

**Personal and Social Factors That Influence  
Advanced Mathematics Course-Taking  
during High School**

Mehmet Ali Ozturk

Dissertation submitted to the faculty of the  
Virginia Polytechnic Institute and State University  
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Educational Research and Evaluation

Kusum Singh, Chair  
Jim C. Fortune  
Lawrence H. Cross  
Robert J. Harvey  
Ken Potter

May 2001

Blacksburg, Virginia

Keywords: Mathematics Course-Taking, Parental Involvement, Peer Influence, Educational Aspirations, Math Self-Concept

Personal and Social Factors That Influence  
Advanced Mathematics Course-Taking  
during High School

Mehmet Ali Ozturk

(ABSTRACT)

This study explored the factors that influence public high school students' advanced math course-taking. The factors investigated were parental involvement, peers' educational aspirations, students' own educational aspirations, and math self-concept. These factors were further examined for students in different settings as defined by school demographic variables of urbanicity, minority concentration, and poverty concentration. The study analyzed longitudinal data from the National Education Longitudinal Study of 1988 (NELS: 88), using structural equation modeling. Results indicated that parental involvement was much more important than peer influence for students' educational aspirations, and in turn, for their advanced level mathematics course-taking. Parental involvement had a larger effect for students in high-minority, high-poverty urban schools, who, on the average, had taken the smallest number of advanced mathematics courses, compared to students in other settings. Results from the study indicated that African-American students' math self-concepts were not affected by their previous math achievement, suggesting the lack of feedback about their mathematics performance. Recommendations based on the findings included improving parental involvement for all students, especially for students in high-minority, high-poverty urban schools, and providing more feedback to African-American students about their level of performance in mathematics and its consequences in terms of advanced math course-taking.

## ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to Dr. Kusum Singh, Dr. Jim Fortune, Dr. Lawrence Cross, Dr. Robert Harvey, and Dr. Ken Potter for their support and assistance in completing this study. I especially appreciate Dr. Kusum Singh's support in every possible way and patience during this long research process.

My special thanks go to my wife, Seleme, and to my son, Burhan, for their unbelievable patience. Without the love and motivation they provided me, I could have not completed this study.

Last but not the least, I want to thank my parents for providing me with a solid educational foundation I needed to reach this point.

## TABLE OF CONTENTS

ABSTRACT.....	ii
ACKNOWLEDGEMENTS.....	iii
TABLE OF CONTENTS.....	iv
LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
CHAPTER I - INTRODUCTION.....	1
Introduction.....	1
Background.....	4
Statement of the Problem.....	7
Description of the Study.....	10
Significance of the Study.....	14
CHAPTER II - REVIEW OF LITERATURE.....	20
Mathematics Course-Taking in High School.....	20
Socioeconomic Status.....	24
Previous Mathematics Achievement.....	38
Parental Expectations/Involvement.....	43
Educational Aspirations of Peers.....	45
Math Self-Concept.....	46
Educational Aspirations.....	47
School Structural Variables.....	48
CHAPTER III - METHODOLOGY.....	52
Data.....	52
Sample.....	53

Analytic Method .....	55
CHAPTER IV - RESULTS .....	59
Math Course-Taking by Major Demographic Variables .....	59
Structural Equation Modeling.....	63
CHAPTER V - CONCLUSIONS .....	84
Summary of Findings.....	84
Implications of Findings .....	92
Delimitations and Limitations of the Study .....	94
Recommendations for Future Research.....	97
REFERENCES .....	99
APPENDIX A.....	110
VITA.....	119

## LIST OF TABLES

Table 1. Number of Math Courses Taken by Gender.....	59
Table 2. Number of Math Courses Taken by Race.....	60
Table 3. Number of Math Courses Taken by High School Program.....	60
Table 4. Number of Math Courses Taken by School Demographic Variables .....	61
Table 5. Number of Math Courses Taken by School Demographic Variables (Stratified).....	62
Table 6. Factor Loadings for the Final Measurement Model .....	68
Table 7. Completely Standardized Phi Matrix for the Final Measurement Model.....	69
Table 8. Total, Direct, and Indirect Effects for the Final Structural Model .....	73
Table 9. Construct Reliabilities by Race and for the Highest and the Lowest Math Course-Taking Groups .....	76
Table 10. Total, Direct, and Indirect Effects for Whites and Asian/Pacific Islanders.....	78
Table 11. Total, Direct, and Indirect Effects for the Highest and the Lowest Math Course-Taking Groups .....	80
Table 12. Observed/Latent Variable Means by Race and for the Highest and the Lowest Math Course-Taking Groups .....	82
Table 13. Correlations between Observed /Latent Variable Means for African-Americans and Hispanics .....	83

## LIST OF FIGURES

Figure 1.1. Initial Causal Model .....	12
Figure 4.1. Initial Measurement Model .....	64
Figure 4.2. Final Measurement Model.....	67
Figure 4.3. Initial Structural Model .....	71

# CHAPTER I

## INTRODUCTION

### INTRODUCTION:

Schools are important agents for the education of youth. Although they serve a variety of purposes, a major role of schools is to prepare students for their future education or career. This preparation takes place, for the most part, in the form of students' taking courses and learning the content offered in these courses. Hence, students can only make the most out of schooling through taking the courses, which will be useful for their future education or career. In this respect, students' course-taking is an important activity in the context of schooling.

Course-taking in high school takes on a different form than it does in elementary or junior high school. High schools offer a differentiated curriculum to their students. It is true that some differentiation can be observed in elementary and junior high schools in the form of ability grouping. Such grouping takes place mostly in two ways: 1) grouping students in the same classroom for different levels of activities and/or content, mostly seen in elementary schools 2) grouping them in different classrooms for different levels (basic, advanced, etc.) of the same course, again offering different activities and/or content, predominantly happening in junior high schools. Both of these groupings are usually done on the basis of students' previous achievement. Yet in high schools, a much higher degree of variation in course-taking patterns can be observed and there are two major sources of this variation. The first source is tracking, where students enroll in different programs of study such as college preparatory, general, or vocational and take different sequences of courses. In recent decades, there has been a shift from an overall formal tracking to students' enrolling in courses on a subject-by-subject basis. In this relatively new system, students enroll in courses in each academic subject according to their ability level in that particular subject (Oakes, Gamoran, and Page, 1992).

The second source is the variety of courses offered by a vast majority of schools in most of the subject areas. This variety exists in terms of both level and quantity. For example, one can find remedial, regular, and advanced placement levels of some of the courses in the same school. A variety of courses in each subject area are also available for students. As long as they meet

requirements (in terms of both graduation and school procedures) set by their schools, students are free to choose among these courses. For example, a high school student may take earth science and biology to meet the graduation requirement for science and opt not to take courses such as chemistry and physics. In some subject areas, where course-taking is sequential, prerequisites for courses constitute a constraint in students' selection of courses. For example, students usually are not allowed to take Calculus before they complete an Algebra course. These are only the major forms of differentiation; and due to the local control of education, there is a multitude of practices in schools in terms of curriculum differentiation (Lee, Croninger, and Smith, 1997; Oakes, et al., 1992).

Historically, this differentiation can be traced back to the birth of the comprehensive high school. Until the early years of the 20<sup>th</sup> century, high schools offered a narrow college-preparatory program, serving only a small proportion of the adolescent population, almost all of whom were students from elite families. But various social, political, and economic changes around the turn of the century, such as the substantial increase in the number of immigrant people in big cities and the shift from a predominantly rural to an increasingly urban society gave a dramatic rise to the enrollment in public secondary schools. Debates over what kind of a curriculum should be offered to this new and diverse student population centered around two options- either a common curriculum appropriate for all or a diverse set of courses to meet the needs of this diverse population. The comprehensive high school with a wide array of course offerings was the settled-upon solution to this problem (Oakes, 1985; Oakes, et al., 1992). Since then, curriculum differentiation in public high schools has continued as a traditional American practice (Oakes, 1985).

Although some researchers (e.g., Coleman, et al., 1966; Armor, 1972) concluded that schooling, compared to students' background characteristics, had only a minor effect on achievement, most research suggests that quantity of schooling has a major impact on student achievement. An explanation of the interplay of these three variables (student background, quantity of schooling, and achievement) may be that, to some extent, background variables exert their influence through quantity of schooling. For example, students from high SES families, for various reasons, receive more schooling compared to their peers from lower SES families, which in turn, improves their achievement. Background variables can still have an effect on achievement in some areas over and above the effect of schooling, depending on the extent to

which out-of-school learning in that particular area can take place. Schmidt (1983a) brought a similar explanation for a possible relationship between student background characteristics and amount of schooling. He stated that such a relationship might exist because background characteristics directly influence the student's choice of some courses over others, and/or student's placement in a program or track by the school might be influenced by student's background, which, in turn, affects the amount of schooling the student receives. Results from his analyses of NLS data also supported his hypothesis. Socioeconomic status was significantly related to the quantity of schooling received in mathematics, science, and foreign languages, even when controlling for ability. In sum, the claim that schooling has a relatively minor effect on achievement may not be a correct one and it is not supported by most of the research in the field. Schmidt (1983a) found substantial positive relationships between quantity of schooling (measured as the total number of hours of instruction during the last three years of high school) in English, mathematics, science and academic achievement in corresponding subject areas (as measured by the NLS tests). These relationships were still significant after controlling for student background characteristics (sex, race, SES, and ability). Many other studies using different methodologies on various data found a similar pattern for the relationship between course-taking and achievement. Although they used different outcome and control variables, overall, their findings were consistent across academic subject areas, races/ethnic groups, and sex (Jones, 1985; Jones, Davenport, Bryson, Bekhuis, and Zwick, 1986; Sebring, 1987; Laing, Engen, and Maxey, 1990; Hoffer, Rasinski, and Moore, 1995; Chenoweth, 1996; American College Testing Program and Council of the Great City Schools, 1998; McLure, 1998).

It is important to state at this point that the number of courses taken is not the only indicator of curricular experiences of students. The effect of course-taking on academic achievement is substantially moderated by some other variables such as course content, quality of instruction, and student learning in the courses taken (McCormick, Tuma, and Houser, 1995). Student learning as affected by course content and quality of instruction has traditionally been a main topic in educational research. These two major "opportunity to learn" variables –course content and quality of instruction- have created a great deal of concern, especially in the context of differential access to knowledge, and have been studied in depth by many researchers (e.g., Oakes, 1985; Oakes, et al., 1992; Horn, Hafner, and Owings, 1992).

An important measurement variable, which also plays a role in studies examining the relationship between course-taking and academic achievement, is the extent to which test content corresponds to course content. For example, Jones, et al. (1986) stated that one alternative explanation for a weaker relationship found in their study between course-taking and achievement in science than in math might be that, due to a possibly greater variation in course content in science courses than in math courses, standardized tests in these two subjects in national studies such as High School and Beyond (the one they used) differed in their rates of course content coverage.

The level and the number of courses taken during high school years have a strong relationship with students' opting for college education as well as the field they choose. Four different explanations can be brought to this relationship: First, more rigorous coursework leads to college education through greater academic achievement and a better transcript listing more and advanced courses. Second, students who already aspire for college will take more rigorous courses; so, it is not that coursework leads to college, but rather college plans drive students towards rigorous coursework. Third, there is a dynamic and mutual relationship between these two variables, which means that the two variables both affect and are affected by each other continuously. Fourth, there are some common variables, which affect both course-taking and going to college, such as socioeconomic status. Regardless of the exact nature of the relationship, students are still asked for their transcripts and a measure of their academic achievement such as an SAT or ACT score to be admitted to a college. The level and the number of courses taken beside the student's achievement in courses listed on the transcript are two important criteria for transcript evaluations. And as mentioned above, course-taking improves academic achievement, which is also reflected in SAT and ACT scores.

## **BACKGROUND:**

Course-taking in secondary schools has been a central issue in educational research for a long time because of its relationship to both educational equity and academic excellence. There have been two major streams of research on the topic: 1) Studies on tracking/ability grouping, which primarily focused on educational equity rather than academic excellence 2) Research on the issue of constrained versus differentiated curriculum, where the major concern was academic

excellence rather than educational equity. A constrained curriculum requires all students to take a narrow and similar set of courses, while a differentiated curriculum provides students with flexibility to choose among a variety of course offerings. Although the two topics (tracking/ability grouping and constrained versus differentiated curriculum) and the two concerns (educational equity and academic excellence) cannot be totally separated from each other, they will be presented separately for purposes of clarity.

The major concern of researchers and educators about tracking/ability grouping has been that it led to educational inequity among races/ethnic groups and socioeconomic status groups. They present evidence from a considerable amount of research consistently showing that economically or culturally disadvantaged students are much more likely to be placed in low level tracks or low ability groups than their advantaged peers are. And once they are placed in these tracks or groups, they are likely to continue to suffer many negative consequences of tracking, since low level tracks offer less content with a slower pace compared to higher level tracks. Moreover, some school administrators' assigning successful teachers to high level tracks as a reward and the phenomenon of self-fulfilling prophecy among both the less successful teachers and the less successful students of low level tracks considerably add to this disadvantage. In sum, disadvantaged students not only start schooling as disadvantaged but also continue as they are. These claims have also been perceived to have serious social implications by educational theoreticians and researchers, since schools, as a system, sustain the existing inequalities in the society (Oakes, 1985; Berliner and Biddle, 1995; Schmidt, McKnight, Cogan, Jakwerth, and Houang, 1999; Oakes, et al., 1992).

On the other hand, there have been proponents of tracking. Oakes (1985) summarizes their basic assertions as follows: 1) learning is maximized when academically alike students are grouped together 2) such a practice also makes things easier for teachers 3) slow learning students develop more positive attitudes about themselves and their schools when they are not grouped together with students who are far more capable. These people also defend meritocracy (system in which the highest positions are given to those with the most ability) in the educational system as long as the testing and the placements are fair (Oakes, et al., 1992).

Some researchers (e.g., Cross, 1999) believe that "differential tracking has lost favor in this country and now is viewed as being almost un-American" (p. 6), whereas still others (e.g., Schmidt, et al., 1999), in their quite recent writings, assert that "*de facto* and even explicit

tracking also characterized US schools and classrooms, especially in mathematics” (p. 57).

Although less recent, Berliner and Biddle (1995) listed the practice of tracking/ability grouping as one of the real problems of American education.

The second line of research related course-taking primarily to academic excellence. A big wave of studies started with the 1983 report called “ A Nation at Risk” (National Commission on Excellence in Education, 1983). In this report, the authors presented the indicators of the decline in the quality of education in U.S. secondary schools both through international comparisons and through results from national longitudinal studies. One of the four areas that the authors summarized their findings and made recommendations about was the secondary school curricula and course-taking processes. They claimed and provided empirical evidence from previous research that the curricula had been diluted and, in effect, the majority of students followed an easy track and avoided even moderately challenging courses, let alone the advanced ones. They stated that this fact was one of the major reasons for the decline in the quality of education and in academic excellence. Not surprisingly, their main recommendation in this area was to raise high school graduation requirements. Having criticized the abundance of electives and the great freedom of choice given to students, this report can be seen as favoring a constrained curriculum rather than a differentiated one.

The issue of constrained versus differentiated curriculum touches upon a fundamental dilemma. The secondary schooling system is expected to meet at least two partially competing objectives. One is to provide a common education to all students and the other is to satisfy their diverse individual educational needs and interests. People who give priority to the first objective claim that it is vital for the welfare of the society, since such an education builds a common civic identity shared by the diverse members of the society. A more recent justification of a constrained curriculum is that there is too much to be learned by all today and it is better to provide students with a solid preparation for their future educational or occupational preferences. In this way, they will have a strong educational foundation for the occupations in rapidly changing fields as well as for the newly emerging ones. The proponents of curriculum differentiation assert that participation in a specialized program gives the students not only a sense of belonging, which will promote their interest in their education, but also many marketable skills (Green, Dugoni, Ingels, and Quinn, 1995).

The choice between a constrained and a differentiated curriculum has also been an issue in interpreting results from international studies. Schmidt et al. (1999), in their preliminary evaluation of results from TIMSS (Third International Mathematics and Science Study), indicated that U.S., with its typical end-of-secondary-school student, either having taken less demanding courses or discontinued the study of mathematics and science early in high school, could not compete with other TIMSS countries. On the other hand, Berliner and Biddle (1995) argued against the idea that U.S. should adopt a narrow academic curriculum as countries whose students achieved higher in academic subjects did and asserted that the breadth of education was a strength of American education and was preferred by Americans. They claimed that American students were more broadly educated than were students in other countries at any given age and had more nonacademic interests and extracurricular activities. In sum, although most research shows that a narrow academic curriculum mandatory for all students produces the best results in terms of average academic achievement in the school (e.g., Lee, Burkam, Chow-Hoy, Smerdon, and Gevert, 1998; Lee, et al., 1997), the debate over which type of curriculum to choose or how to balance the two continues (Evaluation Technologies, Inc., 1985a). So far, the curriculum differentiation approach has continued to prevail in U.S. public high schools.

#### **STATEMENT OF THE PROBLEM:**

Students' course-taking patterns are influenced by both student-level characteristics and school-level factors. Any research taking into account only one of these domains, ignoring the effect of the other, may be misleading. The present study examines the student-level variables that influence high school students' mathematics course-taking. More specifically, this study focuses on how personal characteristics together with factors in students' immediate environment influence mathematics course-taking decisions. These relationships are studied through placing the selected variables into a comprehensive model, which allows investigation of their relative importance in mathematics course-taking as well as the interrelationships among these variables. The outcome variable in the study is the number of mathematics courses taken during high school. The personal characteristics hypothesized to be influential are math self-concept and educational aspirations. Parental expectations/involvement and educational aspirations of peers are treated as factors in the immediate environment of the student.

Socioeconomic status and previous mathematics achievement serve as the background variables in the model, while race/ethnicity is also included in the design through separate analyses for each race/ethnic group. A detailed description of the study design and the variables used is given in the next “Description of the Study” section.

School-level variables (not only the ones affecting students’ course-taking) can broadly be divided into two groups: structural and demographic. Many researchers have defined and categorized these variables in a similar fashion (e.g., Wilkins, 1999; Lee, et al., 1998; Lee, et al., 1997).

Structural variables relate directly to the schooling process and the decisions about them are made by the educators and/or educational policymakers at the state, district, or school level. Examples of this kind of variables are type of school (public/private), graduation requirements, amount of instruction, curriculum materials, variety and level of courses offered, and qualifications of teachers. These variables can be perceived as a close-knit family of variables, since they are closely interrelated within the process of schooling. The structural variables affecting students’ course-taking are type (public/private), variety and level of courses offered, graduation requirements, and tracking (its type and degree).

Demographic characteristics of schools, on the other hand, feature the student body and the environment surrounding the school. Three important demographic variables are urbanicity (i.e., urban/suburban/rural), minority concentration, and poverty concentration. This group of variables are unaffected by the decisions of educational policymakers, yet they have an effect on schooling through various ways (Oakes, 1990). These three variables also have an influence on students’ course-taking.

There is extensive research on school structural variables affecting course-taking, such as tracking/ability grouping (e.g., Oakes, 1985; Calabrese, 1989), curriculum differentiation (e.g., Lee, et al., 1998; Cusick, 1983), and graduation requirements (e.g., Sebring, 1987; Clune and White, 1992). On the other hand, there is a dearth of research on the interrelationships among student-level variables influencing course-taking decisions. Although there are a number of reports mostly prepared by/for National Center for Education Statistics, these publications only give descriptive data about school and/or student characteristics. Usually, the highest level of analysis in these reports is a comparison between/among groups (t tests or ANOVA) for various variables (e.g., Legum, et al., 1998; Green, et al., 1995; Evaluation Technologies, Inc., 1985a).

Obviously, these reports do not intend to explain the process of course-taking or to investigate any causal relationships. Beside these reports, there are studies which could not study causal relationships due to lack of longitudinal data (e.g., American College Testing Program and Council of the Great City Schools, 1998; Sebring, 1987). In this respect, the student level study of course-taking deserves an inclusive approach, which will place important factors into a comprehensive model and examine the relationships among them. This study attempts to fill this gap that currently exists in the literature on mathematics course-taking in high school.

One question that needs to be answered at this point is whether students are free in selecting courses; and if yes, to what extent. Undoubtedly, this question brings to mind the issue of tracking. If tracking highly or even almost totally determined the courses students take, then there would be no need to study student-level variables that affect course-taking decisions. Literature on the effect of tracking on students' course-taking is confusing and contradictory, since the term 'tracking' does not have a uniform meaning, which is a major source of controversial findings and interpretations. Tracking practices differ from one another in a number of important ways, including the number of subjects tracked, the number of levels of courses offered in each subject, the criteria used for assigning students to courses, and whether students are tracked subject by subject or by a single decision made about all subjects (Oakes, et al., 1992; Garet and DeLany, 1988). Debates around the practice of tracking include, but are not limited to, whether formal tracking exists in schools; whether informal, implicit tracking dominates course assignments in the absence of formal tracking; whether differentiating against minority and/or low-SES students through constantly assigning them low-level tracks/courses is a common practice in schools.

Here, only a few important points will be highlighted about this politically charged topic, since it is not one of the main areas of inquiry in this study. First, there has been a tendency towards avoiding formal, explicit tracking in schools at least since late 1970s (Cusick, 1983; Powell, Farrar, and Cohen, 1985). Calabrese (1989), in his article where he expressed his strong antagonism towards implicit tracking noted that, in the large Midwestern urban school district he studied, there was an open scheduling of courses, where any student could take any course (even though he thought it was more illusionary than real). Secondly, there is evidence that in disputes over course selection, students' and parents' wishes prevail (Oakes, et al., 1992). The bottom line in this discussion is that students and parents do have a say in course-taking decisions, even

though their opinions may be influenced, at varying rates, by school personnel and policies (Useem, 1991).

From another perspective, it can be said that the concern about the detrimental effects of tracking also points to the need for research on factors other than tracking, which are influential on students' course selection. To the extent that students will be able to make the right decisions about their courses, being conscious of the consequences of these decisions as well as their rights in making them, the negative (be it real or illusionary) effect of tracking will diminish. This is possible through identifying the factors affecting students' course-taking decisions and their relative importance, and then constructively manipulating them.

### **DESCRIPTION OF THE STUDY:**

The purpose of this study is to examine the student-level variables that influence public high school students' mathematics course-taking. The outcome variable is the total Carnegie units completed by the student in Algebra II, Geometry, Trigonometry, and Calculus during high school. 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" (p. O-1) (Ingels, et al., 1994). Throughout the present document, the term 'mathematics course-taking' was used instead of a more precise, yet much longer, term 'mathematics course enrollment and completion thereafter' for the outcome variable. Therefore, while reading the document, it is important to keep in mind that the outcome variable in this study was the number of courses the student had enrolled in and completed thereafter. This description of the outcome variable excludes the courses that the student had enrolled in at the beginning of the semester/year, but dropped later.

The background variables used in the model are socioeconomic status (SES) and previous math achievement. In this study, SES is defined as a composite variable made up of father's education, mother's education, father's occupation, mother's occupation, and family income. Previous math achievement is defined as the student's 8<sup>th</sup> grade math achievement measured by a standardized test.

Two variables in the student's immediate environment influencing course-taking decisions are identified as parental expectations/involvement and educational aspirations of

peers. Parental expectations are defined as how far parents want their children to go in their education. Parental involvement is defined as the frequency of the student's discussing school courses and going to college with his/her parents. Such definition of parental involvement is not inclusive of all types of parental involvement. As explained in Chapter II, parental involvement may take place within the home and family, in the community, and in the school (Muller and Kerbow, 1993). Examples of other types are parental involvement in children's peer relationships or extracurricular activities. Therefore, the variable 'parental involvement' investigated in this study is only one form of parental involvement. Throughout the document, the term 'parental involvement' was used instead of a more precise, yet much longer, term 'parental involvement in students' course-taking decisions and college plans'. Educational aspirations of peers are defined as the degree of importance, among the student's peer group, of getting good grades and continuing education past high school.

Two personal characteristics hypothesized to be related to course-taking are math self-concept and educational aspirations. Math self-concept is measured by items asking how successful the student perceived himself/herself in the field of math. The three items measuring educational aspirations asked how far the student thought he/she would get in school. The same question was asked to the student when he/she was at 8<sup>th</sup>, 10<sup>th</sup>, and 12<sup>th</sup> grade. Survey items measuring the variables or making up the constructs used in this study are given in Appendix A.

A tentative model, incorporating the above variables, is illustrated in Figure 1-1. All of the relationships in the model are hypothesized to be positive, meaning that an increase in one of the variables in a hypothesized relationship leads to an increase in the other variable. Rationale for the hypothesized relationships as well as the relevant research findings in the literature is given in Chapter II.

