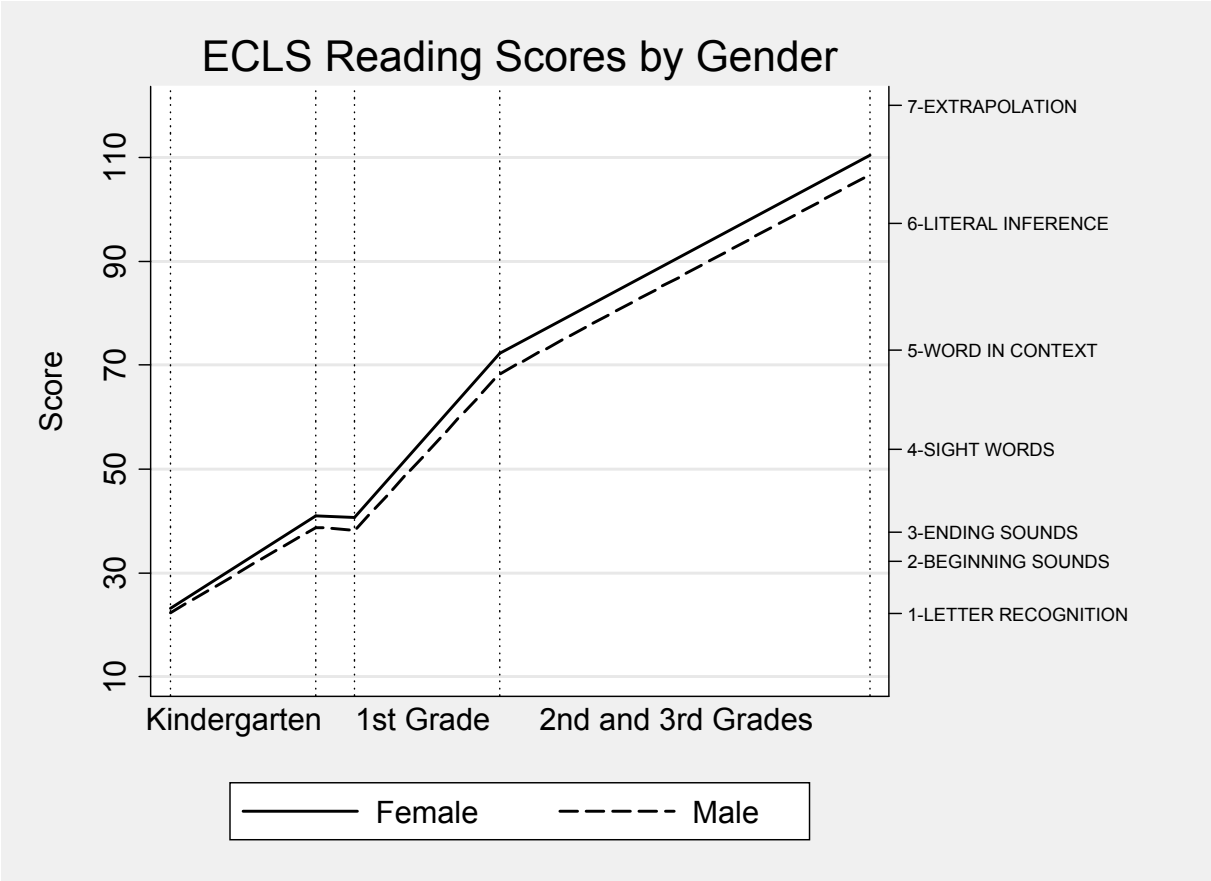
This advantage is seen in Figure 3.1. In kindergarten, the lines representing gains are quite close, and they separate by first grade with the line representing females' learning very slightly steeper. During the second and third grades, the lines that identify male and female learning rates are parallel, with the gain for females slightly higher than the gain for boys. But, in terms of substance, by the end of third grade, both boys and girls are learning literal inference and not yet learning extrapolation.

TABLE 1: READING BY GENDER—ELEMENTARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
MALE STUDENTS				
Before Kindergarten				22.29
During Kindergarten	1.75	0.189	16.44	38.73
	(0.0147)			
Summer K-1st	-0.230	-0.0168	-0.59	38.14
	(0.0651)			
During 1st Grade	3.21	0.206	30.24	68.38
	(0.0271)			
After 1st Grade, into 3rd Grade	1.59	0.102	38.25	106.63
	(0.0094)			
FEMALE STUDENTS (DIFFERENCE FROM MALE STUDENTS)				
Before Kindergarten				**0.94**
During Kindergarten	**0.136**	**0.0146**	**1.28**	2.22
	(0.0211)			
Summer K-1st	0.120	0.00880	0.31	2.53
	(0.0923)			
During 1st Grade	**0.144**	**0.00925**	**1.36**	3.88
	(0.0374)			
After 1st Grade, into 3rd Grade	-0.00694	-0.000445	-0.17	3.72
	(0.0129)			

These analyses are based on students who have at least one reading or math test score in at least one of the five rounds of ECLS-K data. Each estimate in bold is significantly different from the corresponding estimate for male students at the 5 percent level.

FIGURE 1: DIFFERENCES IN READING LEARNING RATES BY GENDER—ELEMENTARY SCHOOL



Secondary school. In early high school, females hold a significant initial advantage in reading achievement compared to males at the beginning of high school. Findings presented in Table 2 show that female students score nearly 2 points higher in eighth grade than their male peers. In addition, while females make reading gains similar to those of males early in high school, their growth rates are slightly higher than those of the males between tenth and twelfth grades (0.002 SD per month), leaving them with a slightly larger point advantage at the end of high school compared to the beginning.

