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Direct and Indirect Effects of Socioeconomic Status and Previous Mathematics Achievement on High School Advanced Mathematics Course Taking

Mehmet A. Ozturk
Kusum Singh

Direct and indirect effects of socioeconomic status (SES) and previous mathematics achievement on high school advanced mathematics course taking were explored. Structural equation modeling was carried out on data from the National Educational Longitudinal Study: 1988 database. The two variables were placed in a model together with the mediating variables of parental involvement, educational aspirations of peers, student's educational aspirations, and mathematics self-concept. A nonsignificant direct effect of SES on course taking suggests the lack of an 'automatic' privilege of high-SES students in terms of course placements. The significant indirect effect of previous mathematics achievement tells that it needs to be translated into high educational aspirations and a strong mathematics self-concept to eventually lead to advanced course taking.

In view of the freedom students in public high schools have in choosing the courses they take, course taking is a critical aspect of the students' education. Research consistently suggests that this is especially true for mathematics. Course taking was found to have the largest effect on academic achievement in mathematics among the academic subjects examined (e.g., Jones, Davenport, Bryson, Bekhuis, & Zwick, 1986; Schmidt, 1983). Researchers found that, even when students' social background and previous academic achievement were controlled, course taking was the single best predictor—twice as strong as any other factor—of achievement in mathematics (Lee, Burkam, Chow-Hoy, Smerdon, & Geverdt, 1998). In a study on National Educational Longitudinal Study: 1988 (NELS: 88) data, results indicated that the achievement growth differences in mathematics and science among high- and low-socioeconomic status students completing the same numbers of courses were small. This was particularly true in mathematics, where none of the socioeconomic status (SES) comparisons were significant among students taking the same numbers of high school mathematics courses (Hoffer, Rasinski, & Moore, 1995). Researchers hypothesize that mathematics is almost exclusively learned in school and that background factors do not exert much of an influence through out-of-school learning (Jones et al.; Schmidt). A parallel interpretation would be that much of the SES differences in mathematics achievement gains over the high school grades are due to the different numbers of mathematics courses that high- and low-SES students complete during high school (Hoffer et al.).

Advanced level mathematics bears importance for almost all students, regardless of their plans for the future. For college admissions and success, these courses play a critical role. Data collected from students admitted to four-year colleges and universities show the high numbers of advanced mathematics courses completed by these students (Owings, Madigan, & Daniel, 1998; U.S. Department of Education, 1997). For students who want to enter the job market after high school, these courses are also beneficial. Many jobs that once required little knowledge of mathematics now call for various skills in algebra and measurement. According to an industry-wide standard, an entry-level automotive worker should have the knowledge to apply formulas from algebra and physics in order to properly wire the electrical circuits of any car (U.S. Department of Education). These advanced courses have also been shown to improve students' fundamental mathematical skills such as problem solving (Jones, 1985; Rock & Pollack, 1995).

Two fundamental background variables that are related to advanced mathematics course taking are SES

Mehmet A. Ozturk is an assistant professor of educational research at Cleveland State University. His research interests include secondary school mathematics and science achievement, psychosocial and educational consequences of adolescent part-time work, and academic expectations in elementary and secondary schools.
Kusum Singh is a Professor of Educational Research and Evaluation at Virginia Tech. Her research focuses on family, social and school factors that affect academic achievement, particularly in mathematics and science. She teaches graduate courses in statistics and research methods.

and previous mathematics achievement. SES has been a significant variable in studies that looked at equity in advanced course taking. There has been a concern regarding any possible discrimination in course placements based on students' SES or minority status (e.g., Calabrese, 1989; Lareau, 1987; Useem, 1991). It may be that parents with higher income and educational levels are at an advantage in terms of being able to support their children toward advanced courses. This can happen in a number of legitimate ways such as role modeling and providing help with homework. However, the intriguing question is whether or not higher levels of SES bring about an 'automatic' privilege in course placements. Any such practice by school administrators or teachers, such as allowing parents of higher SES to have a greater say in their children's course placements, would be a form of discrimination.