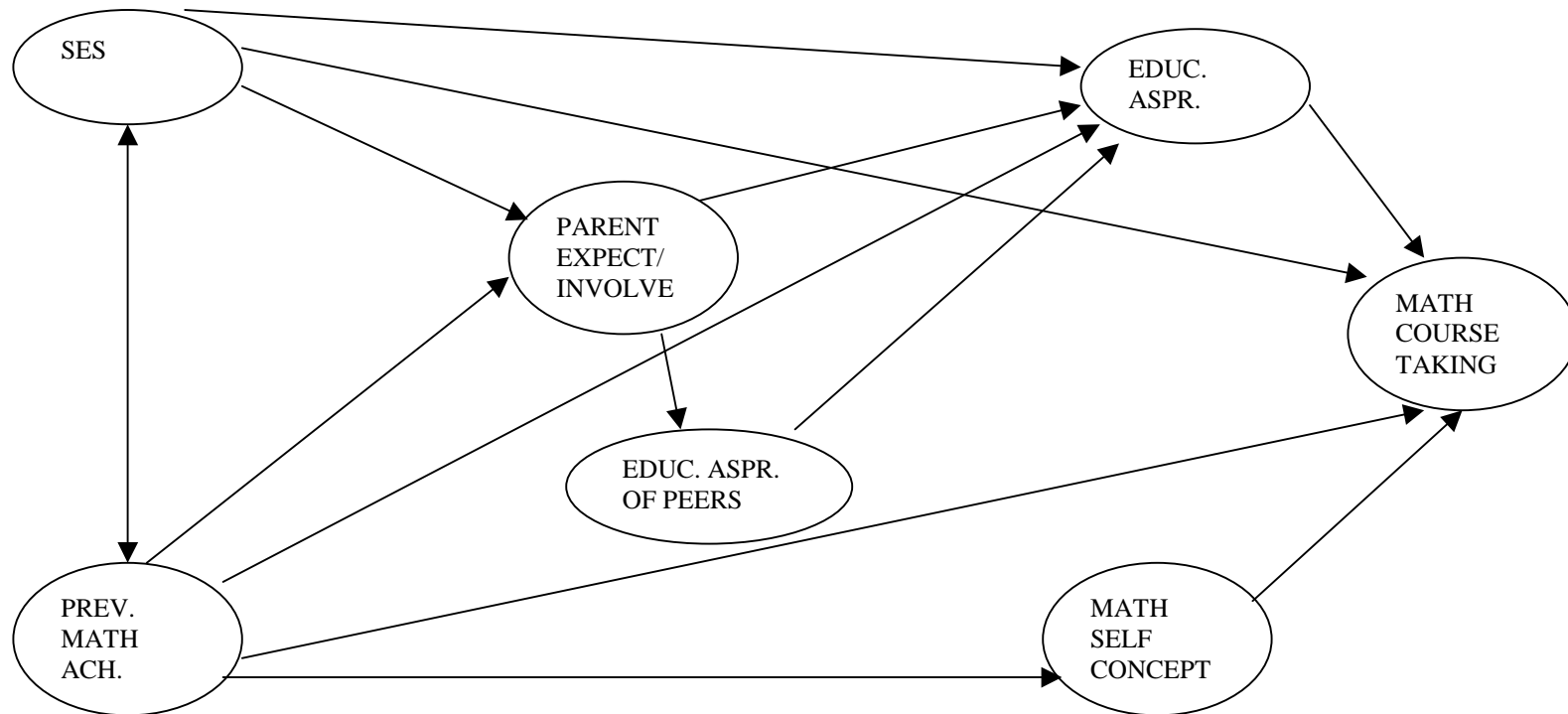


Figure 1-1. The Initial Causal Model in the Present Study

Beside the variables used in the model, there is one other student-level variable, namely, race/ethnicity, which is hypothesized to be related to course-taking. In the present study, separate model estimations for each race/ethnic group are performed and then the results are compared to see if there are any differences in terms of the strength of the relationships hypothesized in the model. Rationale for considering race/ethnicity in the design and relevant research findings are presented in Chapter II. Gender was also initially thought to be included in the study design. However, results from preliminary analyses, consistent with recent research findings (e.g., Legum, et al., 1998; Leslie, McClure, and Oaxaca, 1998), indicated no gender differences in terms of advanced level math course-taking, which is the outcome variable in this study. Therefore, it was deleted from the list of variables to be investigated.

Beside their immediate environment, students' more broadly defined environment also has an influence on their course-taking decisions. In this study, characteristics of this environment are reflected in school demographic variables. Three demographic variables identified are urbanicity, minority concentration, and poverty concentration. The sample is stratified to explore math course-taking by these variables. The NELS: 88 items used to measure these school demographic variables are given in Appendix A. Creation of new levels to be employed in this study, using the original categories of these variables in the NELS: 88 database, and the stratification of the sample using these new levels is explained in Chapter III. Separate model estimations are performed for the strata with the highest and the lowest mathematics course-taking. Rationale for including these variables in the present study and research findings about them are presented in Chapter II.

Relevant structural characteristics of schools, which are type of school (public/private), variety and level of courses offered, graduation requirements, and tracking, are not investigated in this study. These structural variables are controlled by keeping them constant. There are two major reasons for choosing such a strategy. First, it is difficult to examine all three groups of variables (student-level, school demographic, and school structural) in a single study. Secondly, the student-level variables and the school demographic variables, which collectively define the student's psychosocial environment, are conceptually related; whereas school structural variables have much less to do with these two groups of variables. Structural characteristics of schools are largely determined by decisions and policies made by a variety of people in charge at the school, district, state, or even federal level, although the community may also have a minimal influence

on these decisions. Therefore, school structural variables belong to a different realm of investigation and need to be studied together with administrative variables. A brief review of literature on these structural variables and how they are controlled through keeping them constant is presented in Chapter II.

## **SIGNIFICANCE OF THE STUDY:**

Significance of this study may be presented under three sections: 1) significance of mathematics as the subject selected. This section can be divided into two subsections. One is the importance of course-taking in math, compared to course-taking in other subject areas. Second is the importance of advanced level math course-taking, compared to math course-taking regardless of the level 2) significance in the context of academic excellence 3) significance in the context of educational equity.

### **Significance of mathematics as the subject selected:**

**Importance of course-taking in math.** Taking courses is important for academic achievement, particularly in mathematics. Course-taking was found to have the largest effect on academic achievement in mathematics among the academic subjects examined (e.g., Schmidt, 1983a; Jones, et al., 1986). 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, et al., 1998). In a study on NELS: 88 data, results indicated that the achievement growth differences in math and science among high- and low-SES students completing the same numbers of courses were small. This was particularly true in mathematics, where none of the SES comparisons were significant among students taking the same numbers of courses (Hoffer, et al., 1995). These findings reflect the fact that mathematics is almost exclusively learned in school and background factors do not exert as much of an influence through out-of-school learning (Schmidt, 1983a; Jones, et al., 1986). A parallel interpretation would be that much of the SES differences in math achievement gains over the high school grades is due to the different numbers of math courses that high- and low-SES students complete during high school (Hoffer, et al., 1995). These interpretations also

lead to the conclusion that the effect of schooling on achievement is the largest in mathematics. Consequently, proper course-taking decisions in this subject, compared to other subjects, are expected to provide students with a larger benefit from schooling.

**Importance of advanced math courses.** Advanced level math courses are important for almost all of the students regardless of their plans for future. For those who are planning to go to college, these are the academic courses in mathematics and the content taught in these courses serves as a foundation for further studies in many different fields. Colleges and universities, especially the four-year ones, look at advanced level course-taking in mathematics as a criterion for admission to many majors and a majority of state colleges give a mathematics placement test upon enrollment. For example, data collected by the College Board indicated that 68 % of freshmen admitted to four-year colleges and universities in 1997 had taken four years of math in high school. Besides, almost all of these students had taken Algebra and Geometry, and a majority had taken Trigonometry (U.S. Department of Education, 1997). A report by NCES (Owings, Madigan, and Daniel, 1998), using logistic regression with NELS: 88 data, explored the student characteristics predicting enrollment in Tier 1 national universities. The study found out that students who took Calculus in high school were four times as likely to attend these universities as were those who did not take Calculus. Again, students who took physics as their highest level science course in high school, compared to those who had taken chemistry as the highest level science course, were approximately three times more likely to enroll in these universities. Taking three or more years of foreign language was also a significant predictor of enrollment. These variables still appeared significant when a number of other variables hypothesized to be influential were also entered in the analyses.

Having taken advanced level math courses in high school also makes it easy to find a well-paid job. Many jobs once required little knowledge of math now call for various skills in Algebra and Measurement. According to an industry-wide standard, an entry-level automobile 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, 1997). This is the situation in jobs requiring relatively fewer skills. For the ones requiring more skills, a strong background in math is even more needed.

These courses are important for meeting the demand of American companies and institutions for well-prepared people to work in high-tech and scientific jobs. Many high-tech

and scientific positions in U.S. companies and governmental institutions are being filled with non-U.S. citizens. And the demand by these companies and institutions is getting higher and higher everyday. In sum, there are large numbers of positions in these companies waiting to be filled by qualified Americans. This condition is also perceived as a disadvantage for U.S. in today's competitive global markets (U.S. Department of Education, 1997). Leslie, et al. (1998), in their paper stressing the importance of participation of women and minorities in science and engineering fields, state that "all else being equal, we would expect that the more women and minorities enter these fields, which are known to be powerful contributors to national productivity, the larger will be the nation's stock of scientists and engineers, the greater will be the quality of that stock, and the greater will be the productivity of the nation's labor force" (p. 240).

Findings from previous research indicate that advanced coursework in math enhances students' understanding and acquisition of lower level mathematical concepts and skills. Results from a study (Rock and Pollack, 1995), which used NELS: 88 database, suggested that "there was little growth in the understanding of intermediate mathematical concepts and multi-step problem solving skills in the absence of relatively advanced coursework" (p. 7). In this study, advanced coursework was defined as taking Precalculus or Calculus as the highest level of math in high school. The finding in this study was not that the students who took Precalculus or Calculus achieved higher in tests measuring the content of these courses (since the tests used in the study did not measure the knowledge of content taught in these courses), rather they achieved a higher level of understanding of intermediate mathematical concepts and multi-step problem solving skills. Jones (1985) analyzed High School and Beyond data to explore the relationship between course-taking and achievement in math. He found out that students with three credits of mathematics, one of which was Calculus, scored higher in 12<sup>th</sup> grade math test than the students who had also three credits of math, but not including Calculus. He concluded that students who took more advanced courses later better understood the content of earlier mathematics courses than the ones with similar SES background and similar sophomore year verbal and math test scores, yet without advanced math courses. Such a conclusion was justifiable since the senior-year math test only covered content taught in courses prior to Calculus. In sum, taking advanced level math courses is an advantage for all students regardless of their plans for future.

### **Significance in the context of academic excellence:**

The relatively low achievement of U.S. secondary school students in math, both in comparison to other industrialized countries and to achievement within the country in earlier decades has, for long, been a national concern. Aside from older reports and studies (e.g., National Commission on Excellence in Education, 1983), a number of more recent ones have also stressed this underachievement. For example, one of the eight goals set in the National Education Goals Report was devoted to mathematics and science, pointing at the target of becoming the first in the world in math and science achievement (National Education Goals Panel, 1995).

Again, results from TIMSS, a recent international study only on mathematics and science, do not present a comforting picture of math achievement of U.S. secondary school students compared to their peers in other participating countries. The scores were below average in math literacy test, which was administered to the sample students at the end of secondary school. The results were even worse in advanced math test, which was also given at the end of secondary school. U.S. performed next to last in advanced math (Schmidt, et al., 1999). It is important to acknowledge at this point that there are researchers who criticized the interpretations made of the findings from international studies. For example, Bracey (1998), Rotberg (1998), and Berliner and Biddle (1995) indicated that these comparisons were flawed with serious methodological problems and that the samples in different countries were not comparable due to huge differences in cultures and educational systems. In sum, leaving this politically charged topic behind, it is still safe to say that underachievement in math is still a concern of many people, if not all.

Improving course-taking is an important means of raising achievement in this subject. As mentioned before, raising graduation requirements has some impact on course-taking. Yet, specifying these requirements only in terms of quantity, but not content, does not lead to higher rates of course-taking in advanced mathematics courses. For example, although the percentage of students who completed the recommended amount of courses by the “A Nation at Risk” report (National Commission on Excellence in Education, 1983) increased by 34.1 points from 1982 to 1992, the percentage of students who took all Algebra II, Geometry, Trigonometry, and Calculus increased by only 1.9 points during the same period (Green, et al., 1995). Absence of a

significant push by the school policies towards advanced math courses also points to the importance of students' decisions.

### **Significance in the context of educational equity:**

One major concern, well documented in various reports and studies, is the underrepresentation of minorities and women in math and science fields. One of the objectives under the general goal related to mathematics and science in the National Education Goals Report states that the number of U.S. undergraduate and graduate students, especially women and minorities, who receive degrees in mathematics, science, and engineering will increase significantly (National Education Goals Panel, 1995). Even quite recent reports indicate the existence of this underrepresentation. For example, a report by National Science Foundation (Olson, 1999) states that, despite increases between 1985 and 1995, women and minorities are still underrepresented in undergraduate and graduate science and engineering education.

Analyzing this underrepresentation for women and minorities separately within the context of high school math course-taking is more appropriate, since findings for women and minorities are not always the same. As for the minorities, it is safe to say that one reason for this underrepresentation is that they take fewer advanced level math courses during high school and there is empirical support for this notion. An NCES report (Green, et al., 1995) on national data indicated that significant differences among races in completing the set of academic courses in math during high school persisted over time (from 1982 to 1992), although the gap had somewhat narrowed.

On the other hand, there are contradictory findings about math course-taking patterns of females during high school. Generally, older studies found lower rates of math course-taking by females compared to males (e.g., Lee and Ware, 1986), while more recent ones found no significant differences between males and females (e.g., Legum, et al., 1998). This pattern of findings suggests that the gap between males and females that was once there, has disappeared.

In older studies, researchers, having found significant differences between males and females in terms of high school math course-taking, generally asserted that lower participation of females in high school math was an important factor in underrepresentation of women in related fields (e.g., Lantz and Smith, 1981). In more recent studies, however, there is a different

explanation for the relationship between high school years and the underrepresentation that still exists in higher education and occupations in these fields. For example, Leslie, et al. (1998) acknowledge that there is no difference between males and females in high school math course-taking. Yet they claim that several psychological factors influential on females' not opting for science and engineering fields for higher education and/or their future occupations, have their roots in adolescent years. For example, they assert that differences in math self-concept and interest in/attitudes toward math and science begin to emerge in early adolescence and are evident by the end of high school. In sum, psychological factors that are at work during high school years tend to have differential effects on males and females, even though a significant difference in course-taking may not be observed.

### **Conclusion:**

It seems like the differentiated curriculum approach will continue to prevail in U.S. high schools for at least some time and students will be asked to make decisions about the courses they are going to take. Hence, it is crucial to identify the factors influential on students' math course-taking decisions and their relative importance. Moreover, determining which of these factors are more influential than others for various groups of students, as defined by demographic characteristics, is critical. For example, it may be that, for students living in high-poverty urban neighborhoods, educational aspirations of peers are more influential on the students' educational aspirations than are parental expectations/involvement. In case of such a finding, any intervention, intended to increase the amount of advanced level math course-taking by these students, should involve peer groups more than parents. This may take place in the form of peer support groups or other counseling techniques applicable to adolescents. The present study is intended to reveal results that would provide counselors, teachers, and administrators with insight about proper counseling in math course-taking. This, in turn, may help bring the concerns about academic excellence and educational equity down to a minimum.

## **CHAPTER II**

### **REVIEW OF LITERATURE**

This chapter begins with a review of literature on mathematics course-taking in high school, the outcome variable in the study. Then, a review of literature on constructs of interest in the study and their relationship to mathematics course-taking is presented. The model illustrated in Figure 1-1 in Chapter I, showing the hypothesized relationships between the variables, serves as a framework. Each variable in the model is discussed and the review of literature on its relationship with every other related variable is presented. Finally comes a brief review of literature on the school structural variables that are related to math course-taking.

#### **MATHEMATICS COURSE-TAKING IN HIGH SCHOOL:**

Like in many other subject areas, there is a variety of math courses available in secondary schools. The Secondary School Taxonomy (Brown, Gifford, Hoachlander, Meyer, and Tuma, 1989) hierarchically categorizes math courses offered in secondary schools. These categories are Basic, General, Applied, Pre-Algebra, Algebra I, Geometry, Advanced/Other, and Advanced Calculus. Members of the “Basic” category are different levels (1, 2, 3, 4) of Basic Math courses. General Math courses are the most common members of the “General” category. Examples of Applied Math courses are computer math, consumer math, and vocational math. Trigonometry, Statistics, Probability are but some of the courses grouped under the “Advanced/Other” category.

An important feature of mathematics courses in high school is their sequentiality. Typically, students enroll in lower-level math courses before they take more advanced ones. For example, an Algebra class is the first to be taken in high school math curriculum, while Calculus is the last (National Center for Education Statistics, 1999). Yet there is still some variation among schools and among students in schools in terms of sequencing math classes. For example, Lee and Ware (1986) noted that in some schools, Algebra II followed directly after Algebra I and then came Geometry, while in the majority of schools, Geometry was placed between Algebra I

and Algebra II. A common sequence of major math courses in American high schools is Algebra I – Geometry – Algebra II – Trigonometry – Precalculus – Calculus (Lee and Ware, 1986).

Eighth grade Algebra plays an important role in this sequence, since students who take this class as an 8<sup>th</sup> grader (instead of in high school) get a clear advantage over their peers who do not, by gaining a whole year in high school for more advanced level math courses.

Consequences of this advantage in terms of end-of-secondary-school math achievement as well as going to college have been well-documented (U.S. Department of Education, 1997; National Center for Education Statistics, 1999; Shakrani, 1996). Yet many U.S. middle/junior high schools do not offer eighth grade Algebra. According to one study, 67 % of the U.S. public schools offer a full year of Algebra at the eighth grade (Epstein and MacIver, 1992). And only a fraction of students in schools that offer eighth grade Algebra take this course as an eighth grader. The most current statistics tells that only 18 % of eighth graders in the U.S. public schools took eighth grade Algebra in 1998 (Blank and Langesen, 1999).

Some statistical data on high school math course-taking will be informative here. One of the most current publications reporting transcript data presents percentages of 1994 high school graduates, who have earned credit in various math courses. According to this report, 68 percent of 1994 public high school graduates completed a Geometry course, while 56 percent completed an Algebra II course. The percentages for Analysis/Precalculus, Trigonometry, and Calculus were 16, 12 and 9, respectively. No consistent differences between males and females were found, and when there was a difference, females had higher percentages. The consistent pattern for racial/ethnic groups was that Asian/Pacific Islanders had the highest percentages for the above courses, followed by Whites. The third and the fourth places belonged to Hispanics and Blacks, respectively. Note that the percentages for racial/ethnic groups and males/females reflected both public and private school students, since these data were not grouped in terms of school type (Legum, et al., 1998).

Sebring (1987), in a study on six big states, found out a clear and consistent difference among the three high school programs (academic, general, and vocational). For the four advanced level high school math courses (Geometry, Algebra II, Trigonometry, and Calculus), students in academic programs had the highest enrollment rates. The second highest rates belonged to students in general high school programs, and the third to students in vocational programs. As an example, the enrollment rates of New York State students in Geometry were 94

%, 64%, and 49 % for academic, general, and vocational programs, respectively. For Algebra II, the percentages were 88, 56, and 37. For Trigonometry, they were 75, 36, and 17 and for Calculus, 24, 7, and 3. It can be said that this pattern is quite consistent across the country, although there may be slight differences in percentages depending on the tracking policies and practices in different schools and school districts.

Math course-taking statistics about the students in schools with different urbanicity levels seem to be mixed. A current study using transcript data used four levels of urbanicity, namely, big city, urban fringe, medium city, and small place. According to the descriptions of these levels by the report, big city corresponds to urban, and small place corresponds to rural, as used in many studies. Urban fringe and medium city roughly correspond to suburban. The highest percentage of 1994 high school graduates who completed a course in Algebra II belonged to big cities and medium cities (around 60 %). Urban fringes and small places shared the second place (around 56 %). For Geometry, the percentages for big cities, urban fringes, medium cities, and small places were 78, 73, 72, and 64, respectively. For Trigonometry, percentages were 9, 12, 16, and 11. For Calculus, they were 10, 13, 11, and 7. Note that these percentages reflected both public and private school students, since these data were not grouped in terms of school type (Legum, et al., 1998). A 1985 report on nationally representative data collected by NCES in the 1981-82 school year also revealed an inconsistent pattern. According to the report, 28 % of students in urban schools in the 1981-1982 school year enrolled in Algebra II. The percentages for suburban and rural were 32 and 30, respectively. For Geometry, the percentages for urban, suburban, and rural were 45, 53, and 42, respectively. For both of the courses in this report, students in suburban schools had the highest percentage. Urban school students were the second for Geometry; whereas they were the third for Algebra II (Evaluation Technologies Inc., 1985b).

Minority concentration of a high school also makes a difference in terms of average math course-taking. In Matthews's (1984) review, the only two studies containing statistics on minority concentration found out that the larger the percentage of Black students in a school, the more likely it was that lower level math courses were offered and that Black students enrolled in those courses. Conversely, the higher the percentage of White students, the more likely it was that advanced math courses were offered and that White students enrolled in those courses. Jones, Burton, and Davenport (1984) presented the average number of Algebra and Geometry courses the 17-year-olds reported having taken. The data, collected in the 1975-1976 school year,

revealed a significant difference between schools with less than 70 % White students and those with at least 90 % White students. The averages were 1.3 and 1.8, respectively. They also added that 73 % of all Black students, but only 8 % of Whites attended schools with less than 70 % White. Conversely, 66 % of all White students, but only 7 % of Black students attended schools with at least 90 % White students. However, the results for schools with White percentages between 70 and 90 were less clear. The means for these schools were 1.4 for 70-79 % White and 1.6 for 80-89 % White. Another study on nationally representative data from the 1981-1982 school year found a relationship that tended to be nonlinear, which is in contradiction to the two studies mentioned above. In this report, the three minority concentration categories for the two minority groups (Blacks and Hispanics) were 0 %, 1-9 %, and  $\geq 10$  %. The percent of students enrolled in Geometry in the 1981-82 school year was the highest for schools with a 1-9 % Black or with a 1-9 % Hispanic student population. 1-9 % Black student schools still had the highest percentage for Algebra II and 1-9 % Hispanic student schools shared the first place with 0 % Hispanic student schools. The percentages for Algebra II for schools with 0 %, 1-9 %, and  $\geq 10$  % Black students were 29, 33, and 29, respectively. The percentages for Algebra II for the same categories of Hispanic concentration were 31.7, 31.4, and 25.5. The percentages for Geometry for Black concentration were 48, 53, and 42. For Hispanic concentration, they were 46, 53, and 45 (Evaluation Technologies, Inc., 1985b). A shortcoming of this report was that it did not further categorize the schools with  $\geq 10$  % Black or Hispanic student schools, which leaves the reader with question marks about schools with high concentration of minority students. Yet, from the two studies mentioned above (Matthews, 1984; Jones, et al., 1984) and the studies referred later (which do not give raw statistics but correlations), it is safe to conclude that there are significant differences between the two extremes of school minority concentration (very low percentage of minorities and very high, above 40 % minority) in terms of advanced math course-taking. Only the studies mentioned above were found that presented statistics about the issue. Although they are somewhat outdated, current statistics presenting persistent differences among races in completing the set of academic courses in math (e.g., Green, et al., 1995) and those indicating that high (even ever-increasing) percentages of minorities live in minority communities, especially in urban areas (e.g., Lippman, et al., 1996), suggest that not much has changed.

Students in schools with different levels of poverty concentration take varying numbers of advanced math courses. A report by NCES (Lippman, et al., 1996) gives the statistics about the percentages of students who had taken Geometry in schools with different levels of poverty concentration. The data came from the high school transcripts of seniors in the 1990 National Assessment of Educational Progress (NAEP). Sixty percent of students in schools with a poverty concentration of over 40 percent had taken Geometry, whereas the percentage was 74 for schools with 0-5 percent poverty concentration. A report by Evaluation Technologies, Inc. (1985b), on nationally representative data from the 1981-82 school year, reveals the same pattern more clearly. Schools in the report were categorized on the basis of the percent of economically disadvantaged students they had. And the higher this percent, the lower the percentage of students who had enrolled in advanced math courses. The enrollment percentages for Algebra II for 0 %, 1-9 %, 10-24 %, and  $\geq 25$  % disadvantaged student categories were 34, 32, 30, and 27, respectively. The enrollment percentages for Geometry for the same categories were 60, 53, 48, and 34.

In sum, advanced math course-taking by high school students varies by a number of student- and school-level variables. All the variables for which math course-taking statistics are given above are considered in the design of the present study.

## **SOCIOECONOMIC STATUS:**

The term “socioeconomic status” (SES) is used by sociologists to denote an individual or family’s overall rank in the social and economic hierarchy (Mayer and Jencks, 1989). In most research, including national studies (e.g., NELS: 88, High School and Beyond), SES has been measured as a combination of parents’ education, parents’ occupational prestige, and family income (Mayer and Jencks, 1989; White, 1982).

## **SES and math achievement:**

SES, because of its effect on all aspects of students’ lives, has been included in a large body of research on academic achievement. It is widely believed that SES is strongly related to academic achievement at the individual level. White (1982), however, in his meta-analytic

review of 143 studies, came up with results that are contradictory to this widespread belief. He concluded that when SES was typically defined as a combination of income, parents' education, and/or parents' occupation) and the student was the unit of analysis, SES was only weakly correlated ( $r = .197$ ) with math achievement. Yet the correlation between SES and math achievement jumped to  $.697$ , when aggregate units of analysis (such as schools) were used. Many researchers reported similar findings that school-level SES had a positive effect on student achievement above and beyond student-level SES (e.g., Anderson, Hollinger, and Conaty, 1992; Myers, 1985; Jencks and Mayer, 1990).