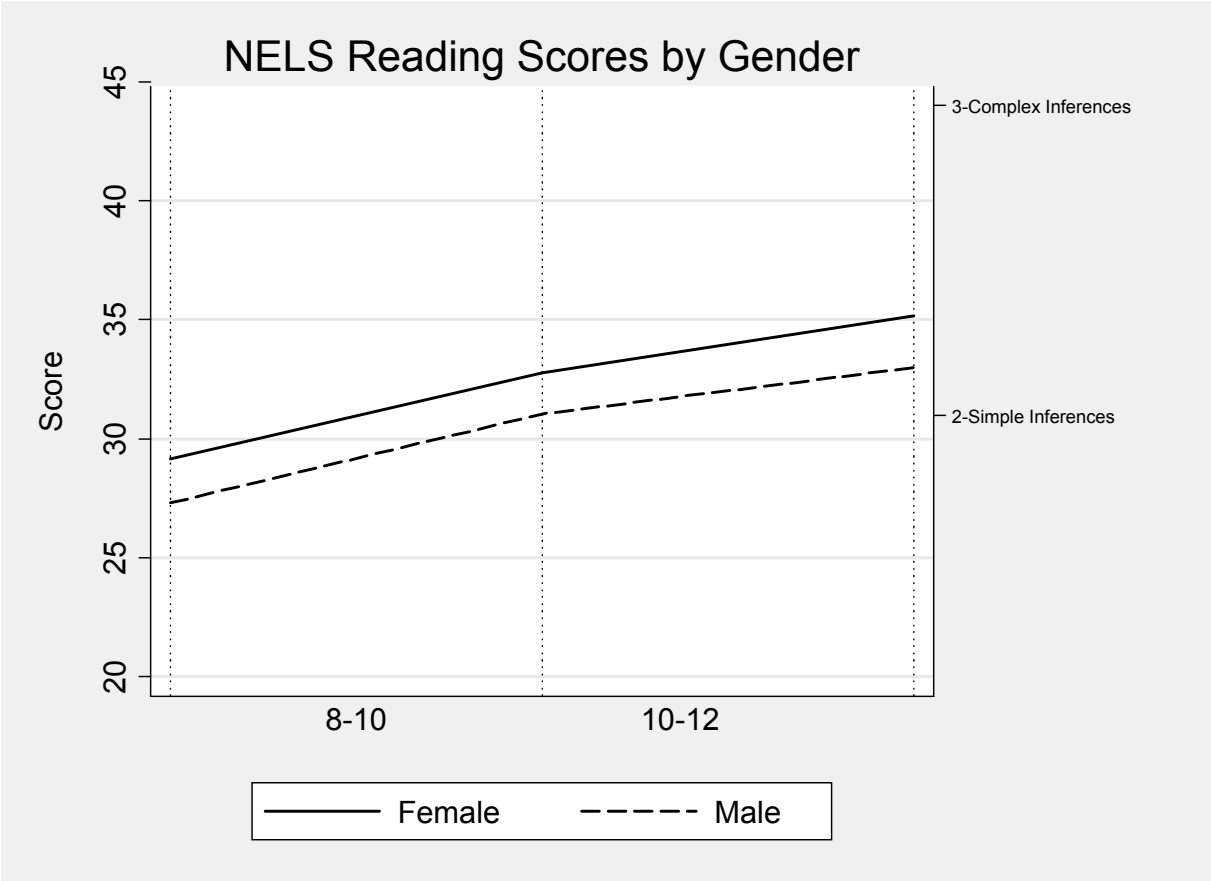
TABLE 2: READING BY GENDER—SECONDARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
MALE STUDENTS				
Before High School				27.30
8th Grade to 10th Grade	0.156	0.0204	3.74	31.04
	(0.0049)			
10th Grade to 12th Grade	0.0809	0.00876	1.94	32.98
	(0.0066)			
FEMALE STUDENTS (DIFFERENCE FROM MALE STUDENTS)				
Before High School				**1.87**
8th Grade to 10th Grade	-0.00670	-0.000875	-0.16	1.71
	(0.0066)			
10th Grade to 12th Grade	**0.0190**	**0.00206**	**0.46**	2.17
	(0.0083)			

Each estimate in bold is significantly different from the corresponding estimate for male students at the 5 percent level.

Females start ahead of males in reading and learn faster both during elementary school and during high school. In both periods, however, the extra gains of females are quite small compared to the overall gains experienced by both males and females. For example, while females gain about 3 more points than males during the K-3 period, males gain over 80 points during this period. Similarly, during high school females learn only about 0.3 points more than boys, while boys only gain about 5 points. Thus, as a percent of the overall gain of boys, the female advantage is fairly small during both periods. From the graph in Figure 2, both groups are, on average, moving from learning simple to more complex inferences.

FIGURE 2: DIFFERENCES IN READING LEARNING RATES BY GENDER—SECONDARY SCHOOL



Gender and Race

Elementary school. In comparison to the differences by gender, differences in reading performance and growth by race are quite stark, as shown in Table 3. Recall that females overall start school with just a 1 point advantage in reading, which swells to 4 points by the end of third grade. Separating males and females by race highlights much larger achievement differences both across racial groups and by gender within race.

White females start kindergarten with reading scores about 1.6 points higher than males. The female advantage in reading widens during early elementary school but remains fairly stable in second and third grades. The earlier advantage leaves white female students with a ??? point advantage over males by the end of third grade.

