Gender Differences in Parental Involvement and Adolescents' Mathematics Achievement

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How does parents' involvement in school differ for sons and daughters, and what difference does it make in the gender gap in mathematics achievement? This article reports on a longitudinal study of the impact of parental involvement on adolescents' mathematics achievement from Grade 8 to 12. The study found that gender differences in scores on mathematics achievement tests were small but consistent among high school seniors. Gender differences in Grade 8 test scores and gains from Grade 8 to 10 were found only when parental involvement was controlled. The relationship between parental involvement and achievement is similar for girls and boys and diminishes over the course of high school to the point that parental involvement has essentially no relationship to the gains in achievement made by seniors.

Researchers and policy makers have long known that family background is an important determinant of success in school (Coleman et al. 1966), yet they know much less about why this is the case. Parental involvement in education is increasingly viewed as a way to improve students' educational performance (Schneider and Coleman 1993). The family as an institution has been criticized as a gendered institution that socializes its young to embrace stereotypical gender roles (Chodorow 1978). The study of mathematics in the United States is stereotypically regarded as the domain of boys and a field in which girls have difficulty. The stereotypes have been empirically supported, to some extent, by gender differences in mathematics performance and in labor force participation in mathematics and science-oriented occupations (Oakes 1990).

Research on how parental involvement is associated with mathematics achievement will provide information about the extent to which some socialization practices in the family are associated with gender differences in mathematics achievement. In this article I analyze how parental involvement in education is related to the difference between boys' and girls' performance on mathematics tests.

According to research on parental involvement, parents' actions vary both in form and in consequence (Muller 1995). Parents respond to their children's needs, including developmental and behavioral needs, within a context (Mac Iver and Epstein 1993). They adjust their involvement to the context, which includes their children's behavior and their opportunities for action. Therefore, parental involvement almost certainly changes throughout childhood and is tailored, to some extent, to each child's needs. It also affects students' academic performance. Since some forms of involvement are more effective than others, it is important to use longitudinal data to study the relationship between involvement and achievement (Muller 1995).

GENDER DIFFERENCES IN MATHEMATICS

Gender differences in mathematics that favor boys are not measured consistently until high school. These differences are most often found in students' performance on standardized achievement tests and are strongest among the top-performing students (Hedges and Nowell 1995). In high school, the variance in boys' test scores becomes greater than in earlier boys' scores and in girls' scores. Thus, boys are represented more strongly at the extremes of the test-score distribution, particularly among high-performing students. These patterns have been observed in various tests administered to high school students (see Friedman 1989; Oakes 1990).

Students' Attitudes

Attitudes may affect students' behavior and result in differential course taking or engagement in mathematics. Boys and girls tend to have different attitudes toward mathematics and their ability to succeed in that area. Using data from 8th- and 10th-grade students in the 1988 National Education Longitudinal Study (NELS), Catsambis (1994) found that the 10th-grade girls were less likely to report liking mathematics and feeling comfortable in mathematics classes and were less likely to expect to have mathematics- or science-related careers. She did not link these differences to performance or course taking. (In separate analyses, however, she found that girls took more mathematics courses than boys; according to the teachers, those courses were more likely to be taken by high-ability students.) Eccles et al. (1985) found that gender differences in self-concept emerged in middle school before students typically make decisions about which courses they will enroll in, in high school. These findings call into question the direct relationship between attitudes and course taking, suggesting a more complex process by which gender differences emerge.

Parents' involvement may influence children's attitudes, including self-concept, which may, in turn, affect academic performance. It is important to recognize that self-concept is multifaceted. That is, the nature and structure of self-concept change throughout childhood, such that an adolescent's self-concept in one area—for example, academics—may be unrelated to self-concept in another area, say social or emotional life. In addition, within academic self-concept, subject-specific measures of self-concept are not necessarily associated with one another. For instance, girls generally have a higher verbal self-concept, while boys have a higher self-concept about mathematics. Furthermore, it is not clear how (or whether) the differences in self-concept are attributable to differences in performance (Marsh 1994).

Parental Involvement and Mathematics Achievement

In studying the socialization of school-age boys and girls, Block (1983) found that parents are more restrictive and more nurturing with daughters but encourage sons to be free and to explore more widely outside the family. Entwisle, Alexander, and Olson (1994) noted that parents' stronger encouragement of sons to explore and take advantage of neighborhood resources contributes to the gender gap in mathematics achievement. Garfinkel and McLanahan (1986) linked the father's presence in the household to the development of analytical thinking among boys, although they only speculated that the difference was due to the father-child relationship.

Aside from studies of differential socialization, such as those just mentioned, few researchers have studied the impact of parental involvement on gender differences in mathematics achievement. Baker and Stevenson (1986) indicated that mothers with more education were more likely to intervene in school decisions about their children's course taking and that boys' mothers were more likely than girls' mothers to intervene to influence their children's placement in mathematics courses.

Parental involvement makes a difference in achievement, in general (see Epstein 1991; Muller 1993; Stevenson and Baker 1987), and specifically in adolescents' mathematics performance and gains in mathematics performance. Muller (1995), analyzing NELS data, found that not all forms of involvement were associated positively with mathematics achievement and that the relationship of involvement to achievement probably changed as the children progressed through school. Overall, the research suggests that parents' involvement in children's education takes many forms, depending, in part, on the children's ages and opportunities for involvement. For example, Bradley and Caldwell's (1984) study of the current and later achievement of preschool children stressed the importance of verbal interaction between parents and children, and Muller (1995) found that verbal interaction was important for 8th-grade students' mathematics achievement. In addition, Epstein (1991) observed that parents' interactions with teachers and the school were an important predictor of elementary school students' achievement. Also, Baker and Stevenson (1986) indicated the importance of parents' involvement in managing 8th-grade students' decisions about school.

Little is known about gender differences in involvement and whether they cause gender differences in academic performance. Stevenson and Baker (1987) found that parents were more likely to be involved in school activities with boys and in home activities with girls; on average, however, parents tended to be more involved with girls. Stevenson and Baker also found that parents' involvement with boys was more likely to diminish as the children grew older but remained at a more constant level with girls. They did not investigate whether the forms of involvement changed over the course of childhood.

