ABSTRACT

Title of dissertation: MATH COURSE TAKING AND ACHIEVEMENT
AMONG SECONDARY STUDENTS WITH
DISABILITIES: EXPLORING THE GAP IN
ACHIEVEMENT BETWEEN STUDENTS WITH AND
WITHOUT DISABILITIES.

Michael Gregory Wilson, Doctor of Philosophy, 2008

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The purpose of this study was to extend school effects research to explore the

influence of specific school-level factors on the math course-taking behaviors of students

with disabilities and to determine whether the level of math courses taken affects the

math achievement of students with disabilities. I also sought to examine these effects

relative to the performance of students without disabilities. I analyzed school and student

level data for 6,398 students in 608 schools from the Education Longitudinal Study of

2002. Using a 2-level hierarchical linear model, I found that school composition and

curriculum structure affect the average 12th grade math achievement of students with

disabilities. I also found an association between curriculum structure and advanced math

course-taking by students with disabilities. I discuss the implications of these findings on

policy and future research.

MATH COURSE TAKING AND ACHIEVEMENT AMONG SECONDARY
STUDENTS WITH DISABILITIES: EXPLORING THE GAP IN ACHIEVEMENT
BETWEEN STUDENTS WITH AND WITHOUT DISABILITIES.

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ACKNOWLEDGEMENTS

I would like to thank my advisor Dr. Peter E. Leone for his trust, guidance, and support throughout my time at Maryland. I would also like to thank my co-chair Dr. Margaret J. McLaughlin for her time, constructive feedback, and high expectations throughout this process. Additionally, I would like to thank Dr. Paula Maccini for her energy and attention to detail, Dr. Deborah L. Speece for her insightful perspectives, and Dr. Robert G. Croninger for having the patience to deal with me "popping in" with questions and always providing a thoughtful answer.

To Will, Jay, and Kenny for being a positive influence when I revert to negativism.

To my mother for not giving up and my sister for believing in me before anyone else took notice.

Finally, to my wife, Tonia, for putting up with "the crazy", and always being the better half of us. I would not have made it without her.

DEDICATION

For Anthony…

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CHAPTER I

Introduction

Educators, researchers and policymakers consider math the foundation for developing both skilled and unskilled workers. Specifically, math is key for individuals pursuing post-secondary studies, businesses seeking employees, as well as for individuals managing life-course events (National Mathematics Advisory Panel, 2007). Many in the business community believe that increasing math achievement is critical to U.S. national economic growth (Ramirez, Luo, Schofer, & Meyer, 2006). Basic math skills, such as numeracy (i.e., number representation and ability to employ mathematical techniques), are associated with effective navigation of basic life events such as health care and making emergency medical decisions (Reyna & Brainard, 2007). Knowledge of mathematics is also important for increasing the number of college-ready students and preparing individuals to pursue advanced degrees in technology fields (National Mathematics Advisory Panel, 2007). For students, the mathematics knowledge that prepares them for work, college and life is learned in the mathematics courses they take during their educational career.

Math course-taking has both a direct cognitive effect, in terms of the math skills students learn, as well as an indirect effect on student's potential income through its association with earning a postsecondary degree, (Rose & Betts, 2001). Math course-taking and math achievement have an effect on earnings independent of students demographic characteristics. Researchers used math course-taking data from the High School and Beyond Study (HSB) to evaluate the senior class of 1982 (Rose & Betts, 2001). They reported an earnings gap of $11,000 dollars between students whose highest

level of high school math course was vocational math versus students whose highest-level class was calculus. Current data on mathematics achievement shows that the performance of American students is flagging when compared U.S. to economic peer countries (Lemke & Gonzales, 2006).

Due to the importance given to mathematical competency, policymakers in the U.S. have been very interested in how the nation's students compare to those in other countries. Currently, there are two international mathematics assessments. The Trends in International Mathematics and Science Study (TIMSS) compares mathematics performance among participating countries. The TIMSS assessment questions are based on the curricula frameworks of the participating countries. For example, researchers have noted that a large proportion of the mathematics framework of the TIMSS is focused on number concepts as opposed to data or statistical concepts. The performance of U.S. students on the TIMSS shows that on average, U.S. eighth graders performance increased an average of 12 scale score points between 1995 and 2003 (Gonzales, Guzman, Partelow, Pahlke, Jocely, Kastberg & Williams, 2003). However, researchers have noted that the TIMSS framework may not be appropriate for understanding the types of mathematics skills that 8th grade students should possess (Niedorf, Binkley, Garris, & Nohara, 2006). Comparatively, the Program for International Student Assessment (PISA) focuses on content more appropriate to secondary students; with approximately 40% of items focused on data concepts. The performance of 15-year old U.S. students on the PISA is well below the average performance of their foreign counterparts (Lemke & Gonzales, 2006). In other words, on average U.S. math students display poorer secondary-level math ability than students in countries that are considered U.S. economic

peer countries. Further, the average U.S. scale score of 483 falls in the bottom third among participating countries.

In addition to the international assessments, the US Department of Education (USDOE) has been supporting the National Assessment of Education Progress (NAEP) since 1969 (National Center for Education Statistics, 2007). The NAEP measures student performance in math, and other areas, in 4th, 8th and 12th grades. The mathematics content focus of the NAEP is similar to that used in the TIMSS. Trends in performance over time among 4th and 8th grade students indicate a modest increase in math scores between 1970 and 1999. Among 4th and 8th grade students' in that span of time, math scores increased 13 and 10 points, respectively. However, among 12th grade students the average math score decreased between 1973 and 1982, then increased by 10 points over the following 10 years only to remain stagnant between 1992 and 1999 (National Center for Education Statistics, 1999). Consequently, the net change in average math score among 12th grade American high-school students between 1971 and 1999 is an increase of just 4 points. The math assessment performance of the nation's secondary school students relative to their international peers suggests that they are less prepared for the types of technology-based jobs that they will compete for in the future (Ramirez, et al., 2006). However, the performance of U.S. secondary aged students in general remains far above the performance of secondary students with disabilities according to current national and state data.

Students with Disabilities and Math Achievement

Several studies have collected data that allow for comparisons of the math achievement levels of students with and without disabilities. These include, NAEP, state

reported assessment results, and results from a nationally representative longitudinal study. Along with general education students, since 1998 the NAEP has provided data on the math performance of students receiving special education services under the Individuals with Disabilities Education Act (IDEA). In addition to the NAEP, math performance data on students with disabilities is available through the National Center on Education Outcomes (NCEO). The NCEO was funded in 1990 to work with states and federal agencies to create adequate assessment and accountability systems, particularly for students with disabilities (National Center for on Education Outcomes, 2007). As part of their efforts, the NCEO conducts and disseminates research related to assessment results reported by states. Finally, the National Longitudinal Transition Study -2 (NLTS-2) is a nationally representative study of a cohort of students with disabilities who were 13 to 16 years old in 2000 (Wagner, Newman, Cameto, & Levine, 2006; National Center for Special Education Research, 2007). This longitudinal study is collecting data on math and reading achievement as well as the work and life experiences of these students as they move through high school into post-secondary life.

Data from all 3 sources (NAEP, NCEO, NLTS-2) indicate that students with disabilities display a significant gap in math achievement in comparison to their non-disabled peers. For instance, the 2005 performance of 8th and 12th grade students with disabilities on the NAEP shows a 25% and 19% gap, respectively, in the percent of students with disabilities who achieved proficiency in mathematics as compared to their non-disabled peers (McLaughlin, Krezmien, Zablocki & Miceli, 2007;National Center for Education Statistics, 2007). Further, an NCEO report on the state assessed mathematics performance for the 2004-2005 school year also indicates considerable gaps in the

percentage of high school students with disabilities who achieve proficiency in math (VanGetson & Thurlow, 2007).

More than three-quarters of students with disabilities surveyed in the NLTS-2 sample scored at or below the national mean in math calculation as measured on the Woodcock Johnson –III Tests of Achievement (WJ-III) (Wagner et al., 2006). Nearly one-third of the sample scored more than 2 standard deviations below the mean in math calculation. Eighty-four percent of students with disabilities scored at or below the mean on tests of applied problems and 15% score more than 2 standard deviations below the mean (Wagner).

Clearly, the data from this national study serve to highlight a considerable gap in math achievement between students with disabilities and those without disabilities (Wagner, et al., 2006). The explanation for this gap might be found in data describing the school experiences of students with disabilities that was collected as part of the NLTS-2 study. For instance, nearly 60% of students with disabilities reportedly received math instruction in the general education setting (Wagner, Marder, Cameto & Levine, 2003). First, within the classroom the instructional experiences of students with disabilities were similar to those of the non-disabled classmates with whom they take classes (Wagner et al., 2003). However, in terms of credentials, the general education math teachers of students with disabilities were less credentialed than general education teachers in areas like language arts and social studies (93% vs 99%). In other words, students with disabilities in general education math classes are more likely to be taught by math teachers without content certification than they are in their general education language arts or social studies classes. Other research suggests that general educators may not be

adequately prepared, in terms of specific coursework, to teach math to students with learning and emotional disabilities (Gagnon & Maccini, 2007; Maccini & Gagnon, 2006).

According to the NLTS2, students with disabilities are likely to be in classes where students are performing below grade level in mathematics. Further, less than 1% of students with disabilities are enrolled in Advanced Placement courses (Wagner et al., 2003). These findings may be indicative of a 'disability track' that labeling creates, whereby curricular expectations of academic performance are lowered in an attempt to provide adaptive programming (National Research Council, 2002). In order to understand the implications of the contexts in which students with disabilities are educated, researchers must explicitly evaluate student achievement in light factors such as the characteristics of schools that students attend and the types of mathematics courses they take.

The Effects of Schools on Student Outcomes

Development is the function of the interaction between individual and environment (Bronfenbrenner, 1989). Social scientists have long recognized that children exist within social environments that continually shape their development. There are a number of theories across disciplines that consider the interaction effects of context, such as school, family, and community, on a child's cognitive and social outcomes (Duncan & Raudenbush, 1999).

Within education, the research that has investigated the effects of school context on student achievement is organized around the theory that schools are social organizations constrained by the realities of resources and policies and that the primary purpose of schools is to structure the process of teaching and learning (Bidwell &

Kasarda, 1980). Schools are influenced by their collective components including, student attributes (i.e., race, SES, or ability composition) as well as teacher attributes. In turn, schools affect student learning as well as teacher behavior through their organization, curricular choices and decisions regarding how to use resources and implement policies. Bidwell and Kasarda's (1980) assert that school effects research must examine the ways that schools choose to structure processes that differentiate the teacher-student instructional conditions (schooling).

Viewed through this lens, the effects of schools on student outcomes are seen as the result of the interaction between the organizational components of schools and the resulting opportunities offered through the schooling process. These opportunities then explain variations in student attainment. For example, schools with high proportions of middle or upper SES students may be characterized by greater social cohesion around the importance of post-secondary education and therefore these schools will structure the curriculum around a college preparatory program that leads to higher general achievement and qualifications for enrollment in college. Further, the high level of social cohesion around post-secondary education may also influence students' goals and expectations. Conversely, schools with high proportions of low SES students from neighborhoods and families that provide few models for higher education may offer a more variable curriculum such as drop-out prevention programs, and lower level academic and vocational courses. Thus, it is important when examining predictors of student achievement to also consider the attributes of schools and resulting schooling process in relation. This is key to understanding how context affects student achievement. Research related to the effects of schools on achievement has been

conducted in general education for some time (Lee, Bryk, & Smith, 1993; Lee,

Croninger, & Smith, 1997a). The research has identified several important factors related

to achievement, including the math performance of students. In the following section I

provide an overview some of that research.

Improving Math Achievement

A great deal of research in general education has been conducted on factors that

improve mathematics achievement. In particular, over the past 30 years researchers in

general education have examined academic achievement within the context of school

organizational factors, including policies, student-body composition, and curriculum

structure (Lee, et al., 1993). The school effects research conceptualizes the process of

schooling as varying in level (e.g., school and classroom), quantity (e.g., allocation of

instructional time), and quality (e.g., curriculum type, instructional variation) according

to external factors (e.g., race, socio-economic, and ability composition or policies, etc.)

that influence school organization (Bidwell & Kasarda, 1980). These studies measure

attributes of schools in ways that allow researchers to better theoretically approximate

and statistically estimate the relationship between school organizational factors (e.g.,

policies, composition), the schooling process (e.g., curriculum structure,

teacher/classroom effects), and student performance.

For students in general education, research indicates a significant relationship

among school and teacher characteristics, the structure of curriculum, math course-taking

and student achievement (Hill, Rowan, & Ball, 2005; Gamoran, 1987; Lee, et al., 1993;

Lee, et al., 1997a). The characteristics of schools and its policies can reasonably be

conceptualized as organizational factors, external to the school in origin, that nevertheless

affect school decisions. The organization of curriculum, and teacher and student behaviors can be reasonably conceptualized as factors related to the schooling process. Where they are measurable interactions conditioned by the organization in which they occur.

School organization. School demographics, such as racial, socio-economic, and ability composition, are contextual variables associated with math achievement through their effect on how schools organize to provide instruction to students (Lee, et al., 1993). For example, if the overwhelming majority of students in a high school begin 9th grade with poor math achievement and low-level middle school math course-taking backgrounds, the high school may offer numerous low-level math courses and few or no advanced level courses. Thus, we would likely find math achievement in that school to be lower than a school composed of largely high math achievement, high middle school math course-taking students.

Research on teacher characteristics also suggests predictive effects. Controlling for student factors, the math content knowledge of teachers is a predictor of math achievement at the primary level (Hill, et al., 2005). Teacher certification, a common proxy for teacher content and pedagogical knowledge is associated with higher achievement among secondary math students (Goldhaber & Brewer, 2000).

Schooling process. Other research has documented the importance of the types of mathematics courses a student takes. Gamoran (1987) and Lee, et al. (1997a) found that the number and type of courses a student takes in high school, particularly advanced courses, is associated with an increase in math achievement for secondary students.

Further, taking college preparatory math courses is beneficial, in terms of achievement, even among students with very low prior achievement (Gamoran & Hannigan, 2000).

The curriculum is the primary structural variable through which schools provide and differentiate learning opportunities to students (Lee & Bryk, 1988). At the secondary level, students' course-taking choices are restricted to those courses available in the curriculum. Schools therefore delineate both a floor and ceiling of opportunity by the extent to which they constrain or expand curricular choices. A constrained curriculum restricts students' course-taking opportunities to academic or college-preparatory courses (Lee, et al., 1997a). Conversely, a cafeteria-style curriculum expands choices and provides students with a variety of academic and non-academic course choices. Thus, curriculum structure and the resulting course-taking behaviors mediate differences in mathematics achievement (Lee, et al., 1993). These are just some examples of how school-level factors have been shown to influence mathematics achievement among secondary students. However, for secondary students with disabilities, there is no similar research on the school level factors that influence math achievement.

School Effects and Students with Disabilities

Little is known about how school processes and organization influence the achievement of students with disabilities. Traditionally, special education research in the area of mathematics has focused on evaluating individualized instructional strategies and determining "what works" to improve the math skills of students with disabilities (Maccini, Mulcahy, & Wilson, 2007). Through this research special educators have identified several effective instructional level interventions for students with disabilities, such as direct instruction, use of mnemonics, graduated instructional approaches,

cognitive strategies, and schema-based instruction. However, this research has focused on low-level math skills as opposed to the higher order mathematical understanding needed for advanced high school mathematics course taking. Further, while this line of research outlines effective instructional interventions for students with disabilities it does not address meaningful differences in organizational choices, such as course offerings, which schools make that may explain variation in student performance.

Research that has modeled the effects of organizational components on student achievement in general education has shown significant findings and further indicates that differences in performance between sub-groups (e.g., race, socio-economic status) vary as a result of organizational factors (Lee, 2000). These statistical models have not been applied to special education due to the lack of appropriate data and because the orientation of research in the field has been inconsistent with modeling organizational effects. However, recent research does offer descriptive data on the schools attended by students with disabilities as well as data on course-taking behaviors in mathematics. These data provide a means for estimating the organizational components of schools serving students with disabilities as compared to their non-disabled peers.

Organizational Contexts of Education for Students with Disabilities

According to the NLTS-2 data, students with disabilities attend schools that are for the most part similar to their non-disabled peers in terms of racial makeup, student mobility, students living in poverty and proportion of students who are identified as having a disability or are English language learners (Wagner, Newman, Cameto, Levine, & Marder, 2003). Yet, on average students with disabilities attend larger schools than their non-disabled peers (1,310 vs. 751) (Wagner, et al., 2003). Further, over one-third of

students with disabilities attend schools where less than half of 12th grade students complete college entrance exams (Wagner, et al.). Students with disabilities also attend schools with more disciplinary problems and violence than their non-disabled peers (Wagner, et al.). Finally, though students with disabilities are taking and completing more math coursework, more of that coursework is taken during the first 2 years of high school and few (<1%) take advanced level math courses (Wagner, et al.).