An even more striking difference emerges between white males and black males. The differences in their reading scores start small, but as black male students progress through elementary school the differences grow quickly. Black male students start kindergarten with a 2-point deficit compared to white males. During kindergarten, black males' learning rates slip behind white males by 0.03 SD per month. The big story hits in first grade during which black male students have learning rates that are slower than those of white male students by 0.07 SD per month, more than double the difference in kindergarten. This disadvantage means that over the first grade year, black male students gain ??? fewer points than white male students on the reading assessment. This is a dramatic setback. The disadvantage is not as great in second and third grades, but the impact of the first grade year remains.

By the time black male students finish third grade, they are a full ??? points behind white male students, almost double the female male gap for Whites.

Black female students also perform poorly in reading relative to white males, but not by as much as black males. Indeed, black females start, continue, and finish better than black males in reading. The reading gains for black female students in kindergarten and in first grade are significantly higher than the gains for black male students ($p<.01$), leaving black females slightly ahead of their male peers but leaving both groups behind white males. At the start of school, black female students score 2 points less than white male students and have slower learning rates throughout elementary school. Compared to white male students, black female students lose ground most in first grade (-0.03 SD less per month). However, this gap in learning rates is less than half the size of the black male disadvantage during the same time period.

Like black males and females, Hispanic males also lose ground relative to white males during elementary school. Hispanic males start kindergarten with more than a 4 point shortfall on the reading assessment compared to white males. Their learning rates are slower during kindergarten and slower still during first grade. This means that during first grade, Hispanic males gain nearly ??? fewer points than white males on the reading assessment. Fortunately, the decline is not as sharp in second and third grades during which Hispanic male students' gains trail those of white male students by just about ??? points.

The picture is more complicated for Hispanic females. They do not start elementary school as far behind white males in reading as Hispanic male students. In addition, Hispanic females actually exceed the learning gains of white males during the summer between kindergarten and first grade.[6] Hispanic female students gain so much ground in the summer compared to white male students that they erase the learning gap???. This good news is shattered, however, in first grade when Hispanic female students learn –0.06 SD less per month than white male students. The net results is that Hispanic females end up about ??? points behind white males, but around ??? points ahead of Hispanic males by the end of 3rd grade.

Asian males and females are the only students other than white females who start kindergarten with stronger performances on the reading assessments than white males. Their advantage continues throughout kindergarten and the summer after kindergarten, though the difference is not significant for the Asian female students. In first grade, there are no significant differences between the Asian students and white male students. During second and third grades, Asian students have significantly lower achievement gains than white male students (-0.03 SD per month). This may be due to the introduction of Asian students who were excluded from the first rounds of data collection on the reading assessment for failure to speak sufficient English but were included in later rounds as their English improved.

[6] Indeed, for Hispanics the reading gains during kindergarten where significantly larger for females than males ($p<.01$).

TABLE 3: READING BY GENDER AND RACE—ELEMENTARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
WHITE MALE STUDENTS				
Before Kindergarten				23.26
During Kindergarten	1.83	0.198		
	(0.0176)			
Summer K-1st	-0.330	-0.0357		
	(0.0761)			
During 1st Grade	3.41	0.369		
	(0.0328)			
After 1st Grade, into 3rd Grade	1.63	0.176		
	(0.0110)			
WHITE FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**1.57**
During Kindergarten	**0.126**	**0.0136**		
	(0.0263)			
Summer K-1st	0.183	0.0197		
	(0.1150)			
During 1st Grade	**0.189**	**0.0204**		
	(0.0475)			
After 1st Grade, into 3rd Grade	-0.000913	-0.0000986		
	(0.0159)			
BLACK MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**-2.38**
During Kindergarten	**-0.283**	**-0.0305**		
	(0.0390)			
Summer K-1st	0.164	0.0178		
	(0.1780)			
During 1st Grade	**-0.630**	**-0.0680**		
	(0.0712)			
After 1st Grade, into 3rd Grade	**-0.164**	**-0.0178**		
	(0.0294)			
BLACK FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**-2.02**
During Kindergarten	**-0.152**	**-0.0165**		
	(0.0389)			
Summer K-1st	-0.0287	-0.00310		
	(0.1620)			
During 1st Grade	**-0.278**	**-0.0300**		
	(0.0685)			
After 1st Grade, into 3rd Grade	**-0.191**	**-0.0207**		
	(0.0249)			

Table Continues on Next Page

TABLE 3 (CONT.): READING BY GENDER AND RACE — ELEMENTARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
HISPANIC MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**-4.42**
During Kindergarten	**-0.231**	**-0.0250**		
	(0.0397)			
Summer K-1st	0.294	0.0318		
	(0.1740)			
During 1st Grade	**-0.615**	**-0.0664**		
	(0.0683)			
After 1st Grade, into 3rd Grade	**-0.0569**	**-0.00615**		
	(0.0238)			
HISPANIC FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**-3.47**
During Kindergarten	-0.00597	-0.000644		
	(0.0445)			
Summer K-1st	**0.435**	**0.0470**		
	(0.1970)			
During 1st Grade	**-0.514**	**-0.0555**		
	(0.0699)			
After 1st Grade, into 3rd Grade	-0.0454	-0.00491		
	(0.0253)			
ASIAN MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**1.93**
During Kindergarten	**0.267**	**0.0289**		
	(0.0822)			
Summer K-1st	**0.835**	**0.0902**		
	(0.3760)			
During 1st Grade	-0.228	-0.0246		
	(0.1340)			
After 1st Grade, into 3rd Grade	**-0.247**	**-0.0266**		
	(0.0393)			
ASIAN FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**2.99**
During Kindergarten	**0.343**	**0.0371**		
	(0.0853)			
Summer K-1st	0.593	0.0641		
	(0.4570)			
During 1st Grade	-0.112	-0.0121		
	(0.1480)			
After 1st Grade, into 3rd Grade	**-0.241**	**-0.0260**		
	(0.0379)			

Estimates in bold are significantly different from the corresponding estimate for White students at the 5% level. Some of the numbers in the end of period column are off by 0.01 points due to rounding.