Researchers who studied racial/ethnic differences in academic achievement emphasized the importance of integrating SES into the studies and the need for distinguishing between the effect of race and that of SES, since the poorest neighborhoods were almost all Black or Hispanic, especially in large urban areas (Mayer and Jencks, 1989; Reyes and Stanic, 1988). Oakes (1990), again pointing out the need to distinguish between the effect of race and that of SES, used Asian-Americans as an example to illustrate her claim that SES is an important factor in achievement differences among races. She stated that Asian-Americans were considered an anomaly among racial and ethnic minorities due to their overachievement and overrepresentation in math and science. She claimed that these high levels of achievement and representation were paralleled by advantages in terms of SES. She backed up her claim with data from the High School and Beyond study that Asian-Americans had the best-educated parents (both fathers and mothers) of any group, participated most in extracurricular activities, such as music lessons, travel, museum visits, and were most likely to own computers.

The relationship between SES and achievement can also be related to the term "cultural capital" (Bourdieu, 1986). Cultural capital refers to all the privileges afforded by the dominant group in a country. The dominant culture is said to determine the paths to and the necessary attributes for success, including school success. In the United States, the privileged group is Whites. There is a body of literature that claims that, even though there has been some improvement since the civil rights movement in 1960's, minority groups are still denied an equal access to the educational and occupational opportunities that Whites have (Ogbu, 1994).

Perpetuation theory, developed by McPartland and Braddock (1981), claims that segregation repeats itself "across the stages of the life cycle and across institutions when

individuals have not had sustained experiences in desegregated settings earlier in life" (p. 149) (McPartland and Braddock, 1981). They claim that this phenomenon also takes place in schools.

Critical sociologists (e.g., Jackson, 1968; Apple, 1979) popularized and discussed the term "hidden curriculum", defined as the implicit goals and meanings of the schooling process. These researchers claimed that students in schools master the norms that shape the social structure of the society and, in this way, unjust societal inequalities are perpetuated. In sum, the effect of SES on academic achievement may be somewhat different for minority students than it is for the majority group.

The effect of SES on academic achievement is also mediated by urbanicity, at least to some degree. For example, some researchers asserted that rural communities usually have fewer economic resources to spend for education and they may not have access to resources that would be readily available in cities, such as libraries and museums, which would enrich the environment to enhance educational outcomes. They perceived those resources as another form of capital associated with geographic location and characterized it more by the proximity to urbanized areas than by population density (Ghelfi and Parker, 1997). Consequently, even families with quite high SES may be limited in their efforts to improve their children's education because of limited opportunities in the neighborhood.

To sum, the relationship of SES to achievement has been extensively researched and its effect is well documented. Following provides a brief review of the conventional components of SES and their relationship to math achievement.

**Parents' education and math achievement.** Parents' education, a component of SES, exerts its effect on student's academic achievement in innumerable ways. There is a large body of research on the relationship between parents' education and student achievement. Parents with higher levels of education provide their children with a more resourceful environment, which would promote learning. The definition of such an environment includes not only material that offers a wealth of educational stimuli such as books and encyclopedias, but also parents themselves with their accumulation of knowledge. Consequently, parents' education has a cumulative effect on student achievement, starting from early ages (Comer, 1990). The resourcefulness brought about by the educational attainment of parents has been called the human capital (Coleman, 1988) and there is a growing body of literature on human capital.

On the average, parents with higher levels of education are also more cognizant of the importance of the quality of schooling their children receive. Therefore, they supervise their children's lives and restrict or regulate any activity that would negatively affect student's achievement, such as watching the television or working part-time (Muller, 1993).

For the specific case of math achievement, all of the mechanisms mentioned above hold true. Yet there may be a gradual decrease in the help provided by the parents directly related to math content, as the student progresses through upper grades in high school. Several studies found out that course-taking had the largest effect on academic achievement in mathematics among the academic subjects examined (e.g., Schmidt, 1983a; Jones, et al., 1986). In a study on NELS: 88 data, results indicated that the achievement growth differences in math and science among high- and low-SES students completing the same numbers of courses were small. This was particularly true in mathematics, where none of the SES comparisons were significant among students taking the same numbers of courses (Hoffer, et al., 1995). These findings suggest that mathematics is almost exclusively learned in school and background factors do not exert as much of an influence through out-of-school learning (Schmidt, 1983a; Jones, et al., 1986).

**Family income and math achievement.** Family income, another component of SES, also plays a unique role in the relationship between SES and math achievement. Financial capital, defined as the fiscal resources of the family used to meet the basic necessities of the student (Coleman, 1988), significantly affects student achievement. Families with greater financial capital can provide their children with educational resources that would enrich their educational experiences, such as books and computers.

From the perspective of student motivation toward success, students from middle and high SES families are more likely to have higher levels of motivation for school success. For example, students from middle class families usually expect that academic achievement will bring real-life awards in the form of good jobs and high salaries. These students have their parents and neighbors who have succeeded in school and already enjoying the benefits of their success. That is, they have their "daily reminders" both in their families and environments that school success will have social and economic payoffs (Oakes, 1990).

The problem of insufficient family income for individuals can be translated into a matter of poverty concentration at the community level. Poverty concentration has long been perceived as a big problem for poor minority neighborhoods in big cities. Statistics reveal that this is a

continuing, or even an ever-growing problem. For example, although the number of students in urban schools have remained the same at approximately 11 million between 1980 and 1990, the percentage of students living in poverty increased over the decade. Data from the Schools and Staffing Survey, collected in the 1987-1988 school year, indicated that forty percent of urban students attended high poverty schools (defined as schools with more than forty percent of students receiving free or reduced price lunch), while only ten percent of suburban students and 25 percent of rural students did so. These high poverty schools have a long list of problems that have an extremely negative effect on academic achievement. Among these problems are limited English proficiency, violence, and poor health (Lippman, et al., 1996).

While students from families with high levels of income have their "daily reminders" that school success will bring real-life awards in the form of good jobs and high salaries, many minority children in big cities have little or no experience to support such beliefs and expectations (Oakes, 1990). These students may know few adults who have succeeded in school or who have translated school success into economic gain. Lack of social institutions in poor communities which would provide students with contact with positive role models can be added as another problem (Oakes, 1990; Lippman, et al., 1996).

Previous research also points to the negative effect of poverty concentration on academic achievement. Anderson, et al. (1992), in their study with NELS: 88, found out that low income students in schools with small concentrations of such students score higher than their counterparts in schools with high concentrations of low income students. Myers (1985), using data from the High School and Beyond study, found out that students in high poverty schools had lower scores than did students in low poverty schools, even controlling for family SES. Analyses with nationally representative SES (Sustaining Effects Study) data (collected between 1976 and 1979) along with the 1980 census data indicated that even after controlling for family background variables, there was a significant negative correlation between the proportion of poor students in a school and student academic performance levels (Orland, 1990).

Some researchers (e.g., Fordham, 1988; Ogbu, 1990) have asserted that the attitudes toward school success held by students living in high poverty Black communities play an important role in explaining their lower levels of engagement in school, and in turn, academic achievement. Fordham (1988) and Ogbu (1990) claimed that these communities exhibited a form of resentment towards academic achievement because of the racial barriers they perceive they

would never overcome, even if they strove for success. Fordham (1988) generalized this pattern of attitudes to most subordinated populations in the United States. Because of this oppositional social identity, these students do not interpret the cultural and language differences they experience in school as barriers to be overcome, but rather "as symbols of identity to be maintained; they have a tendency to equate school learning with linear acculturation or assimilation into White American culture or with a loss of their language and cultural identity" (p. 65) (Ogbu, 1990). Under these conditions, students trying to succeed in school as individuals are implicitly accused of giving up their Black brotherhood and of "acting White" (Fordham, 1988). Hence, they are caught up between their social identity and the individualistic, competitive ideology of American schools (Comer, 1988; Fordham, 1988; Ogbu, 1990).

Poverty concentration is not a phenomenon causing problems only in urban areas. In rural areas, as in urban ones, schools with higher levels of poverty concentration, hosting higher percentages of minority students, have lower levels of average academic achievement (Gjelten, 1982; DeYoung, 1987; Hobbs, 1995).

In the present study, a covariance between SES and previous (8<sup>th</sup> grade) math achievement was hypothesized. Although the relationship between the two is definitely a one-way causal one from SES to math achievement, it was modeled as a covariance in the model, because these two background variables serve for control purposes. That is, the interest in this study is not in the causes of these two variables, rather, in their direct or indirect effect on the outcome variable in the model. Such variables are treated as exogenous variables within the structural equation modeling methodology. And as the literature suggests, this covariance may be different in strength for different groups of students under investigation.

### **SES and parental expectations/involvement:**

Before proceeding with the literature on how SES affects parental expectations/involvement, it will be useful to clarify the difference between parental expectations and parental involvement. Although there is a positive correlation between parental expectations and parental involvement, researchers agree that the relationship between expectations and involvement is mediated by two groups of variables. A categorization of parental involvement will be useful at this point. Muller and Kerbow (1993) categorize parental involvement as

involvement in three different contexts, namely, within the home and family, in the community, and in the school. The first group of variables that influence parental involvement are parents' characteristics. These are "parents' educational capabilities, their view of the appropriate division of labor between teachers and parents, the information they had about their children's schooling, and the time, money, and other material resources available in the home" (p. 79) (Lareau, 1987). This group of variables affect the level of parental involvement in all three contexts. Another important point, made by Steinberg, Lamborn, Dornbusch, and Darling (1992), is "how parents express their involvement and encouragement may be as important as whether and to what extent they do" (p. 1279). This claim is instrumental in understanding racial/ethnic differences in parental involvement. A good example are the findings by Muller and Kerbow (1993). They found out that White parents had the highest level of involvement when social activities or cultural enrichment were involved, such as talking with their children about current school experiences, knowing parents of their children's friends, volunteering in school. Asian Americans, on the other hand, had quite different ways of involvement. While they had the lowest level of talking with their children about high school programs and tended not to know the parents of their children's friends or volunteer in school, they were the highest in restricting their children's TV watching and enrolling their children in extra classes.

The second group of variables mediating the relation between expectations and involvement are school characteristics. Schools' policies vary in the degree to which they encourage parent participation (Schneider, 1993; Lareau, 1987). Such variation takes place between schools. Beside this kind of variation, there are also claims that encouragement of parental involvement by school administrators and teachers varies within schools depending on the parents' SES. These researchers claim that middle-class parents are more welcomed by schools than lower-class parents are (e.g., Ogbu, 1974). Lareau (1987), using a somewhat different perspective, suggested that parents with high SES and/or from the dominant culture use their cultural resources to have themselves welcomed by schools. These variables only affect the degree of parental involvement in the school. In sum, parental expectations lead to parental involvement in all three contexts (home, environment, and school) to the extent to which the two groups of mediating variables mentioned above allow them to.

Research suggests an overall positive correlation between SES and parental expectations. Parents' own educational experiences seem to shape their expectations from their children

(Khattari, Riley, and Kane, 1997). Researchers claim that the positive relationship between parents' educational attainment and the student's academic performance is mediated by parental expectations (Ware, Steckler, and Leserman, 1985; Baker and Stevenson, 1986).

Family income plays an important role in this relationship, too. Muller and Kerbow (1993) found a positive relationship between family income and parents' post-secondary educational expectations from their children. Parents with children in schools with relatively high levels of poverty concentration were far less likely to expect their children to graduate from college than parents with children in other schools (Lippman, et al., 1996).

There is also a combined effect on parental expectations when both parental education and family income are low. Parents who have little or no financial means of supporting their children's college education and, at the same time, do not know much about financial aid sources usually have much lower expectations from their children (Legutko, 1998). Lack of information and counseling about colleges and careers and weak or no ties to affluent and better connected people in high-minority, high-poverty schools also add to the negative effect of low SES on parental expectations (Wells and Crain, 1994).

However, there is an important variable that mediates the relationship between SES and parental expectations. Muller and Kerbow (1993) posed an interesting question about the relationship between SES and parental expectations: Do the parents expect a higher or a lower level of educational attainment from their children than their own? Then, they asserted that parents who perceive education as a means for "upward social mobility" may have expectations of higher educational attainment from their children than their own. Their analysis of national data revealed a positive relationship between parents' highest education and the proportion of parents expecting their children to graduate from college across all races. Yet, across parental education levels -from less than high school to Ph.D.-, higher proportions of minority parents, than White parents, expected their children to graduate from college. A second interesting finding was that White parents with high levels of education expected their children to attain lower levels of education than their own at a much higher rate than minorities. The researchers interpreted these results that White parents do not see earning a higher degree as pivotal for their children to maintain or improve the socioeconomic status they already have as minorities do.

On the other hand, there are claims (e.g., Fordham, 1988; Ogbu, 1990) that high poverty Black communities in metropolitan areas have resentment towards academic achievement

because of the racial barriers they perceive they would never overcome, even if they strove for success. Consequently, parents in these communities do not expect their children to achieve in school or to have high levels of education. Even though families say that they want their children to achieve, their pressure for success is weak. Fordham (1988) asserts that these findings can be generalized to other highly concentrated poor minority communities who perceive the same racial barriers for success. In this respect, high-poverty high-minority communities, especially in metropolitan areas, have different parental expectations/involvement than minorities in other settings do.

Parents in rural areas have, on the average, lower expectations from their children because of the employment opportunities in these areas with minimum educational requirements. Consequently, low levels of education have been widespread and parents themselves have not had the opportunity to see the benefits of higher levels of education either for themselves or for other people in the neighborhood (DeYoung, Huffman, and Turner, 1989). National data collected in 1988 for the NELS: 88 study indicated that parental expectations were significantly lower in rural schools than they were in urban schools, and this difference remained significant after controlling for poverty concentration of the school (Lippman, et al., 1996). In sum, it is relatively less likely for rural parents, compared to urban or suburban parents, to expect from their children higher levels of education than their own with the expectations that they would have more prestigious occupations with higher salaries.

The concept of perceived utility may be related to the parental expectations of subgroups mentioned above. Researchers who studied students' educational aspirations and postsecondary education plans found that perceived utility had a significant positive relationship with students' aspirations and plans (Oakes, 1990; Lantz and Smith, 1981). These findings can be generalized to parents' educational expectations from their children.

Parental expectations turn into parental involvement, although the relationship is mediated by the variables mentioned above. Hence, there are numerous studies that found a positive relationship between SES and parental involvement. For example, Useem (1991), using data collected in the Boston area, found out that parents with high levels of education scored significantly higher than less educated parents in a wide range of parental involvement. In a study with data collected in 1987 from nine high schools in Wisconsin and northern California, Steinberg, et al. (1992) found that middle-class parents had higher levels of parental involvement

than did lower SES parents. Parental involvement in this study was measured by a composite index of five different forms of involvement in the home and at school. Results from another study, using the national High School and Beyond data, again using a composite score of various parental involvement activities both in the home and at school, indicated that SES was positively related to parental involvement (Fehrmann, Keith, and Reimers, 1987).

In short, previous research suggests an overall relationship between SES and parental expectations, and in turn, parental involvement, although it may vary in strength for different groups of students. In the present study, a path from SES to parental expectations/involvement was hypothesized and it is expected that this relationship will appear different in strength for various subgroups of students under investigation.

### **SES and educational aspirations:**

Previous research has found a significant relationship between SES and educational aspirations of the student even after controlling for parental expectations (e.g., Wilson and Wilson, 1992; Anderson, 1980). The direct effect of SES on educational aspirations reveals itself primarily through parents' serving as role models for their children. Such role modeling starts early in a child's life. The child imitates, identifies, and finally internalizes the values and attitudes of his/her parents. This influence is extremely powerful because it takes place in the absence of previous experience and knowledge. And in turn, it also shapes the child's educational or occupational ambitions for his/her later life (Comer, 1990). Elder (1968) has suggested that what parents say about their expectations to their children may not be compatible with what they represent with their own educational and occupational status and this discrepancy may undermine the influence of parents' educational expectations on their children's aspirations.

All three components of SES (parents' education, parents' occupation, and family income) are influential in this relationship. That is, the higher all three components of SES, the higher the student's educational aspirations are. Students who have parents with high levels of education, prestigious occupations, and high amounts of earnings have their "daily reminders" that education has attractive social and economic payoffs (Oakes, 1990).

The same effect also takes place at the community/neighborhood level. People sharing a neighborhood tend to have similar socioeconomic status. And again, people tend to interact with

those of similar SES. Consequently, students from middle or high SES families have positive role models also in their neighborhoods or communities (Oakes, 1990). On the other hand, poor neighborhoods in metropolitan areas, isolated from affluent families, lack positive role models for students who would represent the benefits of education (Sawhill, O'Connor, Jensen, and Coulton, 1992). These neighborhoods tend to have high minority concentrations, and racial barriers for any kind of achievement they perceive they would never overcome, add to this disadvantage (Ogbu, 1990). For students in poor rural areas, perceptions of racial barriers for success may not have any influence on aspirations, yet these students have a different kind of disadvantage in terms of role models. Due to the limited number of economic activities, or even a single one like farming or mining, students in these settings have little means of seeing people holding different jobs. Many only aspire for the job his/her parents perform, especially if they do not want to leave their hometown because of strong family and community ties in these settings (Khattri, et al., 1997). In sum, the relationship between SES and educational aspirations appears significant for all students and there are some additional mechanisms reinforcing the relationship for specific groups.

### **SES and math course-taking:**

Some studies that investigated the relationship between SES and math course-taking at the individual level had no interest in possible mechanisms or mediating variables that would convey the effect of SES to math course-taking and only presented results about the direct relationship. For example, analysis of the NAEP data from the 1977-1978 school year revealed that students who took advanced math courses were more likely to have highly educated parents. Minority status, when entered together with parents' education in the analysis, was not significant (Horn and Walberg, 1984). Lee and Ware (1986) analyzed High School and Beyond data and found out that SES was a positive significant predictor of math course-taking. There were no race differences, after adjusting for SES. Another study (Lee, et al., 1998), using NELS: 88 and the High School Effectiveness Study data, found out that SES had a significant positive relationship with the highest mathematics course completed in high school, even when 9<sup>th</sup> grade mathematics GPA was also entered in the analysis. When entered in the analysis together with previous achievement and SES, minority status was not significant anymore. To summarize,

literature consistently suggests an effect of SES on the number of math courses taken during high school as well as on advanced math course-taking. Race differences seem to vanish once SES is controlled for. Put differently, previous research indicates that race differences in terms of math course-taking mostly reduce to SES differences among these race/ethnicity groups.

SES shows its effect on advanced math course-taking not only at the individual level but also at the school level. The relationship between average student SES and the rated average of the highest math course completed by students in school was found to be significantly positive, even after taking into account the variance due to the effect of SES at the individual level (Lee, et al., 1998). Useem (1991) found a significant relationship between a measure of the school districts' parental education levels and enrollment in accelerated mathematics. Districts with higher levels of parental education had higher enrollments in eighth-grade Algebra and high school Calculus. Another study found that the students in college preparatory programs at low SES schools (those most minorities attend) typically take fewer academic classes than the ones in the same program at higher SES schools do (Rock, Braun, and Rosenbaum, 1985).

There are studies that explored the mechanisms through which SES exerts its influence on course-taking. For example, Baker and Stevenson (1986) argued that the consistent positive relationship between SES and advanced course-taking could be explained in large part by the tendency of well-educated parents to be active managers of their children's schooling. This finding suggests an indirect effect of SES on course-taking through parental involvement in student's course-taking decisions. 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 math course-taking, when several other variables 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 math courses (Useem, 1991). Another finding by Lantz and Smith (1981) was that perceived peer attitudes were significantly related to election of nonrequired math courses, even when this variable was entered in the regression analysis together with parents' education, parents' occupation, parental encouragement, and some other variables. Ogbu (1990) claimed that Black parents living in poor, all-Black neighborhoods had relatively weak pressure on their children for school success and that peer groups, which had "antiacademic success" orientations, considerably pressured

their members not to strive for success. They used criticism and threat of isolation for such discouragement. Steinberg, et al. (1992) also suggested a greater influence of peers than that of parents on Black students' academic matters.

The effect of SES, especially parental education, on course-taking is either magnified or reduced by school characteristics. For example, in the absence of sufficient and/or proper counseling services in school, guidance by parents about course-taking decisions takes on extreme importance. Well-educated parents are able to guide their children through important course-taking decisions, since they are knowledgeable about courses and course sequences common in most schools. On the other hand, those with low levels of education cannot be of any help to their children in this matter (Useem, 1991). There has been a consistent concern about the availability of counseling services to students. In many schools, especially the highly populated ones, the high student-to-counselor ratios limit students' access to counseling. Counselors spend most of their time keeping records, and other activities such as scheduling and monitoring required by the special needs legislation. In some cases, the school counselor sees each student only once a year (Powell, et al., 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 math. Parents did not have any access to counseling services, either. The resulting picture for many students was a gap between the expectations for the future and their understanding of the steps necessary to prepare for the jobs they aspired (Leitman, Binns, and Unni, 1995).

What makes this problem worse is the differential availability of these services to low-SES and/or minority students. These students are the ones who cannot get sufficient –if any– guidance from their families or out-of-school environment and are in need of guidance the most. Unfortunately, most research suggests that these students are less likely to have access to guidance counseling for important course-taking decisions (Lee and Ekstrom, 1987; Leitman, et al., 1995). Another concern sounded by a number of researchers is the differential treatment by guidance counselors and teachers towards minority students in the form of counseling them into less demanding nonacademic courses and discouraging from demanding academic ones (Calabrese, 1989; Leitman, et al., 1995). In sum, the quantity and the quality of counseling services is one of the characteristics of schools that would magnify or minimize the effect of SES on course-taking.

A closely related second feature of schools is the extent to which they allow parental intervention in course-taking decisions. There is much variety in schools' policies about this issue. Useem (1991), in her study of the interplay between school policies and parental involvement in course placements, elaborates how schools can and do block parental intervention in this matter. She explains how school policies and practices can magnify the effect of SES on course-taking. She argues that, in schools which try to constrain parents' attempts to place their children in higher levels of mathematics, parents with college or graduate degrees have more of the social and intellectual 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. Please note that the influence of both of the school characteristics on the relationship between SES and course-taking depends upon parental expectations and intentions for involvement.

In short, literature suggests the existence of mediating variables in the relationship between SES and math course-taking. It also suggests that the relationships between the mediating variables may not have the same strength for all the subgroups under investigation in this study.

The relationship between SES and math course-taking is a key relationship in the proposed model of the present study. A major topic of inquiry is whether SES still has a direct effect on math course-taking in a model where its indirect effects through several variables are also included. Three different indirect paths from SES to math course-taking have been hypothesized in the model. The shortest path is from SES to educational aspirations to math course-taking. The second one is from SES to parental expectations/involvement to educational aspirations to math course-taking. The third one also includes educational aspirations of peers and it is from SES to parental expectations/involvement to educational aspirations of peers to educational aspirations of the student to math course-taking. Some of the relationships in these paths have already been reviewed and others will be reviewed shortly. Another objective of this study is to see whether these relationships differ in strength for various subgroups of students, namely, students from different race/ethnic groups and students in schools with different urbanicity, minority concentration, and poverty concentration levels.

## **PREVIOUS MATHEMATICS ACHIEVEMENT:**

Depending upon the study design and hypotheses, several different measures have been used for mathematics achievement in studies where it served as a background variable. Among these measures are standardized test scores (e.g., Hoffer, et al., 1995), grades (e.g., Lee, et al., 1998), and the grade earned in the last course taken in a particular subject (e.g., Lee and Ware, 1986).

## **Previous math achievement and parental expectations/involvement:**

Generally, research suggests that previous achievement influences parental expectations, although there is a tendency to define the relationship as a feedback loop, meaning parents' expectations are both a cause and an effect of academic achievement (Seginer, 1983; Powell and Peet, 1996; Singh, et al., 1995). There is evidence suggesting that this interaction starts early in child's education. Two studies found that parents' expectations go through a major change during the first and the second grades as a result of the feedback from report cards (Seginer, 1983; Powell and Peet, 1996). And such feedback continues to cumulatively affect parents' expectations throughout the child's schooling (Wentzel, 1998).

In a review of the literature on this relationship, Seginer (1983) found out that the effect of academic achievement on parental expectations varied from no effect to moderate effect (as represented by standardized coefficients in path analyses, ranging from .03 to .40). She concluded that this inconsistency was partly due to the demographic characteristics of the samples used in different studies, such as sex, race, and residence.

A number of studies suggested that the relationship was influenced by several factors. Among those factors are parents' own aspirations -especially those unfulfilled- (Seginer, 1983), parental knowledge about children's cognitive development and its assessment (Seginer, 1983), and theories of intelligence parents hold (Wentzel, 1998). Gurin and Epps (1975) asserted that the valuation of educational achievement as well as the perceived feasibility of its continuation, given the opportunity structure, also affect the relationship between academic achievement and parental expectations/involvement.

The mediating variables presented above also serve as clues for possible differential strength of this relationship for various groups of students. For example, DeBord, Griffin, and Clark (1977) found that the relationship was stronger for Whites than for Blacks. This finding is understandable, because Blacks, not Whites, perceive racial barriers for success (Fordham, 1988) and Black parents' translation of the student's success into subsequent parental expectations is influenced by these perceptions. And low income affects higher percentages of Blacks than of Whites.

Picou and Carter (1976) showed that the relationship was stronger for large city residents than for village dwellers. This finding is also consistent with the interpretations of employment opportunities in rural areas, which require minimum educational attainment, compared to the wide range of opportunities in urban areas requiring high levels of education (DeYoung, et al., 1989). This opportunity structure plays a role in parents' defining their educational expectations from their children. In sum, literature points to a significant relationship between previous academic achievement and parental expectations/involvement and its varying strength for groups of students with different demographic characteristics.