In sum, what is known about the contexts in which students with disabilities are schooled suggests a need to determine whether differences in the contexts in which students with disabilities receive education are meaningful to the math achievement of students' with disabilities. Considering school effects research findings in general education, this research may provide an explanation for the persistent gap in math achievement between students with and without disabilities.

Purpose of the Study

The purpose of this study was to analyze the relationship between school organization, curriculum structure, course-taking and the math achievement status of students with disabilities using data from a nationally representative survey sample. Using data from the nationally representative Educational Longitudinal Survey (ELS:02) I describe and compare the mathematics achievement, school characteristics and course-taking behaviors of students with and without disabilities. Second, I examine the contribution of student demographic, prior achievement and course-taking behaviors on predicting the math achievement and course-taking gap between students with and without disabilities. Third, I examine the contribution of school organizational factors in mediating the mathematics achievement and course-taking gap between students with and

without disabilities. Fourth, I examine the contribution of curriculum structure in mediating the gap in math achievement and course-taking between students with and without disabilities.

Research Questions

The research questions for this analysis were:

1. How do the individual and school characteristics of the 10th grade cohort of ELS:02 students with disabilities compare to their non-disabled peers in terms of demographics, student characteristics, academic background, course-taking, and math achievement at 12th grade?

2. Does the gap between students with and without disabilities in (a) their 12th grade math achievement and (b) their high school math course-taking vary among schools?

3. Does the gap between students with and without disabilities in (a) their 12th grade math achievement and (b) their high school math course-taking vary within and between schools after controlling for students course-taking, 9th grade academic GPA, race, SES, and gender?

4. Controlling for 9th grade academic GPA, race, class, and gender do SES composition, ability composition, school size, and amount of school problems affect the slope in (a) the average 12th grade math achievement and (b) the average high school math course-taking of students with disabilities compared to students without disabilities?

5. Do students with disabilities who attend schools with high average course-taking, and/or low variability in course-taking, and low proportions of low

level math course-taking (a) progress farther in the math pipeline or (b) have higher math achievement at 12th grade?

Educational Longitudinal Study of 2002 (ELS: 2002)

This study used the Educational Longitudinal Study of 2002 (ELS: 2002) dataset. The ELS: 2002 complex sampling methods provide a nationally representative sample of the cohort of American youth who were in 10th grade during the 2001 – 2002 school year and 12th grade during the 2003 – 2004 school year (Ingels, Pratt, Rogers, Siegel & Stutts, 2004).

Both student and school level data were collected. Students, parents, teachers, librarians, and school administrators completed survey data. Students also completed educational achievement assessments. Transcript data were collected from sample students' schools between 2004 and 2005. This study used both student and school level variables in order to determine whether the gap in mathematics achievement and course-taking between students with and without disabilities is moderated by school characteristics via course-taking behaviors.

Definition of Terms

Terms used in this proposal are defined as follows:

Cafeteria Curriculum is a school curricular structure that allows students to take a wide range of low to high-level mathematics courses

Constrained Curriculum is a school curricular structure that restricts course-taking to few, academically focused mathematics courses

Course-Taking is the mathematics coursework or classes that students complete in high school

ELS: 2002 is the Educational Longitudinal Study of 2002

High Proportion Low-level Course-Taking is a dichotomous measure of whether greater than 5% (sample median) of students in a school do not advance beyond the below algebra level of math course-taking.

Math Achievement is a cross-sectional, measured score of student skill on a standardized math assessment.

Math Pipeline is a variable measuring the highest course completed in mathematics

Hierarchical Linear Modeling (HLM) is a statistical software package used to model multilevel data.

Minority students are students included in the ELS: 2002 data whose race is noted as American Indian/Alaska Native, Black or African American, Hispanic, no race specified, Hispanic, race specified, Multiracial, or Native Hawaii/Pacific Islander, non-Hispanic

Multilevel Modeling is a method of statistical analysis where researchers can simultaneously model variance at multiple levels of analysis allowing for more accurate estimates of variance and error terms.

Schooling the processes and structures through which schools provide instruction.

School Composition is an aggregate measure of student demographic characteristics in a school.

School Effects are the measurable outcomes (e.g., standardized math performance) of the processes by which school-level variables effect student outcomes.

School-Level Variables are characteristics of schools such as average socioeconomic status, proportion minority, size, etc.

School Problems are school 'climate' problems identified by school administrators in the ELS: 2002 dataset including: attendance, theft and physical altercations, group or racial tensions, drugs and alcohol problems, or disorderly climate.

Secondary Students are students attending high schools, grades 9 through 12.

SD Math Pipeline is variability in course-taking as measured by the within school standard deviation of the highest course taking on the mathematics pipeline.

Slope or gap is the representation of the change effect of an organizational variable on a level-1 relationship. For example, the effect of being in a high SES school may be to increase the achievement of students or narrow the gap in achievement between minority and non-minority students. Such an effect would be equivalent to a cross-level interaction.

Students with Disabilities are students who have been identified as being in need of special education service due to mental retardation, hearing impairments (including deafness), speech or language impairments, visual impairments (including blindness), serious emotional disturbance, orthopedic impairments, autism, traumatic brain injury, other health impairment or specific learning disabilities.

Student-Level Variables are characteristics of students or their families, such as: race, gender, disability status, socioeconomic status, prior achievement.

CHAPTER II

Literature Review

Math skills are necessary for students' to navigate life and compete for both unskilled and skilled employment in a technology-based global economy (National Mathematics Advisory Panel, 2007; Reyna & Brainard, 2007). The importance of mathematics acquisition by students has long been recognized and of great concern. Recent international assessments have indicated that American students perform below students in U.S. economic peer countries (e.g., United Kingdom or Japan) on assessments of math achievement (Niedorf, Binkley, Garris, & Nohara, 2006), which has only intensified the focus on increasing mathematics achievement among the nation's secondary students.

Students with disabilities perform even more poorly than their peers without disabilities (McLaughlin, et.al., 2007; Wagner, et al., 2006; VanGetson & Thurlow, 2007). Research in special education has tended to focus on developing specific interventions and curricula and has not considered contextual effects of schools as part of the explanation for the gap in achievement between students with disabilities and their peers without disabilities. Recent research has begun to document differences in the learning environments of students with disabilities compared to their non-disabled peers (Ingels, Pratt, Rogers, Siegel & Stutts, 2004;Wagner, Marder, Cameto & Levine, 2003).

As a result of advances in statistical modeling (Raudenbush & Bryk, 2002) and national longitudinal studies of student performance (NCES, 2007), we now have the opportunity to examine the effects of school organization and schooling processes, such as course taking, on the achievement of students with disabilities. The purpose of this

study was to estimate the effects of school characteristics (e.g., school size, SES composition, school problems) on the organization of curriculum (e.g., constrained curriculum, course-taking) and its resulting effect on the math achievement of students with disabilities.

Organization of the Chapter

This chapter is organized into 5 sections. First, I discuss the history of reforms in mathematics education in general and within the context of special education. I then discuss the current status of knowledge on the math achievement of students with disabilities particularly focusing on the gaps in the math achievement of students with disabilities in comparison to students without disabilities. Third, I provide a summary of the known school level factors that affect math achievement in students in general based on the findings of a 1993 review of the literature on effective schools. Within this section I also provide support for examining the effects of how schools structure course-taking opportunities (i.e., curriculum structure) in order to understand school effects on students with disabilities math achievement. In the fourth section, I provide a critical review of the literature on the effects of course-taking and curriculum structure on student achievement in mathematics. Finally, in the fifth section I provide a summary of the findings in this chapter.

Mathematics Reform History

Though math achievement among American students has enjoyed a high profile recently, increasing standards and accountability in math is a longstanding issue in the education system (Coleman, 1966). The National Council for Teachers of Mathematics (NCTM) is the current face of math reform in the United States (NCTM, 1989, 2000).

However, a mathematics education reform movement, led by educators and policymakers, predates the NCTM by nearly 30 years (Woodward, 2004).

The 1957 Soviet launch of Sputnik signaled, to American politicians entrenched in a Cold War, Soviet preeminence in the technology-based arms race. Further, Sputnik suggested to American policymakers a need to increase the production of future scientists in order to compete in and eventually win the Cold War. In order to produce more scientists, the American school system had to increase the focus on math and science. In 1958, Congress passed the National Defense of Education Act with the intent of improving schools, particularly in the areas of math and science (United States Department of Education, 2006).

The focus on math reform resulted in a reexamination of the tenets of traditional mathematics education, including curriculum, pedagogy, and the quality of teachers in secondary mathematics education (Woodward, 2004). The new math curricula called for teachers to focus on abstract and conceptual mathematics over rote memorization of formulas. The utility of instruction based on a behavioral approach was called into question when compared to the abstract and conceptually based models of cognitive and constructivist theories (Woodward & Montague, 2002). Further, the application of the new curriculum would require a teaching force that was highly knowledgeable in mathematics (Woodward).

Academic and mathematics reform efforts continued in the 1970s through the 1990s. Numerous reports outlined poor math performance among American students and noted the looming risks to the American economy as a result of continued failure to reorganize math education (National Commission on Excellence in Education, 1983;

NCTM, 1989; Marshall, 1991). Consistently, these reports cited curricular deficiencies, low coursework expectations and an inadequately trained teaching force as major barriers to high student achievement (Wright, Wright & Heath, 2003).

Today, the NCTM continues to advocate for the participation of all secondary students in a common curricula of ambitious mathematical standards (NCTM, 2000). These standards include a focus on numbers and operations, algebra, geometry, measurement, and data analysis and probability. Conceptually, the focus areas range from number representations and complex numbers to operational relationships and estimation. The NCTM also advocates for math course enrollment in all four years of high school. Concurrently, the NCLB, by threat of sanction, has forced states to examine their curricular standards in relation to assessment and reporting requirements (Latterell, 2007).

Special Education and Mathematic Achievement

While government officials, researchers and economists focused on the math achievement of students with an eye toward a space-race and the Cold War, another movement, with a focus on less quixotic goals, was occurring. Between the 1960s and early 1970s individual states began to pass laws requiring the provision of educational services to individuals with disabilities (Martin, Martin, & Terman, 1996). Prior to these legislative acts, children with disabilities were served in inappropriate settings or not served at all. Beginning in 1954 a number of cases regarding citizen rights, including *Brown v. Board of Education* (347 U.S. 483, 1954) and *PARC v. Commonwealth of Pennsylvania* (334 F. Supp. 1257, 1971) concluded in the favor of the claimant, thus, providing a boost to the disability education movement.

In response to state laws and court decisions, Congress enacted Public Law 94-142, The Education of All Handicapped Children Act in 1975 establishing the right to a Free and Appropriate Public Education (FAPE) for students with disabilities. For over 30 years, the education of students with disabilities has been shaped, more or less entirely, by Public Law 94-142, which would later be renamed the Individuals with Disabilities Education Act (IDEA) (Martin, et al., 1996).

Federal recognition of the right to education services for students with disabilities has not, historically, translated into expectations of academic excellence for students with disabilities. In fact, the absence of high academic standards for students in special education has made it difficult to determine what constitutes an appropriate education for students with disabilities. The only Supreme Court case to consider this question has been *Board of Education v. Rowley* (458 U.S. 176, 1982). In this case the court set an upper limit to what constitutes a *free and appropriate public education* requirement, noting that the IEP "need not convey maximal benefit".

In the 1997 reauthorization of IDEA, several additions were made to the text of the law to further align the expected educational achievement of students with disabilities and their non-disabled peers (McLaughlin & Nagle, 2004). The law indicated that students with disabilities were expected to take state exams and have their disaggregated scores publicly reported. Further, both the 1997 and 2004 reauthorizations of IDEA mandate accommodations that allow students with disabilities access to the general education curriculum (Nolet & McLaughlin, 2000; Soukup, Wehmeyer, Bashinski, & Bovaird, 2007). These additions to the text of the law constitute a formal paradigm shift within the field of special education.

Prior to the 1997 reauthorization, the IDEA was largely dedicated to outlining procedural rather than academic accountability (McLaughlin & Nagle, 2004). Throughout the history of the IDEA special education has operated from a framework of service provision based on individual skills and goals of the students. In other words, the focus was not on student academic outcomes but rather the process of providing services, as outlined in the historical litigation and legislation of special education.

Where IDEA 1997 took steps toward creating accountability for the educational achievement of students with disabilities; the No Child Left Behind Act of 2002 (NCLB) leapt toward that end. With regard to students with disabilities, NCLB requires states to: (1) assess students with disabilities against the same standards as their non-disabled peers; (2) assess students with disabilities using grade appropriate tests; (3) make public the disaggregated subgroup score of students with disabilities; and (4) count scores of students with disabilities on the state assessment toward Adequate Yearly Progress (AYP). The AYP are progressive annual goals measuring the percent of students scoring at the proficient and advanced levels. This goal increases yearly through 2012 when all schools must reach 100% proficiency. While the provisions have appeared in various incarnations in previous legislation, the system of rewards and sanctions that accompany NCLB make the law unique. In addition to the general challenges of implementing the requirements of NCLB for students with disabilities (McLaughlin & Nagle, 2004), states that fail to include all subgroups or meet the requirements of the law for all subgroups, including students with disabilities, face sanctions (20 U.S.C. § 6312; 20 U.S.C. § 6842). In emphasizing accountability for all students, NCLB juxtaposed the view of school organization as predictor of student outcomes with the IDEA's notion of individual

abilities as outcome predictors. The 2004 reauthorization of IDEA provided a tenuous resolution to the contrasts in the laws by aligning special education requirements for accountability and teacher qualifications with the text of NCLB.

Thus, current special education policy is more closely aligned with the conceptualization of schools as organizations whose decisions play a meaningful part in the achievement of students. In part as a result of this alignment of policies and the movement toward greater accountability for outcomes of students with disabilities, data are now available on the math achievement of students with disabilities. Consistently, these data indicate a significant gap between the math achievement of students with and without disabilities.

Math Achievement and Students with Disabilities

A number of federally funded and state assessment programs, including the NAEP, NCEO, and NLTS-2, have produced data that illustrate the gap in math achievement between students with disabilities and their non-disabled peers. The NAEP has measured student performance in math, and other areas, in 4th, 8th and 12th grades since 1969 (National Center for Education Statistics, 2007). The NAEP student performance data are available for both students with and without disabilities. According to NAEP data, there was a 19% gap in the percent of 12th grade students with disabilities who achieved proficiency in mathematics as compared to their non-disabled peers in 2005 (National Center for Education Statistics, 2007). Further, less than 10% of 12th grade students with disabilities achieved proficiency on state mathematics assessments in the 2005-2006 school year.

The NCEO provides states and federal agencies leadership and technical support in an effort create adequate assessment and accountability systems for students. The NCEO also conducts research and disseminates data on state assessment and monitoring efforts. According to a report issued by the NCEO that analyzed the extent of assessment reporting for students with disabilities in each state for the 2004-2005 school year, only 6 states reported more than 40% of students with disabilities achieved proficiency on the high school math assessment (VanGetson & Thurlow, 2007). Conversely, 22 states reported that less than 20% of students with disabilities achieved proficiency.

The gaps in the percent of students with a disability that achieved proficiency varied between states, however, the performance of students with disabilities tended to vary in tandem with the performance of regular education students in their state (VanGetson & Thurlow, 2007). In other words, states where the percent of regular education students exhibited a high rate of proficiency also had students with disabilities that exhibited a relatively high rate of proficiency. Notwithstanding, the gap in the percent of students with disabilities who achieved math proficiency in comparison to their peers without disabilities was as high as 60 percentage points in one state and as small as 17 percentage points in another.

The NLTS-2 study, which began in 2000, follows a nationally representative sample of students with disabilities through secondary and post-secondary school (Wagner, Newman, Cameto, & Levine, 2006; National Center for Special Education Research, 2007). Using surveys and direct assessments, the study examines the student's academic, school, family, post-secondary, and work experiences and beliefs. Math performance of students in the NLTS-2 sample is measured by average student performance on subtests

of the Woodcock Johnson –III Tests of Achievement (WJ-III). The WJ-III is a standardized assessment that includes subtest of math calculation, fluency, and applied problem solving.

The mean math scores of students with disabilities vary widely across disability categories (Wagner et al., 2006). The NLTS-2 indicated that 27% of students with disabilities scored 2 standard deviations below the national mean on a norm-referenced assessment of mathematics functioning (Wagner, Newman, Cameto, & Levine, 2006). Eighty-four percent of students with disabilities score at or below the mean on tests of applied problems and 15% score more than 2 standard deviations below the mean (Wagner). On average, secondary students with disabilities display a 3-½ year gap in math achievement in comparison to their non-disabled peers (Wagner, Marder, Blackorby, Cameto, Newman, Levine, & Davies-Mercier, 2003).