Previous mathematics achievement is also closely related to advanced level mathematics course taking, since it has almost always been a consideration in advanced mathematics course placements. The critical question about previous mathematics achievement is whether students who have succeeded in prerequisite courses automatically enroll in more advanced courses or whether such achievement, by itself, is not enough for these students to further their studies in advanced mathematics. For example, there are studies suggesting that many students will not proceed with advanced courses—despite their proven record—unless they are encouraged to do so or feel confident about their mathematical abilities (e.g., Lantz & Smith, 1981). Almost none of the mathematics courses that would be classified as advanced are required for graduation, and around 60 percent of high school students graduate without having taken any of these advanced courses (Council of Chief State School Officers, 2002; Finn, Gerber, & Wang, 2002). Given these circumstances, it is important to translate previous achievement into advanced course taking.

Literature Review

SES and Advanced Mathematics Course Taking

The term *socioeconomic status* is used by sociologists to denote an individual or family's overall rank in the social and economic hierarchy (Mayer & Jencks, 1989). In most research, including national studies, SES has been measured as a combination of parents' education, parents' occupational prestige, and family income (Mayer & Jencks; White, 1982).

Researchers have explored a number of mechanisms through which SES exerts its influence on course taking. The first one is, undoubtedly, role modeling. Students from middle or high SES families constantly see, in their parents and neighbors, social and economic payoffs that good education could provide, while many minority children in high-poverty areas have few—if any—role models who have succeeded in school or who have translated school success into economic gain (Lippman et al., 1996; Oakes, 1990). These claims suggest an indirect effect of SES on advanced course taking through students' educational aspirations.

Another mechanism in the relationship between SES and advanced mathematics course taking is the high educational expectations middle- and high-SES families have for their children (Khattri, Riley, & Kane, 1997; Muller & Kerbow, 1993), and the conveyance of these expectations to them (Anderson, 1980; Hossler & Stage, 1992; Seginer, 1983; Wilson & Wilson, 1992). Lantz and Smith (1981) found significant positive relationships of educational aspirations and parental encouragement to taking nonrequired mathematics courses in high school. Indicators of SES (parents' education and parents' occupation) were only weakly related to nonrequired mathematics course taking, when other important variables, such as educational aspirations and parental encouragement, were entered in the same regression analysis. Findings from another study indicated that well-educated parents were far more inclined to pressure their children to take demanding mathematics courses (Useem, 1991). Altogether, these findings illustrate an indirect path from SES to advanced course taking through parental expectations and involvement, which influence the student's own educational aspirations.

Peers' educational aspirations may also play a role in the indirect effect of SES on advanced course taking. Previous research suggests that parents want and encourage their children to have friends with similar educational aspirations, since peers' aspirations will be influential on the student's own aspirations (Cooper & Cooper, 1992). Davies and Kandel (1981), in a study of adolescents, found a significant relationship between parents' educational aspirations for their children and aspirations of their children's best friends. Another finding by Lantz and Smith (1981) was that perceived peer attitudes were significantly related to election of nonrequired mathematics courses, even when it was entered in the regression analysis together with parents' education, parents' occupation, parental encouragement, and some other variables.

This group of findings assigns importance to peers' educational aspirations.

An important issue is the difference between parental influence and peer influence on the student's educational aspirations, which will have an impact on course taking decisions. As for the parent or peer influence in general, peers may have a greater influence in some areas of the student's life, such as types of behavior determining the current adolescent lifestyle, whereas parents may have a higher influence in other issues, such as those relevant to future goals (Biddle, Bank, & Marlin, 1980; Davies & Kandel, 1981). However, with regards to the parent or peer influence specifically on the student's educational aspirations, Davies and Kandel found that parental influence was much stronger than peer influence and did not decline over the adolescent years.

Guidance and counseling policies and practices in schools can either magnify or reduce the effect of SES on course taking. There has been an ongoing concern about the availability of counseling services to students and parents, mostly due to high student-to-counselor ratios and counselors' record keeping duties (Martin, 2002; Powell, Farrar, & Cohen, 1985). A study on a nationally representative sample of public school students in grades five through eleven revealed that a considerable number of students were not told about the academic implications of their course taking decisions in mathematics. Parents did not have any access to counseling services either (Leitman, Binns, & Unni, 1995). In the absence of proper counseling in school, well-educated parents are still able to guide their children through important course taking decisions, since they are knowledgeable about courses. On the other hand, those with low levels of education cannot be of any help to their children in this matter (Useem, 1991). What makes this problem worse is even less availability of these services to low-SES or minority students, who cannot get sufficient—if any—guidance from their families or communities and are in need of guidance the most. Many of these students are concentrated in high-minority, high-poverty schools (Lippman et al., 1996) and are less likely to have access to guidance counseling for course taking decisions (Lee & Ekstrom, 1987; Leitman et al.).