Secondary school. Examining the same groups but with older students in Table 4, white and Asian female students are the only groups who start high school ahead of white male students on the reading assessment. Black males and Hispanic males start with the greatest deficit on the reading assessment compared to white males, and for Black males this gap in learning rates is exacerbated during high school.

Black males and females both start behind white males in 8th grade reading and lose ground between 8th and 10th grade. No significant differences by gender were found for blacks for reading during high school. It is also the case that no significant differences in learning rates were found between blacks and white males between 10th and 12th grade. This could be related to the fact that white males learn little during this period, gaining less than 2 points on the test, but also possibly to changes in the composition of test takers during the latter years of high school.

Hispanic males and females also start behind white males in 8th grade reading but they do not appear to lose ground between 8th and 10th grade and the males actually appear to gain ground between 10th and 12th grade. Again, while it is possible that Hispanic males were learning at faster rates during this period, a compositional shift is also quite possible.

Asian males and females start with similar (for males) or higher (for females) reading scores compared to white males. Like Hispanics, they experience no differential growth between 8th and 10th grade but between 10th and 12th the Asian females experience greater growth in reading skills than white males and than Asian males.

In general females gained reading skills at a faster rate than males. The differences were statistically significant and favored females in 7 out of 24 comparisons and were never statistically significant when they favored males. Interestingly, during high school both White and Asian females experienced faster reading growth than their male counterparts between grades 10 and 12 while for Blacks and Hispanics such differences were not found. This could be related to differences in how gender interacts with race during high school or it could reflect differential rates of missing test scores between males and females for Blacks and Hispanics in 12th grade.

TABLE 4: READING BY GENDER AND RACE—SECONDARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
WHITE MALE STUDENTS				
Before High School				27.86
8th Grade to 10th Grade	0.155	0.0168	3.72	31.58
	(0.0055)			
10th Grade to 12th Grade	0.0776	0.00840	1.86	33.44
	(0.0074)			
WHITE FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**2.34**
8th Grade to 10th Grade	-0.00657	-0.000712	-0.16	2.18
	(0.0076)			
10th Grade to 12th Grade	**0.0247**	**0.00268**	**0.59**	2.77
	(0.0094)			
BLACK MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**-5.49**
8th Grade to 10th Grade	**-0.0731**	**-0.00791**	**-1.75**	-7.25
	(0.0251)			
10th Grade to 12th Grade	0.0116	0.00126	0.28	-6.97
	(0.0233)			
BLACK FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**-3.55**
8th Grade to 10th Grade	**-0.0344**	**-0.00372**	**-0.82**	-4.37
	(0.0150)			
10th Grade to 12th Grade	0.00250	0.000270	0.06	-4.31
	(0.0174)			
HISPANIC MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**-4.10**
8th Grade to 10th Grade	-0.0142	-0.00154	-0.34	-4.44
	(0.0140)			
10th Grade to 12th Grade	**0.0414**	**0.00449**	**0.99**	-3.44
	(0.0200)			
HISPANIC FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**-3.09**
8th Grade to 10th Grade	-0.0157	-0.00170	-0.38	-3.46
	(0.0163)			
10th Grade to 12th Grade	0.0206	0.00223	0.49	-2.97
	(0.0158)			

TABLE 4 (CONTINUED): READING BY GENDER AND RACE—SECONDARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
ASIAN MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				-0.06
8th Grade to 10th Grade	0.0358	0.00388	0.86	0.80
	(0.0189)			
	0.0218			
10th Grade to 12th Grade	(0.0317)	0.00236	0.52	1.32
ASIAN FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**2.31**
8th Grade to 10th Grade	0.0129	0.00139	0.31	2.62
	(0.0163)			
10th Grade to 12th Grade	**0.0951**	**0.0103**	**2.28**	4.90
	(0.0205)			