Explanations for the gap in achievement may, in part, be found by understanding the contexts in which students with disabilities receive their education. For students in general education, studies of contextual or school effects have yielded a considerable amount of information on how school level factors (e.g., SES composition, average achievement) affect student achievement in mathematics. Therefore, it is important to understand whether similar school level factors account for variations in performance of students with disabilities.

School Level Factors that Affect Math Achievement

There is an extensive general education research base on school organizational effects on student achievement, including mathematics, dating back to the Coleman report (1966). The Coleman report was commissioned by the U.S. government to examine the

distribution of educational opportunity in schools by race/ethnicity, gender, socioeconomic background and religious affiliation. Coleman reported that schools differed in their composition in terms of the ability of students and that variability in achievement was greater within schools than between them. He also noted that several school level factors had differential affects on some student achievement (e.g., curriculum, teacher characteristics, peer attributes).

Almost 30 years after Coleman, Lee, Bryk, and Smith (1993) reviewed the qualitative and quantitative research literature related to the effects of school organization on student academic achievement. Lee, et al. (1993) analyzed the organization of schools and the schooling process from the perspective of two contrasting models: rational-bureaucratic and personal communal models. From the rational-bureaucratic (bureaucratic) perspective, schools are formal organizations designed to minimize interaction and individualization and maximize specialization. From the personal communal (communal) perspective, schools are small societies in which common values drive informal interactions and relationships and in effect minimize specialization.

Lee, et al. (1993) primarily intended to contrast these two perspectives as a means to build on their theory that communally organized schools are more effective in terms of academic achieving equity and achievement. However, the report also serves to clarify the known organizational factors that vary within effective schools. These include racial, social class, and ability composition as well as school size and parental involvement as factors external to schools that influence schooling. Autonomy of the principal, teacher work environment, and school culture were found to be internal factors that influence the organization of schooling. Finally, social organization, organization of teacher work and

the organization of the curriculum were specific schooling processes that vary between effective and ineffective schools. Of note within the findings on the organization of curriculum was the strong empirical support for course-taking as an explanatory variable of student success.

Lee, et al. (1993) found that the external policies, structures, and demographics that surround schools affect the organization of work within schools. These effects are evinced in the leadership style of principals, the performance expectations of students and teachers, the school culture and norms and the structure of curriculum. Each of these effects, though externally borne, can be appropriately conceptualized as effects of the school on the organization of the schooling process or school effects (Bidwell & Kasarda, 1980). The structure of curriculum, both through the upward boundary it sets and by the informal tracks it delineates, influences course-taking opportunities within schools (Gamoran, 1987). Among school effects, course-taking has the strongest relationship with academic achievement (Lee, et al.).

The Importance of Course-taking

The importance of course-taking to the achievement of secondary students is evident in the general education research on effective school organization (Lee, et al., 1993). Conceptually, the effects of course-taking are distinctive from those of other organizational factors (e.g., demographic composition, number of certified teachers, etc.) because course-taking is directly linked to the processes through which schools provide instruction (Bidwell & Kasarda, 1980). School organizations are primarily responsible for conducting instruction. The process through which instruction occurs is known as schooling. For example, school-level decisions regarding the structure of the math

curriculum (e.g., number of high rigor course offerings) condition schooling through the types of interactions it dictates between teachers (teaching content knowledge demands) and students (course-taking requirements/options). However, school-level decisions about how to structure the math curriculum are conditioned by the characteristics (number of certified calculus teachers, calculus demand, material resources) of the organization itself.

Research indicates that course-taking behaviors are directly affected by the curricular structure of the secondary schools that students attend (Gamoran, 1987; Gamoran & Berends, 1987). School-level decisions on course offerings in mathematics, in terms of type, serve to limit opportunities for student academic growth; the number of offerings effectively stratifies learning opportunities. For example, Lee and Bryk (1988) concluded that because all students in Catholic schools were held to the same academic expectation (college preparatory) and available courses were limited to an academic core, students essentially occupied the same high-level track. Conversely, students in public high schools are provided with a multitude of choices to fulfill graduation requirements. Consequently, students choose courses at various levels of rigor across various subjects. Even after controlling for the effects of student selection in Catholic schools, this policy of the "constrained curriculum", as it would later be termed (Lee, Croninger, & Smith, 1997a), had a significant independent effect on student achievement (Lee & Bryk).

One of the reasons course-taking matters is that instructional methods of teachers vary within classrooms in complexity and speed (Gamoran & Berends, 1987). Current research suggests that students with disabilities tend to be enrolled in less rigorous classes (Wagner, 2003). Teachers in less rigorous classes are more likely to be inexperienced and

provide simplified work at a slow pace. These classes are characterized by a focus on basic ideas and the use of structured written work. Teachers in high-rigor classes engage students in discussions and activities about complex ideas. Teachers in less rigorous courses perceive their students more negatively and less able in general (Gamoran).

The importance of course experiences is not limited to the rigor of the classroom experience or perception of teachers. Students are aware of the hierarchical position of their classes on the scales of course rigor (Gamoran & Berend, 1987). Thus, their position within the curriculum structure and consequently the expectations for and of themselves are institutionalized. Peer groups within the classroom affect classroom behaviors (Gamoran & Berends, 1987). Academically, the behaviors of peer group members in low rigor courses serve to impede each other's academic growth. Students with disabilities appear to be clustered in classrooms with low-achieving students (Wagner, et al., 2003).

Examinations of curriculum structure through course offerings and course-taking behaviors serve as close proxies for the schooling experiences of students within classes and may explain stratification of opportunities in schools and subsequent, differences in achievement. Consequently, research that seeks to examine the school-level factors that explain variation in student performance should view course-taking as the primary variable in the analytic model. Further, course-taking behaviors are of particular importance in modeling school effects on the math achievement of students with disabilities considering the tracking of students with disabilities that is suggested in the research (Wagner, et al., 2003). To date, there is no research on how the course-taking behaviors of students with disabilities relates to their math achievement.

School Level Factors and Math Achievement of Students with Disabilities

Efforts to address the performance of students with disabilities have focused almost exclusively on improving the instructional practices of special and general educators. These efforts have produced a considerable body of literature on strategies such as the use of direct instruction, concrete-semiconcrete-abstract (CSA) sequencing, progress monitoring, graphic representations, and other technologies to improve student learning in mathematics (Maccini, Mulcahy & Wilson, 2007; Pashler, Bain, Bottge, Graesser, Koedinger, McDaniel & Metcalfe, 2007). This focus on "intervention research" has left the field of special education rich in instructional design knowledge that has resulted in improved student learning. However, there is no research-based knowledge of the school-level contextual factors that effect the math achievement of students with disabilities. Nationally representative data from the NLTS-2 offers some information on selected characteristics of schools attended by secondary students with disabilities and the contexts in which they are educated.

Composition

Demographic composition of a school has been shown to be an important predictor of math achievement among secondary students (Konstantopoulos, 2006). Compositionally, schools attended by secondary students with disabilities are similar in racial/ethnic makeup to schools attended by students in general (Wagner, Newman, Cameto, Levine, & Marder, 2003). On average, students with disabilities attend schools where 16% of the student population has a disability as defined by the IDEA. Additionally, student mobility, the proportion of students who are English language learners (ELL) or living in poverty are each similar to national averages across schools.

School Size

Empirical research suggests a relationship between school size and student performance at the secondary level. Students appear to have the highest achievement in secondary mathematics when attending 'mid-sized' schools of approximately 600 – 900 students (Lee, 2000). On average, students with disabilities attend schools that are larger than their non-disabled peers (1,310 vs.751) (Wagner, et al., 2003). The average academic general education class size of secondary students with disabilities is also larger than that of their non-disabled peers (27 vs. 22).

Academic Press

Academic press is commonly evaluated using measurable proxies such as time spent on homework, percent students completing college entrance exams, percent students enrolling in post-secondary school, and measures of teacher and student beliefs regarding the academic emphasis of the school (Rumberger & Palardy, 2005). Generally, students with disabilities attend schools with a moderate level of academic press. According to data from NLTS-2, 34% of students with disabilities in that sample attend schools where less than 50% of 12th grade students complete college entrance exams (Wagner, et al., 2003). Conversely, 26% of the students attend schools where more than 75% of the students complete college entrance exams. Twenty-seven percent attend schools where fewer than 50% of graduates attend 2- or 4-year colleges after high school. Thirty-three percent attend schools where more than 75% of graduates attend 2- or 4-year colleges after school.

Though not frequently cited as a measure of academic press, pressure to improve test scores may be viewed as a relevant proxy for the academic press of schools (Wagner, et

al., 2003). Further, this type of pressure on teachers and students may result in greater attention to the academic deficits of students with disabilities (McLaughlin & Rhim, 2007). According to Wagner, over 90% of students with disabilities attend schools where school personnel report a fair- to great deal of emphasis placed on improving test scores of students.

School Climate and Environment

The learning environment of schools is related to student performance (Pallas, 1988). This environment is affected by events in and around the school such as the number of disciplinary problems, suspensions, expulsions, and acts of violence or crime. Students with disabilities attend schools that are more problematic (e.g., disciplinary problems, violence, and crime) than their non-disabled peers (Wagner, et al., 2003). Twenty-nine percent of students with disabilities attend schools that report more than 175 out-of-school suspensions per year. Thirty percent of students with disabilities attend schools that report 25 or more violent incidents per year.

Coursework

As a result of the movement toward increased academic standards, students with disabilities are taking and completing more mathematics coursework at the high school level than they were 2 decades ago (Wagner, et al., 2003). The average high school requires about 2 ½ years of mathematics coursework for graduation. However, the percentage of students with disabilities taking math drops from 98% to 85% between freshman and junior years of high school, suggesting that many students with disabilities are not attempting to take extra or advanced mathematics coursework (Wagner, 2003).

Specific data on the rigor of courses taken by students with disabilities are scarce. Over 70% of students with disabilities are enrolled in life or study skills classes in an average semester. Only 60% of courses taken by students with a disability in a given semester are academic (Wagner, 2003). Students with disabilities are less likely than general education students to take occupationally specific vocational education classes (52% vs. 64%) but more likely to take pre-vocational classes (34% vs. 15%). Students with disabilities more often take these classes in the final 2 years of high school when their academic course-taking simultaneously decreases (Wagner).

As a result of NCLB, the focus of school policies for students with disabilities tends to center on standardized testing participation, accommodations and exemptions (Wagner et al., 2003). Little is known about the curricular organization of the public schools that educate students with disabilities. However, the fact that math course-taking by students with disabilities decreases from freshman (98%) to junior (85%) year suggests that schools are not demanding that students with disabilities go very far in their math coursework (Wagner et al., 2003).

Teachers

Between 18 – 26% of teachers of students with disabilities report using slower paced instruction in classes (Wagner, et al., 2003). A recent study of the educational contexts of students with LD indicates that 85% of their general education teachers reported using print materials frequently (Newman, 2006). Up to 90% of these teachers report that they rarely engage their students in community-based learning or field trips. Within special education 24% of general education teachers view students with LD in

their class as somewhat appropriately placed and another 7% believe their placement is not appropriate (Newman, 2006).

The data on the actions and perceptions of teachers in the general education classes of students with LD do not serve as an overwhelming indictment of curriculum structuring for students with disabilities. However, taken on the whole, the data on the contexts of education for students with disabilities appear to align unfavorably with the description of less rigorous classes given in the research (Gamoran & Berends, 1987). These data suggest that the increase in participation of students with disabilities in general education academic classes may be occurring only in less rigorous and/or low ability classes (Wagner, et al., 2003). As a result of what is known of the context in which students are schooled a question must be raised: how does school organization effect math achievement for students with disabilities?

Research on School-level Factors

Only two studies in the special education literature have examined school level variation as it relates to achievement. Malmgren, McLaughlin, and Nolet (2005) reported that achievement levels of students with disabilities were higher in schools where students in general education have higher levels of achievement. This study represents the sole discussion of contextual effects based on large-scale data, and its findings suggest the need for further examination of school effects on the achievement of students with disabilities.

Another study analyzed the relationship between school level performance in reading achievement of students receiving special education and the environmental characteristics of schools associated with Effective Schools Research (ESR) (Cook,

Gerber, & Semmel, 1997). The authors reported that while characteristics associated with effective schools were related to an increase in reading performance among general education students a corresponding decrease in reading performance was seen among students with mild disabilities. However, the Cook et al's, (1997) analytic model measures the effects of ESR characteristics on average school-level reading achievement only, thereby assuming that school characteristics affect all students with disabilities in the same way and not accounting for the differential experiences among students with disabilities and within schools (e.g., course-taking). Thus, the field of special education remains devoid of a research base on the effects of course-taking on the math performance of students with disabilities within the context of school characteristics and schooling. This gap in knowledge is particularly problematic in light of empirical findings that indicate course-taking, controlling for student-level predictors affects student math achievement in general.

Critical Review of Relevant Research

In light of the lack of research on school effects and students with disabilities, I examined the scholarly research on school effects, via course-taking, and math achievement among general education students to determine the variables that may be predictive or covariant with math achievement among students with disabilities. In order to complete the review of literature, I conducted a 3-step literature search. The procedures and criteria for inclusion are described below.

Selection Procedures and Criteria

The Lee, Bryk and Smith (1993) comprehensive review of the literature on the organization of effective secondary schools identified the relevant questions in the

qualitative and quantitative research on school effects and schooling prior to 1993. Therefore, my search did not include qualitative school effects research and was limited to the quantitative literature on school effects completed during or after 1993. The purpose of my review was to identify specific school organizational variables (e.g., demographic composition, policy requirements, etc.) related to secondary student achievement in mathematics. Further, I sought to identify specific measures of schooling (i.e., curriculum structure and course-taking) that significantly effect math achievement in secondary students' for use in my analysis. I intend to investigate the combined influence of these variables on the math achievement of students with disabilities identified in the ELS: 2002 database.

I conducted a search of the following electronic databases for publications between 1993 and 2007: Academic Search Premier, ERIC, Education Abstracts, Education Research Complete, PsychArticles, PsychCritiques, Psychology and Behavioral Sciences Collection, PsychInfo, and SocIndex. First, the databases were searched using the terms: *math and mathematics, course taking, and achievement.* I then conducted a hand search of the *Educational Evaluation and Policy Analysis* between 1993 and 2007. Finally, I performed an ancestral search of all articles collected for this review. In order to be included in this review each study met 4 criteria:

- The study sample includes secondary-aged students
- At least one outcome is a measure of math achievement
- The study includes an independent measure related to student course-taking
- The study includes a measure of a school organizational component variable as conceptualized in Bidwell & Kasarda (1980)

As a result of the search process, I identified 7 articles appropriate for this review (Chaney, Burgdorf & Atash, 1997; Everson & Millsap, 2004; Lee, Burkam, Chow-Hoy, Smerdon, & Geverdt, 1998; Lee, Croninger, & Smith 1997a; Lee & McIntire, 1999; Lee, Smith & Croninger, 1997b; Teitelbaum, 2003). Each of the studies modeled school effects on student math achievement using secondary data analysis of large-scale databases (see Table 2.1). To assess the methodological strengths and weaknesses in the field, these studies were reviewed using an electronic coding system. The coding system used in this review was adapted from methods outlined by Thompson, Diamond, McWilliam, Snyder, and Snyder (2005). In the following sections I will describe the theoretical basis, samples, weights, measures, analyses, results, discussions and limitations of the studies included in this review.

Theoretical Basis

Each of the studies I reviewed established a theoretical basis for research aligned with the framework established in Lee, et al. (1993). Specifically, the studies focused on school level variables that effect student achievement in mathematics through curriculum structures and course-taking, independent of individual student characteristics. Two studies focused on policies related to altering curriculum structures

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through graduation requirements (Teitelbaum, 2003; Chaney, Burgdorf, & Atash 1997). Teitelbaum (2003) examined the effect of minimum graduation requirement policies on course-taking behaviors, course completion, and math achievement gains. The authors

explored whether increasing math credit requirements to 3 courses was related to increases in the number of math courses-taken, level of math courses taken, and the subsequent math achievement gain score among a sample of public secondary school students from the NELS: 88 data. The other graduation requirements study was also interested in the influence of graduation requirements on the course-taking behaviors of students (Chaney et al., 1997). Though this study examined the relationship using math achievement data of secondary students from 1990 National Assessment of Educational Progress (NAEP) and the 1990 High School Transcript studies.

One study of school effects examined the relationship between school location (rural vs. non-rural) on the social and structural organization of schools and student achievement (Lee & McIntire, 1999). The study used 1996 NAEP mathematics achievement data. Everson and Millsap (2004) analyzed the relationship between school and individual characteristics and SAT-math scores. The authors' intent was to advance the understanding of school effects by modeling the direction and structure of the relationships among school organizational factors, schooling, student characteristics, and achievement using multilevel structural equation models.