The mechanisms mentioned above are ways in which parents' socioeconomic characteristics can legitimately play an indirect role in students' course taking. However, there are also concerns sounded by researchers that imply a direct effect of SES, which can be seen as a form of discrimination based on SES. For example, some researchers assert that there is a differential treatment of minority students by school counselors and teachers through counseling them into undemanding nonacademic courses and discouraging them from academic ones (Calabrese, 1989; Leitman et al., 1995). Still others believe that the extent to which schools allow parental involvement in course placements is another factor that works against low-SES or minority students. In schools that try to constrain parental intervention in course taking decisions, parents with high SES or members of the dominant culture have more of the social, intellectual, and cultural resources to acquire the crucial information about course placements and the courage to take initiative. On the other hand, parents with low levels of education remain uninformed and discouraged by the school personnel to take initiative in this matter (Lareau, 1987; Useem, 1991).

Previous Mathematics Achievement and Advanced Mathematics Course Taking

Findings about the direct effect of previous mathematics achievement on subsequent mathematics course taking are inconclusive. Some studies found that mathematics achievement still had a significant effect on subsequent mathematics course taking, even after taking into account the effect of mathematics self-concept (e.g., Marsh, 1989); whereas others found that previous mathematics achievement did not consistently predict subsequent mathematics course taking. For example, Lantz and Smith (1981) found that when the last grade earned in mathematics was entered into regression analysis with several other variables, such as parents' education, parents' occupation and the student's mathematics self-concept, it predicted the participation in nonrequired mathematics courses in only one sample out of three. Students' subjective comparisons of their mathematics performances with those of other students as well as with their own performances in other subjects were better predictors of mathematics participation than the last grade earned.

The direct effect of previous mathematics achievement on subsequent mathematics course taking, especially at an advanced level, may be expected, since previous achievement, measured either by grades or standardized test scores, is a widespread criterion in high school mathematics course placements (Oakes, Gamoran, & Page, 1992; Useem, 1991). However, note that its use as a criterion does not necessitate successful students' enrollment in subsequent nonrequired advanced level mathematics courses.

Research Questions

The present study tries to answer two important questions: First, is there any discrimination in advanced mathematics course placements based on students' socioeconomic status? Second, do students who succeed in previous mathematics courses automatically enroll in the more advanced ones? Put differently, is previous mathematics achievement a necessary *and* sufficient condition for taking advanced mathematics courses; and to what degree do some variables, such as mathematics self-concept and educational aspirations, mediate the relationship between previous mathematics achievement and advanced mathematics course taking?

Method

Study Design

The present study focused on the effects of two background variables—namely, SES and previous mathematics achievement—on advanced mathematics course taking. The purpose of the study is to see how much of the effect of each of these two variables is direct and how much is an indirect effect mediated through parental involvement, educational aspirations of peers, educational aspirations of the student, or mathematics self-concept. This has been done through testing a causal model that includes these secondary variables. The hypothesized relationships are illustrated in Figure 1.

School-level variables reflecting school policies that are influential on students' course taking were controlled by keeping them constant. These variables are type of school, variety and level of mathematics courses offered, graduation requirements, and type of tracking. The following is a description of how and why these variables were kept constant.

In this study, only students in public high schools were selected. Two major differences between public and private high schools influenced our decision to ask the research questions stated above for public high school students only. The first difference is in the curriculum. Most private high schools are characterized by a narrow academic curriculum, where all students complete a narrow set of mostly academic courses, almost all of which are required for graduation. Catholic schools, a large sector of private schooling, are a good example of this type of curriculum (Lee et al., 1998; Lee, Croninger, & Smith, 1997). In contrast, public high schools predominantly feature a differentiated curriculum approach (Lee et al.). In these schools, students take a subset of courses among a variety of available offerings and are free to take elective courses beyond graduation requirements. Both research questions stated above are related to students' course selections and placements. In view of the above-mentioned policies and practices in most private schools, these research questions are primarily relevant to public high school students.