### **Previous math achievement and math self-concept:**

Before reviewing its relationship with previous achievement, a definition of self-concept will be helpful. Shavelson, Hubner, and Stanton (1976) defined self-concept as a person's perceptions of self formed through previous experience and one's interpretations of his/her environment. There are terms used interchangeably with self-concept, such as self-confidence in one's ability (e.g., Lee and Ware, 1986; Lantz and Smith, 1981), or concepts which are closely related to self-concept, such as self-efficacy, a term coined by Bandura (1977).

Self-concept has also been defined as expectation for success in future performances (e.g., Feather, 1988). Feedback from prior performances serves as a foundation for expectations for future success. In the case of math self-concept, previous accomplishments/failures in math, or more precisely, their perceptions by the individual play an important role in its formation. A review of longitudinal studies based on structural equation modeling by Marsh and Yeung (1997) revealed that previous academic achievement influences subsequent self-concept and prior academic self-concept influences subsequent achievement.

Researchers have identified two comparison processes in the relationship between achievement and self-concept. In a social comparison, the student compares his/her achievement with the achievement of other students. In a self-comparison, the student compares his/her achievement in a subject, such as math, with his/her achievement in other subjects. Students' perceptions of their math achievement in both comparisons were found to be influential on their math self-concept (Lantz and Smith, 1981). Aside from the two above, student's comparison of his/her most current performance in a subject with his/her past performance in the same subject plays a crucial role. Lee and Ware (1986) found that the grade earned in the student's last math course relative to his/her overall math GPA was significantly influential on the student's math self-concept.

An important feature of math self-concept is its domain specificity. That is, math self-concept is highly correlated with math achievement, but not with English achievement. Likewise, English self-concept is highly correlated with English achievement, but not with math achievement. And the two self-concepts are uncorrelated (Marsh, Byrne, and Shavelson, 1988; Marsh and Yeung, 1998).

The significant relationship between previous math achievement and math self-concept appears to hold true for all kinds of students and no differences in the strength of this relationship for various groups of students were hypothesized in this study.

### **Previous math achievement and educational aspirations:**

The direct effect of previous achievement on educational aspirations represents the student's interpretation of the conditions in the process of translating success into subsequent aspirations. The value assigned to success and the feasibility of its continuation in subsequent educational pursuits influence the student's translation of previous achievement into educational aspirations, just as they do parents' attitudes toward success (Gurin and Epps, 1975). The concept of perceived utility can also be related to the issue. Several studies revealed that the perceived utility of math by the student in his/her future career is a significant factor in shaping his/her educational aspirations based on previous math achievement (Lantz and Smith, 1981; Reyes, 1984; Linn and Hyde, 1989).

In the present study, the direct effect may also represent the influence of significant people in student's environment other than parents and peers, such as teachers and successful role models in his/her neighborhood/community. Please note that only the parents' and peers' influence on the student's educational aspirations is included in the model; therefore, the influence of other significant people may be taken over by the direct effect. Pointing to the importance of role models, Wilson and Wilson (1992) claimed that the relative increase in Black students' educational aspirations in recent decades might be due in part to the increase in the number of successful role models for these students.

Just as perceived racial barriers for success by Black parents in poor metropolitan areas result in lower parental expectations (Fordham, 1988; Ogbu, 1990), such perception may be effective in the formulation of educational aspirations by Black students in these settings. Put differently, these students may have lower educational aspirations, even when they have the same levels of success as White students. Therefore, this relationship can be expected to be weaker for Black students in poor urban areas than it is for other students. Again, low level of income plays a larger role for Blacks in leveling down their aspirations than it does for Whites.

The employment opportunities in rural areas that do not require high levels of formal education downsize the educational aspirations of students in these settings (Haas, 1992). Consequently, even the successful students do not aspire for high levels of education. On the other hand, the full range of jobs requiring college degrees and offering high salaries in urban areas is a big reinforcement for urban students to turn their school success into subsequent aspirations.

Since, in this study, the relationship between previous achievement and educational aspirations also represents the influence of significant people other than parents and peers, the presence/absence of role models in the neighborhood/community, who could turn their school success into social and economic prosperity, can be listed as a factor influencing this relationship. Students living in high-poverty neighborhoods, mostly in metropolitan areas, do not have such role models (Sawhill, et al., 1992). Consequently, these students living in isolated neighborhoods, having no social networks or social institutions that encourage further educational attainment, have difficulty aspiring high, based on their achievement. In sum, literature indicates a significant relationship between previous academic achievement and the

student's educational aspirations and its varying strength for groups of students with different demographic characteristics.

### **Previous math achievement and math course-taking:**

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

The direct effect of previous math achievement on subsequent math course-taking, especially at an advanced level, may be expected above and beyond its indirect effect through other variables, since previous achievement, measured either by grades or standardized test scores, is a widespread significant criterion in high school math course placements (Useem, 1991; Oakes, et al., 1992).

The effect of previous math achievement on math course-taking is a key relationship in the model. From the literature, it is not clear how much of the effect of previous math achievement on math course-taking is indirect through other processes. Put differently, the question, whether previous achievement still has a significant direct effect after taking into account its indirect effects, needs further exploration. From another perspective, the direct effect represents a rough measure of the effect of school policies on course-taking, after taking into account the indirect effects through student's educational aspirations -either direct or shaped by parental expectations/involvement and educational aspirations of peers-, and through math self-concept.

## **PARENTAL EXPECTATIONS/INVOLVEMENT:**

The relationship between parental expectations and parental involvement as well as the mediating variables in this relationship have already been reviewed.

### **Parental expectations/involvement and educational aspirations of peers:**

Being careful about their children's peer relationships is an important kind of parental involvement. Peers exert influence on students' thinking and behavior, especially during adolescence. As adolescents start to spend more time away from home with peers, parental monitoring of their peer relationships becomes more crucial (Cooper and Cooper, 1992). Therefore, parents who want their children to have high levels of education would also like them to have friends with similar educational aspirations. To the degree they can translate their expectations into involvement, they try to oversee, and if necessary, intervene their children's choice of friends at school and in the neighborhood. Such a mechanism brings about a relationship between parental expectations/involvement and educational aspirations of peers. In other words, the higher the expectations parents have from their children and, at the same time, the higher the level of their involvement in their children's schooling, the higher the educational aspirations of their children's friends will be. For example, Davies and Kandel (1981), in their study on adolescents, concluded a significant relationship between parents' educational aspirations for their children and aspirations of their children's best friends.

In this study, no differences in the strength of this relationship for various groups of students are hypothesized. Regardless of the student's race or the demographic characteristics of the school he/she attends, it is hypothesized that this relationship will hold true at the same strength.

### **Parental expectations/involvement and educational aspirations:**

Parents have considerable influence on their children's thinking and behavior. The same influence is also at work on the student's educational aspirations. Parents' expectations from their children play a large role in the formation of the student's own aspirations. Parents communicate

their expectations to their children through demands, supports, or encouragement (Sewell and Hauser, 1976).

Research on this topic consistently found a significant relationship between parents' educational expectations from their children and students' own educational aspirations (e.g., Hossler and Stage, 1992; Anderson, 1980; Wilson and Wilson, 1992). Seginer (1983), in her review of literature, concluded that the researchers consistently found a moderate but significant relationship between parents' expectations and children's own aspirations. She indicated that the standardized regression coefficients ranged from .32 to .66, when SES, IQ, academic achievement, and in some studies, teachers' and peers' expectations, were held constant. Seginer also concluded that this significant relationship held true for children of different ages, nationalities, and race.

An important issue investigated in the present study is the strength of the relationship between parental expectations/involvement and the student's educational aspirations compared to the one between educational aspirations of peers and the student's own aspirations. As for the parent or peer influence in general, peers may have a higher 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, and Marlin, 1980; Davies and Kandel, 1981). Another important finding is that peers usually exert their influence through modeling, whereas parents influence through communicating their norms (Biddle, et al., 1980). As for the parent or peer influence specifically on the student's educational aspirations, Davies and Kandel (1981) found that parental influence was much stronger than peer influence and this influence did not decline over the adolescent years.

There have been claims about the relative importance of these two influences for students from different races. Steinberg, et al. (1992) assert that peer influence is stronger for Black students than it is for students from other races and that any positive effects of parental expectations/involvement may be undermined by this negative influence. Ogbu (1990) claims that although Black parents say that they want their children to succeed in school, their pressure and involvement is relatively weak. He states that there is a strong peer pressure among these adolescents against academic success in the form of criticism and threat of isolation. He also describes several strategies employed by successful Black youth to cope with this strong peer

pressure. These findings indicate that there is a possibility of finding a relatively weak relationship between parental expectations/involvement and Black students' educational aspirations, especially if parents report that they want their children to succeed, and yet these expectations are not translated into pressure for success or involvement in their schooling. When such relatively weak pressure from parents is coupled with a strong peer pressure against any pursuit of academic success, this possibility becomes a strong one.

Similar claims have been made about urban students. Lack of parental support has been given as a big detriment to urban students (Carnegie Foundation, 1988). Researchers (e.g., Lippman, et al., 1996) claimed a stronger peer influence among urban students, compared to suburban or rural students. This implies a weaker parental influence. Family factors reinforcing a relatively strong peer influence include, but are not limited to, having only one parent and lack of parental support. Social factors include a greater need by urban students for peer groups for socialization and protection, compared to suburban or rural students (Lippman, et al., 1996). Although no distinctions were made in the above NCES report in terms of minority or poverty concentration, it is safe to say that the conditions above are more valid in high poverty urban neighborhoods, almost all of which host concentrations of minorities. In sum, a weaker relationship between parental expectations/involvement and urban students' educational aspirations is expected than for suburban or rural students. This relationship is expected to be even weaker for students in high minority, high poverty urban schools.

## **EDUCATIONAL ASPIRATIONS OF PEERS:**

### **Peers' educational aspirations and the student's educational aspirations:**

Peers are a major source of influence on youth's thinking and behavior, especially during adolescence. With an increasing level of independence from the family and the home, adolescents usually socialize with their peers more than they do with their parents. Parallel to this greater socialization, a higher level of interdependence takes place among the members of peer groups. This brings about a larger influence of peer group members on each other's ideas. Such influence is also observed on adolescents' educational aspirations. Especially during adolescence, a period of considerable need for acceptance by peers, norms of the peer group are reinforced

through various ways at a high level (Biddle, et al., 1980). Therefore, educational aspirations of peers have an impact on students' own aspirations. For example, Davies and Kandel (1981) investigated the importance of parent and peer influence on adolescents' educational aspirations and found that adolescents' educational aspirations were still significantly related to those of their peers, even when parent influence and background variables such as SES were also entered into the analysis.

The relationship between educational aspirations of peers and those of the student's, compared to the one between parental expectations/involvement and the student's aspirations, has already been reviewed. The relative strength of these relationships for students with different demographic characteristics has been mentioned before, too.

## **MATH SELF-CONCEPT:**

### **Math self-concept and math course-taking:**

Self-concept, an important affective variable, has been related to a number of educational outcomes. There is a long line of theoretical and empirical research suggesting a significant relationship between academic self-concept and persistence and performance in school (Stipek and Weisz, 1981). More specifically, the relationship between math self-concept and high school math course-taking has been found to be significant. For example, Lantz and Smith (1981) found that, when items measuring self-concept were entered into regression analysis with several other variables, such as parents' education, parents' occupation and last grade in mathematics, they were still good predictors of enrollment in nonrequired math courses. Results from a study on High School and Beyond data revealed that math self-concept was a significant predictor of subsequent math coursework, after controlling the effect of prior math and verbal ability (Marsh, 1989).

There is a dearth of research on minorities as to how affective factors, including math self-concept, influence their math participation (Oakes, 1990). In this respect, the present study is an exploratory one, with no preset hypotheses about the strength of this relationship for students of different races.

## **EDUCATIONAL ASPIRATIONS:**

### **Educational aspirations and math course-taking:**

Students are expected to take the courses that will be useful in reaching their educational goals. This is true at every stage of education, including high school. Accordingly, previous research has found a significant relationship between the student's educational aspirations and math course-taking during high school. For example, Lee and Ware (1986), using High School and Beyond data, investigated the effect of several individual factors as students go along the high school math pipeline and found that each successive "course group" had higher educational aspirations. They also highlighted the greater importance of educational aspirations at earlier transitions (e.g., in the decision to take Geometry after Algebra I), compared to the more advanced course progressions (e.g., in the decision to take Precalculus after Trigonometry). Lantz and Smith (1981) found a significant relationship between educational aspirations and students' choice of nonrequired math courses during high school.

This relationship, however, is mediated by the perceived utility of taking the courses for reaching one's educational goals. Students will continue to take the courses, especially the demanding ones, to the extent that they believe they will be useful for their educational plans. Accordingly, Lantz and Smith (1981) found a high relationship between perceptions of the amount of math necessary for one's chosen career and the intention to take nonrequired high school math courses.

This relationship emphasizes the importance of guidance and counseling both by parents and school personnel about proper and timely course-taking. Students, who have little or no access to any kind of guidance or counseling about course-taking, may not realize the importance of these courses for their educational plans and miss the opportunities to take them. The concern about the limited availability of counseling services for students has already been mentioned.

In sum, research suggests a significant relationship between educational aspirations and math course-taking, which is mediated by perceived utility of these courses for future educational plans. In accordance with the findings that low SES and/or minority students have less access to guidance and counseling by parents or school personnel (Lee and Ekstrom, 1987; Leitman, et al., 1995), a weaker relationship is expected for minority students, since insufficient

guidance brings about a greater disparity between educational aspirations and taking the necessary steps for reaching these goals. By the same token, a weaker relationship can also be expected for students in high minority and/or high poverty schools. The same finding is also anticipated for students in urban schools, because these are the schools with larger sizes and less school resources (Lippman, et al., 1996). This, in turn, reduces the availability of guidance and counseling services for students.

## **SCHOOL STRUCTURAL VARIABLES:**

The school structural variables that are related to math course-taking are not investigated in this study. These variables are controlled through keeping them constant. Following is a brief review of literature on these variables and how they are controlled in this study.

### **Type of School:**

Being highly independent in most states in their practices and curricular choices, private schools exhibit a considerable variation in their curricular emphasis, course-offerings, and graduation requirements, all of which influence students' course-taking. For example, Catholic schools, a large sector of private schooling, are characterized by a narrow academic curriculum (Lee, et al., 1998). All of the students in these schools complete a narrow set of mostly academic courses, almost all of which are required for graduation (Lee, et al., 1997). On the other hand, public high schools predominantly feature the differentiated curriculum approach (Lee, et al., 1998). 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.

Significant differences between public and private schools as well as between their students require separate treatment of public and private school students. Since an overwhelming percentage of students attend public schools, only students in public high schools were selected in this study.

### **Variety and Level of Courses Offered:**

The effect of the variety and level of courses offered in a school on students' course-taking is self-evident, because course selection by students is limited by the offerings in school. For example, if not offered in school, a student cannot take Calculus, even if he/she wants to. Schmidt (1983b) stated that large amount of variation among schools in quantity of schooling students receive was due to differences in course offerings. Sebring (1987) also noted that students' opportunities for learning were bounded by course offerings in schools, graduation requirements, and students' selection of courses.

In the present study, course-taking in Algebra II, Geometry, Trigonometry, and Calculus is investigated. Accordingly, only students in schools that offered all of Algebra 2<sup>nd</sup> year, Geometry, Trigonometry, and Calculus were selected. Research suggests that in schools, where the variety in low-end (basic, general) math 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 above courses 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 this study. Such control would have significantly reduced the sample size due to the variation in these courses among schools.

### **Graduation Requirements:**

Graduation requirements by the schools have at least some impact on their students' course-taking, since these requirements set the minimum for course-taking in various subject areas. Catholic schools' requiring almost all of the courses in their narrow academic curriculum (Lee, et al., 1997) is a good example of this impact. There is also variation in graduation requirements in public schools among states and among districts within states (Hoffer, et al., 1995).

A major movement towards raising the graduation requirements in public schools started with the "A Nation at Risk" report (National Commission on Excellence in Education, 1983). In this report, the authors claimed a significant decline in the quality of education in the U.S. secondary schools using results from international as well as national longitudinal studies. They

asserted that the curricula had been diluted and, in effect, the majority of students followed an easy track and avoided even moderately challenging courses, let alone the advanced ones. They stated that this was one of the major reasons for the decline in the quality of education and in academic excellence. Not surprisingly, one of the main recommendations in the report was to raise high school graduation requirements. The Commission recommended that all students seeking a high school diploma be required to complete four years of English, three years of mathematics, three years of science, three years of social studies, and one-half year of computer science. An additional two years of foreign languages was strongly recommended for the college-bound students.

Research on the effect of raising graduation requirements on course-taking suggested that these changes had their primary impact in the states where the new requirements were set above the preexisting average course-taking. It also suggested that it had the greatest impact on non-college-bound students who were previously below the average. Overall, the results of higher graduation requirements can be seen as a moderate success (Clune and White, 1992).

There is still some movement in states towards raising graduation requirements, although it is not comparable to the major trend in 1980s triggered by the “A Nation at Risk” report. And these efforts are occasionally nourished by reports or new policy decisions made at different levels, such as the “Goals 2000” report (National Education Goals Panel, 1995) and the recent policies made by Virginia Department of Education on using SOL (Standards of Learning) test results for important decisions such as school accreditation (Virginia Department of Education, 1997).

A noteworthy point here is that almost all of the public schools specify their graduation requirements in terms of Carnegie units, which is a measure of how long a course meets, independent of content. One Carnegie unit is granted when a student completes a course that meets for five 50-55 minute periods per week for an entire school year. And the units counted towards graduation may be in different courses for different students (Hoffer, et al., 1995). For example, a student may count one General Mathematics course and a Consumer Mathematics course towards graduation, whereas another may count Algebra II and Geometry. Such specification of requirements leaves considerable freedom to students for selecting courses to meet the requirements and this has been perceived as a problem by many researchers (e.g., Lee, et al., 1998).

There are some recent attempts to specify graduation requirements in terms of course titles. One example is the regulations by Virginia Department of Education. According to the new regulations, all students are required to complete two courses at or above the level of Algebra, in one of which they are also expected to pass the end-of-course Standards of Learning test (Virginia Department of Education, 1997). Even this level of specification leaves considerable freedom for students, since they will still be free to take more and/or advanced courses in the other two years of their high school education.

The most current reports on state-level graduation requirements indicate that almost half of the states require two years of math for a high school diploma. For example, both in 1990 and 1994, 22 states had these requirements (Legum, et al., 1998). Among 32 states reported in another study, 15 required two years of math for graduation as of 1998 (Blank and Langesen, 1999). Accordingly, only students in schools, which required two years of math for graduation, were selected in the present study.

### **Tracking:**

Since tracking has already been mentioned above several times, neither the literature on tracking nor its importance in course-taking is mentioned here. The multitude of tracking practices in schools make it difficult for researchers to employ a precise measure of this variable and in much survey research, the three-track categorization (i.e., academic/college preparatory, general, and vocational/technical) has been employed as a crude measure of tracking (Oakes, et al., 1992). In the present study, tracking is also defined as grouping students into different high school programs. Being unable to measure the type and degree of tracking in the school more precisely, whether tracking existed in the school of the student or not was treated as a structural variable and kept constant through selecting students who were tracked into any one of the three programs (general, academic, or vocational/technical).

## CHAPTER III

### METHODOLOGY

#### DATA:

In this study, the data were drawn from the base year and first and second follow-up of the National Educational Longitudinal Study: 1988 (NELS: 88). NELS: 88 is a major project carried out by National Center for Education Statistics (NCES) for the U.S. Department of Education, as part of a series of longitudinal studies. It was designed to provide longitudinal data about students' experiences in almost every aspect of their lives during the important transitions from elementary through junior high and high school and into higher education or their occupations. 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 stratification of schools was 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 students 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 a representative sample of the nation's seniors in the second follow-up, respectively (Ingels, et al., 1994).

Students in the study were, at each wave of data collection, given questionnaires covering a wide range of topics related to almost every aspect of their lives. Students also completed a series of standardized tests, which measured their educational achievement and cognitive growth between eighth and twelfth grades in four subject areas- reading, mathematics, science, and

social studies. These tests were given at each wave, too. In the second follow-up, students' high school transcripts were also collected (Ingels, et al., 1994).

The study collected data not only from students at each wave of data collection but also from parents, teachers and principals at certain waves. Parent data were collected in the base year and in the second follow-up. Teacher data were collected from two teachers per student (taken from English, social studies, mathematics, or science) in the base year and in the first follow-up as well as from one teacher per student (taken from mathematics or science) in the second follow-up. Data from principals of the schools sample students attended were collected in the base year as well as in the first and the second follow-up. Questionnaires given to parents, teachers, and principals also cover a wide variety of topics (Ingels, et al., 1994).

### **SAMPLE:**

Sample selection in the present study can best be explained step by step exactly as it was done. Before proceeding with the sample selection steps, some further information about the NELS: 88 sample will be useful. Within the overall NELS: 88 sample, students are further defined as members of certain subgroups. This is necessary, since the sampling scheme of the study is complex. Two simple examples of this complexity are oversampling of certain groups and freshening of the sample at each wave of data collection to reach a nationally representative sample. The NELS: 88 study also allows researchers to reach nationally representative subsamples out of the overall sample, through providing sampling weights for these subgroups, based on the probability of selection of these groups into the overall sample.

In the first step, the 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<sup>th</sup> graders, regardless of whether they graduated from high school four years later or not. Among these students, only the ones who graduated from high school in Spring 1992, were selected in the first step in this study. Since this second selection was from the nationally representative sample of 1988 8<sup>th</sup> graders, it constitutes a

nationally representative sample of 1988 8<sup>th</sup> graders, who graduated from high school four years later in Spring 1992. The resulting sample size after this selection was 11,786.

In the second step, only students who did not change their schools between 01-01-88 (which can be seen as the beginning of the semester in which NELS: 88 base year data collection started, when the students were eighth graders) and second follow-up data collection (second semester of 12<sup>th</sup> grade) (Ingels, et al., 1994) were selected. This selection was necessary, since the levels for school structural variables had to be the same throughout high school for individual students to be able to keep them constant. Even after keeping the school structural variables constant, school demographic variables are still in the overall study design and they also need to be constant for each student, since only one value for these variables for each student is used in various analyses. The resulting sample size was 9,381.

Sample selection from third step through sixth step was performed to keep the relevant school structural variables constant. Rationale for such an approach as well as for the ways they were kept constant has already been given in Chapter II.

In the third step, only students in public schools were selected. The resulting sample size was 7,939.

In the fourth step, only students in schools that offered the complete set of math courses, which are of interest in the present study, were selected. These courses are Algebra 2<sup>nd</sup> year, Geometry, Trigonometry, and Calculus. The resulting sample size was 4,260.

In the fifth step, only students in schools that required two years of math for graduation were selected. The resulting sample size was 2,245.

In the sixth step, only students who were either in general or academic or vocational/technical program were selected. The resulting sample size was 2,093.

After the sixth step, there were three school demographic variables that were considered. These were urbanicity (urban, suburban, rural), minority concentration (measured as the percentage of minority students in school), and poverty concentration (measured as the percentage of students receiving free-reduced price lunch).

In the seventh step, the items in NELS: 88 database for these three school demographic variables were recoded to create new variables to be used in this study. The subjects, for whom the value for one or more of these three variables was missing, were also eliminated.

The levels of the original items were as follows:

Urbanicity: 1= Urban 2= Suburban 3= Rural

Minority Concentration: 0= None 1= 1-5 % 2= 6-10 % 3= 11-20 %

4= 21-40 % 5= 41-60 % 6= 61-90 % 7= 91-100 %

Poverty Concentration: 0= None 1= 1-5 % 2= 6-10 % 3= 11-20 %

4= 21-30 % 5= 31-50 % 6= 51-75 % 7= 76-100 %.

The levels of the “urbanicity” variable were kept the same. The levels of the new “minority concentration” and “poverty concentration” variables were created with an attempt to make the levels within each variable even in terms of cell frequencies in the sample after the sixth step of sample selection.

The levels of the new variables were as follows:

Urbanicity : 1= Urban 2= Suburban 3= Rural

Minority Concentration: 1= 0-5 % minority 2= 6-20 % minority 3= 21-100 % minority

Poverty Concentration: 1= 0-5 % poor 2= 6-20 % poor 3= 21-100 % poor

Still in the seventh step, total Carnegie units in math courses, which are of interest in this study, were summed up to create a new variable. This new variable, which is the outcome variable in the present study, is the sum of Carnegie units 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” (p. O-1) (Ingels, et al., 1994). The resulting sample size was 2,045. All the analyses in this study were performed on this sample (N= 2,045) after the seventh step of sample selection.

Among the racial groups, Whites, African Americans, Hispanics, and Asian/Pacific Islanders were studied. The NELS: 88 item used for the 'racial group' variable in this study had five categories. Among these categories, four were investigated and the only other group of American Indians/Alaskans was not studied because of very small number of observations for this group.

## **ANALYTIC METHOD:**

Initially, descriptive analyses were carried out to see whether hypothesized differences among the subgroups in the study existed in terms of the outcome variable.