The final 3 studies focused, at least in part, on the organization of curriculum in secondary schools and its effect on course-taking and math achievement (Lee, et al., 1998; Lee, et al., 1997a; Lee, et al., 1997b). Specifically, 2 of the studies examined whether a constrained curriculum versus a differentiated curriculum resulted in different course-taking behaviors and math achievement among secondary students (Lee et al., 1998; Lee, et al., 1997a). As noted in the research on the distribution of academic achievement differences between catholic-private and public schools; a constrained

curriculum limits the course choices of students to a common, typically academically focused set of courses (Lee & Bryk, 1989). A high school curriculum that is highly differentiated, both in terms of the number of low (e.g., below algebra) course offerings and the range of offerings within course-types (e.g., degree of rigor) is typical of public high schools. This greater differentiation in course offerings is associated with greater differentiation in achievement within public schools.

The final study attempted to delineate the organizational components of high schools that were associated with higher and more equitably distributed math achievement (Lee, et al., 1997b). The authors explored the structure of high school social, curricular, and instructional organization.

Sample Selection and Description

Six studies utilized datasets from the National Center for Education Statistics (Chaney, Burgdorf, & Atash 1997; Lee, Burkam, Chow-Hoy, Smerdon, & Geverdt, 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Lee, et al., 1997b; Teitelbaum, 2003). These national datasets employ multi-stage probability samples of high school students nested within schools. These sampling methods provide a nationally representative sample of high school students (Kish, 1995). It is of note that none of the studies selected a special sample or students with disabilities making generalization of findings from these studies to students with disabilities problematic (Kish, 1995).

A considerable amount of research on school effects has been conducted using data from the National Center for Education Statistics' National Education Longitudinal Studies Program (Schneider, Conroy, Kilpatrick, Schmidt, Shavelson, 2007). The goal of the program is to provide longitudinal data on the educational, vocational, and personal

growth of American high school students. The research programs include the National Longitudinal Study of the High School Class of 1972 (NLS-72), the High School and Beyond study (HS&B), and the National Education Longitudinal Study of 1988 (NELS-88). Recent additions to the program include the Early Childhood Longitudinal Study and the Educational Longitudinal Study. However, these study data were not used in the analyses included in this review. I provide a summary of the sampling methods used in the National Assessment of Education Progress: 1990 & 1996 (NAEP:1990; NAEP:1996), the 1990 High School Transcript Study (HSTS:1990), and the National Educational Longitudinal Study of 1988 (NELS:1988).

Studies using NAEP:1990-HSTS:1990 or NAEP:1996 data. Of the 6 studies that used NELS program data, 2 used NAEP:1990 (Chaney, et al., 1997; Lee, et al., 1997a) and 1 used NAEP:1996 data (Lee & McIntire, 1999) as the primary source for analysis. Both the NAEP 1990 & 1996 used a 3-stage sample design with 94 geographic areas as the primary sampling units (PSU's), then selected schools within PSU's, then students within schools (Allen, Carlson & Zelenak, 1999). Students who were judged functionally disabled or incapable of meaningful response to assessments and surveys were excluded from the sample. In the NAEP:1996, students with disabilities were over-sampled for mathematics assessments in 83% of the schools that were used in the analysis in Lee and McIntire (1999).

In order to test their constrained curriculum theory, Lee, et al. (1997a) selected only secondary students with both math assessment and transcript data in the NAEP:1990 and HSTS:1990. Further, the authors only selected students within schools who had graduated and whose high schools had data on course offerings. The authors chose

students who graduated since they were interested in the effects of course-taking and achievement over the course of high school. The selection restraints resulted in a sample of 3,056 students in 123 high schools. As noted earlier, due to the sample design of the NAEP and the author's inclusion of design weights in the analysis, the results of the analysis can be generalized to the cohort of 1990 high school graduates.

For their analysis of graduation requirements effect on achievement, Chaney, et al. (1997) also selected only secondary students who had graduated and had both math assessment and transcript data in the NAEP: 1990 and HSTS: 1990. The authors further excluded students who had an IEP or were limited English proficient. For the math analysis, selection restraints resulted in a sub-sample of 3,369 students in 140 high schools. Lee and McIntire (1999) did not provide a description of how they arrived at a sub-sample for their analysis, therefore, I was unable to determine which 8th grade students attending public school that were included in the NAEP: 1996 sample were the basis for the analysis and conclusions.

Studies using NELS: 88 data. Three of the 6 studies that used National Education Longitudinal Study analyzed data from NELS: 88 (Lee, et al., 1998; Lee, et al., 1997b; Teitelbaum, 2003). NELS: 88 is a longitudinal study intended to examine the educational, post-secondary, and vocational development of a cohort of students beginning in 1988 (Spencer, Frankel, Ingels, Rasinski, & Tourangeau, 1990). The NELS:88 used a 2-stage sampling process in its base year to sample 8th grade students in public and private schools in the U.S.. The sample excluded students with mental handicaps, emotional or physical disabilities, as well as those whose command of the English language would make participation in assessments and surveys unrealistic.

Lee, et al. (1998) drew their sub-sample from the High School Effectiveness Study (HSES). The HSES is a study within the NELS: 88 that samples NELS: 88 schools and augments the sample by adding students within those schools who were in the 10th grade in 1990. At the student level, the authors selected students with HSES data on 10th and 12th grade math assessment scores, complete high school transcript information, race, gender, and socio-economic status data (Lee, et al., 1998). At the school level, the authors selected only schools with completed administrative questionnaires at the first two waves and schools that were either public, Catholic, or National Association of Independent Schools. The selection process resulted in a sub-sample of 3.430 students in 184 high schools.

Lee, et al., (1997b) drew a sub-sample of students from the 3-waves (1988/1990/1992) of the NELS: 88. At the student level, the authors selected students who had assessment data at all 3 waves, attended a school with at least 5 other students in the NELS sample, and were attending the same school in 10th and 12th grades. At the school level, schools were selected if they had provided teacher and school data, and were public, Catholic, or elite private schools. The selection criteria resulted in a sample of 9,631 students in 789 high schools.

Teitelbaum (2003) also drew a sub-sample of students using 3-waves of the NELS: 88. Teitelbaum selected students who had complete high school transcript data, a high school identification number, base year and second follow-up test scores (8th and 12th grades), graduated in 1992, attended a public school with graduation requirement information, and remained in the same school between 10th and 12th grades. These restrictions resulted in a final sub-sample of 5,586 students in 732 schools.

College Board – SAT data. The last of the 7 studies drew a sample from the College Board's 1995 cohort of seniors who took the Scholastic Aptitude Test (SAT) (Everson & Millsap, 2004). The sub-sample was restricted to SAT takers who completed a 43-question survey about their school experiences, academic and family background. The sub-sample was further restricted to those schools for which data on the number of students eligible for free and reduced lunch, school size, proportion of minority students, and school location were available from the National Center for Education Statistics. The resulting analytic sub-sample consisted of 288,066 students in 258 high schools. Results of analyses from this sub-sample cannot be generalized beyond SAT test-takers who respond to the voluntary questionnaire as no data are provided on non-respondents and the population of SAT takers may be meaningfully different from non-SAT takers.

Weights. Because of the complex sampling design used to generate NCES NELS program data, design weights must be included (Kish, 1995). Sampling weights are used to adjust for differential sampling rates and non-response so that inferences about population parameters can be made from results. One of the 6 studies that used NELS program data reported not including design weights in the analysis (Teitelbaum, 2003).

Measures

Studies using NAEP: 1990; -HSTS: 1990; and NAEP:1996 data. As a result of time constraints and the purpose of the NAEP: 1990 and NAEP: 1996, students taking the mathematics assessment answer only a limited number of test items. As a result, math scores are not measured but rather estimated using two scaling methods; Item Response Theory (IRT) and Average Response Method (ARM). As a result of scaling procedures, particularly ARM, some variable estimates may be biased (Johnson & Allen, 1992).

Chaney et al., (1997) used the NAEP: 1990 measure of mathematics achievement as the primary outcome to analyze the influence of graduation requirements on student achievement. They used data from the HSTS: 1990 to measure math courses taken in terms of number and type. Specifically, the authors used school data on course titles and classification (e.g., college-preparatory vs. non-college-preparatory) to distinguish types of course-taking behaviors. Students 9th grade point average (GPA) was used as a measure academic skill level upon entering high school. The authors dichotomized the 4-point scaled GPA into above 2.0 or 2.0 and below for their analysis. This decision was made "to simplify the discussion of GPAs".

The analytic model included gender, race (Black/Latino vs. White/Other), parental education, and students attitude toward math at the student level (Chaney et al., 1997). Each of these variables was dummy-coded. The authors argue that the dichotomized race variable is important for increasing cell sizes and emphasizing the important distinction between minorities vs. non-minorities rather than distinctions among minorities. At the school level, dummy coded variables for school sector (public v. private), mathematics given priority, and graduation requirements (more or less than 2 years of mathematics). School region and urbanicity were also entered into the model as school-level variables. Lee, et al. (1997a) also used the NAEP: 1990 math assessment values as an outcome and 9th grade dichotomized GPA variable as a control for academic ability. The authors included dichotomized gender, race (Black/Latino/Native American vs. White/Other), and a composite measure of socioeconomic status as student level variables.

The authors examined course-taking, indirectly, within the context of their theory that course offerings predict course-taking and subsequently achievement (Lee et al., 1997a). Thus, at the school level the authors included a z-scored measure of the percent of academic math courses offered in schools, the average number and z-scored variability (SD) of number of academic math Carnegie units completed by graduates, and the z-scored measure of the percent and variability (SD) of academic or college-preparatory programs completed by graduates. The authors also included an aggregate measure of 9th grade GPA, a combined measure of average socioeconomic status (percent subsidized lunch, and Orshansky percentile), NAEP measure of minority concentration, and a measure of school size. School level GPA, socioeconomic status, and school size were z-scored.

Lee and McIntire, (1999) used NAEP: 1996 mathematics assessment data as an outcome measure to examine the affects of student characteristics and rural location on the organization of schools. The authors also included measures of race, socioeconomic status, and a composite measure of math aptitude. Course-taking was measured via an 'algebra taking' variable.

At the school level, the authors included an aggregate measure of student achievement on the math assessment, a location measure (e.g., rural vs. nonrural), number of students enrolled, and a measure of the percentage of students in the school receiving free or reduced lunch (Lee & McIntire). The measure of location categorizes both suburban and large-urban schools as "non-rural". This decision will mask likely differences in achievement and outcomes between urban and suburban schools relative to their rural counterparts. The authors also included measures of instructional resources,

use of progressive instruction, and professional training reported by math teachers. Composite measures of instructional resources and progressive instruction, from teacher reports, as well as algebra course offering were included as measures of instructional resources. Composite measures of professional training, safe/orderly climate and collective support were included as measures of organizational resources. Eigenvalues were provided for these composite variables.

Studies using NELS: 88 data. Lee, et al., (1998) used NELS: 88 math assessment estimated 12th grade math achievement and highest level of courses completed as outcome variables in their study of how curriculum structure affects math course-taking and achievement. The highest course-completed variable is an 8-level variable that indicates variable math tracks of students termed a "mathematics pipeline" (Burkam, Lee, & Smerdon, 1997).

At the student level, the authors modeled a composite measure of socioeconomic status as well as gender, minority status and students 9th grade math grades. Gender and minority status were dummy coded in the same way as the previous study on curriculum structure and achievement (Lee, et al., 1997a). Ninth grade mathematics course grades were z-scored and used as a math GPA to control for math ability at the beginning of high school.

Variables used to measure the math curriculum structure included aggregate measures of the number and variability of highest math course completed, and aggregate number and variability of math credits completed below the algebra level (Lee et al., 1998). The number of math courses offered below algebra and whether or not calculus was offered were also included as measures of curriculum structure.

School level variables included: school sector (public, Catholic, and National Association of Independent Schools (NAIS)), aggregate socioeconomic status, school size, minority concentration, proportion low-achieving students, aggregate mean and SD of 12th grade math achievement, and aggregate mean and SD of 9th grade math coursework GPA. Minority concentration was dummy coded where schools that reported 40% or more minority enrollment were coded high minority.

Lee, et al., (1997b) used the NELS: 88 estimated math score at 10th and 12th grade to analyze the effects of structural practices on student growth in early and late high school. The authors delineated 3-types of structural practices in schools; traditional, atypical, and no structural practice. Decisions on labeling were based on the schools reported adherence to a list of 30 practices that were viewed as traditional, atypical, or no practice.

At the student level, the authors included measures of socioeconomic status, minority status, gender, 8th grade achievement, and early (8th – 10th) and late (10th – 12th) course-taking in mathematics (Lee et al., 1997b). The authors also included an aggregate measure of late math course-taking based on student reports as a school level measure. However, student reports are likely less reliable than transcript reports.

In terms of the academic organization of schools, the model included variability (SD) in math course taking, a Rasch-constructed measure of authentic instruction collected from student and teacher reports as well as variability in authentic instruction measured by the standard deviation of the Rasch score (Lee, et al., 1997b). The model also includes a composite measure of academic press.

At the school level, the authors include aggregate measures of socioeconomic status, minority concentration, sector (public, Catholic, NAIS), and school size (Lee, et al., 1997b). School social organization was also modeled using a composite measure of collective responsibility for learning estimated from items on teacher questionnaires. As noted earlier, measures of structural practices (traditional, atypical, no practices) were modeled at the school level.

Teitelbaum (2003) included NELS: 88 math assessment estimates and the number and type of math courses taken to analyze the influence of graduation requirements on course-taking. A modified, 4-level version of the 8-level math course-pipeline outlined by (Burkam, Lee, & Smerdon, 1997) was used to analyze student's level of math course completion. Course levels were: (1) low level math (pre-algebra and lower), (2) middle math 1 (Algebra 1 and Geometry), (3) middle math 2 (Algebra 2), and (4) advanced math (Trigonometry or higher). The course-pipeline is useful in distinguishing whether graduation requirements influenced students to take higher or lower level math courses to meet requirements (Teitelbaum).

At the student level, Teitelbaum included gender, race, socioeconomic status and the 8th grade NELS: 88 math test score as a control for pre-high school academic ability. Teitelbaum also included measures of region, urbanicity, school size, proportion minority in the initial school level model. He does not report these estimates in the final regression equations, as they were not significant. However, he does include an aggregate measure of socioeconomic status in the model. It is unclear from the authors reporting (1) the variables used to compute the school level measures not included in the final regression

equations, or (2) if the finding is systematically related to the 4,676 students excluded

from the analytic sample because they either were retained or dropped out prior to 1992.

College Board and SAT data. Everson and Millsap (2004) used SAT math scores

to analyze the fit of their latent construct variables to math SAT score. The authors used

self-reported student level variables that served as indicators for their 3-hypothesized

latent variables; socioeconomic background (parents education and income), high school

academic achievement (courses taken and GPA), and participation in academic and

extracurricular activities (AP courses, honors courses and theatre/arts experiences). This

self-report data raises concern over the reliability of data used in the student level model.

At the school level, variables were drawn from the National Center for Education

Statistics data on secondary schools in 1994. Measures included: the number of students

eligible for free and reduced lunch, an average measure of socioeconomic status, the

proportion of minority students, and a measure of urbanicity (Everson & Millsap, 2004).

Summary of measurement findings. Each of the outcome variables included in the

studies in this review were appropriate for measuring math achievement. However,

scores drawn from math assessment variables on NAEP data were scaled and do not

represent individual student scores but population characteristics (Chaney, et al., 1997;

Lee, et al., 1997a; Lee & McIntire, 1999). The ARM scaling method used for the

estimates of the math assessment variable may underestimate some student background

characteristics (Johnson & Allen, 1992). Therefore, analyses based on score estimates

produced for the NAEP: 1990; 1996 may result in biased parameters.

Course-taking was modeled in a number of different ways in these studies. One

study used student self-reports to model course-taking behaviors (Everson & Millsap,

2004). Due to the questionable reliability of self-report versus transcript data, this was the weakest measure of course-taking identified in this review. Three studies examined student transcripts to model the number of math courses taken in high school (Chaney, et al., 1997; Lee, et al., 1997a; Lee, et al., 1997b). Both of these also modeled curriculum structure at the school level, one by examining graduation requirements (Chaney, et al., 1997), the other 2 by analyzing the average and variability of academic math course-taking (Lee, et al., 1997a; Lee, et al., 1997b). The curriculum structure measure used by Chaney et al., (1997) may present a considerable weakness. Since state graduation requirements supersede school requirements variability in graduation requirements does not vary from school to school but from state to state. Contrastingly, an analysis of average and variable math course-taking, such as in Lee et al., (1997a; 1997b; 1998), may capture variability within and between schools and is preferable for modeling the effects of curriculum structure on achievement and/or course-taking.

Lee and McIntire (1999) modeled course-taking at the school level in terms of the structure of the curriculum. The study examined curriculum structure in terms of the highest course offering. While this measure appears useful for understanding school level organization, measurement in the aggregate assumes that the curriculum structure of schools affects all students in the same way (Bidwell & Kasarda, 1980).