Gender Alone

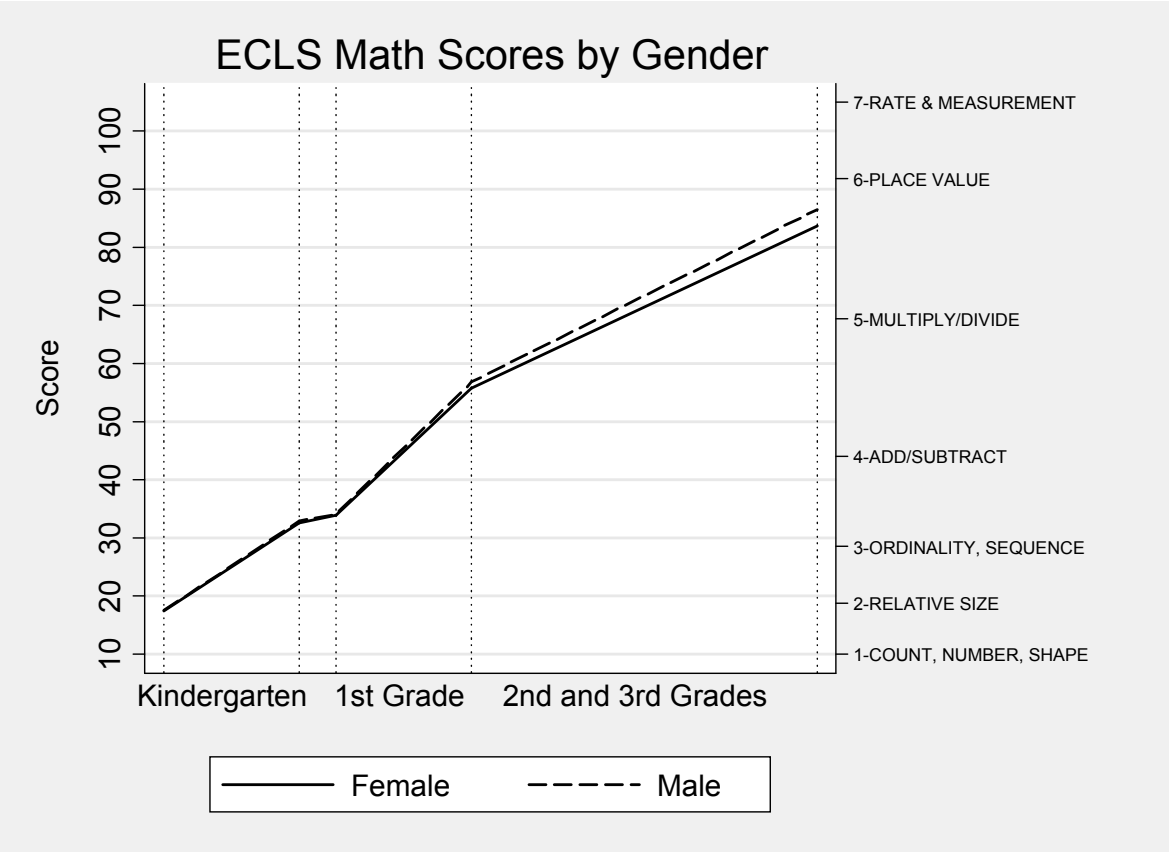
Elementary school. Male and female students start kindergarten with very similar math scores, but in sharp contrast to the reading results, male students begin to edge out girls in first grade (see Table 5). Also in contrast to the reading results, the gap continues to widen over time. In kindergarten, boys and girls start with similar math scores and make similar gains on the math assessment. In first grade, girls begin to make less gain in math (-0.008 SD). By the third grade assessment, girls have earned 2.79 points less on the math assessment than boys. But this does not translate to a great difference in skill attainment. Both male and female students are learning place value by the end of third grade, as shown in Figure 3.

TABLE 5: MATH BY GENDER—ELEMENTARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
MALE STUDENTS				
Before Kindergarten				17.53
During Kindergarten	1.63	0.198	15.37	32.91
	(0.0132)			
Summer K-1st	0.469	0.0403	1.21	34.11
	(0.0649)			
During 1st Grade	2.41	0.195	22.72	56.83
	(0.0229)			
After 1st Grade, into 3rd Grade	1.23	0.0998	29.68	86.51
	(0.0069)			
FEMALE STUDENTS (DIFFERENCE FROM MALE STUDENTS)				
Before Kindergarten				-0.03
During Kindergarten	-0.0350	-0.00425	-0.33	-0.36
	(0.0180)			
Summer K-1st	0.0464	0.00399	0.12	-0.24
	(0.0890)			
During 1st Grade	**-0.0959**	**-0.00776**	**-0.90**	-1.15
	(0.0316)			
After 1st Grade, into 3rd Grade	**-0.0684**	**-0.00553**	**-1.64**	-2.79
	(0.0097)			

These analyses are based on students who have at least one reading or math test score in at least one of the five rounds of ECLS-K data. Each estimate in bold is significantly different from the corresponding estimate for male students at the 5 percent level.