The major part of the analyses was development and estimation of models through structural equation modeling. Structural equation modeling is the most suitable analytic technique for the study of causal relationships in non-experimental data. The models in this study included a mixture of manifest and latent variables. Such a model is known as a nonstandard model since it contains a mixture of manifest and latent variable, as opposed to a standard model where all the variables in the model are either manifest or latent. A manifest variable is a variable that is directly observed or measured in a study. These variables are measured by a single indicator in structural equation modeling. A latent variable, on the other hand, is a hypothetical construct that is not directly observed or measured. Latent variables are measured by more than one indicator in structural equation modeling (Hatcher, 1994).

In this study, a two-step approach to structural equation modeling, as suggested by Anderson and Gerbing (1988), was used. According to this approach, confirmatory factor analysis is used to develop an acceptable measurement model in the first step. A measurement model is a factor-analytic model in which the latent variables of interest are identified and which observed variables are used to measure each latent variable are indicated. In a measurement model, no causal relationships are specified, but rather each of the manifest and latent variables in the model are allowed to covary with every other variable. The purpose in this step is to see how well the specified measurement model fits the data. Model modification suggested by the confirmatory factor analysis is then made, if it is deemed necessary and theoretically sound.

Having come up with a final measurement model with an acceptable fit, the researcher proceeds with the second step. In this step, only the hypothesized causal relationships among the latent and the manifest structural variables are specified in an initial structural model. Put differently, relationships between some of the structural variables, not all of them, are specified. Consequently, the resulting model becomes a combination of a measurement and a structural model. This model is tested to see how well it fits the data and whether it explains the relationships among the variables more efficiently than the measurement model does. Again, model modification suggested by the results is made if it is judged necessary and theoretically sound to come up with a final structural model (Hatcher, 1994).

Model modification is made through adding or deleting model parameters and it can be made in the measurement and/or the structural model. These parameters may be variances, covariances, or path coefficients. All computer programs developed for structural equation

modeling generate modification indices, which suggest changes in the model that would improve the fit between the data and the model. However, it is recommended that only very few changes are made and if and only if they are also supported by theory and literature. Otherwise, these modifications will be data driven and sample specific; hence, the resulting models will not generalize to the population. This is particularly true if the sample size is relatively small (MacCallum, 1986). Accordingly, haphazard model modifications were avoided in this study.

Structural equation modeling with latent variables has two major advantages over regression. First, latent-variable approach allows the researcher to examine the construct validity of the measures he/she uses. That is, if the variables thought to measure each construct (latent variable) have a shared variance and collectively make up a latent variable, and at the same time do not share any variance with the items measuring other constructs, then the researcher has evidence that he/she is studying the constructs he/she is interested in. In regression, where constructs are measured with one variable, there is no way of offering any evidence for construct validity.

Second, using latent variables provides the opportunity to work with perfectly reliable structural variables. One of the assumptions in regression is that all variables are measured without error, which means that the measures are perfectly reliable indicators of the constructs they are intended to measure. In social sciences, this is an unrealistic assumption most of the time. In latent-variable models, however, the variables thought to measure the latent variables have two variance components. First component is the shared variance with other variables measuring the same latent variable and the second component is the portion, which is not shared and does not measure the latent variable it is intended to measure. This second component (error variance) is integrated in the model, so that the latent variables are composed of only the variance shared by the indicators. Through modeling the error variance separately, the researcher has the opportunity to have perfectly reliable structural variables (Hatcher, 1994).

In this study, a structural model for the overall sample, using the two-step approach mentioned above, was developed first. This model allowed studying the relative importance of variables as well as their direct and indirect effect on the outcome variable for the overall sample. Then, this overall model was estimated for students from different racial backgrounds and for students in schools with different demographic characteristics. Comparison of results

from model estimations for these groups allowed investigation of differential functioning of the model parameters for these groups.

To identify the demographic characteristics of schools with the lowest and the highest average of math course-taking, the sample was stratified by the three school demographic variables (urbanicity, minority concentration, and poverty concentration). Since these three variables had three levels each, a total of twentyseven ( $3 \times 3 \times 3$ ) sampling cells were created. Then, the cells with the lowest and the highest average of math course-taking were selected for comparison.

Consequently, the present study included multi-sample analyses for different races as well as for groups of students in the sampling cells with the lowest and the highest average of math course-taking. The purpose of such analysis is to determine whether or not components of the measurement model, the structural model, or both are invariant (i.e., equivalent) across groups. The first step is to see if the covariance matrix across groups is the same; that is, there are no statistically significant differences among corresponding elements of the covariance matrix. Almost all of the time, the covariance matrix is not the same across groups. The rest of the multi-sample analysis involves testing a series of hypotheses, from the least restrictive to the most restrictive. The first hypothesis is that the number of factors is the same across groups. The second is that not only the number of factors is the same but also the factor loadings are invariant across groups. The third is that not only the number of factors and the factor loadings are the same but also the error variances are the same across groups. The final hypothesis is that the number of factors, factor loadings, error variances, and the factor variances and covariances are the same across groups. Each successive hypothesis assumes the acceptability of the previous one. In the case of the rejection of any hypothesis along the sequence, there is usually no need to test subsequent hypotheses (Joreskog and Sorbom, 1996).

For descriptive analyses and for creation of correlation matrices, standard deviations, and means to be used in structural equation model estimations, SPSS 7.5 (SPSS Inc., 1996) computer program was used. For structural equation model estimations, LISREL 8.30/PRELIS 2.30 computer software (Joreskog and Sorbom, 2000) was employed.

## CHAPTER IV

### RESULTS

The chapter starts with an exploration of the outcome variable (math course-taking) by major demographic variables. Namely, these variables are gender, race, high school program the student is in, and the urbanicity, minority concentration, and poverty concentration of the school the student attends. The second part discusses estimations of various structural equation models and multisample analyses for the subgroups under investigation. This part is presented in a narrative style to allow the reader follow the decisions made in the face of the findings at each step of the analysis. All results presented in this chapter come from data analyses, where the sample was 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.

#### **Math Course-taking by Major Demographic Variables:**

Number of math courses taken by gender is given in Table 1. The mean difference between males and females was not statistically significant,  $t(349758) = -.939$ ,  $p = .348$ . As mentioned earlier, based on the finding that the mean difference between males and females was not significant, gender was excluded from the list of variables to be investigated in the study.

Table 1

#### Number of Math Courses Taken by Gender

Gender	<u>M</u>	<u>SD</u>	<u>n</u>
Male	1.69	1.11	977
Female	1.69	1.12	1068

Means and standard deviations are weighted; sample sizes are not weighted.

Number of math courses taken by race is given in Table 2. Asian/Pacific Islanders take significantly higher numbers of math courses than all other racial groups ( $p < .001$ ). Whites take significantly higher numbers of math courses than African Americans and Hispanics ( $p < .001$ ). There is no statistically significant mean difference between African Americans and Hispanics ( $p = .149$ ).

Table 2

Number of Math Courses Taken by Race

Race	<u>M</u>	<u>SD</u>	<u>n</u>
White	1.72	1.10	1638
Asian/Pacific Islander	2.29	1.02	153
African-American	1.33	1.15	116
Hispanic	1.30	1.05	130

Means and standard deviations are weighted; sample sizes are not weighted.

Number of math courses taken by high school program is given in Table 3. Students in academic programs take significantly higher numbers of math courses than students in general or vocational programs ( $p < .001$ ). Students in general high school programs take significantly higher numbers of math courses than students in vocational programs ( $p < .001$ ).

Table 3

Number of Math Courses Taken by High School Program

Program	<u>M</u>	<u>SD</u>	<u>n</u>
Academic	2.18	0.92	1102
General	1.27	1.04	713
Vocational	0.71	0.95	230

Means and standard deviations are weighted; sample sizes are not weighted.

The school demographic variables (urbanicity, minority concentration, and poverty concentration) were entered in a three-way ANOVA to see if the interactions between/among them were significant and to detect the strata where math course-taking was highly different from the rest of the strata (i.e., the strata with the highest and the lowest numbers of math courses taken). There was a significant three-way (urbanicity x minority concentration x poverty concentration) interaction,  $F(6, 349785) = 737.22, p < .001$ . Simple main effects were not investigated, since the intent was to see if there was a significant three-way interaction and then to identify the strata for which separate structural equation models would be estimated for comparison purposes. However, in Table 4, means and standard deviations of number of math courses taken for each of these variables are given for descriptive purposes. Table 5 presents the means and standard deviations of the number of math courses taken for each of the cells created by stratification of the three school demographic variables.

Table 4

Number of Math Courses Taken by School Demographic Variables

		<u>M</u>	<u>SD</u>	<u>n</u>
Urbanicity	Urban	1.61	1.10	326
	Suburban	1.73	1.08	1141
	Rural	1.65	1.18	578
Minority Concentration	0-5%	1.73	1.12	847
	6-20%	1.76	1.09	655
	21-100%	1.55	1.11	543
Poverty Concentration	0-5%	1.78	1.02	582
	6-20%	1.77	1.10	769
	21-100%	1.52	1.18	694

Means and standard deviations are weighted; sample sizes are not weighted.

Table 5

Number of Math Courses Taken by School Demographic Variables (Stratified)

		0-5% Minority			6-20% Minority			21-100% Minority		
		0-5% Poor	6-20% Poor	21-100% Poor	0-5% Poor	6-20% Poor	21-100% Poor	0-5% Poor	6-20% Poor	21-100% Poor
Urban	M	2.55	1.93	--	1.57	1.94	1.97	1.47	1.98	1.16
	SD	0.60	0.99	--	1.13	1.07	0.94	0.99	0.93	1.08
	n	9	29	0	29	41	16	9	59	134
Suburban	M	1.79	1.65	1.47	1.94	1.91	1.49	1.40	1.78	1.71
	SD	0.99	1.16	1.33	0.98	0.94	1.18	0.96	0.99	1.17
	n	229	209	58	195	131	72	63	58	126
Rural	M	1.32	1.81	1.79	1.25	1.45	1.56	2.03	--	1.49
	SD	1.14	1.12	1.16	1.16	1.23	1.19	1.27	--	1.15
	n	31	172	110	7	70	94	10	0	84

Means and standard deviations are weighted; sample sizes are not weighted.

After examination of the cell means in Table 5, two cells were selected for comparison in terms of the relationships between the student-level variables, investigated in the context of structural equation modeling. The first one was suburban with 6-20 % minority and 0-5 % poor. The second one was urban with 21-100 % minority and 21-100 % poor. The means for these two cells were 1.94 and 1.16, respectively. These two were decided to be the ones with the highest and the lowest number of math courses taken, respectively. Although there were cells with higher means than the one selected as the highest [e.g., urban with 0-5 % minority and 0-5 % poor ( $M = 2.55$ )], their cell frequencies were unacceptably small in terms of their representativeness and in terms of sample size required for structural equation modeling. Comparison between the two cells in the context of structural equation modeling is explained later in this chapter.

### **Structural Equation Modeling:**

In all analyses in the context of structural equation modeling, all variables were treated as continuous. Although it is recommended that the indicator variables have a minimum of four values to be treated as continuous (Hatcher, 1994), the variables in this study with three levels were also treated as continuous with the assumption of an underlying continuity for these variables.

### **Development of the Measurement Model:**

As illustrated in Figure 4-1, the initial measurement model consists of five constructs, each measured by three or four indicator variables, and three constructs, each measured by only one indicator variable. The survey items used to measure each variable in the model can be found in Appendix A. In this model, parental expectations and parental involvement were treated as two separate constructs, as suggested by the literature.

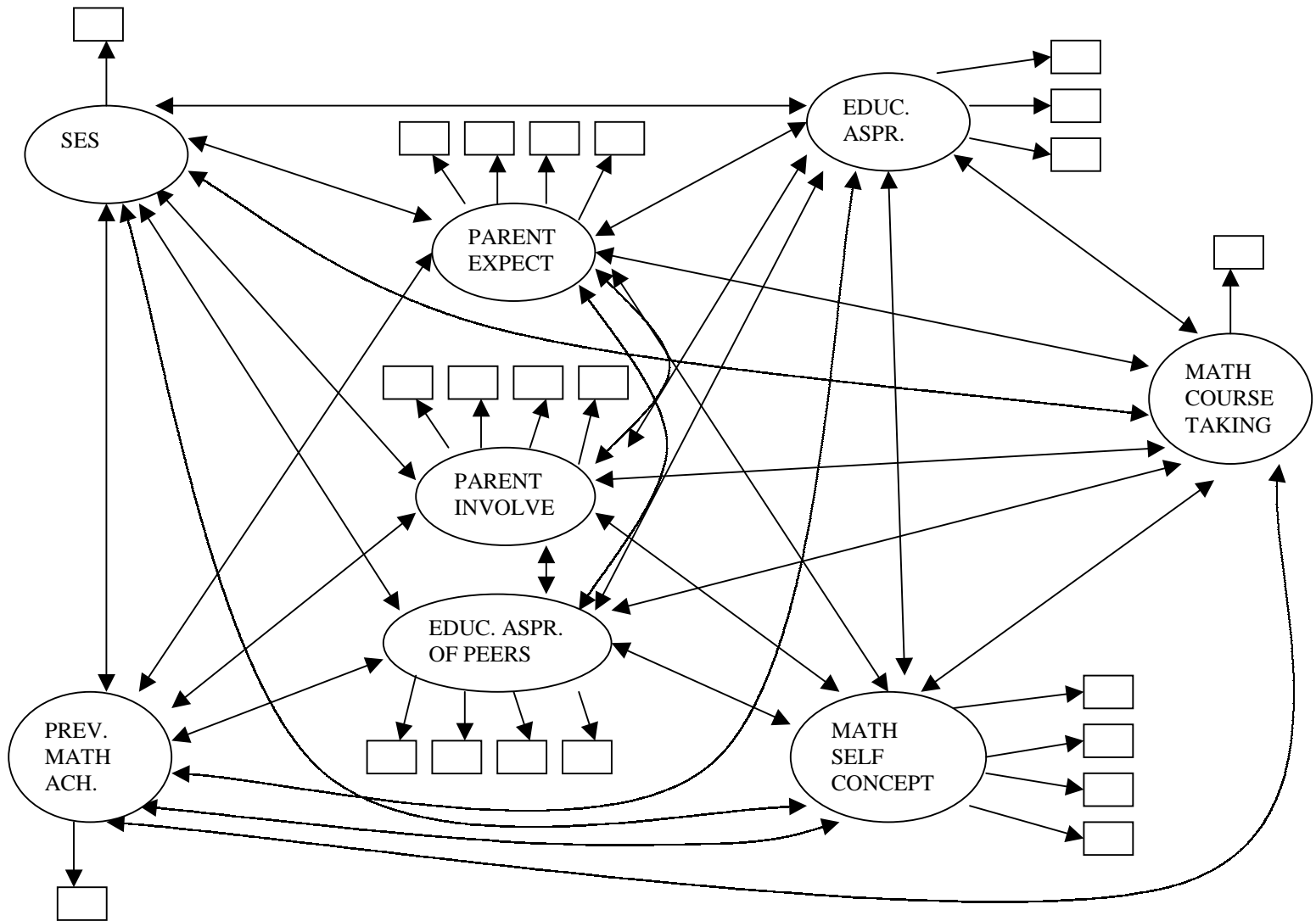


Figure 4-1. Initial Measurement Model

This initial model was estimated using the data ( $n = 2045$ ) after the seventh step of sample selection, explained in Chapter III. The sample size for the estimation was 1313, after listwise deletion of missing data in the sample. Results indicated multicollinearity between parental expectations and educational aspirations of the student. The completely standardized Phi value for these variables (the measure of the correlation between these constructs) was 1.10. Theoretically, a completely standardized Phi value of 1.00, the highest possible value, indicates a perfect correlation between any two constructs in the model. Therefore, a value of 1.10 was a strong indicator of multicollinearity. To verify this finding, factor scores for the two constructs were created through exploratory factor analysis and the bivariate correlation between the factor scores was examined. The resulting correlation coefficient was .797, again indicating a high correlation. High correlation between these constructs was also supported by previous literature that suggests a strong relationship between these variables. Since multicollinearity constitutes a problem in estimations of structural equation models, the decision was to not keep both constructs in the model. One other option was to treat parental expectations and parental involvement as a single construct, although the literature suggested that the relationship between the two be moderated by a number of variables. To check if such treatment was possible, the correlation between the two constructs was investigated. To this end, factor scores for both constructs were created through exploratory factor analysis and then the bivariate correlation between factor scores was calculated. The resulting correlation coefficient was .334. With such a low correlation, it was inappropriate to combine these two constructs into a single construct. Multicollinearity between parental expectations and educational aspirations of the student and avoiding treatment of parental expectations and parental involvement as a single construct resulted in excluding parental expectations from the model, while keeping parental involvement and educational aspirations of the student.

This second measurement model was estimated using complete data ( $n = 1661$ ) after listwise deletion of missing data in the sample. Results from the estimation of this second measurement model yielded a good fit. Although the Minimum Fit Function Chi-Square, a measure of overall fit of the model to the data, was 1269.39 with 117 degrees of freedom indicated a poor fit in the form of a significant difference ( $p = 0.0$ ) between the sample covariance matrix and the fitted covariance matrix, it is well known that this measure is highly sensitive to sample size and usually suggests a poor fit with large sample sizes. Other commonly

used fit indices, relatively less dependent on sample size, suggested a good fit of the model. Values of .90 and above for comparative fit index (CFI) and goodness of fit index (GFI) indicate a good fit. The values for this model were .90 and .92, respectively, suggesting a good fit. Values of .05 and below for standardized RMR indicate a good fit and the value for the model was .05, again suggesting a good fit. The maximum modification index suggested estimating a covariance between two error terms [maximum modification index = 455.08 for element (12,11) of theta-delta], which is theoretically inappropriate, unless there is good reason. With acceptable values of fit indices and all loadings significant at  $p < .05$  level, this model was decided to be the final measurement model. Figure 4-2 illustrates the final measurement model, Table 6 presents the factor loadings, and Table 7 gives the completely standardized phi matrix for the final measurement model.

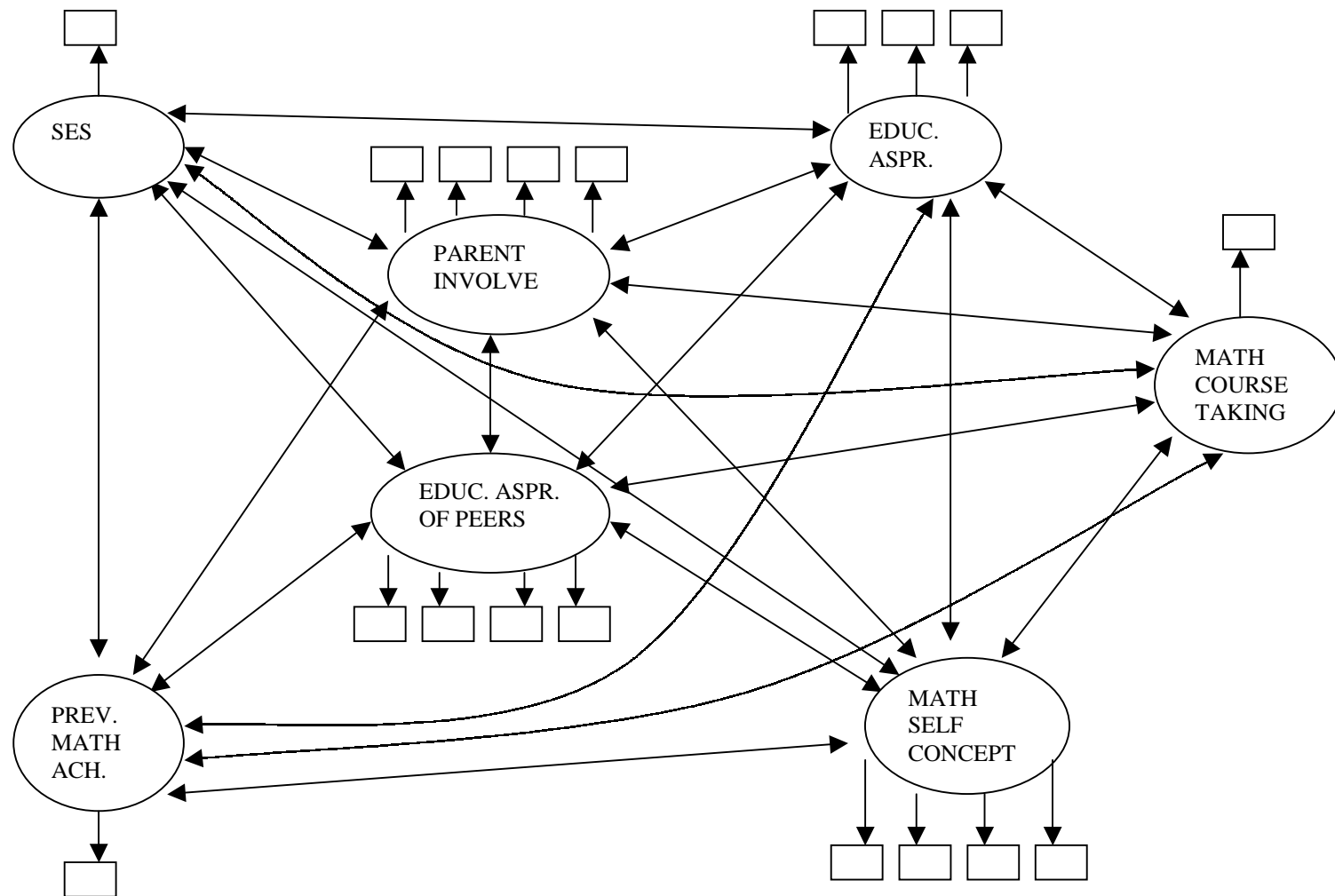


Figure 4-2. Final Measurement Model

Table 6

Factor Loadings for the Final Measurement Model

	Number of Math Courses Taken	Educational Aspirations of the Student	Math Self- Concept	Educational Aspirations of Peers	Parental Involvement	Previous Math Achievement	SES
TOTALMAT	1.00						
BYS45		.66					
F1S49		.78					
F2S43		.76					
F1S63D			.90				
F1S63J			.88				
F1S63Q			.90				
F1S63S			.69				
F1S70D				.66			
F1S70I				.73			
F2S68D				.42			
F2S68H				.47			
F1S105A					.47		
F1S105G					.57		
F2S99A					.50		
F2S99F					.64		
BY2XMSTD						1.00	
F2SES1							1.00

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

Table 7

Completely Standardized Phi Matrix for the Final Measurement Model

Construct	Number of Math Courses Taken	Educational Aspirations of the Student	Math Self-Concept	Educational Aspirations of Peers	Parental Involvement	Previous Math Achievement	SES
Number of Math Courses Taken	1.00						
Educational Aspirations of the Student	.62	1.00					
Math Self-Concept	.40	.31	1.00				
Educational Aspirations of Peers	.24	.43	.15	1.00			
Parental Involvement	.36	.64	.17	.46	1.00		
Previous Math Achievement	.59	.54	.40	.11	.26	1.00	
SES	.34	.51	.10	.15	.36	.41	1.00

### **Development of the Structural Model:**

After deciding on a final measurement model, the causal relationships among the constructs were specified in an initial structural model. The hypothesized relationships among the constructs, based on theory and previous research findings, are illustrated in Figure 4-3.