In analyzing the contribution of parent-child relationships to the emergence of the gender gap in mathematics, I used nationally representative longitudinal data on adolescents from three points in time. To study how parental involvement affects girls' and boys' comparative performance on mathematics achievement tests, one must examine the relationship between involvement and performance at multiple time points, since it is not clear precisely when gender differences emerge. A gender difference in scores on mathematics tests is not found consistently among middle school students. Mathematics courses are more likely to be required of all students during middle school, and there is little evidence of differential participation in mathematics classes at this point (although Catsambis, 1994, found that girls were more likely than boys to be placed in high-ability classes, according to the teachers). In addition, middle school classes may be less competitive and less individualistic than high school classes. Also, parents may have more opportunities for involvement in middle school than in high school activities. Furthermore, at the time of the transition from middle school to high school, changes owing to physiological development may bring out adolescents' gender differences.

DATA AND METHOD

Sample

The database for this analysis included the base year and the first and second follow-ups of NELS. As 8th-grade students, the respondents were asked to complete survey questionnaires about their backgrounds; schoolwork, teachers, and activities; and home lives, attitudes, and social relationships. In addition, a series of curriculum-based cognitive tests, prepared by the Educational Testing Service, were administered to each student to measure ability in reading, mathematics, science, and social studies. The students were followed up two and four years later, when most were in Grades 10 and 12. At each point, they took a new battery of tests and were interviewed (for a complete description of the data set, see Ingels et al. 1994).

I used only public school students in my analysis because mathematics achievement and parental involvement are different in private schools (Coleman and Hoffer 1987). I selected students for analysis only if data from all three waves (including mathematics test scores) were available. In addition, I excluded Native Americans from all analyses because they are a distinctive racial and ethnic group and thus should not be categorized with any other group but are too small a group to be examined separately (Schneider and Coleman 1993). These exclusions resulted in a sample of 12,766 students.

Variables

The students were surveyed and tested when most were in the 8th, 10th, and 12th grades. I attempted to make these analyses comparable while using the measures most appropriate for the students' grade levels. Because parental involvement is likely to change with adolescents' development and in response to their academic performance, it is important to use the most current involvement measures available. In general, I used the data on the Grade 8 students to predict Grade 8 achievement and gains from Grade 8 to Grade 10. Similarly, I used the data on the Grade 10 students to model 10th-grade achievement and gains from Grade 10 to Grade 12. All the analyses are weighted with the three-wave panel weight and adjusted for the design effect, as suggested by Ingels et al. (1994). I used pairwise deletion to estimate all the models. I also conducted analyses using listwise deletion (not shown) and found no difference in the substantive conclusions.

Parental involvement. I used the students' reports of parental involvement, rather than the parents' reports that were available only for 8th graders. One cannot assume that parents' reports are any more correct than students' reports; they just represent a different perspective. I judged that for my purposes the students' reports, which indicate the students' perspective, were more valid for the examination of students' academic behavior. In addition, parents' reports were not available for the 10th graders, and it was essential to maintain the best possible comparability of measures across the waves. Furthermore, current reports of involvement (such as the students' Grade 10 reports) capture the adolescents' development and current relationships with their parents. A full analysis of the differences between students' and parents' perceptions is beyond the scope of this article.

The forms of parental involvement I used were similar to those I developed earlier (Muller 1995) when examining parents' involvement with Grade 8 students. In the 1995 study, I used a combination of parents' and students' reports (rather than only students' reports, as here) and found two important dimensions of involvement: (1) whether the locus of activity is the home or the school and (2) whether such activity can be characterized as parental management of a child's educational career or intervention in a crisis. In the case of parental management, the parents' authority is not subordinate to the school's, as it often is when parents intervene in a crisis.

In my analyses, I used students' reports to measure nine forms of Grade 8 involvement and seven forms of Grade 10 involvement. Most of these forms were management-related activities in which the parents' authority was maintained. All the students reported how frequently they discussed school activities or what they studied in class. The 8th-grade students reported how frequently they discussed high school plans and the 10th-grade students reported how frequently they discussed college plans with their fathers and mothers. In addition, the 8th-grade students noted whether they took art, music, or dance lessons outside school, and the 10th-grade students listed the frequency of those lessons. The 8th-grade students also reported the amount of time they were left unsupervised after school.

Both the 8th- and 10th-grade students indicated whether their parents had attended a school meeting and (separately) a school event. These two forms of involvement are school-based activities in which parents are likely to maintain their "managerial" authority. A school meeting, in which school policy and programs are discussed, is more likely to be formal, whereas school events may have a more social or extracurricular content.

To obtain a measure of parental intervention, I summed the students' reports as 8th-grade students and separately as 10th-grade students on how often their parents contacted the school or checked homework. Intervention is likely to place parental authority subordinate to the school. The school may define acceptable student behavior, for example, the completion of homework or compliance with school rules, and parents are expected to support the school's authority. For a measure of parental restriction of activity for each grade level, a form of home-based management, I summed the students' reports of parents' restrictions on weekday television watching or how often the students could go out with friends. In addition, because intervention and restrictions may be a response to negative behavior, I constructed interaction terms between low grades (mostly Ds or below) and each form of parental involvement.

I checked for nonlinearities in the relationships between the measures of parental involvement and the outcomes. Most variables are associated with the outcomes in a simple linear fashion. The most important exception is after-school supervision, which I discuss later.

Academic performance. Mathematics achievement tests were administered to each student in

Grades 8, 10, and 12. The scores used here are the Item Response Theory (IRT) scores. To reduce ceiling and floor effects, IRT uses information about the student's prior test performance and the level of difficulty of each test item (Ingels et al. 1994.) The mathematics grades are the students' reports of mathematics grades "from the ninth grade until now" or, in the case of 8th-grade students, "from the sixth grade until now."