FIGURE 3: DIFFERENCES IN MATH LEARNING RATES BY GENDER—ELEMENTARY SCHOOL



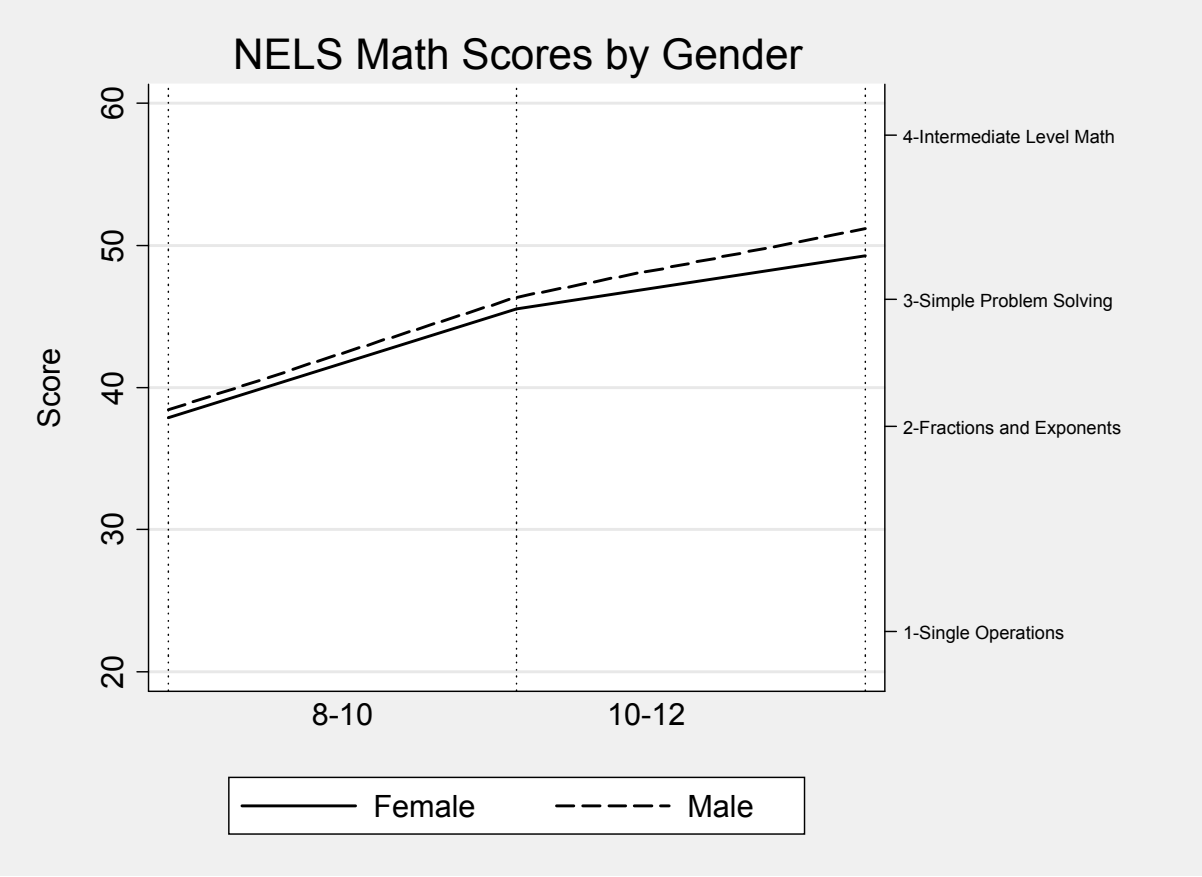
Secondary school. Perhaps not surprisingly, given the elementary school student results presented earlier in Table 8, females start high school with slightly lower math achievement than their male peers (a difference of about a half point). These differences, presented in Table 6, do not increase between eighth and tenth grades but do increase between tenth and twelfth grades when female students gain about 0.84 points less per period on the math test than boys. This gap in gain represents about 0.01 of a standard deviation on the tenth-grade test. By the end of high school, the initial male advantage on the math assessment increases to an advantage of almost 2 points. In terms of a gap in substantive knowledge, the difference between male and female students seems quite small. Both genders on average have already gained simple problem-solving skills and are beginning to learn more complex mathematics skills.

TABLE 6: MATH BY GENDER—SECONDARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
MALE STUDENTS				
Before High School				38.44
8th Grade to 10th Grade	0.330	0.0296	7.92	46.36
	(0.0058)			
10th Grade to 12th Grade	0.200	0.0152	4.81	51.17
	(0.0057)			
FEMALE STUDENTS (DIFFERENCE FROM MALE STUDENTS)				
Before High School				**-0.56**
8th Grade to 10th Grade	-0.0117	-0.00105	-0.28	-0.84
	(0.0076)			
10th Grade to 12th Grade	**-0.0442**	**-0.00336**	**-1.06**	-1.90
	(0.0076)			

Each estimate in bold is significantly different from the corresponding estimate for male students at the 5 percent level.

FIGURE 4: DIFFERENCES IN MATH LEARNING RATES BY GENDER—SECONDARY SCHOOL



Gender and Race

When looking at achievement by gender only, the differences do not seem large or problematic. However, the gender by ethnicity comparison indicates that the combination of ethnicity and gender is especially important to understanding the achievement patterns of some subgroups in particular, especially Asian students.

Elementary school. Although white females start kindergarten demonstrating stronger math skills than white males, their learning rates are not as fast and by the end of third grade, white females have gained about ??? points fewer than white males on the math test. The largest gap in the learning rates occurs during first grade (-0.005 SD per month) and the white female rate of learning math is still significantly slower than white males during second and third grades.

Black males and females start kindergarten about 4 points behind white males and have slower learning rates during kindergarten, 1st grade, and between 1st and the end of 3rd. This leaves them about ??? points behind white males on the math assessment by the end of third grade. Such a large deficit presents a difficult challenge to overcome and is much larger than the overall 3-point gender difference in math scores at the end of elementary school.

Hispanic male and female students start behind both white male students and black students but make faster gains than black students in kindergarten through third grade. In fact, estimates indicate that the gains for Hispanic male students roughly match those of white male students in second and third grades.[7] By the end of third grade the math deficit for Hispanic students, regardless of gender, compared with white male students at the end of third grade is only about half as large as for black students???.

Asian males start kindergarten with higher math scores than white males, keep pace with white male gains in kindergarten, and then gain far more during the summer between kindergarten and first grade. This 0.05 SD per month advantage in the summertime learning pushes them ??? points ahead of white male students by the end of the summer. In first grade, their monthly math gains slip dramatically (-0.03 SD), cutting their large advantage nearly in half ??? (again, perhaps due to the influx of English language learners to the sample in first grade). During second and third grades, Asian male students again outpace everyone.