Two of the seven studies define course taking using math pipeline as a student level variable to determine the highest level of courses taken in mathematics (Lee, et al., 1998; Teitelbaum, 2003). This method appears to be the most useful for identifying 'math tracks' in student course-taking, in terms of discriminating on course rigor and measuring subsequent effects on achievement. Teitelbaum modeled graduation requirements as a

school level variable of curriculum structure. Lee et al., (1998) modeled curriculum structure based on the constrained curriculum theory noted in earlier research (Lee, et al., 1997a).

The studies cited in this review used similar student-level measures as demographic controls or measures (e.g., race, gender, prior achievement, etc.) in their studies. Chaney, et al., (1997), Lee, et al., (1998), Lee, et al. (1997a), and Lee, et al. (1997b) provided clear operational definitions of these characteristics and linked them to specific data variables.

At the school level, these studies also modeled variables that were compositional (e.g., school sector, size, minority concentration, aggregate performance, etc.). Here again, several studies provided clear operational definitions of variables and linked them to relevant data from their sub-samples (Chaney, et al., 1997; Everson & Millsap, 2004; Lee, et al., 1998; Lee, et al., 1997a; Lee, et al., 1997b).

Data Analysis

All of the studies in this review used multilevel modeling in their analysis. Six of the seven studies employed both descriptive and regression-based multilevel modeling techniques to analyze data (Chaney, et al., 1997; Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Lee, et al., 1997b; Teitelbaum, 2003). The final study provided a descriptive analysis and used a multilevel structural equation model to fit their theoretical equation (Everson & Millsap, 2004). Multilevel modeling techniques are most appropriate for the analysis of questions related to school effects (Lee, 2000; Raudenbush & Bryk, 2002). Multilevel modeling allows researchers to predict values at the student level, based on values at multiple levels (e.g., student, classroom, school) (Luke, 2004).

A more detailed treatment of multilevel modeling and school effects research is provided in Chapter 3.

Multilevel modeling is tolerant of missing data issues that are commonly encountered in large-scale datasets (Chaney, et al., 1997; Everson & Millsap, 2004; Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Lee, et al., 1997b; Teitelbaum, 2003). Further, the goal of this type of analysis is to explain rather than control for group differences found in the data. Therefore, use of multilevel modeling obviated the issues that are viewed as statistical problems in analyses using multiple regression or analysis of variance (Luke, 2004). Consequently, each of the studies provided brief descriptions of group differences, including tests of statistical significance where appropriate, on the outcome variable and then modeled those differences.

Six studies used a two-level hierarchical structure in their analysis, with student characteristics at level-1 and school characteristics at level-2 (Chaney, et al., 1997; Everson & Millsap, 2004; Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Teitelbaum, 2003). In addition to the multilevel model, Everson and Millsap (2004) used SEMs at both student and school level to test the influence of characteristics on student performance. One study used a 3-level hierarchical structure in their analysis, with multiple tests scores at level-1, nested in student characteristics at level-2, who were in turn nested in schools at level-3 (Lee, et al., 1997b).

The 5 studies that used the regression-based 2-level multilevel modeling techniques all employed a 3-step process in their analysis: (1) partitioning of the variance within- and between schools, (2) modeling the outcome variable, within schools, as a function of student characteristics, and (3) modeling the outcome variables relationship to

average school-level characteristics controlling for within school student characteristics (Chaney, et al., 1997; Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Teitelbaum, 2003). The study that used a regression-based 3-level multilevel modeling technique reported the following process for their analysis: (1) modeling achievement growth within student, (2) modeling the outcome variable, within schools, as a function of student characteristics, and (3) modeling the outcome variables relationship to average school-level characteristics controlling for within school student characteristics (Lee, Smith & Croninger, 1997). Achievement growth in this study was modeled using only 3-points, 8th, 10th, and 12th grade math scores. As noted by the authors, the use of only 3 points for modeling growth yields less than ideal parameter estimates.

Four studies provided a clear explanation of this process (Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Lee, et al., 1997b). All of the studies included in this review appeared to have made appropriate decisions about scaling and centering of variables included in their models (Raudenbush & Bryk, 2002, p. 31). Only one study explicitly stated what and why centering decisions were made (Lee, et al., 1998).

Summary of Data Analysis

Data analyses are a particular strength in the school effects literature included in this review. The use of multilevel modeling for estimating the effects of organizations on math achievement allows for measurement at the appropriate level of analysis and results in less biased parameter estimates than traditional methods (Raudenbush & Bryk, 2002).

Results

Descriptive. Six of the 7 studies investigated explanations for average group/structural differences on a number of variables, either within schools or within

students (Chaney, et al., 1997; Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Lee, et al., 1997b; Teitelbaum, 2003). Five of these studies reported appropriate statistics (e.g., mean, SD, percent) for understanding student characteristics as well as school structure and composition by structural grouping (Huck, 2004). However, Teitelbaum (2003) does not offer an explanation for his decision to present data on socioeconomic status and 8th grade math achievement in quartiles rather than as a continuous score. Lee and McIntire (1999) did not provide a clear summary of descriptive statistics, instead providing effect size differences of gaps in math achievement between rural and non-rural schools by predictor variable.

The final study did not investigate group/structural variation using a regression-based model but rather attempted to fit an explanatory theoretical model (Everson & Millsap, 2004). The authors provided mean performance scores on SAT math and verbal sections as well as path coefficient estimates for their theoretical latent predictors, at the school, family, and student level, for SAT-math scores. Student reporting of math course taking is not presented as a high school achievement variable. Rather, the authors' only present student reported GPA in math courses taken.

Multilevel models. The intraclass correlation (ICC) denotes the proportion of variance in student math scores that is accounted for by the schools students attend (Raudenbush & Bryk, 2002). Among the 6 studies that used regression-based multilevel modeling and for which it would be appropriate, 2 studies reported the ICC for math achievement (Lee, et al., 1998; Lee, et al., 1997a). The adjusted ICC's reported in these studies were .35 and .34 respectively. Additionally, Lee et al., (1998) reported an adjusted ICC of .41 for their second outcome variable highest math course completed.

Four studies did not report an ICC (Chaney, et al., 1997; Lee & McIntire, 1999; Lee, et al., 1997b; Teitelbaum, 2003).

Lambda indicates the reliability of the outcome measure based on the variability of group means on level-2 or -3 characteristics (Raudenbush & Bryk, 2002, p. 46). Three studies reported reliability coefficients for the outcome variables in their models (Lee, et al., 1998; Lee, et al., 1997a; Teitelbaum, 2003). Lambda's were reported at .72, .83 and .51 respectively for math achievement. Lambdas for the highest course completed were .77 (Lee et al., 1998) and .45 (Teitelbaum, 2003).

Five studies that used regression-based multilevel modeling reported gamma coefficients for variables in the within and between school models (Chaney, et al., 1997; Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Teitelbaum, 2003). Two studies reported effect sizes (Lee, et al., 1997a; Lee, et al., 1997b).

Summary of results. Among studies that reported the proportion of between school variance in math achievement it was relatively high. Reported reliability (lambdas') were also high, particularly the coefficient for math achievement and math pipeline variables as modeled in Lee et al., (1998). However, reliability on slope variables was relatively low. Low reliability on slope variables is typical in multilevel modeling (Raudenbush & Bryk, 2002). Three studies modeled variables so that gamma coefficients were equivalent to effect sizes or presented effect sizes in the results (Lee, et al., 1997a; Lee, et al., 1997b; Lee et al., 1998).

Discussions

Each of the studies in this review used large-scale datasets resulting in analyses based on large samples. These subsamples, where appropriately selected and clearly

defined, give the analysis statistical power and reduce the likelihood of Type I error (Huck, 2004). Six of the 7 studies made conclusions that were supported by the findings reported in their research (Chaney, et al., 1997; Everson & Millsap, 2004; Lee, et al., 1998; Lee, et al., 1997a; Lee, et al., 1997b; Teitelbaum, 2003). One study did not provide a description of sub-sample selection methods limiting the utility of their conclusions (Lee & McIntire, 1999).

Limitations

The studies included in this review present 3 main limitations for understanding school effects on math achievement in general and for students with disabilities in particular. First, while the sub-samples drawn as well as the sampling methods of NELS program data are generally a strength of the research, the majority of studies used sample data that is currently over 15 years old. The most recent dataset that was used by only one study in this review contains data last collect in 1996. Secondly, none of the studies identified the disability status of students in their sample or compared variability based on disability status. One study actively excluded students with disabilities from the sub-sample. Finally, one study used student self-report to measure math course-taking experiences (Everson & Millsap, 2004). However, the authors' chose to report math course taking solely in terms of grades received rather than courses taken or completed. As a result, the findings from that study have extremely limited utility for understanding how course-taking or curriculum structure relate to school organization and student achievement in mathematics.

Conclusions/Results of the Studies

In general the studies reviewed here on the effects of schools on math achievement had strong theoretical bases, sampling designs, measures, analyses, and results. Thus, these studies provide an understanding of what is known about how school characteristics and the organization of curriculum affect student achievement in mathematics. In sum, student math achievement is affected by individual characteristics, school composition, as well as the organization of schooling via the curriculum structure. A summary of selected findings from these studies is presented in Table 2.2.

INSERT TABLE 2.2 ABOUT HERE

School Level Predictors of Math Achievement

Graduation Requirements

The effects of graduation requirements on student achievement were somewhat unclear (Chaney, et al., 1997; Teitelbaum, 2003). Findings from both studies appear to indicate that when graduation requirements affect student math achievement it is through encouraging more course-taking in mathematics. However, an effect on achievement was not evident through the number of courses taken but rather whether students were able to advance or pass the math courses they took.

Constrained Curriculum Structure

Curriculum structure was measured with a number of different variables across the studies in this review. School-level measures of average course-taking, variability in course-taking, average low-level course-taking, average low-level course offerings,

academic press, curricular track placement, and highest-level course offering were all used to measure the extent to which a school constrains the curriculum to academic courses. As noted earlier, a constrained curriculum is associated with higher average and greater equity in the distribution of math achievement (Lee & Bryk, 1988). Conversely, a cafeteria-style curriculum is associated with high variability in course-taking. The findings of this review appear to further support the theory of the effects of a constrained curriculum.

The effects of exposure to a limited academic math curriculum on math achievement are strongly supported in the research (Lee, et al., 1998; Lee, et al., 1997a). Students in schools where low-level math course-taking is limited, and therefore the math curriculum is largely academic or college-preparatory, have higher math achievement (Lee et al., 1998). These findings are buoyed by a number of other studies in this review that modeled course offerings, average as well as variability in course-taking, and found significant effects on achievement (Chaney, et al., 1997; Lee & McIntire, 1999; Lee, et al., 1997b). Additionally, Lee, et al. (1998) found that students do not progress as far in the mathematics pipeline in schools that offer more courses below the Algebra I level. Further, when schools offer calculus, usually the highest-level math course offered in high schools, students progress further through the mathematics pipeline.

When examining the gap in achievement between students of differing SES levels, the effect of a constrained curriculum was mixed. A measure of academic press was associated with greater achievement equity in one study (Lee, et al., 1997b). In another study, low variability in math course-taking increased achievement equity in terms of its effect on the SES/gain score slope (Lee, et al., 1997b). However, Lee, et al.

(1998) found school average math course pipeline progress to be unrelated to achievement equity but variability in the number of credits taken below algebra to be a significant predictor of the SES/achievement slope. These findings may suggest that some measures of the constrained curriculum may be more sensitive and better suited to measuring differences in how curriculum structure distributes opportunity than others.

Social Organization

The effects of collective responsibility on math achievement gains were significant in one study (Lee, et al., 1997b). Further, the effects of collective responsibility may be interrelated with structural practices within schools (i.e., communal vs. bureaucratic) and thus partially explain the non-significant findings for atypical structural practices versus traditional structural practices in that study. One study examined another social organization construct, collective responsibility, but did not report a significant effect (Lee & McIntire, 1999).

<div align="center">

Individual Predictors of Math Achievement

</div>

Student Level Variables

Expectedly, student prior achievement was a strong predictor of math achievement in the 5 studies that controlled for this factor (Chaney, et al., 1997; Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999; Teitelbaum, 2003). Lee, et al. (1997b) used achievement growth as an outcome and though the coefficient is not reported, the authors do note that parameters are not independent of initial status (prior achievement).

In 5 studies, student individual socioeconomic status was a significant predictor of math achievement, even after controlling for other individual and school level factors (Chaney, et al., 1997; Lee, et al., 1998; Lee, et al., 1997a; Lee, et al., 1997b; Teitelbaum,

2003). Both gender and minority status were significant predictors of math achievement in 5 studies in this review (Chaney, et al., 1997; Everson & Millsap, 2004; Lee, et al., 1998; Lee, et al., 1997a; Teitelbaum, 2003). Lee & McIntire (1999) also found minority status to be a significant predictor of math achievement.

Math course-taking behavior was also a significant predictor of math achievement (Chaney, et al., 1997; Lee, et al., 1998; Lee, et al., 1997b; Teitelbaum, 2003). The number of math credits earned significantly predicted math scores (Teitelbaum, 2003). The highest-level course completed significantly predicted math achievement (Chaney, et al., 1997; Lee, et al., 1998; Lee & McIntire, 1999; Teitelbaum, 2003). Curricular track was significant in 2 studies (Chaney, et al., 1997; Teitelbaum, 2003). However, one of these studies did not model the effects of course-taking with the curricular track variable (Chaney, et al., 1997). The other found no effect for curricular track when modeled with the math pipeline variable (Teitelbaum, 2003).

School Composition Variables

Several school composition variables were significant predictors of student achievement in mathematics. The 2 studies that modeled average achievement reported that average achievement predicted math achievement (Lee, et al., 1998; Lee, et al., 1997a). The average SES of the student body was also a significant math achievement predictor in 3 of the 5 studies that modeled it (Lee, et al., 1998; Lee, et al., 1997a; Lee & McIntire, 1999). It is noteworthy that only 1 of the 5 studies that modeled high minority concentration at the school level found significant effects on math achievement (Everson & Millsap, 2004). Each of the other studies was able to explain the minority gap by modeling a combination of variables (SES, course-taking, etc.) in their full models.

School size was a significant predictor of math achievement in 2 of 5 studies (Lee & McIntire, 1999; Lee, et al., 1997b). Only one study cited school location (urbanicity) as a significant predictor of math achievement in their full model (Chaney, et al., 1997). In the study that explicitly examined the effects of rural vs. non-rural location; course offerings, school size, school SES, and school climate explained the effect of location on math achievement (Lee & McIntire, 1999). In sum, these studies offer strong support to the theory of schools as organizations that structure and differentiate opportunities for mathematics achievement.

Theory of School Organization, Schooling and Math Achievement

According to Lee, et al. (1993) course-taking is "the principal determinant of academic achievement" (p. 229). The findings of this review appear to support and further clarify this view of the relationship between course-taking and math achievement. Decisions within schools on how resources for schooling (e.g., math curricular structure/course-offerings) are allocated are affected by school organizational factors (e.g., school size, demographic composition of student body). The organization of the math curriculum, in turn, is related to math course-taking, in terms of student progression through the math curriculum, and student math achievement even after controlling for significant student characteristics (e.g., SES, gender, minority status, prior achievement).

Chapter Summary

Math skills are required for students' to effectively navigate life and work in a technologically advanced world. In an increasingly global market, American students lag behind their peers in mathematics achievement. American students with disabilities are in

a particularly poor position for the future, as their math achievement is significantly poorer than their American peers without disabilities.

The importance of mathematics skills to future success has been recognized since the mid- 1900s. This recognition spawned a persistent reform movement that has culminated in a move toward high standards of math learning in general education as outlined by the National Council of Teachers of Mathematics. At the same time, the reform movement has resulted in a move away from procedure-based accountability to outcome-based accountability in special education as dictated by the NCLB of 2001 and IDEA of 2004. Thus researchers and educators have begun to consider how to close the gaps in achievement.

In general education, the drive to close the gaps in math achievement has largely centered on traditionally disadvantaged groups (e.g., minorities, individuals of low-SES) as compared to advantaged groups (e.g., white, middle-class). As part of this research, academicians have attempted to understand the contextual factors that might explain some of the gaps in math achievement of disadvantaged versus advantaged groups. This research has resulted in a theory of school and schooling effects on achievement. Schools as social organizations are influenced by their social composition and political realities, which in turn, create and structure the learning opportunities for students through curriculum decisions. These interactions are significantly related to student achievement in mathematics.

In special education, research has focused heavily on identifying and defining effective instructional methodologies for improving the achievement of students with disabilities. This has resulted in a knowledge base of effective practices that can be

implemented at the classroom level by teachers of students with disabilities. However, special education research has not provided an understanding of how the classroom or school context effects the achievement of students with disabilities. Further, the body of knowledge in special education has not examined whether curriculum structure and course-taking relate to math achievement or mediate the gap between students with disabilities and their non-disabled peers.