Students' attitudes and expectations. Involvement and achievement are associated by a dynamic process; that is, they include students' and parents' responses to one another. Since the final outcome of interest was the students' academic performance, it was important to consider how the students' attitudes affected this process. The students' educational expectations are associated with parents' involvement and with students' own achievement (Muller 1993). The students reported their educational expectations in Grades 8 and 10 with their answers to the question, "As things stand now, how far in school do you think you will get?"

Students' attitudes about their mathematics ability seem to vary by gender (Catsambis 1994; Eccles et al. 1985). Because parental involvement is a primary agent of socialization, it is not clear how involvement may affect and be affected by a student's self-concept about mathematics. Therefore, mathematics-specific self-concept was controlled in some analyses. The 10th-grade students were asked a series of subject-specific questions about how well they thought they were doing in mathematics (for example, their agreement or disagreement with the statement, "Mathematics is one of my best subjects"); their responses formed a Marsh mathematics self-concept scale (Marsh 1994). I constructed the scale in accordance with the recommendations of Ingels et al. (1992).

Course work. The measure of course work varies according to grade level. Alternative analyses conducted with measures of the class's ability level (not shown here) did not change the main findings with respect to gender or parental involvement. The 8th-grade students reported their enrollment in advanced mathematics, remedial mathematics, and algebra, and the 10th-grade students reported which mathematics classes they had taken. I constructed dummy variables if mathematics course work fell into either the "low" or the "advanced" categories (compared with "average") identified by Stevenson, Schiller, and Schneider (1994).

Students' background. Student and family background variables include the student's gender and race and ethnicity, the parents' highest educational levels, and family income. The race and ethnicity categories were European American, African American, Latino, and Asian. I conducted all the analyses only on the European American, African American, and Mexican students (not shown) and found no difference in the substantive conclusions.

RESULTS

Descriptive Statistics

The girls talked with their parents about school more than did boys (see Table 1). The students reported more frequent conversations about their high school programs with their mothers than with their fathers, but the boys talked more with their fathers about their high school programs than did the girls. Muller (1995) found that when fathers talk about high school, this talk may take

Table 1. Descriptive Statistics for the Variables (Weighted) Used in the Analysis

Variable	Girls (*N* = 6,469) Mean or Proportion	Girls *SD*	Boys (*N* = 6,297) Mean or Proportion	Boys *SD*	Total (*N* = 12,766) Mean or Proportion	Total *SD*
Parents' highest education[a]	2.930	.645	3.033	.654	2.982	.650
Family income[a]	9.461	1.387	9.652	1.343	9.557	1.367
Gender (male = 1)	—	—	—	—	.505	—
Asian	.033	—	.036	—	.034	—
Latino	.109	—	.102	—	.105	—
African American	.138	—	.136	—	.137	—
Advanced mathematics (Grade 8)[a]	.414	—	.435	—	.425	—
Algebra (Grade 8)[a]	.368	—	.380	—	.374	—
Remedial mathematics (Grade 8)[a]	.048	—	.073	—	.060	—
Advanced mathematics sequence (Grade 10)[a]	.268	—	.310	—	.289	—
Low math sequence (Grade 10)	.398	—	.405	—	.402	—
Students' grades (Grade 8)[a]	2.988	.540	2.890	.556	2.939	.548
Students' grades (Grade 10)[a]	4.549	1.024	4.409	1.079	4.479	1.052
Mathematics test scores (Grade 8)[a]	35.201	6.251	35.521	6.625	35.363	6.438
Mathematics test scores (Grade 10)[a]	42.409	7.237	42.689	7.790	42.551	7.515
Mathematics test scores (Grade 12)[a]	46.913	7.413	47.871	7.969	47.402	7.697
Self-concept (mathematics, Grade 10)[a]	3.911	.827	4.218	.767	4.065	.803
Educational expectations (Grade 8)[a]	4.636	.667	4.469	.711	4.552	.691
Educational expectations (Grade 10)[a]	6.326	1.154	5.964	1.188	6.144	1.175
Grade 8 Parental Involvement						
Talk about school[a]	1.450	.265	1.313	.285	1.381	.277
Talk with dad about high school program[a]	1.009	.407	1.072	.411	1.040	.409

(Continued)

Table 1 (Continued)

Variable	Girls (N = 6,469) Mean or Proportion	SD	Boys (N = 6,297) Mean or Proportion	SD	Total (N = 12,766) Mean or Proportion	SD
Talk with mom about high school program[a]	1.480	.353	1.335	.384	1.408	.371
Take art, music, dance[a]	.451	—	.246	—	.348	—
Unsupervised time after school	1.367	.605	1.384	.626	1.376	.615
Parents attend school meeting	.466	.272	.468	.278	.467	.275
Parents attend school event[a]	.635	.262	.600	.273	.617	.268
Parents intervene[a]	2.581	.625	2.783	.639	2.683	.635
Parents restrict activity[a]	3.252	.881	3.176	.915	3.214	.898
Grade 10 Parental Involvement						
Talk about school[a]	2.069	.289	1.968	.290	2.019	.291
Talk about college[a]	2.281	.367	2.164	.390	2.224	.379
Take art, music, dance[a]	.700	.608	.438	.531	.569	.576
Parents attend school meeting[a]	.354	.261	.378	.272	.366	.266
Parents attend school event	.206	.220	.211	.229	.209	.225
Parents intervene[a]	1.987	.646	2.093	.660	2.039	.653
Parents restrict activity	2.811	.893	2.778	.925	2.795	.909

[a]Gender difference is significant at $p < .05$.

the form of discipline or intervention; thus, sons may talk more with their fathers because their behavior demands it. Alternatively, fathers may take more interest in their sons because they are more interested in shaping their sons' than their daughters' lives.

The parents restricted the girls' out-of-school activities more than the boys'. They also attended their 8th-grade daughters' school events but attended school meetings about their 10th-grade sons more often. The school events may reflect support for the daughters, whereas the school meetings may be related to obtaining information about school options or setting school policy. The parents intervened in their sons' lives more than their daughters', perhaps because their sons experienced more school-related behavioral problems.