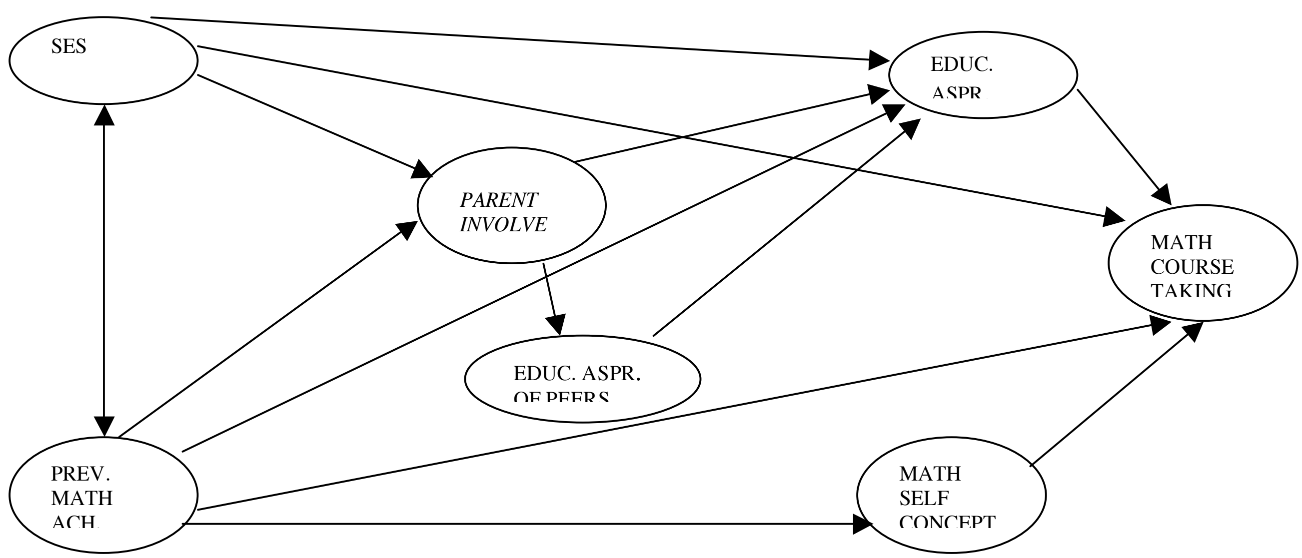

Figure 1. The Causal Model in the Present Study

In the present study, course taking in Algebra II, Geometry, Trigonometry, and Calculus is investigated. Accordingly, only students in schools that offered all of these courses were selected.[1]

School graduation requirements have at least some impact on students' course taking, since these requirements set the minimum for course taking. Since requiring a minimum of exactly two years of mathematics for graduation was the most common practice in the schools that participated in the NELS: 88 study, only students in such schools were selected in the present study.[2]

Broadly, tracking can be defined as a way of grouping students, in which students enroll in different programs of study and take different sequences of courses based on their ability and success levels. The multitude of tracking practices in schools makes it difficult for researchers to employ a precise measure of this variable. In much survey research, the three-track categorization (i.e., academic, general, and vocational) has been employed as a crude measure of tracking (Oakes et al., 1992). Literature on the effect of tracking on students' course taking is confusing and contradictory, since the term 'tracking' does not have a uniform meaning. In the present study, only students who were in any one of the three traditional programs (general, academic, or vocational) were selected, which excluded the ones who were in special or innovative programs.

Data Source and Sample

In this study, the data were drawn from the base year and first and second follow-up of NELS: 88. In the base year, a two-stage stratified sample design was used, with schools as the first-stage unit and students within schools as the second-stage unit (Ingels et al., 1994). The schools were stratified based on type (public versus private), geographic region, urbanicity, and percent of minority enrollment (Spencer et al., 1990). Within each stratum, schools were selected with probabilities in proportion to their estimated eighth grade enrollment, which led to a pool of approximately 1000 schools. In the second stage of sampling, an average of 23 students was selected randomly from each school, producing a total sample of approximately 23,000 eighth-graders for the base year. The first and second follow-up data were collected from the same cohort in 1990 and in 1992, when most of the students were tenth and twelfth graders, respectively. The cohort was freshened with proper statistical techniques in 1990 and in 1992 to achieve a representative sample of the nation's sophomores in the first follow-up and seniors in the second follow-up, respectively (Ingels et al.).