Asian females start kindergarten with roughly the same math scores as white males but gain less than white males in kindergarten by about -0.01 SD per month and less in first grade by about 0.02 SD. Asian girls stage a comeback in second and third grades to outpace white boys by around than 0.003 SD per month. By the end of third grade, however, Asian females are nearly ??? points behind white males on the math assessment, while Asian males are more than ??? points ahead of white males. The gap between Asian female and Asian male students is most stark of all and statistically significant during kindergarten and the following summer. Thus, in this comparison, it is not just ethnicity that matters; within ethnic groups, there are large significant achievement differences by gender. Indeed, within Asians the gender gap at the end of third grade of ??? points is similar in magnitude to the black white gaps which are ??? points for males and ??? points for females.

[7] During first through third grades, Hispanic males gain significantly more ground in math than Hispanic females ($p<.05$).

TABLE 7: MATH BY GENDER AND RACE—ELEMENTARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
WHITE MALE STUDENTS				
Before Kindergarten				19.03
During Kindergarten	1.74	0.111		
	(0.0166)			
Summer K-1st	0.420	0.0268		
	(0.0804)			
During 1st Grade	2.51	0.160		
	(0.0291)			
After 1st Grade, into 3rd Grade	1.25	0.0799		
	(0.0083)			
WHITE FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**0.41**
During Kindergarten	-0.0377	-0.00241		
	(0.0232)			
Summer K-1st	0.0962	0.00615		
	(0.1160)			
During 1st Grade	**-0.0837**	**-0.00535**		
	(0.0419)			
After 1st Grade, into 3rd Grade	**-0.0581**	**-0.00371**		
	(0.0119)			
BLACK MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**-4.18**
During Kindergarten	**-0.390**	**-0.0249**		
	(0.0328)			
Summer K-1st	-0.0144	-0.000918		
	(0.1650)			
During 1st Grade	**-0.414**	**-0.0264**		
	(0.0579)			
After 1st Grade, into 3rd Grade	**-0.130**	**-0.00830**		
	(0.0200)			
BLACK FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**-4.09**
During Kindergarten	**-0.349**	**-0.0223**		
	(0.0336)			
Summer K-1st	-0.0717	-0.00458		
	(0.1660)			
During 1st Grade	**-0.378**	**-0.0242**		
	(0.0593)			
After 1st Grade, into 3rd Grade	**-0.210**	**-0.0134**		
	(0.0201)			

Table Continues on Next Page

TABLE 7 (CONT.): MATH BY GENDER AND RACE — ELEMENTARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
HISPANIC MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**-5.43**
During Kindergarten	**-0.266**	**-0.0170**		
	(0.0310)			
Summer K-1st	0.120	0.00770		
	(0.1570)			
During 1st Grade	**-0.170**	**-0.0109**		
	(0.0542)			
After 1st Grade, into 3rd Grade	-0.0264	-0.00168		
	(0.0178)			
HISPANIC FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**-4.81**
During Kindergarten	**-0.256**	**-0.0164**		
	(0.0334)			
Summer K-1st	0.242	0.0155		
	(0.1630)			
During 1st Grade	**-0.314**	**-0.0201**		
	(0.0554)			
After 1st Grade, into 3rd Grade	**-0.0745**	**-0.00476**		
	(0.0185)			
ASIAN MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				**1.45**
During Kindergarten	0.0677	0.00433		
	(0.0699)			
Summer K-1st	**0.905**	**0.0578**		
	(0.3680)			
During 1st Grade	**-0.448**	**-0.0286**		
	(0.1240)			
After 1st Grade, into 3rd Grade	**0.0899**	**0.00575**		
	(0.0327)			
ASIAN FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before Kindergarten				0.65
During Kindergarten	**-0.148**	**-0.00944**		
	(0.0606)			
Summer K-1st	0.100	0.00641		
	(0.3660)			
During 1st Grade	**-0.312**	**-0.0199**		
	(0.0967)			
After 1st Grade, into 3rd Grade	**0.0538**	**0.00343**		
	(0.0259)			

Estimates in bold are significantly different from the corresponding estimate for White students at the 5% level. Some of the numbers in the end of period column are off by 0.01 points due to rounding.

Secondary school. Differences in math achievement, presented in Table 8, by both gender and race are startling. Black male students begin high school more than 10 points behind white males. The disadvantage for black females compared to white males on the math assessment is slightly less, with about an 8-point deficit. Black male students continue to lose ground in early high school, but make similar gains to white male students later in high school. Black female students lose ground throughout all high school grades. These results leave black female students more than 10 points behind white males at the end of high school and black male students about 12 points behind white males.

Hispanic males and females also start high school with lower scores on the math test than white male students. The Hispanic students are about 6 to 8 points behind white male students, with Hispanic female students performing worse than their Hispanic male peers. Hispanic male students keep pace with the learning rate of white male students throughout high school. However, Hispanic female students make slightly slower math gains than white males.

Asian male students outscore and outpace white male students and every other subgroup on the math assessment at least at the start of high school and during the first two years. In the final two years of high school, Asian male students gain at the same rate as white male students. Asian female students begin high school with an average score about 3 points higher than that of white males, but make similar gains to this group throughout high school. In the within-ethnicity comparison, Asian males gain significantly more on the math test than Asian females later in high school ($p<.05$). Thus compared to white students in math, Asian students regardless of gender are ahead of white male students, however Asian female students are behind Asian male students.