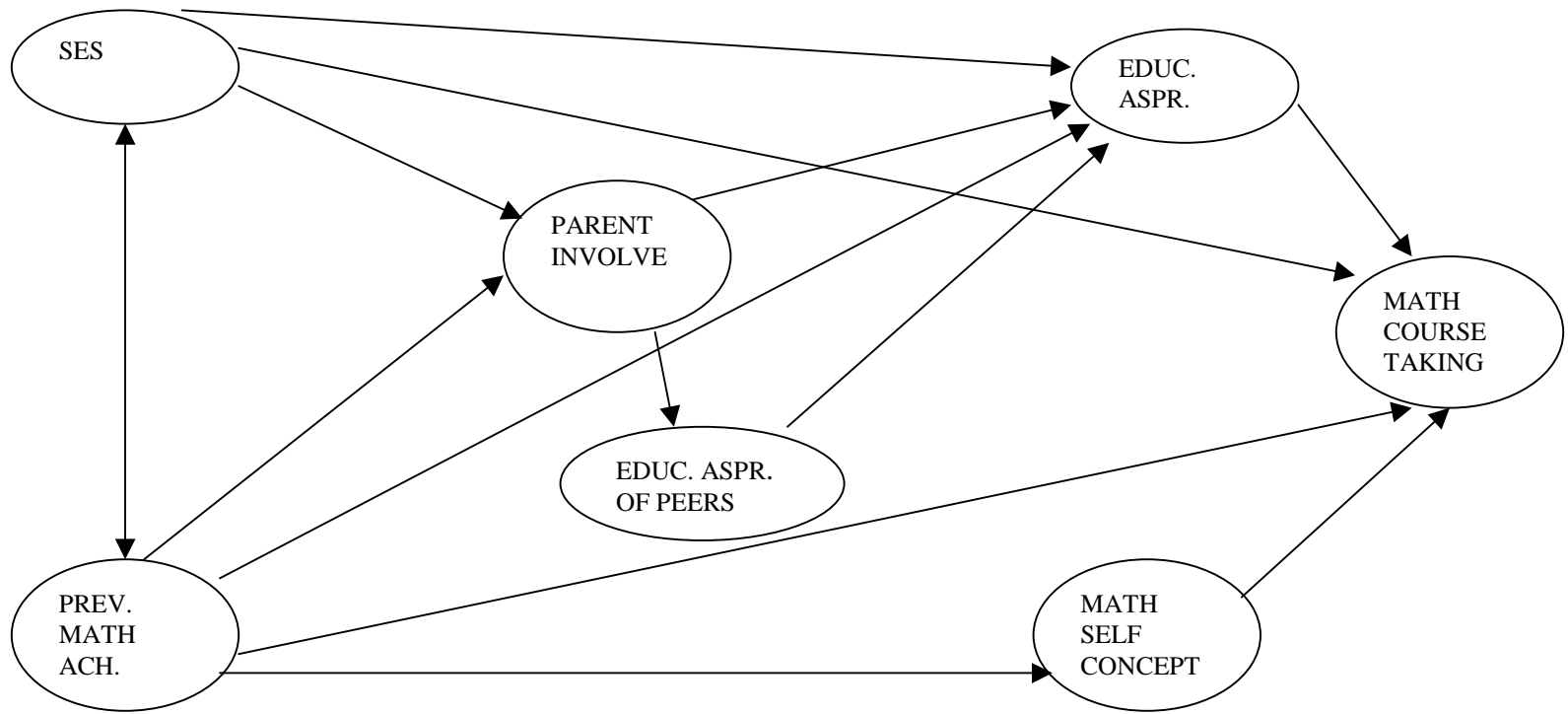


Figure 4-3. Initial Structural Model

This initial structural model was estimated using complete data ( $n = 1661$ ), after listwise deletion of missing data in the sample. Overall, results indicated a good fit. The Minimum Fit Function Chi-Square was 1312.55 with 125 degrees of freedom, indicating a poor fit in the form of a significant difference ( $p = 0.0$ ) between the sample covariance matrix and the fitted covariance matrix. However, it has already been stated that this measure is highly sensitive to sample size and usually suggests a poor fit with large sample sizes. Other fit indices suggested a good fit of the model. Comparative fit index (CFI) and goodness of fit index (GFI) were .90 and .92, respectively. Standardized RMR was .06, again suggesting an acceptable fit. The maximum modification index suggested estimating a covariance between two error terms [maximum modification index = 455.73 for element (12,11) of theta-epsilon], which is theoretically inappropriate, unless there is good reason. The factor loadings were the same as they were for the final measurement model. The directions and magnitudes of path coefficients, representing the hypothesized relationships between the constructs, were in accord with theory and previous research findings. A chi-square difference test was performed to see whether the structural model efficiently explains the relationships between the constructs. If the structural model does as good a job explaining these relationships as the measurement model does, the chi-square difference between the two models should be nonsignificant. The difference between the chi-square values for the measurement model and the structural model was 43.16. The difference in degrees of freedom was 8. With 8 degrees of freedom, the critical value of chi-square is 26.125 at  $p < .001$ . The chi-square difference between the models was greater than the critical value, indicating that the difference was significant. This result suggested that the structural model did not explain the relationships between the constructs as good as the measurement model did. However, this finding might, again, be due to the large sample size and should be considered together with other indicators of goodness of fit. With all other indicators suggesting a good fit and the small chi-square difference compared to the magnitudes of the chi-square values for the measurement and the structural model, this model was decided to be the final structural model. Total, direct, and indirect effects for the final structural model are given in Table 8. The correlation between SES and previous math achievement was .41 for the overall sample.

Table 8

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

		Previous Math Achievement	SES	Parental Involvement	Educational Aspirations of Peers	Math Self- Concept	Educational Aspirations of the Student
Parental Involvement	Total	.14*	.30*	--	--	--	--
	Direct	.14*	.30*	--	--	--	--
	Indirect	--	--	--	--	--	--
Educational Aspirations of Peers	Total	.06*	.14*	.46*	--	--	--
	Direct	--	--	.46*	--	--	--
	Indirect	.06*	.14*	--	--	--	--
Math Self- Concept	Total	.40*	--	--	--	--	--
	Direct	.40*	--	--	--	--	--
	Indirect	--	--	--	--	--	--
Educational Aspirations of the Student	Total	.40*	.35*	.47*	.18*	--	--
	Direct	.33*	.21*	.39*	.18*	--	--
	Indirect	.07*	.14*	.08*	--	--	--
Number of Math Courses Taken	Total	.54*	.13*	.19*	.07*	.16*	.41*
	Direct	.32*	-.02	--	--	.16*	.41*
	Indirect	.23*	.14*	.19*	.07*	--	--

Standardized Total, Direct, and Indirect Effects.

\* indicates significance at  $p < .05$  level.

After deciding on a final structural model, multi-sample analyses were performed. The purpose of and the steps for multi-sample analysis have already been explained in Chapter III. There were two separate multi-sample analyses in this study. First one was for the races and the second one was for the two cells with the highest and the lowest numbers of math courses taken. Complete data, after listwise deletion of missing data, were used for racial groups and for the two cells. Sample sizes for racial groups were 1359, 75, 97, and 122 for Whites, African-Americans, Hispanics, and Asian-Pacific Islanders, respectively. Sample sizes for the cells with the highest math course-taking and the lowest were 162 and 86, respectively. At the first step, the most restrictive hypothesis that all elements of the covariance matrix were the same across groups was tested for both multi-sample comparisons. This hypothesis was rejected ( $p = 0.0$ ) for racial groups (Minimum Fit Function Chi-Square = 948.50 with 513 degrees of freedom). It was also rejected ( $p = 0.0023$ ) for the two cells (Minimum Fit Function Chi-Square = 228.08 with 171 degrees of freedom).

The second step in multi-sample analysis involves testing the least restrictive hypothesis that the number of factors is the same across groups. In the analysis for racial groups, the estimation did not converge. Estimation of the final structural model for Hispanics, which will be discussed later, did not converge due to problems in the theta-epsilon matrix (variance-covariance matrix of error components of indicator variables), either. Lack of convergence for Hispanics might be the primary reason why the estimation for the second step in multi-sample analysis for racial groups did not converge. The estimation for the two cells converged and indicated that the number of factors were not the same across these two groups, either (Minimum Fit Function Chi-Square = 351.17 with 168 degrees of freedom;  $p = 0.00$ ). In both multi-sample analyses, no further hypotheses were tested, since subsequent tests of hypotheses assume the truth of previous hypotheses. The finding that the number of factors was not the same across the highest and the lowest math course-taking groups might be due, in part, to correlated error variances, indicated by modification indices in the output for separate estimations of the final structural model for these groups, which will be discussed later. The maximum modification index for the highest math course-taking group was 37.08 for element (12,11) of theta-epsilon. The maximum modification index for the lowest math course-taking group was 40.28 for element (10,9) of theta-epsilon. These indices suggested that the error variances for these pairs of variables were not random and had shared variance. This shared variance, possibly suggesting

the existence of another factor, which is not specified in the model, might be the major reason for the finding that the number of factors was not the same across the two groups.

Upon receipt of results indicating that the number of factors was not the same across the highest and the lowest math course-taking groups, and being unable to test this hypothesis for racial groups, reliabilities of the latent variables used in the model were examined. Reliabilities of the latent variables for each group are given in Table 9. The coefficient alphas were high and similar across groups for educational aspirations of the student and math self-concept. They were within the acceptable range and similar across groups for parental involvement. The only latent variable with low reliabilities for some groups was educational aspirations of peers.

Following all the above findings about the measurement part of the final structural model for various groups, it was decided that separate estimations of the final structural model would be estimated for the groups and comparisons would be made among racial groups and between the two cells. Realizing the problems about measurement of the latent variables for some of the groups, interpretations and comparisons needed to be made with caution.

Table 9

Construct Reliabilities by Race and for the Highest and the Lowest Math Course-Taking Groups

Construct	White	Asian/ Pacific Islander	African- American	Hispanic	Low Math Course- Taking	High Math Course- Taking
Educational Aspirations of the Student	.75	.77	.79	.78	.73	.79
Math Self-concept	.91	.92	.88	.90	.86	.91
Educational Aspirations Of Peers	.69	.59	.47	.66	.70	.58
Parental Involvement	.65	.66	.65	.66	.69	.64

Coefficient alphas

The final structural model was estimated separately for each racial group. After listwise deletion of missing data, sample sizes for racial groups were 1359, 75, 97, and 122 for Whites, African-Americans, Hispanics, and Asian/Pacific Islanders, respectively. There were no problems in the estimation of the model for Whites and Asian/Pacific Islanders. The fit of the model was good for Whites (CFI = .90; GFI = .92; standardized RMR = .06). The fit was not so good for Asian/Pacific Islanders (CFI = .86; GFI = .83; standardized RMR = .10); however, the parameter estimates were all within acceptable range. There was one negative factor loading for educational aspirations of peers in the results for African-Americans. Having known that the coefficient alpha of this construct for African-Americans was significantly low (coefficient alpha = .47) and having received parallel results from the estimation of the structural model, it was decided that no interpretations, based on the results from the structural model estimation, would be made about this group. The estimation did not run for Hispanics and gave error, indicating that the theta-epsilon matrix was not positive definite. Therefore, no interpretations, based on results from structural model estimation, were possible for this group. The major problem about this model estimation for African-Americans and Hispanics was the sample size. It was also a problem in terms of yielding a poor fit for Asian/Pacific Islanders, although the estimation ran smoothly and gave interpretable results for this group. For structural equation modeling technique, it is recommended that the minimum number of observations would be the larger of 150 observations or 5 observations per parameter to be estimated (Hatcher, 1994). Since the same model was estimated for all groups, ideally, the minimum sample size for each group would be 230 (5x 46). In sum, only the results for Whites and Asian/Pacific Islanders from the structural model estimations were compared. As explained later, bivariate correlations were used to examine the relationships between the constructs for African-Americans and Hispanics. Total, direct, and indirect effects for these two groups are given in Table 10. The correlation between SES and previous math achievement was .38 and .31 for Whites and Asian/Pacific Islanders, respectively.

Table 10

## Total, Direct, and Indirect Effects for Whites and Asian/Pacific Islanders

			Previous Math Achievement	SES	Parental Involvement	Educational Aspirations of Peers	Math Self- Concept	Educational Aspirations of the Student
Parental Involvement	White	Total	.15*	.31*	--	--	--	--
		Direct	.15*	.31*	--	--	--	--
		Indirect	--	--	--	--	--	--
	Asian/Pacific Islander	Total	.07	.39*	--	--	--	--
		Direct	.07	.39*	--	--	--	--
		Indirect	--	--	--	--	--	--
Educational Aspirations of Peers	White	Total	.07*	.14*	.46*	--	--	--
		Direct	--	--	.46*	--	--	--
		Indirect	.07*	.14*	--	--	--	--
	Asian/Pacific Islander	Total	.02	.14	.35*	--	--	--
		Direct	--	--	.35*	--	--	--
		Indirect	.02	.14	--	--	--	--
Math Self- Concept	White	Total	.43*	--	--	--	--	--
		Direct	.43*	--	--	--	--	--
		Indirect	--	--	--	--	--	--
	Asian/Pacific Islander	Total	.32*	--	--	--	--	--
		Direct	.32*	--	--	--	--	--
		Indirect	--	--	--	--	--	--
Educational Aspirations of the Student	White	Total	.41*	.38*	.47*	.18*	--	--
		Direct	.35*	.23*	.39*	.18*	--	--
		Indirect	.07*	.14*	.08*	--	--	--
	Asian/Pacific Islander	Total	.33*	.20*	.41*	.12	--	--
		Direct	.30*	.04	.37*	.12	--	--
		Indirect	.03	.16*	.04	--	--	--
Number of Math Courses Taken	White	Total	.56*	.13*	.19*	.07*	.16*	.40*
		Direct	.32*	-.02	--	--	.16*	.40*
		Indirect	.23*	.15*	.19*	.07*	--	--
	Asian/Pacific Islander	Total	.28*	.07	.22*	.06	.03	.54*
		Direct	.09	-.04	--	--	.03	.54*
		Indirect	.19*	.11*	.22*	.06	--	--

Standardized Total, Direct, and Indirect Effects.

\* indicates significance at  $p < .05$  level.

The final structural model was also estimated separately for the highest and the lowest math course-taking groups. After listwise deletion of missing data, sample sizes for the highest and the lowest math course-taking groups were 162 and 86, respectively. There were no problems in the estimation of the model for the two groups. The fit of the model was not so good for the highest group (CFI = .88; GFI = .84; standardized RMR = .09). The fit was not so good for the lowest group, either (CFI = .84; GFI = .79; standardized RMR = .11); however, the parameter estimates were all within acceptable range. Again, it is likely that sample size played an important role in getting these poor fits of the model. However, the results from model estimations were used for comparison between the two groups, since the estimated values of parameters were within acceptable range and these values were not totally unexpected. Total, direct, and indirect effects are given in Table 11. The correlation between SES and previous math achievement was .33 and .24 for the highest and the lowest math course-taking group, respectively.

Table 11

## Total, Direct, and Indirect Effects for the Highest and the Lowest Math Course-Taking Groups

			Previous Math Achievement	SES	Parental Involvement	Educational Aspirations of Peers	Math Self-Concept	Educational Aspirations of the Student
Parental Involvement	High Math Course-Taking	Total	.24*	.27*	--	--	--	--
		Direct	.24*	.27*	--	--	--	--
		Indirect	--	--	--	--	--	--
	Low Math Course-Taking	Total	.01	.19	--	--	--	--
		Direct	.01	.19	--	--	--	--
		Indirect	--	--	--	--	--	--
Educational Aspirations of Peers	High Math Course-Taking	Total	.11*	.13*	.49*	--	--	--
		Direct	--	--	.49*	--	--	--
		Indirect	.11*	.13*	--	--	--	--
	Low Math Course-Taking	Total	.00	.08	.41*	--	--	--
		Direct	--	--	.41*	--	--	--
		Indirect	.00	.08	--	--	--	--
Math Self-Concept	High Math Course-Taking	Total	.41*	--	--	--	--	--
		Direct	.41*	--	--	--	--	--
		Indirect	--	--	--	--	--	--
	Low Math Course-Taking	Total	.35*	--	--	--	--	--
		Direct	.35*	--	--	--	--	--
		Indirect	--	--	--	--	--	--
Educational Aspirations of the Student	High Math Course-Taking	Total	.48*	.28*	.54*	.15	--	--
		Direct	.36*	.14	.47*	.15	--	--
		Indirect	.13*	.15*	.07	--	--	--
	Low Math Course-Taking	Total	.33*	.41*	.67*	.09	--	--
		Direct	.32*	.28*	.64*	.09	--	--
		Indirect	.01	.12	.04	--	--	--
Number of Math Courses Taken	High Math Course-Taking	Total	.37*	.18*	.20*	.06	.27*	.37*
		Direct	.09	.07	--	--	.27*	.37*
		Indirect	.29*	.10*	.20*	.06	--	--
	Low Math Course-Taking	Total	.52*	.10	.36*	.05	.35*	.53*
		Direct	.22*	-.12	--	--	.35*	.53*
		Indirect	.30*	.22*	.36*	.05	--	--

Standardized Total, Direct, and Indirect Effects.

\* indicates significance at  $p < .05$  level.

To see the factor means for groups, indicator variables for each latent variable in the model were summed up and their means for each group were calculated. Means of their single indicator variables were used for the constructs that were measured by only one indicator in the model. Factor means for each group in the study are given in Table 12, only for descriptive purposes.

Since the results from model estimations for African-Americans and Hispanics could not be used in comparisons between racial groups, only bivariate correlations between the constructs for these two groups were examined. Bivariate correlations between constructs, which are the correlations between the factor means given in Table 12, are presented for African-Americans and Hispanics in Table 13. Being aware of the measurement problems in some constructs for these groups, a large margin for measurement error was kept in mind and only large differences were used for interpretation.

Table 12

Observed/Latent Variable Means by Race and for the Highest and the Lowest Math Course-Taking Groups

Construct		White	Asian/ Pacific Islander	African-American	Hispanic	Low Math Course-Taking	High Math Course-Taking
Number of Math Courses Taken *	M	1.72	2.29	1.33	1.30	1.16	1.94
	SD	1.10	1.02	1.15	1.05	1.08	0.98
Educational Aspirations Of the Student**	M	19.54	21.72	19.47	18.95	19.30	20.72
	SD	3.92	3.16	4.04	4.58	3.78	3.49
Math Self-Concept**	M	16.81	18.45	15.96	17.12	16.55	15.76
	SD	5.91	5.62	5.38	5.62	5.30	5.94
Educational Aspirations Of Peers **	M	9.83	10.27	9.94	9.94	9.95	9.88
	SD	1.77	1.58	1.55	1.67	1.81	1.61
Parental Involvement **	M	8.70	8.69	8.72	8.57	8.50	9.16
	SD	1.74	1.83	1.63	1.89	1.88	1.64
Previous Achievement *	M	54.69	57.78	46.66	48.84	49.02	57.92
	SD	9.84	10.58	7.34	8.51	9.66	9.53
SES*+	M	0.29	0.45	-0.19	-0.31	-0.06	0.62
	SD	0.67	0.82	0.69	0.75	0.71	0.63

\* Mean and standard deviation of the observed variable. (For details on the observed variable, see Appendix A)

\*\* Mean and standard deviation of the sums of the indicator variables. (For details on indicator variables, see Appendix A)

+ SES is a composite variable, an average of five standardized indicators: parents' education, parents' occupation, and family income. (For details, see Appendix A)

Table 13

Correlations between Observed /Latent Variable Means for African-Americans and Hispanics

Construct		Number of Math Courses Taken	Educational Aspirations of the Student	Math Self- Concept	Educational Aspirations of Peers	Parental Involvement	Previous Math Achievement	SES
Number of Math Courses Taken	African-American	1.00						
	Hispanic							
Educational Aspirations of the Student	African-American	.50	1.00					
	Hispanic	.53						
Math Self- Concept	African-American	.13	-.07	1.00				
	Hispanic	.48	.37					
Educational Aspirations of Peers	African-American	.21	.44	.05	1.00			
	Hispanic	-.02	.12	.20				
Parental Involvement	African-American	.40	.39	.19	.38	1.00		
	Hispanic	.17	.36	.13	.08			
Previous Math Achievement	African-American	.57	.37	.03	.17	.32	1.00	
	Hispanic	.59	.52	.32	.04	.18		
SES	African-American	.30	.34	-.03	-.05	.31	.37	1.00
	Hispanic	.33	.40	.07	-.21	.23	.47	

Bivariate Pearson Product Moment Correlation Coefficients.  
All correlations were significant at  $p < .05$  level.

## CHAPTER V

### CONCLUSIONS

This chapter starts with a summary of findings, followed by implications of these findings for educational policy and practice. The chapter proceeds with a discussion of limitations and delimitations of the study. Recommendations for future research conclude the chapter.

#### **Summary of Findings:**

##### **Descriptive findings:**

At the first step of data analysis, the outcome variable (number of math courses taken) was explored by major demographic variables. No significant difference between males and females was found in terms of math course-taking. This finding is consistent with recent empirical findings (e.g., Legum, et al., 1998) that the gender gap in high school math course-taking, that was once there, has disappeared.

There were significant differences among racial groups in terms of math course-taking. Asian/Pacific Islanders take significantly higher numbers of math courses than all other racial groups. Number of courses taken by Whites was significantly higher than the number of courses taken by African-Americans and Hispanics. There was no significant difference between African-Americans and Hispanics. These findings are consistent with recent research findings (e.g., Green, et al., 1995) that the differences among races continue to exist in favor of Asian/Pacific Islanders and Whites, although the gap had somewhat narrowed.

There were large differences among high school programs in terms of math course-taking, indicating a significant effect of program and course placement practices in schools. This finding was not further explored, since it was related to structural characteristics of schools, which were not an area of inquiry in this study. Yet, it provides support for previous findings

(e.g., Oakes, et al., 1992; Schmidt, et al., 1999) that tracking is largely influential on the type and amount of content students are exposed.

There was a significant three-way interaction of urbanicity, minority concentration, and poverty concentration of schools for math course-taking. An examination of means for cells in Table 5 also points to the fact that unique combinations of levels of these three demographic variables result in differences in math course-taking that need further exploration. For example, the lowest level of math course-taking in urban settings belongs to students in schools with 21-100 % minority and 21-100 % poverty. However, in rural settings, the number of math courses taken generally increases as minority and poverty concentration of the school increases. These findings can only be fully interpreted in the light of sociological theories and with knowledge of cultural and social characteristics of each of these unique settings. The demographic characteristics of the sample with the lowest level of math course-taking coincide with the ones identified in previous research. Students in high minority, high poverty urban schools are having problems in many areas of their education and course-taking, especially at the advanced level, is only one of these areas (Lippman, et al., 1996). The identification of the highest math course-taking group in this study at least does not contradict with previous research findings that seem to be mixed about advanced level math course-taking by urbanicity.

### **Findings from structural equation modeling:**

**Measurement model.** During the development of the final measurement model, a very high positive correlation was found between parents' educational expectations from 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 and 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 overgeneralization of this large influence to all aspects of adolescent life may not be correct.

The second finding during the development of the final measurement was that there was a low positive correlation between parental expectations and parental involvement. The literature (e.g., Lareau, 1987) suggests that the relationship between parental expectations and parental

involvement in the home is mediated by a number of parental characteristics, such as their educational capabilities, amount of time, money, and other resources available to them to involve in their children's schooling and education. Therefore, such low correlation can be explained, in part, by the availability of these resources. Another factor may be that parental influence takes place in the form of implicit and subtle transmission of values and norms (Biddle, et al., 1980). Yet, transmission and reinforcement of these values and norms is sustained over a long time. This type of influence is in contrast with the peers', which takes place through role modeling. Therefore, there may not be a strong relationship between expectations and involvement, even for parents with high expectations. Parallel to this idea, Steinberg, et al. (1992) claimed that the way parents express their involvement and encouragement might be as important as to what extent they get involved.

**Structural model.** SES and math achievement, which served as background variables in the model, were found to be correlated moderately. The correlation between the two for the overall sample was .41. White (1982), in his meta-analytic review, found the correlation between SES and math achievement at the individual level to be .197. This coefficient was .697 when aggregate units of analysis, such as schools, were used. Since the model in the present study was not multi-level, where school-level covariance between the two variables would be separately estimated simultaneously, the coefficient of .41 also represents the school-level covariance beside student-level covariance and is within the expected range. Substantially, this correlation indicates that the combination of parents' education, type of occupation, and income has an effect on adolescents' math achievement. The ways in which these factors make a difference have already been discussed in Chapter II.

The literature suggested that the extent to which parents know implicit norms in the society is critical in using their financial and educational resources for their children's academic achievement. It is said that members of the majority group are more aware of these norms and are more successful than minorities in employing their resources for their children's educational achievement. A review of the relationship between SES and math achievement can be found in Chapter II. The strength of the relationship was comparable across the groups. It was .38, .31, .37, and .47 for Whites, Asian/Pacific Islanders, African-Americans, and Hispanics, respectively and .33 for the highest math course-taking group. The only group for which it was relatively weak was the lowest math course-taking group (.24). Although it needs further research, this

finding points to the importance of environmental factors. Put differently, the conditions in the neighborhood/community may limit the use of family resources for educational purposes. A major factor in this context would be the quality of schooling in high-poverty urban schools. The overall attitude toward schooling and the value assigned to education by the community deeply affect the quality of schools in the neighborhood. Moreover, it is known that schools in these settings are having greater difficulty in many areas, such as financial resources and hiring teachers (Lippman, et al., 1996).

SES was found to have a moderate positive effect on parental involvement. The path coefficient was .30 for the overall sample and was comparable across races. It was .31 and .39 for Whites and Asian/Pacific Islanders, respectively. The bivariate correlation between SES and parental involvement for African-Americans and Hispanics was .31 and .23, respectively. The path coefficient was .27 for the highest math course-taking group and it was significant at  $p < .05$  level. Again, the only group for which the coefficient was relatively low was the lowest math course-taking group (.19) and it was nonsignificant at  $p < .05$  level. Literature (e.g., Fordham, 1988; Ogbu, 1990) suggests that minorities living in high-poverty urban settings perceive racial barriers for success and have developed resentment toward academic success. On the other hand, it is crucial that parents see education as a means for "upward social mobility" to get involved in their children's schooling and encourage them for further educational attainment (Muller and Kerbow, 1993). Therefore, these perceived barriers may be an important factor for minorities living in high-poverty urban settings. For Whites living in these areas, the psychological distance between parents and schools due to large school sizes and bureaucracy, the fast pace of life in big cities, single-parent families are among the possible causes for this relatively small effect of SES on parental involvement. In sum, a weaker relationship between SES and parental involvement was expected and found for this group.

SES was found to have a small to moderate direct effect on students' educational aspirations for the overall sample (.21). It was .23 for Whites. However, the effect was much smaller for Asian/Pacific Islanders at .04. Considering that Asian/Pacific Islanders have the highest educational aspirations (see Table 12 for factor means), it can be said that regardless of their SES, this group has, on average, high educational aspirations. Probably, this finding is related to how Asian/Pacific Islanders view education. Although there is no evidence from the present study, it is likely that this group perceives education as an important means for social and

occupational advancement. One shortcoming of this study is that perceived utility of mathematics for future plans could not be integrated in the study, since items related to this construct were only asked to students who had taken advanced math courses, but not to those who had not taken these courses. Future research in this area should consider integrating this construct in the study design. The bivariate correlation between SES and students' educational aspirations was .34 and .40 for African-Americans and Hispanics, respectively. The direct effect of SES on students' educational aspirations was .28 for the lowest math course-taking group and .14 (nonsignificant at  $p < .05$  level) for the highest math course-taking group.