At the first step of sample selection for the present study, students who were members of the NELS: 88 sample in all three waves of data collection (base year, first follow-up, and second follow-up) and for whom transcript data were available, were selected. This group was readily defined by NELS: 88 as a subgroup within the overall sample, and a sampling weight was provided. This group is a nationally representative sample of 1988 8^{th} graders, regardless of whether they graduated from high school four years later or not. Among these students, only those who graduated from high school in Spring 1992 were selected in the first step of this study.

At the second step, relevant school variables were kept constant by selecting students who met all of the criteria below:

- Did not change their schools between base year (8^{th} grade) and second follow-up (12^{th} grade);
- Enrolled in a public school;
- Enrolled in schools that offered the complete set of mathematics courses of interest in the present study (Algebra II, Geometry, Trigonometry, and Calculus);
- Were in schools that required exactly two years of mathematics for graduation; and
- Were either in general, academic, or vocational programs.

All the analyses in this study were performed on this sample after a listwise deletion of missing data, which resulted in a sample size of 1,699.

Measures

Advanced mathematics course taking. This variable was measured as the sum of total Carnegie units earned in Algebra II, Geometry, Trigonometry, and Calculus. A Carnegie unit is defined as "a standard of measurement used for secondary education that represents the completion of a course that meets one period per day for one year" (Ingels et al., 1994, p. O-1).

Socioeconomic status of the student. SES was measured by F2SES1, a continuous composite variable already available in the NELS:88 database. It was constructed from the base year parent questionnaire data using five items: father's education level, mother's education level, father's occupation, mother's occupation, and family income. Occupational data were recoded using Duncan's Socioeconomic Index (SEI) (as cited in Ingels et al., 1994), which assigns values to various occupational groups.

Student's previous mathematics achievement. This variable was measured by BY2XMSTD, a score from a standardized mathematics test administered in the spring of 1988 (spring of 8th grade for the sample).

Parental expectations. This variable was measured by two first follow-up (10th grade) and two second follow-up (12th grade) questions, asking the students how far in school they think their father or mother (one question for father and one for mother) wants them to go. There are ten choices indicating different levels of education.

Parental involvement. This variable was measured by two questions asked both in the first follow-up and the second. The first question asked how often the student discussed selecting courses at school with either or both parents or guardians in the first half of the school year. The second question asked how often the student discussed going to college with either or both parents or guardians in the first half of the school year. Choices were *never*, *sometimes*, and *often*.

Educational aspirations of peers. This variable was measured by two first follow-up and two second follow-up questions. One question asked the student how important, within the student's peer group, it is to get good grades. The second question asked, in the same context, how important it is to continue education past high school. Choices were *not important, somewhat important,* and *very important*.

Mathematics self-concept. This variable was measured by four first follow-up questions, asking the student to choose the best answer for the following items:

1. Mathematics is one of my best subjects.
2. I have always done well in mathematics.
3. I get good marks in mathematics.
4. I do badly in tests of mathematics.

The available choices were *false*, *mostly false*, *more false than true*, *more true than false*, *mostly true*, and *true*. The fourth item was reverse coded for consistency. These four questions in the NELS: 88 database come from the SDQ-II by Marsh (as cited in Ingels, Scott, Lindmark, Frankel, & Myers, 1992).

Educational aspirations of the student. This variable was measured by one base-year, one first follow-up, and one second follow-up question asking the students how far in school they think they will get. There were six educational levels as choices for the base-year question, nine for the first follow-up, ten for the second follow-up.

Analytic Method

Structural equation modeling was used as the analytic technique. Such modeling allowed studying the relative importance of variables as well as their direct and indirect effects on the outcome variable. Recall the hypothesized relationships among the variables in the model (Figure 1). All of the relationships in the model are hypothesized to be positive, meaning that an increase in one variable in a hypothesized relationship leads to an increase in the other.

In all analyses, data were weighted by F2TRP1WT, the sampling weight in the NELS: 88 database, created specifically for the sample used in this study. This subsample is described as the students who were sample members in the base year, first follow-up, and the second follow-up of data collection and for whom high school transcripts were collected. An alpha level of .05 was used for all statistical tests.

For creation of correlation matrices, standard deviations, and means to be used in structural equation model estimations, the computer program SPSS 10.1 (SPSS Inc., 2000) was used. For structural equation model estimations, LISREL 8.54 computer software (Joreskog & Sorbom, 2003) was employed.