I conducted a review of recent research and identified 4 salient school level-variables, organizational and structural, and 5 individual characteristics that account for meaningful differences in math course-taking and subsequent student performance in mathematics in general education that may also account for variability in the performance of students with disabilities. The results of that review allowed me to identify several school level variables including: (1) school size, (2) average student achievement, (3) average student SES, and (4) the presence of a constrained curriculum. I also identified a number of student level variables, in addition to disability, including: (1) prior achievement, (2) gender, (3) race, (4), socioeconomic status, and (5) math course-taking. These variables were modeled on math achievement in order understand the relative effects of context on the achievement of students with disabilities.

CHAPTER III

Methodology

Current data indicates that students with disabilities exhibit a significant gap in math achievement in comparison to their non-disabled peers. Special education research on how to address this deficit has centered on improving instructional practices. Findings within the school effects literature suggest that school organizational factors influence the organization of schooling, which in turn significantly affects the math achievement of secondary students irrespective of individual characteristics. These studies suggest that the principal process through which school organizations affect student learning is the structure of the curriculum. However, the individual centered framework of special education has resulted in a dearth of information on the school organization and structural factors that affect the math achievement of students with disabilities.

The purpose of this study was to: (1) extend the research on school effects to understand how schools influence the math course-taking behaviors of students with disabilities, and (2) determine whether the level of progress through the math curriculum affects math achievement in students with disabilities.

I utilized data from the Educational Longitudinal Study of 2002 (ELS: 2002). Below, I describe the ELS: 2002 study purpose, design, instruments, response rates, as well as strengths and limitations for understanding the experiences of students with disabilities. I then provide a rationale and description of the variables that were included in this study and the resulting sub-sample. Finally, I offer a description of the analytic methods that I employed in my analysis, including a description of the software

programs, Hierarchical Linear Modeling (HLM) and the Statistical Package for Social Sciences (SPSS), used to complete the analysis.

Educational Longitudinal Study of 2002 (ELS: 2002)

This study used the Educational Longitudinal Study of 2002 (ELS: 2002) dataset. ELS: 2002 is a multilevel longitudinal study of the high school and post-secondary experiences of the 2002 cohort of 10th graders. The purpose of the study was to collect information relevant to policy, such as school processes, student experiences and outcomes (Ingels, Pratt, Rogers, Siegel & Stutts, 2004). Individual students in the ELS: 2002 are followed for 10 years, with school based assessments occurring in 2002 and 2004 (10th and 12th grades). The study collects data using direct assessment, as well as student, parent, librarian, and administrator questionnaires. Additionally, as part of the 2004 first follow-up, transcript data were collected on sample students. The transcript data consists of school data on student course completion history, grades, attendance, and SAT or ACT scores. Particularly relevant to this analysis is that, the data collected for the ELS: 2002 are intended to inform researchers on: the features of effective schools, the equitable distribution of academic outcomes, academic achievement in mathematics, the impact of course-taking on achievement during or after high school as well as other issues.

Sampling Design

The ELS: 2002 used a 2-stage sampling design with schools as the primary sampling unit (PSU). The ELS: 2002 used a stratified probability proportionate-to-size (PPS) method to sample schools in the United States. Schools were stratified by region and urbanicity consistent with sampling methods employed in the NELS: 88 design.

Several types of schools were excluded from the sampling frame prior to this process, including, schools with no 10th grade, closed schools, schools not enrolling students, Department of Defense schools, ungraded schools, Bureau of Indian Affairs schools, detention centers, correctional facilities, and special education schools. Selected schools were invited to participate. Sixty-eight percent of eligible schools participated. Ninety-nine percent of school administrators responded and thus some school characteristic information was available for most schools for comparison.

Within selected schools, approximately 26 10th grade students in the 2001-2002 school year were selected at the second stage. In this stage a systematic stratified sample was selected in order to arrive at a nationally representative sample that met precision requirements through the final follow-up of the study. Students were stratified on race (e.g., Asian, Hispanic, Black, or Other ethnicity). Students were excluded from the sample based on the following: foreign students, students whose command of English was insufficient for understanding materials, and students with disabilities whose level of functioning made assessment impractical or not useful. With regard to inclusion of students with disabilities, the ELS: 2002 errs on the side of inclusion and instructed school officials to do so when making decisions on students' ability to participate.

The final sample for the ELS: 2002 was 15,362 students in 752 schools. As a result of the sample design, the base-year student and school sample are nationally representative. Sample data also included responses from 13,488 parents, 7,135 teachers, 743 principals, and 718 librarians. These data are not representative of their respective respondent groups.

Most students in the ELS: 2002 base year sample were high school seniors in 2004. However, some students in the sample dropped out; others transferred schools. In addition to tracking students who had dropped out and transferred schools, the ELS: 2002 sample was freshened from the population of spring term seniors who were not sophomores during the base year of the study. These students were included as part of the first follow-up sample. Therefore, the 2004 follow-up sample, including the freshened sample, is representative of those students who were sophomores in 2002 as well as students who were high school seniors in 2004. The final sample for the ELS: 2002 base year to first follow-up including the freshened sample was 16,373 students in 752 schools.

Instruments. Data for the ELS: 2002 were collected from students, parents, teachers, administrators, and school librarians. Student instruments included direct assessments of mathematics and reading as well as a survey of school experiences, self-perceptions, future plans, and family. Survey information was collected from the student's parent(s), reading and math teacher(s), as well as school administrators and a school librarian. In this section I provide a brief description of these instruments. Additional information on ELS: 2002 instruments is included in Appendix A.

Direct assessments. The ELS: 2002 math assessment items tested students on low through advanced high school mathematics including: arithmetic, algebra, geometry, data/probabilities, and advanced topics. The test content was based largely on existing content items from the NAEP, PISA, and NELS: 88. Ninety-percent of math test items were multiple-choice. Because math assessment scores are estimated using Item

Response Theory (IRT), traditional psychometric properties of the test (e.g., reliability and validity) were not available.

Student questionnaire. Tenth grade students that participated in the ELS: 2002 completed a 45-minute self-report survey. The self-report had 7 sections and asked students about their school experiences, future plans, foreign language use, work, family, and personal beliefs about themselves. The section on school experiences was the most extensive part of the survey. In this section students were asked about their schools' climate, their level of engagement in school, their perceived curricular track, the learning environment in their school, time spent on homework, and use of school facilities.

Parent questionnaire. The parents of 10th grade students who were included in the sample were asked to voluntarily participate in a parent questionnaire during the base year (2002) of the survey. With respect to this study, the sections on family background, the school life of their child, and parent opinions of their child's school are pertinent. The family background section asks parents about their education level, race/ethnicity, religious affiliations, occupation, and primary and or other languages used in the home.

Teacher questionnaire. Both the English and Math teachers of students included in the sample completed teacher questionnaires. Teacher response data were intended to provide information on factors that may influence student performance in school.

School administrator questionnaire. School administrators were asked to provide information on school characteristics, the students and teachers within the school, policies, programs, technology, and the school climate. Data collected in the school administrator questionnaire provide information that indicates school organizational or contextual realities in schools.

One of the administrator data points that was of interest in this study were the questions related to problems that occur in the schools. The base-year administrator questionnaire includes 19 questions on the types of problems that occur in schools (BYA49A…S) (Appendix B). The questions require administrators to respond on a 5-point likert-type scale (1 = Happens daily, 2 = Happens at least once a week, 3 = Happens at least once a month, 4 = Happens on occasion, 5 = Never happens).

Transcript data. The ELS: 2002 transcript study is an extension of NCES transcript studies that began with High School and Beyond in 1982 (Bozick, Lytle, Siegel, Ingels, Rogers, Lauff, & Planty, 2006). Transcript data provide reliable measures of educational experiences of students, including: courses taken in high school, course grades, grade-point average, SAT/ACT scores, competency and advanced placement test taking, and school course offerings. Transcripts were collected between 6 months to 1 year after most students in the base year sample graduated from high school. Records were collected from base year schools unless students transferred following the base year, in which case transcripts were collected from both base year and last school attended. Transcripts were also collected from the 12th grade schools of those students who were part of the 2004 freshened sample and all students who dropped out. Full transcript records were retained for 86% of the sample students.

Courses were coded at the school level based on the title and description of courses taken from the course catalog for each school. Expert coders reviewed course coding along several key areas including: AP courses, special education courses, within school coding consistency, and track and sequence indicators.

Variables

Variable selection for the analysis was directly informed by the critical review of literature provided in Chapter 2. In this section, I provide a description of the independent and dependent variables. Where appropriate, I discuss the theoretical rationale and limitations of the dataset for the analysis. A conceptual model of the relationship between the variables that were included in the model is provided in Figure 1.

Student-Level Independent Variables

To construct a level-1, within school model, I included measures of student disability status, gender, race, and socioeconomic status. I also included measures of student course-taking and 9th grade academic GPA.

INSERT FIGURE 1 ABOUT HERE

Disability status. The ELS: 2002 dataset has 3 methods for identifying students who have a disability: (1) teacher survey response, (2)data collected from the sampling list of 10th grade students enrolled in schools, and (3) logical imputation using transcript credit data . During base year sampling, eligible schools were asked to provide a list of the 10th grade students enrolled in their schools. Math and English teachers who completed base year questionnaires were also asked whether they believe the student has a learning, physical, or emotional disability that affects their work in class. The nature of responses to attitude or opinion judgments, such as that called for in the item on disability status in the teacher survey is such that responses to this item may be questionable in terms of accuracy (Sudman, Bradburn, & Schwartz, 1996, p. 251). Particularly in

comparison to school records on student IEP status. Therefore, I viewed the dichotomous (0 = No; 1 = Yes) IEP status item (BYIEPFLG) from the school record data as preferable for the purposes my analysis. However, the ELS: 2002 IEP status variable alone was not sufficient for conducting my analysis.

There are considerable difficulties associated with analyses using the ELS: 2002 IEP status variable. As noted earlier, IEP status data were taken from the 10th grade student enrollment list provided by the school during the base year student-sampling phase of the study. In many cases, the IEP status of students in the sample is not known. Table 3.1 shows that the IEP status of 7,735 students in the sample is unknown.

INSERT TABLE 3.1 ABOUT HERE

Because there was a considerable amount of missing data in the IEP status variable, special education course credit information from the ELS: 2002 transcript file was used to logically impute data on student's disability status. Students' who received credits in a course labeled special education under the ELS: 2002 coding system, such as the special education resource room course, are likely students with a disability. Therefore, students whose transcripts indicated that they received at least one half credit in a special education resource room course were coded as having a disability. Notwithstanding, there may be a possibility that some students who received credit in courses coded "special education resource" for ELS: 2002 were students with very low-performance and/or at-risk for a disability but did not actually have an IEP. This limitation is discussed in Chapter 5. Using the special education resource data the number

of students categorized as receiving special education services for this analysis was expanded to 2,513. The result of the logical imputation of course credit data on the IEP data are presented in Table 3.2.

INSERT TABLE 3.2 ABOUT HERE

Gender. A student gender variable was included as the measure of gender in the analysis. The measure is an ELS: 2002 created dichotomous composite variable (F1SEX) from the student questionnaire response. When the item was missing from the student questionnaire response, ELS: 2002 researchers took the data from base year via: (1) school roster, (2) logical imputation, or (3) statistical imputation. In the base year to first follow-up cohort of ELS: 2002, 50% of participants were male and 50% were female.

Race. ELS: 2002 created a composite categorical race variable (F1RACE_R) from the student questionnaire or student roster when not available in the student questionnaire. If data were not available from the student roster, ELS: 2002 researchers took race data from the parent questionnaire response. Finally, if none of the previously noted responses were available, the researchers logically imputed data where possible. The composite race variable categories and frequencies for the base year to first follow-up cohort were: (1) American Indian/Alaska Native (.86%), (2) Asian, Hawaii/Pacific Islander (9.77%), (3) Black or African American (13.36%), (4) Hispanic, no race specified (6.72%), (5) Hispanic, race specified (8.31%), (6) Multiracial (4.73%), (7) Native Hawaii/Pacific Islander, non-Hispanic (.42%), and (8) White, non-Hispanic (55.82%). The composite race variable was included in the analysis. As with the studies

included in the review, the composite race variable was transformed to a dichotomous

variable in order to focus on the important distinction between minority and non-minority

student achievement. White and Asian students were coded non-minority while all other

race categories were coded minority.

Socioeconomic status (SES). ELS: 2002 created a composite variable of SES that

was used in the analysis. The composite variable of SES (F1SES1R) includes five

standardized and equally weighted components taken from the parent, and if not

available, the student questionnaire or imputation. The components of the SES variable

were: father's education, mother's education, family income, father's occupation, and

mother's occupation. SES data were either taken from base year data or imputed for the

ELS: 2002 base year to first follow-up cohort. The composite SES measure was z-scored

in the analysis (M = .0, SD = 1.00).

Course-taking. A number of methods were used to analyze the significance of

course-taking on math achievement in the research reviewed in the previous chapter. As

noted in Chapter 2, course-taking behavior, measured in terms of the highest-level

coursework completed and number of math courses taken consistently evidenced effects

in the literature. The ELS: 2002 math pipeline variable (F1RMAPIP) is a measure for

capturing movement through the hierarchy of math course-work while distinguishing

between the various levels of mathematics offered at the secondary level and is related to

math achievement (Burkam, Lee, & Smerdon, 1997).

INSERT TABLE 3.3 ABOUT HERE

The ELS: 2002 math course taking pipeline variable (F1RMAPIP) was included in the analysis to measure course-taking. The 8-category variable indicates the highest level of math course completion. The data were taken from the ELS: 2002 transcript data file. The levels of math course-taking pipeline are outlined in Table 1. The distribution of course-taking in the analytic sample was (1) no math (0.8%), (2) non-academic (2.1%), (3) low academic (2.9%), (4) middle academic (19.2%), (5) middle academic II (24.3%), (6) advanced I (18%), (7) advanced II (18%), and (8) advanced III (14.7%). The course-taking measure was z-scored (M = .0, SD = 1.00) for the multivariate analysis.

Prior achievement. Grade point average (GPA) has known limitations in predicting the performance of students with disabilities. Teachers consider a number of factors when grading students. These considerations differ between general and special education teachers, individual teachers, as well as schools (Blackorby, Wagner, Levine, Cameto, & Guzman, 2003). While 8th grade math test scores would be an ideal measure to account for learning prior to entering high school, this measure is not available in the ELS: 2002. Two of the studies reviewed used 8th grade math scores as either a control for prior achievement (Teitelbaum, 2003) or as the initial variable in their model of math growth (Lee, et al., 1997b). Three studies used students 9th grade GPA as a control on prior achievement (Chaney, et al., 1997; Lee, et al., 1998; Lee, et al., 1997a).

Therefore, I included the measure of 9th grade GPA in academic courses (F1RAGP9) in the model as a proxy for prior academic ability. Mathematics, science, English, social studies, language (non-English), and fine arts were defined as "academic" for the purpose of this measure. Ninth grade academic GPA was available for 88.13% of sample participants. The mean 9th grade GPA within the analytic sample was 2.68 with a

SD of 0.86. For ease of interpretation in the multivariate analysis, the measure was z-scored (M = .0, SD = 1.00).

School-Level Independent Variables

For the level-2, between school models, I included measures of average achievement, average socioeconomic status, school size, extent of school problems, average math pipeline progression, within school standard deviation of math pipeline progression, and average low-level math pipeline progression. These measures were adopted from the salient findings in the research as well as the school characteristics that are known to vary around student's disability status.

School Composition

Average achievement. I used the aggregate measure of 9th grade academic GPA as the school-level measure of average student achievement within the analytic sample. The measure was z-scored (M = .0, SD = 1.00) for multivariate analysis.

Average socioeconomic status. I aggregated the student-level measure of socioeconomic status. This measure was included in the analysis as the school level average socioeconomic status within schools. The measure was z-scored (M = .0, SD = 1.00) for multivariate analysis.

School size. A measure of the total school enrollment in 2001 (CPO2STEN) from the NCES Common Core of Data and Private School Survey was included in the ELS: 2002 dataset. This variable was included in the analysis as the measure of school size (M = 1247.92, SD = 829.12). The measure was z-scored (M = .0, SD = 1.00) for multivariate analysis.

School Climate

 School problems. A measure of problems and violence in schools was not included in the studies examined in the critical review. However, current research indicates that on average students with disabilities attend schools that are more problematic than their non-disabled peers (Wagner, et al., 2003). This may represent a significant difference in the school experiences of students with disabilities.

 The base-year administrator questionnaire of the ELS: 2002 includes 19 questions on the types of problems that occur in schools (BYA49A…S). Responses were given on a 5-point likert-type scale with higher scores indicating fewer problems. For the purpose of my analysis the measures were recoded so that higher scores were indicative of more school problems. The multiple measures of overlapping, or correlated, school problems necessitated the reduction of variables to facilitate analysis at level-2 of the multilevel model as well as ease the interpretation of findings (Tabachnick & Fidell, 2007).