These statistics suggest that parents may be involved slightly differently in their sons' and daughters' lives, in ways that are consistent with the literature about younger children. Parents may be more nurturing and restrictive toward their daughters but may discipline their sons more, and they may reach out to the school differently for their sons than for their daughters.

The boys' test scores were higher than the girls' in each grade in which the examination was administered, but the girls' grades were higher. The girls' educational expectations were higher than the boys', although the boys' parents had higher incomes and educational levels than the girls'.[1] The boys were more likely to report being in almost all kinds of mathematics sequences, including advanced mathematics, algebra, remedial mathematics, and higher-level course work in Grade 10.[2] They also had higher self-concepts regarding mathematics.

The data analyzed here measured adolescents at three points in time. I began by estimating the relationship of parental involvement to mathematics achievement in the 8th and 10th grades and to the gains in achievement between Grades 8 and 10 and Grades 10 and 12. Gender differences are documented more fully in high school, when classes are different from those in middle school and parents' opportunities for involvement may diminish. Finally, to determine whether there are gender differences in the process by which involvement influences achievement, I estimated separately, by gender, the effects of parental involvement on mathematics achievement.

Gender Differences in Achievement

Table 2 shows models estimating the mathematics test scores of the 8th- and 10th-grade students and the gains the students made between Grades 8 and 10 and 10 and 12. Estimates of the scores on 8th-grade mathematics tests, shown in the first set of models, indicate no gender difference. When the students' grades and expectations were controlled, the coefficient for gender became significant and indicated that the boys scored approximately .6 of a test question (approximately .1 of a standard deviation, *SD*) higher than the girls. That difference increased to 1.4 test questions when parental involvement was controlled. Thus, parental involvement may mask some of the gender differences in 8th-grade students' performance that may exist at this grade level in the absence of differential involvement.

Parental involvement was associated with test performance in both positive and negative ways. Talking with parents about school was associated positively with performance, as was taking art, music, or dance classes. When the parents restricted their 8th-grade students' activities, the students attained higher test scores. Parental intervention, however, was associated negatively with test performance, probably because of the negative association between test scores and an unmeasured behavioral problem. On the other hand, intervention accompanied by low grades had no effect on test scores. Thus, intervention may have a different association with test scores, depending on the nature or magnitude of the problem.[3] The negative relationship between achievement and talking with fathers about high school programs suggests that fathers may have used the discussions as intervention or discipline.[4]

Table 2. Regression Coefficients (standard errors in parentheses) for Predictions of Mathematics Test Scores and Gains in Test Scores

	Grade 8 Scores			Gains from Grade 8 to 10			Grade 10 Scores				Gains from Grade 10 to 12			
Gender (boys = 1)	.029	.610**∝	1.412**	-.064	.200	.426**	-.089∝	.701**	.582	.024	.680**	.908**	.917**	.744
	(.181)	(.170)	(.175)	(.125)	(.123)	(.128)	(.204)	(.188)	(.189)	(.189)	(.106)	(.104)	(.106)	(.107)
Students' grades		2.823**	3.121**		1.023**	1.187**		1.660**	1.830**	1.057**		.507**	.552**	.321**
		(.090)	(.111)		(.068)	(.084)		(.052)	(.059)	(.073)		(.030)	(.035)	(.041)
Educational expectations		1.342**	1.210**		.749**	.767**		1.255**	1.450**	1.427**		.362**	.401**	.407**
		(.075)	(.077)		(.055)	(.057)		(.051)	(.055)	(.054)		(.029)	(.032)	(.032)
Talk about school			1.966**			.781**			-.277	-.318			.092	.077
			(.207)			(.152)			(.216)	(.213)			(.121)	(.120)
Talk with dad about high school program			-.627**			-.693**								
			(.138)			(.101)								
Talk with mom about high school program			.068			-.145								
			(.157)			(.115)								
Talk about collage									-.973**	-.980**			-.282	-.293
									(.169)	(.167)			(.094)	(.094)
Take art, music, dance			1.387**			-.007			-.444**	-.361**			.063	.085
			(.191)			(.140)			(.091)	(.089)			(.051)	(.050)
Unsupervised time after school			-.541**			-.208**								
			(.075)			(.055)								
Parents attend school meeting			-.030			-.117			.537*	.641**			.313**	.351**
			(.175)			(.128)			(.198)	(.195)			(.111)	(.110)
Parents attend school event			-.082			.305*			-.842**	-.853**			-.080	-.091
			(.183)			(.134)			(.231)	(.228)			(.129)	(.128)
Parents intervene			-.961**			-.314**			-.716**	-.743**			-.085	-.101*
			(.079)			(.058)			(.091)	(.090)			(.051)	(.051)
Parents restrict activity			.255**			.248**			.312**	.325**			-.037	-.030
			(.055)			(.040)			(.062)	(.061)			(.035)	(.035)
Intervene x low grades			.966**			.323*			.766*	.733*			-.080	-.083
			(.213)			(.156)			(.274)	(.270)			(.153)	(.152)
Restrict x low grades			-.017			.034			.261	.170			.274**	.247*
			(.183)			(.134)			(.188)	(.186)			(.105)	(.105)

(Continued)

Table 2 (Continued)

	Grade 8 Scores			Gains from Grade 8 to 10			Grade 10 Scores				Gains from Grade 10 to 12			
Self-concept (math)										1.509** (.085)				.484** (.048)
Adjusted R^2	.395	.441	.460	.776	.785	.788	.380	.478	.488	.502	.856	.863	.864	.865

Note: All models control for parents' highest education, family income, race and ethnicity, and mathematics course work. Models of gains were estimated by regressing the later test score on the Grade 10 test score, for example, the grade 10 test score on the grade 8 score. All analyses used pairwise deletion and were weighted and adjusted for the design effect

[a] The coefficient for gender is significantly different from the coefficient to the immediate right in the more complex model.

* $p < .05$, ** $p < .001$.