Results

During confirmatory factor analysis of the measurement model, parental expectations were included as a separate latent variable. However, estimation of this model yielded a high collinearity between parental expectations and educational aspirations of the student. As verification, factor scores for the two constructs were created through exploratory factor analysis, and the bivariate correlation between the factor scores was calculated. The resulting correlation was .798, again indicating a high collinearity. As a result, parental expectations were eliminated from the model, and educational aspirations of the student were kept. Estimation of this revised model yielded a good fit (CFI = .94; GFI = .92; Standardized RMR = .05). With acceptable values of fit indices and all loadings significant at $p < .05$ level, this model was chosen to be the final measurement model. Table 1 presents the factor loadings.

After deciding on the measurement model, the causal relationships among the variables were specified in an initial structural model. Overall, results indicated a good fit with the hypothesized relationships (CFI = .94; GFI = .92; Standardized RMR = .06). The directions and magnitudes of path coefficients, representing the hypothesized relationships between

Table 1

Factor Loadings for the Final Measurement Model

	No. of Math Courses Taken	Ed. Aspirations of the Student	Math Self-Concept	Ed. Aspirations of Peers	Parental Involvement	Previous Math Ach.	SES
TOTALMAT	1.00						
BYS45		.66					
F1S49		.79					
F2S43		.76					
F1S63D			.90				
F1S63J			.88				
F1S63Q			.90				
F1S63S			.69				
F1S70D				.65			
F1S70I				.72			
F2S68D				.43			
F2S68H				.47			
F1S105A					.48		
F1S105G					.58		
F2S99A					.50		
F2S99F					.64		
BY2XMSTD						1.00	
F2SES1							1.00

Completely Standardized Factor Loadings.
All loadings were significant at $p < .05$ level.

the variables, were in accord with theory and previous research findings. Therefore, this model was decided to be the final structural model. Total, direct, and indirect effects for the final structural model are given in Table 2. The correlation between SES and previous mathematics achievement was .40.

Discussion

Findings

During the development of the final measurement model, a very high positive correlation was found between parents' educational expectations for their children and students' educational aspirations. This finding supports the claim that, starting from early childhood, children imitate, identify, and, finally, internalize the values and attitudes of their parents (Comer, 1990). It is also congruent with previous findings (e.g., Davies & Kandel, 1981) that parental influence does not decline over the adolescent years. However, the finding in the present study is about the parental influence in matters of future educational plans and should not be overgeneralized to all aspects of adolescent life.

One of the two key questions in this study was whether SES would still have a significant direct effect on mathematics course taking after its indirect effects were taken into account. This analysis found no direct effect of SES on mathematics course taking; however, its indirect effect was not trivial (.14). This finding fails to support the claim that parents' SES plays a direct role in students' course placements. It implies that there is no *automatic* privilege of being a student from a middle- or high-SES family; rather, parental involvement is critical in students taking advanced mathematics courses. When the total indirect effect of SES is partitioned into its components, .09 belongs to the indirect path from SES to educational aspirations of the student to mathematics course taking and .05 belongs to the indirect path from SES to parental involvement to educational aspirations of the student to mathematics course taking. The significant relationship between parental involvement and educational

Table 2

Total, Direct, and Indirect Effects for the Final Structural Model

		Previous Math Ach.	SES	Parental Inv.	Educational Asp. of Peers	Math Self-Concept	Educational Asp. of the Student
Parental Involvement	Total	.13*	.31*	--	--	--	--
	Direct	.13*	.31*	--	--	--	--
	Indirect	--	--	--	--	--	--
Educational Aspirations of Peers	Total	.06*	.14*	.47*	--	--	--
	Direct	--	--	.47*	--	--	--
	Indirect	.06*	.14*	--	--	--	--
Math Self-Concept	Total	.40*	--	--	--	--	--
	Direct	.40*	--	--	--	--	--
	Indirect	--	--	--	--	--	--
Educational Asp. of the Student	Total	.40*	.35*	.46*	.18*	--	--
	Direct	.34*	.21*	.38*	.18*	--	--
	Indirect	.06*	.14*	.08*	--	--	--
No. of Math Courses Taken	Total	.53*	.14*	.19*	.07*	.17*	.41*
	Direct	.30*	.00	--	--	.17*	.41*
	Indirect	.23*	.14*	.19*	.07*	--	--

Standardized Total, Direct, and Indirect Effects.
* indicates significance at p < .05 level.

aspirations of the student coupled with the finding that there was a very high correlation between parental educational expectations for the student and the student's own educational aspirations stresses parents' critical role in their children's education. Furthermore, our results support the findings of Davies and Kandel (1981) that parental influence on the student's educational aspirations was much stronger than that of peers and did not decline over the adolescent years.