A key relationship in this study was the one between SES and math course-taking. A major question was whether SES would still have a significant direct effect on math course-taking, after its indirect effects through the variables in the model were taken into account. For the overall sample, the direct effect of SES on math course-taking was -.02, which was nonsignificant at  $p < .05$  level. 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. However, it may still be true that parents with high SES and/or from the dominant culture use their cultural resources to have themselves welcomed by schools and acquire crucial information about course placements (Lareau, 1987). Such action by parents reflects a great deal of parental involvement and in turn, may result in their children's proper and timely course-taking. When the total indirect effect is partitioned into its components, .09 belongs to the indirect path from SES to educational aspirations of the student to math course-taking. .05 belongs to the indirect path from SES to parental involvement to educational aspirations of the student to math course-taking; and only .01 belongs to the path from SES to parental involvement to educational aspirations of peers to educational aspirations of the student to math course-taking. This partition points to the importance of students' having high educational aspirations. It also emphasizes the importance of parental involvement as a means of raising students' educational aspirations, which would, in turn, result in more advanced level math course-taking. These results also support previous findings (e.g., Davies and Kandel, 1981) that parental influence on educational aspirations of the student is much stronger than peer influence and this influence does not decline over adolescent years.

For Whites and Asian/Pacific Islanders, the magnitudes of the coefficients making up the indirect effect were similar to those for the overall sample. However, the indirect effect of SES

on math course-taking was higher for the lowest math course-taking group (.22) than it was for the highest math course-taking group (.10). It was also higher than the ones for Whites (.15) and for Asian/Pacific Islanders (.11). This difference comes, for the most part, from the larger magnitudes of path coefficients for the lowest math course-taking group from parental involvement to educational aspirations of the student and from educational aspirations of the student to math course-taking. These findings point to the importance of parental involvement for this group. This result was also expected since the students in these settings do not get any support or encouragement from their neighborhood/community to attain a good education. Lack of institutions in these settings which would provide students with contact with positive role models has been identified as a problem for students in high-poverty urban schools (Lippman, et al., 1996). Insufficient counseling services in large schools with bureaucracy also add to this disadvantage. In sum, parental involvement appears as a productive way of raising students' educational aspirations, and in turn, their math course-taking for this group. Combined with a previous finding in this study, these findings may be interpreted from a different point of view for minorities in these settings. These interpretations need further and stronger evidence. Having found that SES has the smallest direct effect on parental involvement for the lowest math course-taking group and that parental involvement has the largest effect on students' educational aspirations, and in turn, their math course-taking, the critical relationship in this scheme becomes the one between SES and parental involvement. Parental involvement for this group is not parallel to parents' educational and financial resources, even though the mean SES for this group is around the national average. For minorities in this group, this may be due to the perceptions of racial barriers for success mentioned earlier. On the other hand, if these perceptions are mitigated and parents get involved at the rate of their resources, then such involvement is likely to have significant positive effects on students' aspirations and math course-taking.

The effect of previous math achievement on parental involvement was found to be small (.14) for the overall sample. Please note that parental involvement in the present study was measured as the frequency of students' discussing with their parents courses/programs in school and going to college. Therefore, this effect can be perceived as the level of parental encouragement of their children for a better educational attainment in high school as well as for furthering their education to college. This effect was .15 for Whites and .07 (nonsignificant at  $p < .05$  level) for Asian/Pacific Islanders. The bivariate correlation for African-Americans and

Hispanics was .32 and .18, respectively. It was .24 for the highest math course-taking group. There was no effect of previous math achievement on subsequent parental involvement for the lowest math course-taking group (.01; nonsignificant at  $p < .05$  level). Although there was some encouragement by parents based on their children's achievement for other groups, this indicates relative indifference by parents of the lowest math course-taking group towards their children's academic achievement. This finding is in accord with the previous findings discussed in the previous paragraph and supports the idea that parental involvement may play a crucial role in raising students' educational aspirations and number of math courses they take, if parents of this group get involved in their children's schooling sufficiently. The explanations given in the above paragraph as well as the tentative interpretation about minorities in this group are also valid about this finding.

The effect of previous math achievement on math self-concept was found to be moderate to large for the overall sample (.40). This effect was similar in magnitude for all groups except for African-Americans. It was .43 and .32 for Whites and Asian/Pacific Islanders, respectively; and .41 and .35 for the highest and the lowest math course-taking groups, respectively. The bivariate correlation between the two variables was .32 for Hispanics. These results were expected, since students shape their math self-concept based on their previous accomplishments in math. The only group for which the effect was almost nonexistent substantially was African-Americans. The bivariate correlation was .03. Matthews (1984) stated that previous research had found minorities to enjoy math, to have a positive attitude towards math, and to want to take more math courses, even though many of them had low achievement in math. She asserted that this finding was encouraging, since these students were not easily discouraged by poor performance. However, from a different point of view, previous findings, as well as the finding in the present study may also imply that the feedback mechanism by which students should form their math self-concept is not functioning well. Put differently, a false high self-confidence may not be as beneficial for these students, at least in the long run. It would be more useful for them to have a more realistic self-assessment of their math achievement, so they can seek assistance and compensate for any existing reasons for lower achievement. This finding needs further exploration; however, under normal circumstances, teachers are the primary people to make students realize their standing in academic subjects. It seems likely that these students need a

clearer feedback in the form of more definite evaluations of their performance, so that they may realize the consequences of poor performance for their future education.

The effect of math self-concept on math course-taking was found to be small (.16) for the overall sample. It was .16 for Whites and .27 and .35 for the highest and the lowest math course-taking groups, respectively. The bivariate correlation between the two variables was .13 and .48 for African-Americans and Hispanics, respectively. This effect was .03 (nonsignificant at  $p < .05$  level) for Asian/Pacific Islanders. Knowing that this group has the highest average number of math courses taken, it can be said that these students, on the average, continue to take advanced level math courses, even when they do not have much confidence in their math skills. Once again, perceived importance of math, and in particular advance level courses in math, is likely to play an important role in these students' perseverance in pursuing advanced math courses. As mentioned earlier, perceived utility of math could not be included in the study due to limitations of the database; therefore there is no evidence from the present study for the above claim. Future research may consider investigating it together with math self-concept.

The direct effect of previous math achievement on the number of math courses taken was found to be .32 for the overall sample. This effect was .32 for Whites and .09 (nonsignificant at  $p < .05$  level) for Asian/Pacific Islanders. It was .22 for the lowest math course-taking group and .09 (nonsignificant at  $p < .05$  level) for the highest math course-taking group. The bivariate correlation between the two variables was .57 and .59 for African-Americans and Hispanics, respectively. Since these bivariate correlations also reflect the indirect effect, it is understandable that they appeared higher than the direct effects based on structural equation modeling for other groups.

Results from previous research in this field are mixed. Marsh (1989) found that previous math achievement still had a significant effect on subsequent math course-taking, after taking into account the effect of math self-concept. Lantz and Smith (1981), however, had mixed results about the significance of the effect of previous math achievement on subsequent math course-taking, when several other variables were also entered in the analysis. A direct effect of previous achievement was still expected in this study above and beyond its indirect effect, since previous achievement, measured either by grades or standardized test scores, is a widespread criterion in high school math course placements (Useem, 1991; Oakes, et al., 1992).

It seems like the direct effect of previous achievement on math course-taking is smaller for Asian/Pacific Islanders and for the highest math course-taking group. Since there is a multitude of practices in course placements in high schools, it is difficult to determine the major reasons for this small effect for these groups. Another factor, still related to course placements, may be the extent to which students and/or their parents want to make sure that the students take advanced level courses, regardless of their previous achievement. In sum, it is, most likely, an interaction of parents' pressure for their children's taking advanced level courses and schools' flexibility in terms of rules and regulations for course placements.

### **Implications of Findings:**

Perhaps, the most important findings in this study were about parental involvement. Please note that the type of parental involvement investigated in this study was involvement in children's course-taking decisions and college plans. Therefore, findings about parental involvement and their implications can only be generalized to this type of involvement. Parental involvement was found to be strongly related to students' own educational aspirations, which, in turn, would lead to increase in students' advanced mathematics course-taking. This finding was true for the overall sample as well as the subgroups studied. More importantly, the results of the study suggest that parental involvement has a relatively strong relationship with educational aspirations of students who live in high-minority, high-poverty urban areas. However, these students, probably, do not receive sufficient support or encouragement from their parents. Findings, along with previous research, point to two possible factors causing a low level of involvement. First, due to their own life experiences and circumstances, parents of these students may not see education as a means for social and occupational advancement (Fordham, 1988; Ogbu, 1990). Second, they may not fully realize the importance of their involvement in their children's schooling. Regardless of the importance of these factors for different racial groups or individual families, it seems like it may be useful to enhance these parents' awareness of the importance of education for their children's future. Getting these parents as well as the students into contact with positive role models from the same racial background who have harvested fruits of education in terms of income and social prestige may be critical. To improve these parents' realization of the importance of their involvement for their children's schooling,

seminars, conferences, and group discussions can be organized for parents. These interventions are necessary but not sufficient steps for improving the quality of parental involvement. An equally important intervention is improving the quality of communication between the parent and the student and between the parent and teachers, counselors, administrators. Programs intended to teach parents and students why and how to communicate with each other more effectively may be a way of improving the quality of communication. All these interventions require systematic and sustained efforts by parents and the school personnel. An effective home-school interface with continued communication and feedback may prove useful.

A second important finding was that math self-concept of African-Americans was not related to their previous math achievement, whereas the two variables were moderately correlated for other groups. It is well known that individuals normally base their self-concept on their previous accomplishments, and this is true for any field of activity. In this respect, it is important for students to get objective feedback about their level of achievement along with support and encouragement for further effort. A false high self-confidence held by an underachieving student may be deceiving and may prevent the student from putting more effort to compensate his/her weakness in any given subject. On the opposite side, a successful student who does not get appraisal for his/her achievement may not continue to put effort in subsequent tasks. In sum, the lack of correlation between previous math achievement and math self-concept for African-American students implies that this feedback mechanism does not function healthily for these students. Within the context of schooling, teachers and counselors are the primary people to provide students with feedback about their performance. They should work with underachieving students more closely, providing more frequent feedback about their performance, and encourage them to put more effort. They should also appraise successful students and encourage them for continued effort. Although indirectly, this finding also supports previous findings that minority students were less informed about course placement practices in schools and, consequently, missed out on more opportunities to take advanced level courses than the members of the majority group. A major reason for the lack of such feedback seems to be the insufficient counseling services in schools, especially in the large and highly bureaucratized ones. However, teachers may play an important role in the absence of enough guidance by counselors. They may talk to students about the importance of their performance level in their

current courses for enrolling in subsequent advanced level courses. Such guidance is especially needed in math, where courses are sequential in nature.

### **Delimitations and Limitations of the Study:**

Since the source of the data was a national database (NELS: 88) and the overall sample selected from the NELS: 88 database was a nationally representative sample of 1988 8<sup>th</sup> graders, who graduated from high school four years later in Spring 1992, the results from the study can be generalized nationwide. However, as explained in Chapter III, the sample selection steps taken to control the school structural variables should be taken into account. These steps were necessary for the strength of the study design. To recapitulate the sample selection procedure, only students who did not change schools between 01-01-1988 and the second follow-up data collection (second semester of 12<sup>th</sup> grade) were selected. Only students in public schools, which offered the full set of courses that were of interest in this study and, required two years of math for graduation, were selected. Finally, only students who were either in a general or an academic or a vocational/technical program were selected. Therefore, the findings can only be generalized to students who match the above description. Such description, still, does not constitute a major limitation for the generalizability of results from this study to a large population.

An important phenomenon in generalizing findings from any study is nonresponse bias. Nonresponse bias occurs when there is a systematic difference between respondents and nonrespondents to survey items in terms of the variables investigated in the study. Such bias can only be explored through following up on either all nonrespondents or at least a random sample of nonrespondents and comparing the responses of respondents and nonrespondents. Since the data were not collected by the researcher in this study, it was impossible to follow up on nonrespondents. In sum, findings from this study can only be generalized to the population described above, assuming that there is no systematic difference between respondents and nonrespondents.

Perhaps, the major limitation of this study was small sample sizes for the subgroups investigated. Structural equation modeling is a large-sample analytic technique. As mentioned earlier, minimum number of observations recommended for estimation of the final structural model in this study was much larger than the ones used for the subgroups. Therefore, results for

these groups should be interpreted cautiously, even though the results for the groups were inspected carefully to see to it that the parameter estimates were within the expected and the acceptable range. Interpretations based on results from structural equation modeling were avoided when there was an indication of a possible problem in estimation.

A second limitation was the treatment of variables with three levels as continuous variables. As mentioned earlier, it is recommended that variables have at least four levels to be treated as continuous. Knowing that there was an underlying continuity for these variables, they were treated as continuous.

Another limitation was not including in the model variables that were found, by previous research, to be important in the context of math course-taking. A major variable that could not be included in the model due to limitations of the NELS: 88 database was perceived utility of mathematics. Inclusion of this variable in the model could have been useful for a better and fuller understanding of the relative importance of the variables as well as the relationships between them. There might be other variables not included in the model, but it is rarely the case in social sciences to investigate each and every variable related to a nontrivial outcome variable in the same study.

A minor limitation was the inability to control for the lower level math course offerings by schools. The offerings were almost totally controlled for the higher level offerings through selecting students in schools, which offered the full set of advanced math courses that were of interest in this study. However, an attempt to control for the lower level math course offerings would have significantly reduced the sample size.

Although it is not a limitation, the present study tried to explain only the relationships between the variables that were important at the student-level. Therefore, variance and covariance due to school-level or class-level variables were left unexplained and/or could not be separated from the variance/covariance at the student-level. Another approach to the study of math course-taking may be a multi-level analysis. An elaboration of such an approach can be found in the next "Recommendations" section.

A cautionary note about the causal inferences made in this study is necessary. Although structural equation modeling is a powerful analytic technique for the study of causal relationships in nonexperimental data, it certainly has limitations. The causal inferences made in this study based on the findings from structural equation modeling do not have the firmness and

rigor of a true experimental study. Bollen (1989) names the three components of the description of a cause as isolation, association, and the direction of influence and offers an in-depth discussion of each of these components. Briefly, isolation of the relationship between two variables from all other influences is necessary to be able to establish causality with absolute certainty. An example for misinterpretation of an association between two variables is spurious relationships, where the two variables thought to have a causal relationship, have a common cause, and are only correlated because of this third variable. The second condition is an association between the two variables, after these variables are isolated. Many times, the precision of the magnitude and significance of this association is jeopardized because of the assumptions made in statistical analyses. Finally, a relationship can be said to be causal only if the direction of causation is correct. For example, a variable that comes later in time cannot be the cause of another variable with temporal priority. The reader is referred to Bollen (1989) for an elaboration of causality, comparison between experimental and nonexperimental research, and possible threats to valid causal inferences in both experimental and nonexperimental research.

Experimental studies have major advantages over nonexperimental research in terms of meeting the conditions discussed above. However, many variables concerning human beings do not lend themselves to experimentation. For example, parental involvement, one of the variables in this study, cannot be manipulated in an experimental setting. For this reason, the overwhelming majority of social science research has been nonexperimental and many important policy decisions have been made based on accumulation of consistent findings by nonexperimental research efforts. Moreover, the relationships studied by social sciences are complex and absolute control over external variables is not possible. Therefore, causal inferences based on findings from experimental studies are true only to the degree of control over external influences.

As for the study of causal relationships through structural equation modeling using nonexperimental data, the purpose should be to seek support for a theoretical model derived from theory and previous research. In other words, the causal model should not be based on data. The models intended to explain the relationships between/among variables should continually be refined to reach a better understanding of the nature of these relationships. In this respect, if the causal inferences, still being in accord with theory and previous research, add to our understanding of the relationships between/among variables, and there is no reason to believe

that they are unacceptable, it can be said that they are the best representation of these relationships until they are challenged by better models.

As for the application of structural equation modeling in the present study, the model used was derived from theory and previous research and no data-driven modifications were made in the structural part of the model. The variables with temporal priority were hypothesized to affect variables that came later in time. These two factors strengthen the plausibility of causal inferences made in this study. On the other hand, exclusion of nontrivial variables from the model (e.g., perceived utility of mathematics), which would affect the nature of the relationships between the variables, is a shortcoming of this study in employing structural equation modeling in the analysis of nonexperimental data. In sum, the findings and interpretations in the present study should be viewed with caution, keeping the above delimitations and limitations in mind.

### **Recommendations for Future Research:**

Several different approaches can be used in the study of math course-taking. Just as in many educational fields of inquiry, the nature of data is multi-level. Put differently, the very fact that students are nested in classes, and classes are nested in schools bring about several levels of variance/covariance among variables. There are school-level variables (e.g., urbanicity, minority concentration, poverty concentration), class-level variables (e.g., amount of emphasis put by the teacher on the importance of math for future educational plans), and student-level variables (e.g., math self-concept, educational aspirations), that affect math course-taking. Each group of variables exhibits variance/covariance within themselves. Therefore, relationships between relevant variables can be better researched in a study where variables at different levels are investigated simultaneously. In such a multi-level study, variables at each level are modeled at their own levels in a simultaneous way. The total variance in the data is partitioned into variance/covariance at several levels. Such an approach can be employed through hierarchical linear modeling or multi-level structural equation modeling. One step further would be to also investigate the interactions between the groups of variables at different levels, such as the interaction between parental involvement (a student-level variable) and minority concentration of the school the student attends (a school-level variable). However, the techniques that would

allow studies described above are quite recent and sophisticated and, currently, not many applied researchers employ these techniques.

Findings from this study also suggest that further research that eliminates the shortcomings of the present study may result in stronger evidence. For example, a study with a similar design using more reliable measures of constructs investigated in this study and larger sample sizes for the groups may bring about more trustworthy results. Integrating other nontrivial variables, such as perceived utility of math, is likely to be useful to get a fuller picture of the relationships between the variables. A finer description of subgroups for comparison purposes may also be productive. In the present study, some levels of minority concentration and poverty concentration were merged to have larger sample sizes for subgroups investigated. Such an approach prevented more useful descriptions of these subgroups, which could yield results that do a better job reflecting the differences among subgroups. For example, high-minority, high-poverty urban schools were defined as urban schools with 21-100 % minority and 21-100 % poverty. However, with sufficient sample size, an investigation of urban schools with much higher minority and poverty concentration, such as 80-100 %, may reveal results that would be specific to a population that have unique social and cultural characteristics. The same utility of a finer definition of specific populations is also valid for other settings. In this respect, employment of instruments that would reveal social and cultural differences between subgroups may improve the quality of findings.

All the recommendations above also lead to the importance of qualitative study of these specific populations to learn more about their unique characteristics that may play a role in this field of inquiry. For diagnostic purposes, a careful examination of schools and their policies about course placements and related practices is critical. For example, knowing the extent to which schools allow the parents to participate in course-taking decisions is as crucial as knowing the importance of parental involvement for proper course-taking by students. In sum, with the wide range of variables directly or indirectly influencing course-taking, there is need for further research using different perspectives and study designs for their particular purposes of investigation.

## REFERENCES

- American College Testing Program, & Council of the Great City Schools (1998). Charting the right course: A report on urban student achievement and course-taking. (ERIC Document Reproduction Service No. ED 417 258)
- Anderson, J., Hollinger, D., & Conaty, J. (1992). Poverty and achievement: Re-examining the relationship between school poverty and student achievement. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.
- Anderson, J.C., & Gerbing, D.W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. Psychological Bulletin, 103(3), 411-423.
- Anderson, K.L. (1980). Educational goals of male and female adolescents. The effects of parental characteristics and attitudes. Youth & Society, 12(2), 173-188.
- Apple, M.W. (1979). Ideology and curriculum. London: Routledge & Kegan Paul.
- Armor, D.J. (1972). School and family effects on Black and White achievement: A reexamination of the USOE data. In F. Mosteller & D.P. Moynihan (Eds.), On equality of educational opportunity (pp. 168-229). New York: Vintage Books.
- Astin, A.W. (1993). What matters in college?: Four critical years revisited. San Francisco, CA: Jossey-Bass.
- Baker, D.P., & Stevenson, D.L. (1986). Mothers' strategies for children's school achievement: Managing the transition to high school. Sociology of Education, 59, 156-167.
- Bandura, A. (1977). Self-efficacy theory in human agency. American Psychologist, 37, 191-215.
- Berliner, D.C., & Biddle, B.J. (1995). The manufactured crisis. New York: Longman.
- Biddle, B.J., Bank, B.J., & Marlin, M.M. (1980). Parental and peer influence on adolescents. Social Forces, 58(4), 1057-1079.
- Blank, R.K., & Langesen, D. (1999). State indicators of science and mathematics education. Washington, DC: Council of Chief State School Officers.
- Bollen, K.A. (1989). Structural equations with latent variables. New York: John Wiley & Sons.
- Bourdieu, P. (1986). The forms of capital. In J.G. Richardson (Ed.), Handbook of theory and research for the sociology of education (pp. 241-258). New York: Greenwood Press.

Bracey, G.W. (1998). TIMSS, rhymes with 'dime', as in 'witted'. Phi Delta Kappan, 79, 686-687.

Brown, C., Gifford, A.G., Hoachlander, E.G., Meyer, R.H., & Tuma, J.E. (1989). The secondary schools taxonomy (SST). (ERIC Document Reproduction Service No. ED 315 544)

Calabrese, R.L. (1989). The discriminatory impact of course scheduling on minorities. Peabody Journal of Education, 66(4), 30-41.

Carnegie Foundation (1988). An imperiled generation: Saving urban schools. Princeton, NJ: Author.

Chenoweth, K. (1996). SAT, ACT scores increase: Higher scores attributed to more rigorous coursework. Black Issues in Higher Education, 13(14), 6-8.

Clune, W.H., & White, P.A. (1992). Education reform in the trenches: Increased academic course-taking in high schools with lower achieving students in states with higher graduation requirements. Educational Evaluation and Policy Analysis, 14(1), 2-20.

Coleman, J.S. (1988). Social capital in the creation of human capital. American Journal of Sociology, 94 (Supplement), S95-S120.

Coleman, J.S., Campbell, E.Q., Hobson, C.J., McPartland, J., Mood, A.M., Weinfeld, F.D., & York, R.L. (1966). Equality of educational opportunity. Washington, DC: U.S. Government Printing Office.

Comer, J.P. (1988). Educating poor minority children. Scientific American, 259(5), 42-48.

Comer, J.P. (1990). Home, school, and academic learning. In J.I. Goodlad, & P. Keating (Eds.), Access to knowledge. An agenda for our nation's schools (pp. 23-42). New York: College Entrance Examination Board.

Cooper, C.R., & Cooper, R.G., Jr. (1992). Links between adolescents' relationships with their parents and peers: Models, evidence, and mechanisms. In R.D. Parke & G.W. Ladd (Eds.), Family-peer relationships: Modes of linkage (pp. 135-158). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Cross, L.H. (1999). Are Virginia's public schools failing? Assessing the assessments. Virginia Issues & Answers, 6(1), 2-6.

Cusick, P.A. (1983). The egalitarian ideal and the American high school. New York: Longman.

Davies, M., & Kandel, D.B. (1981). Parental and peer influences on adolescents' educational plans: Some further evidence. American Journal of Sociology, 87(2), 363-387.

DeBord, L., Griffin, L.F., & Clark, M. (1977). Race, sex, and schooling: Insights from the Wisconsin model of the early achievement process. Sociology of Education, 50, 85-102.

DeYoung, A. (1987). The status of American rural education research: An integrated review and commentary. Review of Educational Research, 57(2), 123-148.

DeYoung, A., Huffman, K., & Turner, M. (1989). Dropout issues and problems in rural America, with a case study of one Appalachian school district. In L. Weis, E. Farrar, & H. Petrie (Eds.), Dropouts from school: Issues, dilemmas, and solutions (pp. 55-71). Albany, NY: State University of New York Press.

Elder, G.H., Jr. (1968). Adolescent socialization and personality development. Chicago: Rand McNally.

Epstein, J.L., & MacIver, D.J. (1992). Opportunities to learn. Effects on eighth graders of curriculum offerings and instructional approaches. (ERIC Document Reproduction Service No. ED 351 419)

Evaluation Technologies, Inc. (1985a). An analysis of course-taking patterns in secondary schools as related to student characteristics. High School and Beyond: A national longitudinal study for the 1980's. (ERIC Document Reproduction Service No. ED 257 633)

Evaluation Technologies, Inc. (1985b). An analysis of course offerings and enrollments as related to school characteristics. Contractor report. (ERIC Document Reproduction Service No. ED 262 011)

Feather, N.T. (1988). Values, valences, and course enrollment: Testing the role of personal values within an expectancy-valence framework. Journal of Educational Psychology, 80, 381-391.

Fehrmann, P.G., Keith, T.Z., & Reimers, T.M. (1987). Home influence on school learning: Direct and indirect effects of parental involvement on high school grades. Journal of Educational Research, 80, 330-337.

Fordham, S. (1988). Racelessness as a factor in Black students' school success: Pragmatic strategy or pyrrhic victory? Harvard Educational Review, 58(1), 54-84.

Garet, M.S., & DeLany, B. (1988). Students, courses, and stratification. Sociology of Education, 61, 61-77.

Ghelfi, L.M., & Parker, T.S. (1997). A county-level measure of urban influence (Staff Paper No. 9702). Washington, DC: U.S. Department of Agriculture.