Models predicting Grade 8 test scores use only cross-sectional data, so it is impossible to establish how fully parental involvement precedes academic behavior. Moreover, prior achievement (measured by self-reported grades) may not be controlled adequately. Parental involvement, as measured here, may have contributed to students' preparation for learning, rather than to current learning. That is, the students' performance on tests in Grade 8 may indicate how well the students were prepared for the course work and hence may reflect learning opportunities before middle school, rather than parental involvement in the children's daily learning activities.

Using these Grade 8 variables to predict Grade 10 test scores allowed me to understand something about the temporal order of these behaviors and attitudes. The second set of models in Table 2 shows coefficients predicting gains in scores on mathematics achievement tests between Grades 8 and 10. I used Grade 8 test scores to predict Grade 10 scores; thus, the coefficients associated with the other variables in the model represent the contribution of this variable to the Grade 10 score when the prior score is held constant. This is not a strict measure of gain, as would be the case if the difference between the two scores were regressed on the other variables; rather, it is an approximation of growth. I use the term *gain* to describe the regression of the latter score on the earlier score.

I found no differences between the gains in the girls' and boys' mathematics test scores in the first model, in which the parents' highest education, family income, race and ethnicity, and mathematics course work were controlled. The second model, in which grades and expectations were added, also indicated no significant gender difference. Nor were gender differences found when mathematics course work was not controlled (analysis not shown).

When parental involvement was included in the model, the coefficient for gender became significant; it indicated that the boys' test scores increased by about .4 of a test question more than the girls', or approximately 5.5 percent of an *SD* of the Grade 10 test scores. Thus, when scores on the Grade 8 mathematics test were taken into account, I found no evidence of a gender difference in the gains made between Grades 8 and 10 until parental involvement was controlled; even then, the difference was small.

Among the Grade 8 parental involvement measures, the strongest positive predictors of Grade 10 test scores were how much the parents restricted out-of-school activities and how much their children talked with them about school. Students whose parents attended school events also had slightly higher test scores, whereas as those who were unsupervised after school had smaller gains in test scores.[5] Intervention was associated negatively with gains.

The next set of models in Table 2 predicts Grade 10 test scores, controlling for Grade 10 course work, expectations, and reports of grades from Grades 8 to 10. The 10th-grade measures of parental involvement are included in the last two models of the set. The final model also includes the 10th-grade measure of mathematics self-concept, which is not available in any other wave.

Gender differences in Grade 10 mathematics test scores are not evident in the first, basic model shown.[6] When students' grades and expectations were controlled, the gender coefficient became significant and indicated that the 10th-grade boys scored approximately .7 of a test question higher than the 10th-grade girls, or approximately 10 percent of an *SD*. The small coefficient remained essentially unchanged when parental involvement was added to the third model in this sequence.

The subject-specific self-concept measure explains the small gender difference in scores on the 10th-grade mathematics test shown in the last model of the third set. It also significantly reduced the association of grades with test scores. Probably the association between test scores, grades, and mathematics self-concept is different for girls than for boys. For example, girls may respond to grades as an indicator of their mathematics ability differently from boys. Also, grades (which are based on academic performance and behavior) may reflect ability differently for girls because girls are less likely to misbehave.

Most forms of parental involvement with the 10th-grade students were found to be either not significant or negatively associated with the test scores. The most striking finding was that the coefficient for 10th-grade students talking about school, which was a strong predictor of Grade 8 test scores, has no association with Grade 10 mathematics achievement. The two measures of talking about school are identical except that one was reported by the 8th-grade students and the other by the 10th-grade students.

Parental restriction of activity is the strongest positive predictor of Grade 10 mathematics scores; parental intervention shows a moderate negative association. The frequency of taking art, music, or dance lessons is also associated negatively with mathematics test scores. In sum, parents' restriction of activities with friends and weekday television watching is the only form of involvement that is associated with higher 10th-grade test scores. This finding differs markedly from the results for the Grade 8 test scores, which are strongly associated with how much the students talked with their parents about school.

The last section of Table 2 shows models predicting gains made between Grades 10 and 12. In the basic model, the boys made significantly greater gains than did the girls in Grade 10.[7] When students' grades and expectations were added to the model, the gender difference in test scores increased slightly: The boys gained about two-thirds (.68) of a test question in Model 1 but almost an entire question (.91) in Model 2. The gender coefficient remained essentially unchanged when parental involvement was added to the model. In the final model, when mathematics self-concept in Grade 10 was added, the gender coefficient was reduced slightly. None of the changes in the gender coefficients are statistically significant.

Most of the coefficients of parental involvement are zero or modestly negative. Attending a meeting had a small positive influence on the students' learning from Grade 10 to 12. Apparently, either the effects of parental involvement cease as adolescents work to completion their high school diplomas or effective forms of involvement change, and those forms were not measured.

Parental Involvement and Achievement, by Gender

These results suggest that a small gender difference may be observed at each point at which test scores are measured in the NELS, in Grades 8, 10, and 12. Furthermore, the gender difference found earlier in the students' school careers may be related more closely to involvement than that measured during high school. The gender differences in test scores and in gains in test scores among the 10th-grade students were extremely small and were found only inconsistently. The data in Table 1 indicate that the parents were involved in significantly different ways with their sons and daughters. Thus, I examined whether parental involvement is associated with achievement differently for boys than for girls.

Table 3 shows the final models predicting test scores and gains from Table 2, for boys and girls separately, including the background variables not shown in Table 2. The results in Table 3 allowed me to analyze whether the same factors are related to boys' and girls' performance.[8] The first two models in Table 3 show coefficients predicting Grade 8 test scores with background, parental involvement, grades, expectations, and course work. I found some minor differences in the relative magnitude of the coefficients for boys and girls, but only three of the differences were significant: (1) the positive effect of family income was larger for the girls, (2) the negative effect of being African American was larger for the boys, and (3) the negative association between parental intervention and Grade 8 test scores was larger for the boys. In general, however, the models are remarkably similar.