The other key question in this study was to what degree the relationship between previous mathematics achievement and advanced mathematics course taking was mediated by other variables. The direct effect of previous mathematics achievement on the number of mathematics courses taken was found to be .30, which was significant. A direct effect of previous achievement was expected in this study, above and beyond its indirect effect. The finding that previous achievement also had a significant indirect effect of .23 implies that, even though previous achievement may be a necessary condition most of the time, it is not a sufficient condition for students to take advanced and more challenging mathematics courses. When the indirect effect was partitioned, a major portion belonged to the path from previous mathematics achievement to educational aspirations to course taking (.14). The second largest belonged to the path from previous mathematics achievement to mathematics self-concept to course taking (.07). These two components made up almost all of the indirect effect. Since knowledge of mathematics is cumulative and mathematics courses are sequential, these findings suggest that early and continued success in mathematics is critical for maintaining high educational aspirations as well as self-confidence in mathematics.

Implications

Perhaps the most important finding is that parental involvement plays a critical role in students' advanced mathematics course taking. Schools can play a major role in improving this determining factor. In the case of advanced mathematics course taking, the first step to enhancing parental involvement is to inform parents about the importance of these courses for the student's future. This should be done in as many ways as possible, including advising, parent conferences, and sending information to parents. A next step may be to inform parents about the courses, their sequences and prerequisites, and related policies. This, first of all,

requires schools being transparent in their course placement policies. Such transparency may also help eliminate claims of implicit discriminatory tracking in many schools. Schools can also clearly state their course placement policies on their websites, in parent manuals, or other related publications. This will encourage parents to get involved in their children's course taking.

Findings from this study also indicate that successful students in mathematics need to translate their achievement into high educational aspirations to continue taking non-required advanced mathematics courses. This translation naturally occurs at home for students from families with a high level of education, where examples of opportunities a strong background in mathematics can provide are immediate. This issue, however, is critical for students coming from disadvantaged families and communities with little appreciation for education and little knowledge of the education system. In the absence of a push by school policies towards advanced coursework, the only source of guidance, encouragement, and support for these students will be their teachers and school counselors. Therefore, frequent individual advising should be provided to such students in order to encourage and motivate them to take advanced courses and alert them to prerequisites and other course placement criteria.

Recommendations for Future Research

First, a useful follow-up study would check any possible differential relationships among the variables in the model for students in schools with different demographic characteristics. For example, parental involvement may be more important for minority students living in high-minority, high-poverty inner cities than it is for Whites living in low-minority, low-poverty suburbs. The three school demographic variables that need to be considered are poverty concentration, minority concentration, and urbanicity.

Second, future research should also consider perceived utility of mathematics as a possible influential variable. Several studies revealed that the perceived utility of mathematics by students in their future career is a significant factor in shaping educational aspirations based on previous mathematics achievement (Lantz & Smith, 1981; Linn & Hyde, 1989; Reyes, 1984). Due to the limitations of the NELS: 88 database, this variable could not be included in the present study.

Finally, qualitative studies investigating the nature of relationships between parents and school administrators may prove useful in improving students' advanced course taking through parental involvement.

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[1] Research suggests that in schools where the variety in low-end (basic, general) mathematics courses is limited, students tend to take more advanced courses and the average achievement in the school is higher (Lee et al., 1998). Although selecting students in schools offering the courses counted as advanced in this study provided control over advanced level course offerings, inability to control for the variety in lower level course offerings should be acknowledged as a limitation of the study. Such control would have significantly reduced the sample size due to the variation in these courses among schools.

[2] After the collection of data used in this study, there have been changes in the graduation requirements imposed by states, school districts, or individual schools. These ongoing changes have especially gained momentum after the No Child Left Behind Act of 2001. They include introducing graduation (exit) examinations and requiring specific courses to be taken for graduation. However, this study does not investigate the effect of graduation requirements on course taking, and only deals with it for control purposes. We believe that there have not been any significant changes in the variables investigated through the causal model in this study.