TABLE 8: MATH BY GENDER AND RACE—SECONDARY SCHOOL

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
WHITE MALE STUDENTS				
Before High School				39.15
8th Grade to 10th Grade	0.325	0.0247	7.79	46.94
	(0.0061)			
10th Grade to 12th Grade	0.198	0.0151	4.75	51.68
	(0.0063)			
WHITE FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				0.02
8th Grade to 10th Grade	0.00143	0.000109	0.03	0.06
	(0.0082)			
10th Grade to 12th Grade	**-0.0459**	**-0.00349**	**-1.10**	-1.04
	(0.0086)			
BLACK MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**-10.47**
8th Grade to 10th Grade	**-0.0469**	**-0.00357**	**-1.12**	-11.59
	(0.0229)			
10th Grade to 12th Grade	**-0.0318**	**-0.00242**	**-0.76**	-12.35
	(0.0185)			
BLACK FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**-7.94**
8th Grade to 10th Grade	**-0.0761**	**-0.00579**	**-1.83**	-9.77
	(0.0193)			
10th Grade to 12th Grade	**-0.0289**	**-0.00220**	**-0.69**	-10.46
	(0.0148)			
HISPANIC MALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**-5.83**
8th Grade to 10th Grade	-0.0153	-0.00116	-0.37	-6.20
	(0.0181)			
10th Grade to 12th Grade	0.0184	0.00140	0.44	-5.76
	(0.0192)			
HISPANIC FEMALE STUDENTS (DIFFERENCE FROM WHITE MALE STUDENTS)				
Before High School				**-7.81**
8th Grade to 10th Grade	**-0.0481**	**-0.00366**	**-1.15**	-8.96
	(0.0146)			
10th Grade to 12th Grade	**-0.0452**	**-0.00343**	**-1.08**	-10.04
	(0.0160)			

Table 8 (Continued): Math by Gender and Race—Secondary School

Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	Level At End of Period
Asian Male Students (difference from White Male Students)				
Before High School				**3.35**
8th Grade to 10th Grade	**0.0626**	**0.00476**	**1.50**	**4.85**
	(0.0206)			
10th Grade to 12th Grade	0.0244	0.00186	0.59	5.43
	(0.0291)			
Time Period	Gain Per Month	Effect Size Per Month	Gain Per Period	At End of Period
Asian Female Students (difference from White Male Students)				
Before High School				**2.93**
8th Grade to 10th Grade	0.0193	0.00147	0.46	3.40
	(0.0273)			
10th Grade to 12th Grade	-0.0153	-0.00116	-0.37	3.03
	(0.0234)			

Conclusion

The general pattern that males do better in math and females do better in reading appears in at least some grade-levels for all ethnic groups. Although the coefficient estimates are sometimes in the opposite direction from this pattern, these reversals are never statistically significant. The results are in the expected direction and statistically significant for 14 out of 48 comparisons at the 5 percent level and 3 more comparisons at the 15 percent level (see the Appendix Table A1 for details).

The results for Whites are strongest with statistically significant results at the 15% level for 7 of 16 comparisons. The results for the other ethnic groups are not statistically significant as often as for whites. This is likely in part because they are based on smaller sample sizes.

The gender gap results are also stronger in the earlier grades than in the later grades with two interesting exceptions. First, only one of eight comparisons is statistically significant for the summer between kindergarten and 1st grade. This suggests that gender may matter more during school than it does when students are not in school. Second, the gender gaps in learning rates are statistically significant in 4 out of 8 comparisons between grades 10 and 12 of high school, perhaps because of important changes in social norms and expectations that become more prominent during this period.

In sum, while gender gaps in achievement are fairly small compared to ethnic differences, the gender gaps in learning rates are fairly consistent over time in that when statistically significant differences are found they suggest that males tend to learn more math and females tend to learn more reading during both elementary and high school regardless of ethnicity. These patterns are of interest in that they show that whatever the forces are that drive these gender differences, they appear to operate across racial and ethnic lines, at least within the U.S. school system.

References

Dee, Thomas (2006) "The Why Chromosome," *Education Next*, No. 4.

Logerfo, Laura, Austin Nichols, and Sean F. Reardon (2006) "Achievement Gains in Elementary and High School," The Urban Institute, Washington, D.C.

Mead, Sarah (2006) "The Truth about Boys and Girls," The Education Sector, Washington, D.C. June.

Murray, Charles (2005) "Where are the Female Einsteins?," American Enterprise Institute, Washington, D.C., November.

Appendix
Test Statistics for Gender Gaps in Growth Rates by Race/Ethnicity

Table A1
Are Gender Differences Statistically Significant by Race?
P-values of Test Statistics and Signs of Male-Female Growth Coefficient Estimate Differences

	Mathematics				Reading			
Time Period	Black	White	Hispanic	Asian	Black	White	Hispanic	Asian
Elementary								
Growth During Kindergarten	0.31	*0.11* >	0.50	**0.02 >**	**0.01 <**	**0.00** <	**0.00 <**	0.50
Growth Summer K-1st	0.50	0.41	0.50	*0.11* >	0.50	0.11	0.50	0.50
Growth During 1st Grade	0.50	**0.05** >	**0.03 >**	0.50	**0.00 <**	**0.00** <	0.24	0.50
Growth 1st Grade to 3rd Grade	**0.00 >**	**0.00** >	**0.03 >**	0.50	0.50	0.95	0.50	0.50
Secondary								
Growth 8th to 10th	0.31	0.86	*0.13* >	0.19	0.16	0.39	0.50	0.50
Growth 10th to 12th	0.50	**0.00** >	**0.01 >**	0.27	0.50	**0.01** <	0.50	**0.04 <**

Note: 0.50 implies >=0.50, 0.00 implies<=0.005, bold implies<0.05, italics implies <0.15.
>,< gives sign of male-female coefficients.