The second two models in Table 3, in which gains between Grades 8 and 10 were predicted, also indicate similar patterns for the boys and girls. The parental involvement associated with gains in the girls' test scores is also associated with gains for the boys, with only the following exceptions: Taking art, music, or dance classes is associated positively with gains for the girls and negatively for the boys. Similarly, the parents' attendance at school meetings is associated positively with the girls'

Table 3. Regression Coefficients (standard errors in parentheses) for Predictions of Mathematics Test Scores and Gains in Test

	Grade 8 Scores		Gains from 8 to 10		Grade 10 Scores		Gains from 10 to 12	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
Intercept	9.910**∝	14.391**	3.230*∝	.968	22.987**	20.967**	6.378**∝	7.929**
	(.794)	(.844)	(.578)	(.644)	(.818)	(.960)	(.490)	(.564)
Parents' education	1.446**	1.363**	.335	.267*	1.588**	1.597**	.455**	.388**
	(.117)	(.128)	(.085)	(.096)	(.123)	(.141)	(.070)	(.080)
Family income	.402**∝	.220**	.083*∝	.280**	.404**	.425**	-.086*	-.057
	(.054)	(.063)	(.039)	(.046)	(.057)	(.069)	(.032)	(.039)
Asian	.068	.076	.453	1.066*	-.046	-.025	.693	-.460
	(.638)	(.675)	(.457)	(.501)	(.681)	(.748)	(.382)	(.420)
Latino	-3.620**	-3.251**	-1.051**	-.688*	-4.419**	-3.296**	-.594*	-.239
	(.384)	(.428)	(.278)	(.319)	(.410)	(.476)	(.233)	(.269)
African American	-5.278**∝	-7.020**	-1.560**	-1.201**	-6.307**∝	-8.111**	-1.806**	-1.580**
	(.358)	(.393)	(.262)	(.300)	(.376)	(.431)	(.216)	(.251)
Advanced mathematics	.543	.147	.092∝	-.695**	2.495**∝	-.309	-.477*	-.644**
	(.286)	(.299)	(.205)	(.222)	(.313)	(.358)	(.177)	(.201)
Remedial-low mathematics	-4.671**	-5.13**	-2.374**	-2.566**	-8.289**	-8.500**	-1.778**	-1.597**
	(.529)	(.482)	(.382)	(.362)	(.300)	(.357)	(.179)	(.211)
Algebra	6.409**	6.804**	1.655**	1.961**	—	—	—	—
	(.298)	(.309)	(.222)	(.240)	—	—	—	—
Students' grades	3.221**	3.023**	1.258**	1.112**	1.231**	.937**	.244**	.379**
	(.150)	(.166)	(.112)	(.127)	(.100)	(.106)	(.057)	(.060)
Educational expectations	1.183**	1.245**	.592**∝	.918**	1.359**	1.507**	.408**	.405**
	(.106)	(.113)	(.077)	(.084)	(.072)	(.082)	(.042)	(.048)
Talk about school	1.803**	2.096**	1.159**	.502*	.195∝	-.885*	.450*∝	-.324
	(.289)	(.296)	(.208)	(.221)	(.278)	(.324)	(.156)	(.182)
Talk with dad about high school program	-.584**	-.670*	-.505**	-.916**	—	—	—	—
	(.180)	(.212)	(.129)	(.157)	—	—	—	—
Talk with mom about high school program	-.108	.209	-.314*	.019	—	—	—	—
	(.213)	(.234)	(.153)	(.174)	—	—	—	—
Talk about college	—	—	—	—	-1.101**	-.869**	-.556**∝	.002
	—	—	—	—	(.225)	(.245)	(.127)	(.138)
Take art, music, dance	1.543**	1.107**	.407*∝	-.454*	-.268*	-.435*	.094	.041
	(.251)	(.297)	(.181)	(.221)	(.111)	(.145)	(.062)	(.082)
Unsupervised time after school	-.399**	-.672**	-.156*	-.257*	—	—	—	—
	(.102)	(.110)	(.073)	(.082)	—	—	—	—
Parents attend school meeting	-.280	.192	.265∝	-.502*	1.384**∝	-.065	-.053∝	.799**
	(.239)	(.258)	(.172)	(.191)	(.259)	(.291)	(.146)	(.164)
Parents attend school event	.228	-.299	.306	.299	-.242∝	-1.397**	.493*∝	-.620**
	(.254)	(.266)	(.182)	(.197)	(.301)	(.341)	(.169)	(.192)
Parents	-.794**∝	-1.119**	-.461**	-.190*	-.921**	-.579**	.025∝	-.240*

(Continued)

Table 3 (Continued)

	Grade 8 Scores		Gains from 8 to 10		Grade 10 Scores		Gains from 10 to 12	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
intervene	(.107)	(.117)	(.077)	(.088)	(.117)	(.138)	(.066)	(.077)
Parents restrict	.219*	.292**	.145*∝	.349**	.176*∝	.484**	-.004	-.039
activity	(.075)	(.082)	(.054)	(.061)	(.080)	(.093)	(.045)	(.053)
Intervene x low	.976**	.966*	.284	.320	.197	1.138*	.027	-.159
grades	(.297)	(.308)	(.213)	(.228)	(.378)	(.385)	(.212)	(.217)
Restrict x low	.084	-.105	.093	-.026	.538*	-.131	-.050	.457*
grades	(.249)	(.270)	(.179)	(.200)	(.257)	(.268)	(.144)	(.151)
Self-concept	—	—	—	—	.973**∝	2.015**	.627**∝	.326**
(math)	—	—	—	—	(.110)	(.130)	(.062)	(.075)
Adjusted R^2	.467	.456	.795	.784	.527	.490	.877	.857

∝The coefficient for girls is significantly different from the coefficient for boys.
* $p < .05$; ** $p < .001$.

achievement and negatively with boys'. Also, the positive effect of parental restriction of activities is larger for the boys.

In addition, both educational expectations and family income are associated more strongly with gains in the boys' test scores. Advanced mathematics course work is negatively associated with gains in the boys' test scores. This finding could indicate a ceiling effect among the boys in high-level mathematics classes.