 Principal components analysis (PCA) is useful for reducing variables to a set of components that describe the relationship among the variables (Tabachnick & Fidell, 2007). Using PCA, I reduced the 19 measures to 5 components with eigenvalues >1.00 (Appendix C). Though inspection of the scree-plot suggested that only the first 3 components occupied a separate trajectory, analysis of the cumulative variance explained indicated that the final 2 components explain an additional 22% of variance over the 42% of variance explained by the first 3 components. Therefore, all 5 components were included in the model.

 The first component, which extracted 16% of the variance, was labeled 'Drug and Alcohol Problems in School.' The second component, which extracted 14% of the

variance, was labeled 'Disorderly Climate in School.' The third component, which

extracted 13% of the variance, was labeled 'Gang and Racial Tension.' The fourth

component, which extracted 11% of the variance, was labeled 'Attendance.' The final

component, which extracted 11% of the variance, was labeled 'Theft, Vandalism, and

Physical Conflict.' The factor scores produced by PCA are normalized (M = 0, SD = 1)

and were unaltered for use in the multivariate models.

Curriculum Structure Measures

Average highest course-taken. I used the aggregate within-school highest math

course-taken from the math pipeline variable to measure average course-taking at the

school level. The measure was z-scored (M = .0, SD = 1.00).

Standard deviation in course-taking. . In addition to the mean, each school in the

sample has a within school standard deviation of highest course-taken on the math

pipeline variable. I aggregated the within-school standard deviation of highest math

course taken (M = 0.91, SD = 0.40). This variable was z-scored for the multivariate

analysis (M = 0, SD = 1).

Proportion low-level math course-taking. I also created an aggregate of a student-

level dummy coded variable that identified whether students highest math course taken

was below the level of algebra (1 = below algebra, 0 = algebra and above). This variable

was then aggregated, where it represents the proportion of students whose highest course

taken was a low-level (below algebra) math course. To facilitate interpretation in the

multivariate analysis, this aggregated measure was dummy-coded (0 = Low Proportion

Low-Level Pipeline, 1 = High Proportion Low-Level Pipeline). Because the distribution

of the variable was positively-skewed, it was dummy coded on the sample median (Mdn = .05, SD = .11).

When included in the full between school hierarchical model as a measure of curriculum structure, this variable produced unexpected effects on the average math achievement slope as well as an expected significant negative effect on the disability slope of math course-taking. Further inspection of the model suggested that results were likely confounded with school size. In other words, only those schools that contributed at least 20 students to the analytic sample could meet the 5% threshold. Thus, larger school size was confounded with the proportion of low-level math course-taking variable. Consequently, this variable was dropped from the model.

Dependent Variables

Because the primary interest of this study is to assess school effects via course-taking on high school math achievement, it was most appropriate to measure math achievement at the end of high school when all coursework had been completed. High school math achievement was modeled using the 12th grade math IRT score (F1TXM1IR). The measure was z-scored (M = .0, SD = 1.00) for ease of interpretation in the multivariate analysis.

Additionally, research questions 2 through 5 require that course-taking be modeled as an outcome variable in the multivariate analysis. In order to address these questions, course-taking was modeled as the dependent variable using the math pipeline variable. The 8-level math pipeline variable approximates a normal distribution and can be appropriately modeled as a continuous variable (Burkam, Lee, & Smerdon, 1997).

Methodology

The purpose of the study was to estimate the relative effect of disability status and school-level variables on the 12th grade math achievement and math course-taking of students who were in 10th grade in 2002 and 12th grade in 2004 while controlling for student demographic characteristics and, where appropriate, course-taking. I have provided descriptive statistics of students, by disability status, in order to document differences in the secondary experiences of students with and without disabilities, particularly regarding course-taking behaviors and 12th grade achievement in mathematics. Below, I provide a description of the analysis that was used for this study. Additionally, I provide a brief discussion of the approaches that were used to address missing data and the sampling weights that were used in the analysis as well as the methods employed in selecting the analytic sample.

Analytic Sample Selection

As noted earlier, the sample of interest were those students who were 10th graders in 2002 and 12th graders in 2004. Therefore, as a first step, the analytic sample in the study was restricted to the ELS: 2002 base year to first follow-up panel cohort using the "panel flag" (F1PNLFLG). This restriction reduced the analytic sample to 14,713 students in 752 schools. Because the primary interest of my study was the effects of course-taking on student math achievement at 12th grade relative to disability status, I further restricted the analytic sample to students for whom disability status was known using a created index from the disability status variable (BYIEPFLG) and special education resource room credits variable (F1R56_C). This reduced the analytic sample to 8,085 students in 638 schools. The analytic sample was also limited to students whose

records included the 12th grade math IRT score (F1TXM1IR) and all 4 years of high

school transcripts (F1RTR09, F1RTR10, F1RTR11, F1RTR12). The sample was further

restricted to those students for whom 9th grade academic GPA (F1RAGP9), the measure

of prior achievement, was available These restrictions reduced the sample to 6,534

students in 625 schools.

Student characteristics that were relevant in the literature were included in the

model, therefore, complete information on race (F1RACE_R), gender F1SEX), and SES

(F1SES1R) was required in the analytic sample. As noted earlier, using data from both

waves and/or logical imputation, these data for the base year through first follow-up

panel are complete so there was no loss of data at this selection stage.

Finally, at the school level, I was interested in examining the effects of several

school characteristics on students' performance. Therefore, only students whose school

administrator completed the administrator questionnaire (ADMFLG) were included. This

restriction brought the sample size to 6,502 students in 618 schools. In addition I included

a school level variable of school size (CP02STEN) that was included in ELS: 2002 from

the Common Core of Data and Private School Survey data. This restriction reduced the

final analytic sample to 6,398 students in 608 schools.

Sampling weights. Sampling weights are used to adjust for differential sampling

rates and non-response so that inferences about population parameters can be made from

results. Because of its complex sampling design, the ELS: 2002 dataset includes sampling

weights to adjust for unequal probabilities of selection at both the student and school

level. For example, weights adjust for the over-sampling of special selection groups in

the study (e.g., Asian students or Private schools) so that data are representative of the

target population. The school and student level weights also diminish the bias in estimates that result from participant non-response (e.g., parent refusal) by adjusting weights according to predictor variables of non-response. At the student level I used the base year to first follow-up panel weight (F1PNLWT). I normalized the panel weight and applied it to all cases in the analytic sample. At the school level I used the ELS: 2002 base year school weight (BYSCHWT). This weight was also normalized for application to the school level data during analysis.

Missing data. Due to common problems associated with voluntary surveys such as participant non-response, skipped questions, and inappropriate responses, survey data are prone to missing data. To allow researchers flexibility in dealing with missing data, codes are provided in the ELS: 2002 electronic data codebook. ELS: 2002 missing data values are coded as follows: (a) Don't know (-1); (b) refused (-2); (c) legitimate skip (skipped due to questionnaire skip pattern) (-3); (d) non-respondent (-4); (e) out of range response (-5); (f) multiple response (-6); (g) not reached (-7); (h) missing (-9). Data values coded -1 through -7 can reasonably be viewed as legitimately missing values (e.g., school not part of base year sample, required skip). Data values coded -9 are missing, either randomly or nonrandomly, and may represent a potential difficulty in the analysis.

The administrator variables for school problems contained a relatively large number of missing responses (134 schools). A simple approach to dealing with missing data is to use listwise deletion (Tabachnik & Fiddel, 2007). However, listwise deletion would have resulted in a considerable loss of power as schools with missing school problems data represented 22% of schools in the analytic sample. Another, popular

procedure for dealing with missing data is through imputation. Imputation can be completed using various forms of single imputation (e.g., mean, discriminate function, logistic regression) or using multiple imputation (MI) methods. Single imputation methods, can result in estimates that evidence considerably greater bias than MI methods (Allison, 2007). Nevertheless, MI still assumes that the data are complete and therefore underestimates standard errors (Allison, 2002). In fact, all imputation methods treat missing data as true values and therefore misestimate standard errors (Cohen, Cohen, West, & Aiken, 2003, p. 445). Therefore, I conducted an analysis of the effect of imputed means on the multivariate model of climate effects on average outcomes, using a dummy-coded variable for those schools with missing administrator data,

Bias Analysis

I examined differences between the analytic sample and the students and schools that were excluded from the analysis. It was important to determine if, and how, the analytic sample differed on key demographic and outcome variables. In this section I provide a description of the findings of my analyses.

IEP status. Despite my effort to use transcript data to increase the number of students for whom I could definitively assign an IEP status, the data limitations of the ELS: 2002 could not be overcome. The largest loss of cases during sample selection occurred as a result of excluding students whose IEP status was unknown (6,628). Therefore, I conducted an analysis of key demographic and outcome variables in students whose IEP status was known versus those whose IEP status was unknown.

Analytic sample versus excluded sample. As a result of the decisions used to cull an analytic sample, 6,398 students were selected and 7,984 were excluded. I conducted

an analysis of key demographic and outcome variables by students included versus those excluded from the analytic sample.

Analytic sample versus full sample. I compared the key demographic and outcome variables of the analytic sample to the full panel cohort. I examined descriptive statistics for these comparisons.

Included versus excluded schools. I analyzed key demographic and outcome variables of schools included in the analytic sample ($n_j = 608$) versus those that were excluded ($n_j = 141$) from the sample. I aggregated individual student measures of minority status, gender (female), prior achievement, socioeconomic status, math pipeline progression, and 12th grade math IRT score to determine between school means. School administrator reports of the percent of students receiving special education service were also included in the analysis.

Missing school problem data versus no missing school problem data. I modeled the schools with complete administrator school problems response data ($n_j = 474$) against those without administrator school problems response data ($n_j = 134$). Mean values were substituted for missing values and a dummy coded variable (1 = missing, 0 = no missing) was created and used to test the effect of missing school problems data on both the achievement and course-taking intercept in the full between-school multilevel model. A non-significant finding on the dummy coded variable would indicate that schools that did not provide school problems data were not significantly different from schools with school problem data on model variables.

Analysis

I used two types of data analyses in this study. Descriptive and bivariate statistics were used to describe the findings of the first research question. The remaining research questions were analyzed using multilevel modeling software, Hierarchical Linear Modeling (HLM).

Descriptive and bivariate statistics. I present descriptive statistics (e.g., mean, median, standard deviation) and bivariate statistics (correlation coefficient, t-statistic) on the 1st research question of this study:

1. How do the individual and school characteristics of the 10th grade cohort of ELS:02 students with disabilities compare to their non-disabled peers in terms of demographics, student characteristics, academic background, course-taking, and math achievement at 12th grade?

The analytic sample for this question was all ELS: 2002 10th grade students in the base year to first follow-up panel with known disability status data. Characteristics of students with and without disabilities were compared. Tests of significance were conducted on course-taking behaviors and 12th grade math achievement. Descriptive and bivariate statistics were computed using SPSS.

Multilevel modeling. Traditional methods of theoretical as well as analytical modeling in social science have rested on a positivist tradition (Luke, 2004). The positivist tradition tends to ignore the complexity of systems where explanatory variables exist at multiple levels and effects are contextual. Thus, under positivism, relationships between student outcomes and school level effects are not explored. Thus, analytical models in the social sciences had, for sometime, focused on single-level units of analysis.

Considering the nested and hierarchical nature of education (students nested in schools within neighborhoods) these types of analyses are insufficient. Recent developments in statistical modeling eliminate many of the problems associated with simultaneously examining relationships between student and school level effects on student achievement (Lee, 2000).

Multilevel modeling allows researchers to ask questions about individuals nested within groups (e.g., students within schools). Prior to the use of multilevel models, researchers would often ignore the nested, or in the case of schools, hierarchical, structure of data in their analysis (Bidwell & Kasarda, 1980; Lee, 2000; Raudenbush & Bryk, 2002). Thus, researchers would treat correlations at the student and school level as if they were the same. For example, a researcher may assume that the relationship (correlation) between socioeconomic status and math achievement are the same at both the student and school level. As noted in Robinson (1950), this is not the case.

Single-level analyses commonly use ordinary least squares regression (OLS) to predict interval level outcomes. OLS assumes independence of individual cases (Lomax, 2001). However, students are nested in schools through assignments processes that are neither independent nor random (Raudenbush & Bryk, 2002, p. 18). They also tend to share numerous experiences and characteristics. The result of analyses that ignore these factors is to overestimate the errors of school-level variables and potentially inflate Type II error (Lee, 2000).

Multilevel modeling also enables researchers to explicitly model, for example, how relationships between social background and achievement vary between schools as a function of school level factors (Lee, 2000). This type of examination, termed

heterogeneity of regression slopes, is of particular interest when examining school effects on student academic achievement as it allows the researcher to address the effectiveness of schools at distributing achievement across individuals with differing backgrounds (Raudenbush & Bryk, 2002).

Multilevel modeling techniques are the most appropriate methods of analysis for studying school effects on student achievement (Lee, 2000). By directly addressing the statistical issues of unit of analysis, aggregation bias, misestimated error, and heterogeneity, they allow researchers to develop and measure complex theories of schooling (Bidwell & Kasarda, 1980; Lee, 2000). This study addresses one of the many possible complex theories of schooling: How do school decisions about the structure of curriculum differentially affect students with and without disabilities in terms of their math course-taking and achievement?

Hierarchical linear modeling (HLM). The multilevel models used in this analysis were conducted using the HLM software program. HLM was used to address research questions 2, 3, 4, and 5. Since HLM focuses on modeling between school variance, determining the proportion of variance that can be modeled at level-2 for each outcome is a necessary initial step in multilevel modeling (Lee, 2000). The proportion of variance in the outcome that can be modeled at level-2 is determined by calculating the intraclass correlation (ICC). The ICC, which is parcels out the proportion of variance that is between versus within schools, is calculated by:

$$\rho = \tau_{00} / (\sigma^2 + \tau_{00})$$

Table 3.8 displays the properties of the outcome variables in this study, in terms of the appropriateness for multilevel modeling. The ICC for both the 12th grade math

achievement (.26) and math pipeline variable (.26) were acceptable for modeling at level-2. Additionally, the reliability estimates for both outcomes, while moderate, were acceptable for modeling.

INSERT TABLE 3.4 ABOUT HERE

In addition to understanding the proportion of variance that can be modeled at level-2, the issue of centering of variables is key to understanding and interpreting the results of multilevel models (Raudenbush & Bryk, 2002).

Centering. Centering concerns are primarily located around those variables that are predictors at level-1 of the model. Interpretation of the intercept is based on centering decisions made at this level. In the models used for this study, two types of centering choices were used. I group-mean centered two predictor variables (Average math achievement/Math pipeline progression and Disability Status) that I intended to model at level-2. Additionally, because they are known to differ between schools, I group mean centered '9th grade academic GPA' and 'Math Pipeline Progression' whenever included at level-1. However, the error-terms of these variables were fixed as my research questions do not hinge on modeling the level-2 variance of these predictors. Relative to group-mean centered variables, the intercept became the unadjusted sample mean. All demographic variables in the models were grand-mean centered. Grand mean centering adjusts for differences according to group (school) membership. Therefore, relative to grand-mean centered variables, the intercept became the outcome for a student whose score on the predictor was equal to the sample mean. Thus, I was able to discuss the

meaning of the intercepts (average 12th grade achievement in a school or average highest math course completed in a school) and the meaning of the disability slope as an effect controlling for all demographic variables in the model.

Multilevel modeling questions. Below, I provide a discussion of the models and decisions made to address the multilevel modeling questions posed in this study.

2. Does the gap between students with and without disabilities in (a) their 12th grade math achievement and (b) their high school math course-taking vary among schools?

Regarding research question 2, I constructed an unconditional level-2 model to determine the proportion of variance in (a) average 12th grade math achievement and (b) math course-taking of students with disabilities that is within and between schools. The equation for this question is a random coefficients regression model: where math achievement is the function of the level one intercept coefficient plus the level one predictor (IEP) plus a random effect on the intercept, slope, and a level-1 error term. A second equation that substitutes math course-taking (math pipeline) for math achievement served to answer part b of question 2.

3. Does the gap between students with and without disabilities in (a) their 12th grade math achievement and (b) their high school math course-taking vary within and between schools after controlling for students course-taking, 9th grade academic GPA, race, SES, and gender?

For research question 3a, I constructed a random coefficients regression model equivalent to that used for question 2. However, this model included intercepts for race, class, and gender centered around the sample mean. It also included the math pipeline variable and

9th grade academic GPA centered on their group mean since these factors are known to vary between schools. This model examines the effect of disability on (a) course-taking, and (b) math achievement while controlling for the effects of race, 9th grade academic GPA, course-taking and socioeconomic status.

4. Controlling for 9th grade academic GPA, race, class, and gender do SES composition, ability composition, school size, and amount of school problems affect the slope in (a) the 12th grade math achievement and (b) the high school math course-taking of students with disabilities compared to students without disabilities?