Gjelten, T. (1982). A typology of rural school settings. Washington, DC: U.S. Department of Education.

Green, P.J., Dugoni, B.L., Ingels, S.J., & Quinn, P. (1995). National Education Longitudinal Study of 1988. Trends among high school seniors, 1972-1992 (NCES 95-380). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Gurin, P., & Epps, E.C. (1975). Black consciousness, identity, and achievement. New York: Wiley-Interscience.

Haas, T. (1992). What can I become: Educational aspirations of students in rural America. ERIC Digest. (ERIC Document Reproduction Service No. ED 345 931)

Hatcher, L. (1994). A step-by-step approach to using the SAS System for factor analysis and structural equation modeling. Cary, NC: SAS Institute Inc.

Hobbs, D. (1995). Social organization in the countryside. In E. Castle (Ed.), The changing American countryside: Rural people and places (pp. 369-396). Lawrence, KS: University Press of Kansas.

Hoffer, T.B., Rasinski, K.A., & Moore, W. (1995). Social background differences in high school mathematics and science coursetaking and achievement (NCES 95-206). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Horn, E.A., & Walberg, H.J. (1984). Achievement and interest as functions of quantity and level of instruction. Journal of Educational Research, 77(4), 227-232.

Horn, L., Hafner, A., & Owings, J. (1992). A profile of American eighth-grade mathematics and science instruction (NCES 92-486). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Hossler, D., & Stage, F.K. (1992). Family and high school experience influences on the postsecondary educational plans of ninth-grade students. American Educational Research Journal, 29, 425-451.

Ingels, S.J., Dowd, K.L., Baldrige, J.D., Stipe, J.L., Bartot, V.H., & Frankel, M.R. (1994). National Education Longitudinal Study of 1988. Second Follow-Up: Student Component

Data File User's Manual (NCES 94-374). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Jackson, P.W. (1968). Life in classrooms. New York: Holt, Rinehart, & Winston.

Jackson, L.A., Gardner, P.D., & Sullivan, L.A. (1993). Engineering persistence: Past, present, and future factors and gender differences. Higher Education, 26, 227-246.

Jencks, C., & Mayer, S.E. (1990). The social consequences of growing up in a poor neighborhood. In L.E. Lynn, Jr., & M.G.H. McGeary (Eds.), Inner-city poverty in the United States (pp. 111-186). Washington, DC: National Academy Press.

Jones, L.V. (1985). Black-White differences in mathematics: Some new research findings. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Jones, L.V., Burton, N.W., & Davenport, E.C., Jr. (1984). Monitoring the mathematics achievement of Black students. Journal for Research in Mathematics Education, 15(2), 154-164.

Jones, L.V., Davenport, E.C., Jr., Bryson, A., Bekhuis, T., & Zwick, R. (1986). Mathematics and science test scores as related to courses taken in high school and other factors. Journal of Educational Measurement, 23(3), 197-208.

Joreskog, K., & Sorbom, D. (1996). LISREL 8: User's reference guide. Chicago, IL: Scientific Software International, Inc.

Joreskog, K., & Sorbom, D. (2000). LISREL 8.30 and PRELIS 2.30 [Computer software]. Chicago, IL: Scientific Software International, Inc.

Khatti, N., Riley, K.W., & Kane, M.B. (1997). Students at risk in poor, rural areas: A review of the research. Journal of Research in Rural Education, 13(2), 79-100.

Laing, J., Engen, H., & Maxey, J. (1990). Coursework patterns, ACT assessment scores, and related data. College and University, 65(4), 335-344.

Lantz, A.E., & Smith, G.P. (1981). Factors influencing the choice of nonrequired mathematics courses. Journal of Educational Psychology, 73(6), 825-837.

Lareau, A. (1987). Social class differences in family-school relationships: The importance of cultural capital. Sociology of Education, 60, 73-85.

Lee, V.E., & Ekstrom, R.B. (1987). Student access to guidance counseling in high school. American Educational Research Journal, 24(2), 287-310.

Lee, V.E., & Ware, N.C. (1986). When and why girls "leak" out of high school mathematics: A closer look. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Lee, V.E., Burkam, D.T., Chow-Hoy, T., Smerdon, B.A., & Gevertz, D. (1998). High school curriculum structure: Effects on coursetaking and achievement in mathematics for high school graduates (NCES Working Paper No. 98-09). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Lee, V.E., Croninger, R.G., & Smith, J.B. (1997). Course-taking, equity, and mathematics learning: Testing the constrained curriculum hypothesis in U.S. secondary schools. Educational Evaluation and Policy Analysis, 19(2), 99-121.

Legum, S., Caldwell, N., Davis, B., Haynes, J., Hill, T.J., Litavec, S., Rizzo, L., Rust, K., Vo, N., & Gorman, S. (1998). The 1994 High School Transcript Study tabulations: Comparative data on credits earned and demographics for 1994, 1990, 1987, and 1982 high school graduates (rev. ed.) (NCES 98-532). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Legutko, R.S. (1998). Family effect on rural high school students' postsecondary decisions. Rural Educator, 20(2), 11-14.

Leitman, R., Binns, K., & Unni, A. (1995). Uninformed decisions: A survey of children and parents about math and science. NACME Research Letter, 5(1), 1-10.

Leslie, L.L., McClure, G.T., & Oaxaca, R.L. (1998). Women and minorities in science and engineering. Journal of Higher Education, 69(3), 239-276.

Linn, M.C., & Hyde, J.S. (1989). Gender, mathematics, and science. Educational Researcher, 18, 17-19, 22-27.

Lippman, L., Burns, S., McArthur, E., Burton, R., Smith, T.M., & Kaufman, P. (1996). Urban schools. The challenge of location and poverty (NCES 96-184). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

MacCallum, R. (1986). Specification searches in covariance structure modeling. Psychological Bulletin, 100(1), 107-120.

Marsh, H.W. (1989). Sex differences in the development of verbal and mathematics constructs: The High School and Beyond Study. American Educational Research Journal, 26, 191-225.

Marsh, H.W., & Yeung, A.S. (1997). Causal effects of academic self-concept on academic achievement: Structural equation models of longitudinal data. Journal of Educational Psychology, 89, 41-54.

Marsh, H.W., & Yeung, A.S. (1998). Longitudinal structural equation models of academic self-concept and achievement: Gender differences in the development of math and English constructs. American Educational Research Journal, 35(4), 705-738.

Marsh, H.W., Byrne, B.M., & Shavelson, R. (1988). A multifaceted academic self-concept: Its hierarchical structure and its relation to academic achievement. Journal of Educational Psychology, 80, 366-380.

Matthews, W. (1984). Influences on the learning and participation of minorities in mathematics. Journal for Research in Mathematics Education, 15(2), 84-95.

Mayer, S.E., & Jencks, C. (1989). Growing up in poor neighborhoods: How much does it matter? Science, 243(4897), 1441-1445.

McCormick A.C., Tuma, J., & Houser, J. (1995). Vocational course-taking and achievement: An analysis of high school transcripts and 1990 NAEP assessment scores (NCES 95-006). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

McLure, G.T. (1998). High school mathematics course-taking and achievement among college-bound students: 1987-1996. NASSP Bulletin, 82(598), 110-118.

McPartland, J.M., & Braddock, J.H. (1981). Going to college and getting a good job: The impact of desegregation. In W.D. Hawley (Ed.), Effective school desegregation: Equality, quality, and feasibility (pp. 141-154). London: Sage Publications.

Muller, C. (1993). Parent involvement and academic achievement: An analysis of family resources available to the child. In B. Schneider & J.S. Coleman (Eds.), Parents, their children, and schools (pp. 77-114). Boulder, CO: Westview Press.

Muller, C., & Kerbow, D. (1993). Parent involvement in the home, school, and community. In B. Schneider & J.S. Coleman (Eds.), Parents, their children, and schools (pp. 13-42). Boulder, CO: Westview Press.

Myers, D.E. (1985). The relationship between school poverty concentration and students' reading and math achievement and learning. Washington, DC: Decision Resources, Inc.

National Center for Education Statistics (1999). Do gatekeeper courses expand education options? (NCES 1999-303). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

National Commission on Excellence in Education (1983). A nation at risk: The imperative for educational reform. Washington, DC: U.S. Government Printing Office.

National Education Goals Panel (1995). The National Education Goals Report. Washington, DC: U.S. Government Printing Office.

Oakes, J. (1985). Keeping track: How schools structure inequality. New Haven, CT: Yale University Press.

Oakes, J. (1990). Opportunities, achievement, and choice: Women and minority students in science and mathematics. In C.B. Cazden (Ed.), Review of Research in Education, 16, 153-222.

Oakes, J., Gamoran, A., & Page, R.N. (1992). Curriculum differentiation: Opportunities, outcomes, and meanings. In P.W. Jackson (Ed.), Handbook of research on curriculum (pp. 570-608). New York: Mc Millan.

Ogbu, J. (1974). The next generation. New York: Academic Press.

Ogbu, J.U. (1990). Overcoming racial barriers to equal access. In J.I. Goodlad, & P. Keating (Eds.), Access to knowledge. An agenda for our nation's schools (pp. 59-89). New York: College Entrance Examination Board.

Ogbu, J.U. (1994). Racial stratification and education in the United States: Why inequality persists. Teachers College Record, 96, 264-298.

Olson, K. (1999). Despite increases, women and minorities still underrepresented in undergraduate and graduate S&E education (Report No. NSF-99-320). Arlington, VA: National Science Foundation, Division of Science Resources Studies. (ERIC Document Reproduction Service No. ED 427 958)

Orland, M.E. (1990). Demographics of disadvantage: Intensity of childhood poverty and its relationship to educational achievement. In J.I. Goodlad, & P. Keating (Eds.), Access to knowledge. An agenda for our nation's schools (pp. 43-58). New York: College Entrance Examination Board.

Owings, J., Madigan, T., & Daniel, B. (1998). Who goes to America's highly ranked "national" universities? (NCES 98-095). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Picou, S.J., & Carter, M.T. (1976). Significant other influence and aspirations. Sociology of Education, 49, 12-22.

Powell, A.G., Farrar, E., & Cohen, D.K. (1985). The shopping mall high school. Boston: Houghton Mifflin Company.

Powell, D.R., & Peet, S.H. (1996). Educational/occupational expectations and aspirations: Mothers' views of their children's futures. Paper presented as a poster session at the annual meeting of the American Educational Research Association, New York, NY.

Reyes, L.H. (1984). Affective variables and mathematics education. Elementary School Journal, 84, 558-581.

Reyes, L.H., & Stanic, G.M.A. (1988). Race, sex, socioeconomic status, and mathematics. Journal for Research in Mathematics Education, 19(1), 26-43.

Rock, D., Braun, H.I., & Rosenbaum, P.R. (1985). Excellence in high school education: Longitudinal study, 1980-1982 (Final report). Princeton, NJ: Educational Testing Service.

Rock, D.A., & Pollack, J.M. (1995). Mathematics course-taking and gains in mathematics achievement. Statistics in brief (NCES 95-714). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Rotberg, I.C. (1998, May 15). Interpretation of international test score comparisons. Science, 280, 1030-1031.

Sawhill, I., O'Connor, A., Jensen, L., & Coulton, C. (1992). Families in poverty: Patterns, contexts, and implications for policy. Washington, DC: Family Impact Seminar.

Schmidt, W.H. (1983a). High school course-taking: Its relationship to achievement. Curriculum Studies, 15(3), 311-332.

Schmidt, W.H. (1983b). High school course-taking: A study of variation. Curriculum Studies, 15(2), 167-182.

Schmidt, W.H., McKnight, C.C., Cogan, L.S., Jakwerth, P.M., & Houang, R.T. (1999). Facing the consequences: Using TIMSS for a closer look at U.S. mathematics and science education. Boston: Kluwer Academic Publishers.

Schneider, B. (1993). Parents, their children, and schools: An introduction. In B. Schneider & J.S. Coleman (Eds.), Parents, their children, and schools (pp. 1-12). Boulder, CO: Westview Press.

Sebring, P.A. (1987). Consequences of differential amounts of high school coursework: Will the new graduation requirements help? Educational Evaluation and Policy Analysis, 9(3), 257-273.

Seginer, R. (1983). Parents' educational expectations and children's academic achievements: A literature review. Merrill-Palmer Quarterly, 29(1), 1-23.

Sewell, W.H., & Hauser, R.M. (1976). Causes and consequences of higher education: Models of the status attainment process. In W.H. Sewell, R.M. Hauser, & D.L. Featherman (Eds.), Schooling and achievement in American society (pp. 9-27). New York: Academic Press.

Shakrani, S. (1996). Eighth-grade algebra course-taking and mathematics proficiency (NCES 96-815). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Shavelson, R.J., Hubner, J.J., & Stanton, G.C. (1976). Self-concept: Validation of construct interpretations. Review of Educational Research, 46, 407-441.

Singh, K., Bickley, P.G., Trivette, P., Keith, T.Z., Keith, P.B., & Anderson, E. (1995). The effects of four components of parental involvement on eighth-grade student achievement: Structural analysis of NELS:88 data. School Psychology Review, 24(2), 299-317.

Spencer, B.D., Frankel, M.R., Ingels, S.J., Rasinski, K.A., Tourangeau, R., & Owings, J.A. (1990). National Education Longitudinal Study of 1988. Base Year Sample Design Report (NCES 90-463). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

SPSS Inc. (1996). SPSS 7.5 [Computer software]. Chicago, IL: Author.

Steinberg, L., Lamborn, S.D., Dornbusch, S.M., & Darling, N. (1992). Impact of parenting practices on adolescent achievement: Authoritative parenting, school involvement, and encouragement to succeed. Child Development, 63, 1266-1281.

Stipek, D.J., & Weisz, J.R. (1981). Perceived control and academic achievement. Review of Educational Research, 51, 103-137.

U.S. Department of Education (1997). Mathematics equals opportunity. White paper prepared for U.S. Secretary of Education [On-line]. Available: <http://ed.gov/pubs/math/index.html>.

Useem, E.L. (1991). Student selection into course sequences in mathematics: The impact of parental involvement and school policies. Journal of Research on Adolescence, *1*(3), 231-250.

Virginia Department of Education (September, 1997). Regulations establishing standards for accrediting public schools in Virginia (8 VAC 20-131-10 et. seq.) [On-line]. Available: [http://www.pen.k12.va.us/VDOE/VA\\_Board/Standards/SOA/clensoa.html](http://www.pen.k12.va.us/VDOE/VA_Board/Standards/SOA/clensoa.html).

Ware, N.C., Steckler, N.A., & Leserman, J. (1985). Undergraduate women: Who chooses a science major? Journal of Higher Education, *56*, 73-84.

Wells, A.S., & Crain, R.L. (1994). Perpetuation theory and the long-term effects of school desegregation. Review of Educational Research, *64*(4), 531-555.

Wentzel, K.R. (1998). Parents' aspirations for children's educational attainments: Relations to parental beliefs and social address variables. Merrill-Palmer Quarterly, *44*(1), 20-37.

White, K.R. (1982). The relation between socioeconomic status and academic achievement. Psychological Bulletin, *91*(3), 461-481.

Wilkins, J.L.M. (1999). Demographic opportunities and school achievement. Journal of Research in Education, *9*(1), 12-19.

Wilson, P.M., & Wilson, J.R. (1992). Environmental influences on adolescent educational aspirations. Youth & Society, *24*(1), 52-70.

Worthley, J.S. (1992). Is science persistence a matter of values? Psychology of Women Quarterly, *16*, 57-68.

## APPENDIX A

### NELS: 88 ITEMS USED IN THE STUDY

**Mathematics Course-taking:** In this study, this variable was measured as the sum of total Carnegie units earned in Algebra II, Geometry, Trigonometry, and Calculus. The following NELS: 88 items were summed up to create the “total mathematics course-taking” variable.

F2RAL2\_C: Total Carnegie units in Algebra II

F2RGEO\_C: Total Carnegie units in Geometry

F2RTRI\_C: Total Carnegie units in Trigonometry

F2RCAL\_C: Total Carnegie units in 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” (p. O-1) (Ingels, et al., 1994).

**Socioeconomic Status of the Student:** This variable was measured by F2SES1. F2SES1 is a continuous composite variable already available in NELS : 88 database. It was constructed using five items from the base year parent questionnaire data. The data used to create this item were 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), which assigns values to various occupational groups. If the data needed were not available in parent component data, then data from other components (such as student component) were used. After any necessary coding, each nonmissing component was standardized to a mean of 0 and a standard deviation of 1. Then nonmissing standardized components were averaged to create the F2SES1 composite.

**Student’s Previous Math Achievement:** This variable was measured by BY2XMSTD. BY2XMSTD is a score from a standardized mathematics test administered in the Spring of 1988 (Spring of 8<sup>th</sup> grade for the sample). It is a continuous variable.

**Parental Expectations:** This construct was measured by a latent variable made up of four survey items asked to the student.

F1S48A: How far in school do you think your father want you to go? [First follow-up (10<sup>th</sup> grade) item]

F1S48B: How far in school do you think your mother want you to go? [First follow-up (10<sup>th</sup> grade) item]

The codings for these two items were:

1= Less than high school graduation

2= Graduation from high school

3= Vocational after high school

4= Attend two-year college

5= Attend four-year college

6= Graduation from college

7= Post graduate education

8=Do not know

9=Parent doesn't care

10= Does not apply

For these two items, 8 and 10 were recoded as missing and 9 was recoded as zero in this study.

F2S42A: How far in school do you think your father want you to go? [Second follow-up (12<sup>th</sup> grade) item]

F2S42B: How far in school do you think your mother want you to go? [Second follow-up (12<sup>th</sup> grade) item]

The codings for these two items were:

1= Less than high school graduation

- 2= High school graduation only
- 3= Less than two years of vocational, trade, or business school
- 4= Two years or more of vocational, trade, or business school
- 5= A degree from a vocational, trade, or business school
- 6= Less than two years of college
- 7= Two or more years of college
- 8= Finish college (four- or five-year degree)
- 9= Master's degree or equivalent
- 10= Ph.D., M.D., or other professional degree

**Parental Involvement:** This construct was measured by a latent variable made up of four survey items asked to the student.

F1S105A= In the first half of this school year, how often have you discussed selecting courses or programs at school with either or both of your parents or guardians? [First follow-up (10<sup>th</sup> grade) item]

F1S105G= In the first half of this school year, how often have you discussed going to college with either or both of your parents or guardians? [First follow-up (10<sup>th</sup> grade) item]

The codings for these two items were:

- 1= Never
- 2= Sometimes
- 3= Often

F2S99A= In the first semester or term of this school year, how often did you discuss selecting courses or programs at school with either or both of your parents or guardians? [Second follow-up (12<sup>th</sup> grade) item]

F2S99F= In the first semester or term of this school year, how often did you discuss applying to college or other schools after high school with either or both of your parents or guardians? [Second follow-up (12<sup>th</sup> grade) item]

The codings for these two items were:

1= Never

2= Sometimes

3= Often

**Educational Aspirations of Peers:** This construct was measured by a latent variable made up of four survey items asked to the student.

F1S70D= Among the friends you hang out with, how important is it to get good grades? [First follow-up (10<sup>th</sup> grade) item]

F1S70I= Among the friends you hang out with, how important is it to continue their education past high school? [First follow-up (10<sup>th</sup> grade) item]

The codings for these two items were:

1= Not important

2= Somewhat important

3= Very important

F2S68D= Among your close friends, how important is it to them that they get good grades? [Second follow-up (12<sup>th</sup> grade) item]

F2S68H= Among your close friends, how important is it to them that they continue their education past high school? [Second follow-up (12<sup>th</sup> grade) item]

The codings for these two items were:

1= Not important

2= Somewhat important

3= Very important

**Math Self-Concept:** This construct was measured by a latent variable made up of four survey items asked to the student. The student was asked to choose the answer that was best for him/her for these four items.

F1S63D= Mathematics is one of my best subjects. [First follow-up (10<sup>th</sup> grade) item]

F1S63J= I have always done well in mathematics. [First follow-up (10<sup>th</sup> grade) item]

F1S63Q= I get good marks in mathematics. [First follow-up (10<sup>th</sup> grade) item]

F1S63S= I do badly in tests of mathematics. [First follow-up (10<sup>th</sup> grade) item]

The codings for these four items were:

1= False

2= Mostly false

3= More false than true

4= More true than false

5= Mostly true

6= True

For F1S63S, the codings were reversed so that all the items were in the same direction (i.e., the higher the score, the higher was the math self-concept).

**Educational Aspirations:** This construct was measured by a latent variable made up of three survey items asked to the student.

BYS45= As things stand now, how far in school do you think you will get? [Base year (8<sup>th</sup> grade) item]

The codings for this item were:

1= Won't finish high school

- 2= Will finish high school
- 3= Vocational, trade, or business school after high school
- 4= Will attend college
- 5= Will finish college
- 6= Higher school after college

F1S49= As things stand now, how far in school do you think you will get? [First follow-up (10<sup>th</sup> grade) item]

The codings for this item were:

- 1= Less than high school graduation
- 2= High school graduation only
- 3= Less than two years of trade school
- 4= Two or more years of trade school
- 5= Less than two years of college
- 6= Two or more years of college
- 7= Finish college
- 8= Master's degree
- 9= Ph. D., M.D.

F2S43= As things stand now, how far in school do you think you will get? [Second follow-up (12<sup>th</sup> grade) item]

The codings for this item were:

- 1= Less than high school graduation
- 2= High school graduation only
- 3= Less than two years of vocational, trade, or business school
- 4= Two or more years of vocational, trade, or business school
- 5= A degree from a vocational, trade, or business school

- 6= Less than two years of college
- 7= Two or more years of college
- 8= Finish college (four- or five-year degree)
- 9= Master's degree or equivalent
- 10= Ph. D., M.D., or other professional degree

**Sex:** This variable was measured by F2SEX.

The codings for this item were:

- 1= Male
- 2= Female

**Race:** This variable was measured by F2RACE1.

The codings for this item were:

- 1= Asian, Pacific Islander
- 2= Hispanic
- 3= Black, not Hispanic
- 4= White, not Hispanic

**High School Program:** This variable was measured by F2HSProg. F2HSProg is an item, which categorizes the high school program reported by the student in another item. In the item originally asked for the high school program the student is in, there is more variety in options. F2HSProg narrows down these options to the levels below:

The codings for this item were:

- 1= General high school program
- 2= Academic program

- 3= Vocational, technical program
- 4= Other specialized high school program
- 5= Special education program
- 6= Alternative/Dropout prevention program

In this study, only students in general high school program or academic program or vocational/technical program were selected.

**Urbanicity:** This variable was measured by G12URBN3.

G12URBN3 trichotomizes the urbanicity of the area in which the student's school is located. "This metropolitan status is defined by QED for public school districts, for Catholic dioceses, or in some cases for the county in which the school is located. QED bases the classifications on the Federal Information Processing Standards as used by the U.S. Census" (p. H-18) (Ingels, et al., 1994).

The codings for this item were:

- 1= Urban – central city
- 2= Suburban – area surrounding a central city within a county constituting the metropolitan statistical area (MSA).
- 3= Rural – outside MSA.

**Minority Concentration:** This variable was measured by G8MINOR. G8MINOR is the percentage of minority students in the eighth grade reported by the school.

The codings for this item were:

- 0= None
- 1= 1-5 %
- 2= 6-10 %

- 3= 11-20 %
- 4= 21-40 %
- 5= 41-60 %
- 6= 61-90 %
- 7= 91-100 %

**Poverty Concentration:** This variable was measured by G8LUNCH. G8LUNCH is the percentage of students receiving free or reduced price lunch reported by the school.

The codings for this item were:

- 0= None
- 1= 1-5 %
- 2= 6-10 %
- 3= 11-20 %
- 4= 21-30 %
- 5= 31-50 %
- 6= 51-75 %
- 7= 76-100 %

## MEHMET ALI OZTURK

**EDUCATION:** Ph.D. Educational Research and Evaluation, May 2001  
Virginia Tech, Blacksburg, VA

M.S. Ed. School Psychology, September 1995  
City College of City University of New York, New York, NY

B.A. Guidance and Counseling, June 1990  
Bogazici University, Istanbul, Turkey

### **RESEARCH: Experience:**

Graduate Assistant, Educational Research and Evaluation Program, Department of Educational Leadership and Policy Studies, Virginia Tech, August 1996 - May 2001.

### **Publications:**

- Singh, K. & Ozturk, M. (2000). Effect of part-time work on high school mathematics and science course-taking. *Journal of Educational Research*, 94(2), 67-74.

### **Presentations:**

- Singh, K. & Ozturk, M. (2000, February). *Part-time work and adolescents' educational and social development: A narrative synthesis of empirical literature*. Paper presented at the Annual Meeting of the Eastern Educational Research Association, Clearwater Beach, FL.
- Singh, K. & Ozturk, M. (1999, April). *Part-time work and school related outcomes for high school seniors: An analysis of NELS: 88*. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Canada.
- Singh, K. & Ozturk, M. (1999, February). *Mathematics and science courses taken in high school: Effect of part-time work*. Paper presented at the Annual Meeting of the Eastern Educational Research Association, Hilton Head, SC.
- Singh, K., Granville, M., & Ozturk, M. (1997, February). *The differences in science achievement among African-American, Hispanic, and Caucasian-American 10<sup>th</sup> graders: Effects of classroom variables*. Paper presented at the Annual Meeting of the Eastern Educational Research Association, Hilton Head, SC.