In the third set of models, Grade 10 test scores were regressed on background; grades from Grades 8 to 10; and 10th-grade parental involvement, expectations, and course work. Once again, I found striking similarities between the models predicting boys' and girls' achievement, although there were more differences than in the previous models. Four forms of parental involvement indicate gender differences in their relationships to the scores on the 10th-grade mathematics tests. Talking about school is negatively related to the boy's test scores and unrelated to the girls'. Similarly, parents' attendance at school events is associated negatively with the boys' achievement only. Attending meetings is associated positively with the girls' 10th-grade mathematics achievement but is unrelated to the boys' test scores. Restricting activities has a positive association with the achievement of all students, but the relationship is stronger for the boys.

The boys' mathematics-specific self-concept is associated more strongly than the girls' with test scores. In addition, as with the scores on the Grade 8 mathematics test, the negative effect of being African American on boys' Grade 10 test scores is greater than that of African American girls, and both the African American boys and girls achieved much lower scores than did the European Americans.

The last pair of models shows five gender differences in the association between parental involvement and gains in test scores from Grades 10 to 12. Talking about school is associated positively with the girls' gains and is not associated with the boys', and talking about college is associated negatively with gains only in the girls' test scores. In contrast, the parents' attendance at school meetings is associated positively with gains in the boys' test scores but not those of the girls. Parents' attendance at a school event has a positive association with the girls' gains in test scores but is related negatively to the boys'. The parents' intervention is negatively associated only with the boys' gains.

In view of these findings, it may be that gains in the girls' learning from Grades 10 to 12 are associated more closely with verbal interaction and supportive involvement, whereas the boys' gains are associated more closely with social control and guidance. Furthermore, the locus of activity appears to be the home for girls and the school for boys. For the girls, parents attendance at a school event may be a form of support; also, parents talking with children makes a difference for girls but is unrelated to gains for boys. Parents' attendance at a school event is negatively associated with the boys' gains, but attendance at a meeting, at which information on a school's programs and policies is likely to be provided, is positively associated. The gains in the boys' test scores are also positively related to restrictions on out-of-school activities associated with low grades, although the gender difference is not significant. Thus, the association of home-based parental involvement with school performance (as may occur in the case of low grades) suggests that involvement that is connected more closely with school may be more effective for boys.

These results illustrate that a small gender gap exists at each stage and provide insight into the differences in the ways that parental involvement varies, depending on the gender of the child. It is difficult to gauge how the levels of parental involvement and their association with test scores are related to boys' and girls' performance on mathematics tests. Table 4 shows the average scores for a student with average background characteristics, depending on the student's gender and whether the student's parents were effectively involved at low or high levels. A low level of effective involvement is defined as the lowest possible value for each form of involvement that is positively associated with test scores and the highest value for involvement that has a negative association with test scores. A high level of effective involvement is the reverse; that is, the highest possible values are assigned to positive involvement and the lowest values to negative involvement. Estimates of test scores that were based on the pooled average level of involvement are also shown.

Table 4. Predicted Mathematics Test Scores for an Average Student, by Level of Parental Involvement and Gender

Parental Involvement	Grade 8 Scores	Gains: Grade 8–10	Grade 10 Scores	Gains: Grade 10–12
Girls				
Low involvement	28.426	38.699	37.622	45.599
Average involvement	34.69	42.282	42.455	47.037
High involvement	44.753	47.330	51.401	48.973
Boys				
Low involvement	27.015	38.236	35.345	46.087
Average involvement	36.085	42.717	42.489	47.795
High involvement	47.631	47.550	52.177	52.138

Table 4 illustrates that varying the levels of involvement made a substantial difference in the students' test scores. The difference in the girls' Grade 8 math achievement, depending on the level of parental involvement, was about 16 test questions, or approximately 2.5 *SD*. The difference for the boys' scores was larger, over 20 test questions, or 3.2 *SD*. The differences were smaller for Grade 10 test scores. The differences in gains were also smaller because the pooled average test score was used to predict the achievement score two years later. The range of test scores for low and high levels of parental involvement shows the "effects" of all measures of parental involvement on test scores for an otherwise average student. As was discussed earlier, it is important to remember that the children's unmeasured behavior is almost certainly captured in these measures of involvement; thus, the range is due not only to differences in parental actions but to variation in students' behavior and other unmeasured factors.

Table 4 also shows that the average test scores increased over high school (as expected) and that the difference between test scores based on parents' level of involvement decreased. The range of Grade 10 test scores was 3.4 and 6.1 questions for girls and boys, respectively, or less than 1 *SD* for each.

DISCUSSION

The kinds of activities in which parents are likely to engage—and engage effectively—change as students progress through school. Children are probably open to different kinds of relationships with their parents, depending on their developmental age. Older adolescents demand much more autonomy from their parents and are therefore more likely to discourage or reject parental attempts at involvement. Moreover, schools and curricula probably vary in their openness to parental involvement. As the content of the curricular material becomes more complicated, parents may feel increasingly inadequate in helping their children with schoolwork or even with deciding which courses to take. Finally, in the transition from elementary school to middle school and then from middle school to high school, schools may become progressively less open to parents' participation; alternatively, parents may feel more removed from the higher-level schools, which also may be more distant geographically. Thus, for numerous reasons, parents may be less likely to participate in activities or to remain involved in their children's schools and other activities outside the home.

Furthermore, students may be less likely to report parental involvement. The results reported here suggest that parents' involvement, especially at home and as measured in my study, may not make much difference in older adolescents' achievement. Also at this period, parental involvement is not associated with the gender gap in mathematics test scores.

Some of the forms of involvement that I measured, such as how much children talk with parents about school, how much time children are left unsupervised after school, and perhaps how restrictive parents are, probably measure qualities of the parent-child relationship as it was when the children were younger (Muller 1993). Thus, it seems likely that if these forms of parental involvement were present earlier in the parent-child relationship (before Grade 8), the parents' differential involvement may be mitigating some aspect of the earlier processes, perhaps in the school, that contributes to a gender difference. One cannot say if this is so without data from an earlier period in the children's lives.

Parents may be more involved with their daughters because the girls are more successful in school. Parents' involvement with their sons and daughters may change differentially, so that what was measured in eighth-grade students is not representative of what was measured earlier. Furthermore, the relationships between involvement and achievement may not be the same in younger children as in older children.

The observed differences in parents' involvement with their sons and daughters are consistent with the literature described earlier. Daughters experience more nurturing and more restrictions; sons are more likely to report that parents intervene and to engage in relationships outside the home. Daughters also appear to build supportive verbal relationships with parents, which may be developed most fully inside the home. The involvement analyzed here was all reported by the students. It is likely that parents' reports would disagree with the students'. Indeed, the disagreements may have meaning for understanding students' academic behavior if they reflect a lack of communication or rapport between parents and children. The students' reports probably better represent the students' receptivity to parental relationships (than would parents' reports), yet they are probably much more removed from parental intentions.

The data did not permit an analysis of parents' involvement by gender except for one type of involvement; thus, I cannot say whether such an analysis would reveal differences that are not otherwise apparent. On this one measure in which the parents' gender was specified—how often the students talked with their mothers and their fathers about planning their high school programs (two separate questions)—the parents exhibited patterns of involvement that differed both from one another and according to the children's gender. Sons talked more with their fathers and daughters talked more with their mothers. When the students talked with their fathers about planning their high school programs, I found a negative association with eighth-grade achievement. In addition, I found a negative association with achievement when the daughters talked about this subject with their mothers. This finding suggests that children's discussions with their fathers and daughters' discussions with their mothers may be disciplinary. Yet the relationship of involvement to achievement is not different for boys and for girls.

Insofar as performance in mathematics is related to stereotypical gender roles, there is no evidence that parents play a positive part in reinforcing these roles. In fact, the evidence is to the contrary: Parents' involvement in their children's education works against girls' tendency to perform less well than boys in mathematics. Other evidence, however, suggests that girls' experiences in mathematics may not be so positive: Girls are more afraid than boys to ask questions in class (Catsambis 1994) and have a lower self-concept about mathematics. Even so, they earn better grades in the subject. In fact, they tend to earn better grades in all subjects (Feingold 1992). Yet, the data in Tables 2 and 3 suggest that the relationship among mathematics self-concept, mathematics grades, and test scores may be different for girls and boys.

Furthermore, girls have a higher self-concept about their verbal skills (Marsh 1994). Hence, in high school, they may weigh their strength in mathematics against their strength in courses demanding high verbal skills and pursue their greater strength. Catsambis (1994) found that among the NELS 10th-grade students, the boys were more likely than the girls to anticipate careers in mathematics or science. As a result of girls' stronger supportive verbal relationship with their parents, the parents may consider their daughters' point of view and support their daughters' decisions in favor of fields other than mathematics.

As previous research documented, I found small but consistently measured gender differences in the 12th-grade students' mathematics performance: The girls earned higher grades and the boys scored better on the achievement tests. Eighth-grade gender differences were apparent when parental involvement was controlled. The student's life course and stage in school appear to be important in shaping the gender difference in mathematics performance and in the relationship of parental involvement to the student's performance.

The data in Table 3, in which boys and girls are compared, suggest that race and ethnicity may be important in future research. Those results show that the effect of being African American is larger for boys than for girls. I found no gender differences among Asians and Latinos. Other differences might emerge if Latinos were disaggregated into subgroups (Mexican American, Puerto Rican, and so on). In analyses of Mexican Americans (not shown), I found no difference in the substantive conclusions. Further disaggregation is beyond the scope of this article, but it deserves priority in studies of racial and ethnic differences both in parental involvement and in the gender gap in mathematics.

CONCLUSION

The results reported here suggest that parents may contribute to equalizing the mathematics opportunities available to girls. Certainly parents' involvement does not appear to reinforce gender stereotypes about mathematics performance. These results also suggest the possible limits of effective parental involvement. Moreover, involvement is sensitive to available parental resources and to racial and ethnic differences; therefore, high school girls' experience may promote or discourage mathematics learning through some mechanism that depends on parents' social class and race and ethnicity. Future research should attend to these differences.

NOTES

1. My earlier analyses (Muller 1995) of parental involvement and mathematics achievement using some parents' reports showed similar associations to those described here.

2. The statistics associated with the response categories for income and education have little intuitive meaning. The median parents' education was "some college" for both boys and girls. The median family income was $31,208 for boys and $30,500 for girls.

3. High school transcripts, available for most students, showed that the girls actually took more high-level mathematics courses than the boys in high school. Thus, the observed difference may have been due to differential reporting. Transcript data were unavailable for some students and are appropriate only for predicting scores on 12th-grade achievement tests; hence, I judged the students' self-reports to be a better measure for the purposes of this study. Models using transcript-reported course

work as controls (not shown) did not yield substantive conclusions different from those presented here.

4. The coefficient for the interaction term is positive and essentially equal in magnitude to the negative coefficient for intervention and indicates that for students earning Ds or Fs, parental action had no effect.

5. The forms of parental involvement are correlated with one another; for example, talking about school and talking with father have a correlation of .39 (not shown). Nevertheless, this negative relationship existed when no other forms of involvement were in the model (not shown).

6. There is a nonlinearity in the relationship between being unsupervised after school and test scores that is not apparent here. The lowest value for the unsupervised after-school variable is "never." The students who were never supervised had similar test scores to those who were left for two to three hours. Among the students who were left unsupervised, about 88 percent of the sample, a negative relationship between being unsupervised and test scores was found. This pattern was similar for girls and boys. For a more detailed discussion of this topic, see Muller, Schiller, and Lee (1991).

7. Nor were they significant when course work was excluded from the models (not shown).

8. The gender coefficient was essentially the same when course work was not included in the model (not shown).

9. Another approach to analyzing differences between boys and girls would have been to pool the data, as in Table 2, and include interactions between gender and each form of involvement. Those analyses, not shown, yielded substantively similar results to the ones presented in Table 3.

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