For research question 5, the initial between-schools model, I constructed a 2-level model with intercepts and slopes as outcomes. The model equations for these initial between school models were:

(Student Level): $Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} \ldots + r_{ij}$

(School Level): $\beta_{0j} = \gamma_{00} + \gamma_{01}W_j + u_{0j}$

$\beta_{1j} = \gamma_{10} + \gamma_{11}W_j + u_{1j}$

Where: β_{0j}= Level-1 one coefficient (Intercept)

β_{1j}= Level-1 one coefficient (Disability Status)

r_{ij} = level-1 random effect (error term)

γ_{00} = level-2 coefficient

W_j = level-2 predictor

u_{0j} = level-2 random effect (error term)

Using this model I examined both student and school level effects on math achievement. Specifically, I modeled the school level variability in average achievement and course-taking as well as the slope (gap) in average achievement between students with and without disabilities. I modeled the effect of average 9th grade academic achievement, average socioeconomic status, schools size, and the five school climate components on the intercept and the slope, which measures the gap between students with and without disabilities. All predictors were grand-mean centered. Level-2 predictors that were non-significant were subsequently dropped from the model.

5. Do students with disabilities who attend schools with high average course-taking, and/or low variability in course-taking (a) progress farther in the math pipeline or (b) have higher math achievement at 12th grade?

This final question was modeled by adding measures of curriculum structure to the intercept (β_{0j}) and disability (β_{1j}) slopes in the initial between-school model. Thus, the combined full between-school models were approximately:

$$Y_{ij} = \gamma_{00} + \gamma_{01}W_j + \gamma_{10}(X_{ij} - X_{.j}) + \gamma_{11}W_j(X_{ij} - X_{.j}) + u_{0j} + u_{1j}X_{ij} + r_{ij}$$

Finally, after modeling each of the questions, I calculated the proportion of variance on the intercept and disability slope that was explained by the fully conditional between-school models over the fully conditional within school models of achievement and course-taking. This proportion was calculated using the following formula:

$$R^2 \text{ Change} = (\text{Tau}_1 - \text{Tau}_2)/\text{Tau}_1$$

The results of this, and all other analyses are presented in Chapter 4.

CHAPTER IV

Results

The results of this study are presented below using descriptive and bivariate

statistics to discuss research question 1 and gamma coefficients and variance parameters

of two separate multilevel models to address research questions 2 through 5.

Additionally, I present R^2 change statistics to facilitate a discussion of the between school

variance explained by the fully-conditional multilevel model. First, I present the results of

the bias analysis conducted on the included and excluded sample groups. Where

appropriate standardized effect sizes are used to discuss the magnitude of relationships.

For ease of interpretation, the discussion of effect size (d) will conform to the definition

of effect sizes (.20 = small, .50 = moderate, .80 = large) established in Cohen (1992).

IEP Status Bias Analysis

The results of the analysis indicated considerable differences between students

with known and unknown disability status in the cohort. The mean for students with

unknown disability status was significantly (p < .001) higher than those for students with

known status in terms of their prior achievement, 12th grade math IRT score,

socioeconomic status, and math course-taking (Table 4.1).

INSERT TABLE 4.1 ABOUT HERE

Analytic Sample versus Excluded Sample

Table 4.2 shows there was no statistically significant (p > .05) difference

between groups on socioeconomic status and 12th grade math IRT score. Students

included in the analytic sample did have significantly higher prior achievement (d = .07)

than excluded students. However, students excluded from the analytic sample progressed significantly further in the math pipeline (d = .04). Despite these statistically significant findings, effect sizes were small (.00 - .07).

INSERT TABLE 4.2 ABOUT HERE

Analytic Sample versus Full Sample

An examination of the means presented in Table 4.3 suggests that the analytic and full samples are similar on the key variables of the model. All effects of group differences were small, with the largest for 9th grade academic GPA (d = .15)

INSERT TABLE 4.3 ABOUT HERE

Included versus Excluded Schools

With the exception of percent receiving special education services, schools excluded from the analysis did not significantly differ from those included in the analytic sample in terms of average SES, average 12th grade math IRT score, average progression in math pipeline, school size, or percent of minority and female students (Table 4.4).

INSERT TABLE 4.4 ABOUT HERE

Missing School Problem Data versus No Missing School Problem Data

Results of the analysis indicated no significant findings for missing school problems data in the course-taking or achievement models. Further, an examination of the gamma coefficients in Table 4.5 for both models indicates minimal change in the coefficients for either model when the dummy coded variable was included.

INSERT TABLE 4.5 ABOUT HERE

Bias Analysis Summary

The students excluded from the sample because of unknown IEP status evidenced higher prior achievement, course-taking and 12th grade math achievement, average socioeconomic status and they progressed further in the math pipeline than students who were included in the sample. Intuitively, this finding might suggest that excluded students attended higher performing or more exclusive schools than students included in the sample. This was not supported in the analysis of schools excluded versus those included in the sample. That analysis indicated that schools excluded from the sample only differed on the percent of students with disabilities they serve. Thus, students who were excluded from the analytic sample were likely to not be students with disabilities. Further, the lower proportion of students with disabilities served in excluded schools may also suggest that more of these schools may have been private and/or small schools which are more likely to serve fewer students with disabilities. Thus, it is possible that the schools included in the analytic sample may differ in some unknown ways that could

result in their structuring schooling differently than excluded schools on some measure not included in the model.

In addition to the analyses described above, I conducted a comparison of the final analytic student sample to the excluded students' sample. This analysis indicated that students included in the final sample exhibited higher average 9th grade GPA but lower average course-taking than students in the excluded sample. A visual comparison of means of the analytic sample versus the full base-year to first follow-up panel also suggests that students in the analytic sample exhibited a slightly higher 9th grade GPA and course-taking level than students in the panel in general.

Finally, I analyzed the effect of missing versus non-missing school problems data on the course-taking and achievement intercept of the full between-school model in HLM. The schools with missing data appear to be no different on the math course-taking or achievement variable. Further, inclusion of these schools in the models did not alter the beta coefficients. Below, Tables 4.6 and 4.7 provide descriptive information on the analytic sample used in this study.

INSERT TABLE 4.6 ABOUT HERE

INSERT TABLE 4.7 ABOUT HERE

Descriptive and Bivariate Statistics

The comparison of students with disabilities in Table 4.2 indicates that the mean SES (d = .34), 9th grade academic GPA (d = .42), 12th grade math achievement (d = .71), and progression in the mathematics pipeline (d = .65) were all significant and below their peers without disabilities (Table 4.8).

Response to Research Question 1

How do the individual and school characteristics of the 10th grade cohort of ELS: 02 students with disabilities compare to their non-disabled peers in terms of demographics, student characteristics, academic background, course-taking, and math achievement at 12th grade?

Students with disabilities in the analytic sample, on average, have lower academic GPAs at the start of high school, do not go as far in their math course-taking and have lower achievement at the end of high school than their non-disabled peers. The effect size of the 9th grade academic GPA gap between students with and without disabilities was small while the math pipeline and math achievement effects were both moderate. The mean difference in SES between the two groups also had a small effect size. Students with disabilities in the sample were also significantly more likely to be non-Asian minorities and males.

INSERT TABLE 4.8 ABOUT HERE

In order to determine the student and school level variables that account for the gap in achievement and course-taking between students with and without disabilities, I will now turn to the results of the HLM analysis. In the next two sections, I present the within and between school models of math achievement and course taking. Within these sections I respond to questions 2 through 5 of this study.

Within-Schools Models

Tables 4.9 and 4.10 contain results of the level-1 HLM models of 12th grade math achievement and math course-taking respectively. As noted earlier, all variables included in the HLM analysis are dummy coded or z-scored. Therefore, gamma coefficients in the models represent effect sizes in SD units.

Math Achievement

The math achievement table (Table 4.9) illustrates three successive within school models of disability status followed by demographic characteristics and prior achievement and then course-taking. The random effects table provides the variance slope for the full within-school model.

INSERT TABLE 4.9 ABOUT HERE

Model 1. Disability status had a significantly negative relationship to 12th grade math achievement. The effect of disability on achievement (-.80) was large; on average, there was an expected .80 standard deviation difference in scores for students with a disability compared to students without a disability. It is noteworthy that the coefficient for the intercept was significant, though its effect was relatively small (-.19). This

suggests that the average math achievement score in schools with both students with and without disabilities was slightly lower than the sample mean.

Model 2. All four measures of demographic characteristics and prior achievement were significantly related to student's 12th grade math achievement. On average, both female and minority students had lower math achievement than their non-minority male counterparts. Students of higher SES and those who had higher 9th grade academic GPAs had higher math achievement. The negative effect for minority status (-.34) and the positive effect for SES (.32) were moderate. The gender effect (-.14) was small. Despite the significant effects of demographic characteristics, disability status had a moderate and negative effect (-.70) on average 12th grade math achievement even after considering these variables in the model.

Model 3. The effect of 9th grade academic GPA (.47) was moderate. The addition of 9th grade academic GPA reduced the effects of minority status (-.21) and SES (.17) on achievement. The addition of this variable also resulted in an increase in the negative effect for gender (-.33) on achievement. Controlling for minority status, gender, socioeconomic status, and 9th grade academic GPA, we expect disability status to have an average effect of a .54 standard deviation decrease in 12th grade math achievement. Thus, prior academic GPA helps to explain some of the difference between students with and without disabilities 12th grade math achievement.

Model 4. Again, all measures included in the model significantly predicted 12th grade mathematics achievement. Students who progressed further in the math pipeline exhibited higher math achievement. Course-taking exhibited a moderate effect (.47) on 12th grade math achievement. With course-taking included in the model the effects of

both minority status (-.13) and SES (-.12) were small. The negative effect size for girls (-.28) was also reduced and remained small. The effect of 9th grade academic GPA (.25) was reduced by nearly half to a small effect on math achievement. Though remaining a significantly negative predictor of average 12th grade math achievement, the effect of disability status (-.33) was reduced from a moderate to a small effect in Model 4. In other words, a portion of the variance of 9th grade academic GPA, minority status, gender, and minority status associated with 12th grade math achievement is actually attributable to students' course-taking.

Accounting for race, gender, SES, and 9th grade achievement, students with disabilities who progressed further in the math pipeline exhibited higher average 12th grade mathematics achievement. Further, controlling for demographic characteristics, 9th grade academic GPA, and math pipeline progression, there was an expected .33 standard deviation difference in average 12th grade math achievement. This is a large reduction in effect size from the initial model (-.80) and a small decrease from Model 3 (-.54).

Additionally, the random effects table indicated that there was a small amount of variance (.05) on the disability slope of 12th grade math achievement (e.g., disability vs. no disability achievement gap) that may be modeled at level-2. The level-2 variance on the disability slope and the corresponding research questions were addressed in the between-school model that is presented following the presentation of the within-school models of math course-taking.

Math Course-Taking

The math course-taking Table 4.10 illustrates 3 successive within school models including: disability status followed by demographic characteristics, and then prior

achievement. The random effects table provides the variance slope for the full within-school model.

Model 1. As with achievement, disability was significantly and negatively related to high-school math course-taking. The effect of disability on progression in the math course-taking pipeline was quite large (-.72); on average, students with a disabilities progression in the math pipeline was an expected .72 of a standard deviation less than a student without a disability. As with math achievement, the intercept for course taking was negative (-.24) and significant. Here again, there was .24 percent of a standard deviation lower average course-taking in schools with at least one student with and one student without a disability.

INSERT TABLE 4.10 ABOUT HERE

Model 2. Among demographic characteristics added to the model, minority status and SES were significantly related to student progression in the math pipeline. Minority students progressed nearly one quarter of a standard deviation less than their non-minority counterparts. In schools with an average SES one standard deviation above the mean, students had an average expected .26 standard deviation increase in math pipeline progression. Gender was not significantly related to math pipeline progression, though the p-value (.05) of the coefficient suggests the effect of gender on math pipeline progression cannot be dismissed. Controlling for minority status, gender, and SES, the negative effect of disability on math pipeline progression (-.61) was moderate.

Model 3. All variables in the final model remained significant. The effect of prior achievement on math pipeline progression (.46) was moderate. The inclusion of 9th grade academic GPA in the model attenuated the effects of both minority status (-.15) and SES (.12) on math course-taking. Including 9th grade academic GPA in the model resulted in a small but negative effect of gender (-.11) on math pipeline progression. The effect of the 9th grade academic GPA variable also mediated the effect of disability on course-taking, though the effect of disability (-.45) remained moderate. Controlling for 9th grade academic GPA, minority status, gender, and SES, the average effect of disability was an expected .45 standard deviation decrease in math pipeline progression.

Response to Research Questions 2 and 3

Research question #2 was:

> Does the gap between students with and without disabilities in (a) their 12th grade math achievement and (b) their high school math course-taking vary among schools?

The variability in math course-taking is larger than it is in 12th grade math achievement. However, performance on both of these indicators varies between schools.

Research question #3 was:

> Does the gap between students with and without disabilities in (a) their 12th grade math achievement and (b) their high school math course-taking vary within and between schools after controlling for students course-taking, 9th grade academic GPA, race, SES, and gender?

> Yes. The characteristics of students with disabilities, including; race, SES, 9th grade academic GPA, gender, and course-taking all significantly predict 12th grade

math achievement and high school math course-taking. However, when these predictors are controlled for, the schools that students with disabilities attend still explain .05 and .36 percent of the variance, respectively.

<div align="center">*Between-Schools Models*</div>

Tables 4.11 and 4.12 contain results of the level-2 HLM models of 12th grade math achievement and math course-taking respectively. In addition, Table 4.13 includes the calculation of the variance explained across all within- and between-school models for the disability status slope.

Math Achievement

Table 4.11 displays the two school level models of variation on the disability slope of math achievement and the intercept. Model 4 contains the significant school level composition and climate variables. Model 5 displays the fully conditional between-school model including curriculum structure variables.

Model 5. Controlling for student level demographic, prior achievement, and course-taking characteristics, the average SES and average 9th grade academic GPA of students in schools had a significant effect on the achievement of all students within a school. On average, there was an expected .24 of a standard deviation increase in achievement for a student (with or without a disability) in a school whose SES composition was 1 standard deviation above the sample mean. Schools where the average 9th grade academic GPA was one standard deviation above the average had an average .19 standard deviation increase in average achievement. All other school level predictors of composition and climate included on the intercept were non-significant and dropped from the model.

INSERT TABLE 4.11 ABOUT HERE

Model 5 also indicates a significant effect (.08) for the climate variable, "Drugs and Alcohol Problems in School" on the disability slope. Thus, controlling for student level predictors, the expected gap (-.30) in the math achievement of students with disabilities was smaller (.08) in schools where administrators report drug and alcohol problems. All other school level predictors of composition and climate included on the slope of disability status were non-significant and dropped from the model.

Though the administrator report of Drug and Alcohol Problems was a significant level-2 predictor, an examination of the chi-square table indicates that I was only able to explain one-half of a percent of the variance on the disability slope from the fully conditional within-school model.

Model 6. All measures of curriculum structure were significant on the intercept. Average highest math course taken (.10), and variability in course-taking (-.19) each had small effects on average 12th grade math achievement in schools. In terms of the disability slope, the curriculum structure variables were not significant but the inclusion of these variables in the model reduced the disability slope effect to -.26 of a standard deviation. Thus, schools with high average math course-taking and low variability in course-taking have higher average math achievement among all students.

The graph in Figure 2 illustrates the relationship between the two measures of curriculum structure and 12th grade math achievement for both students with and without disabilities. The set of bars on the right show that students with disabilities, on average,

had the highest achievement in schools with high average course-taking and low variability in course-taking (constrained curriculum). On average, students with disabilities had an expected achievement score that was .26 of a standard deviation lower than the mean (-.14). In schools with a constrained curriculum the expected average achievement was (-.40 + .29 = -.11). Students with disabilities had the lowest achievement in schools with low average course-taking and high variability in course-taking. With the exception of the low average/low variability in course-taking curriculum structure, the effects of curriculum structure on math achievement followed the same pattern for students with and without disabilities. I now turn to examine the between-school models of math course-taking.

INSERT FIGURE 2 ABOUT HERE

Math Course-Taking

As in the previous table, Table 4.12 displays the two school level models of variability on the intercept and disability slope. Models 4 and 5 contain variables from the initial composition and culture and then the curriculum structure model respectively.

Model 4. Controlling for student level characteristics, the average SES (.25) and 9th grade academic GPA (.10) as well as the presence of attendance problems (-.05) had a significant, yet small effect on the average math pipeline progression of all students within a school. Combined, being in a school that is plus one standard deviation above the sample mean on the measures of average SES and 9th grade academic GPA, resulted

in an expected average math pipeline increase of .35 of a standard deviation for all students. But the effect of being in a school with higher attendance problems produced .05 of a standard deviation decrease in students' average math pipeline progression.

Students with disabilities experience significant decreases in math pipeline progression in schools where "Group or Racial Tensions" exist (-.27) or "Drugs and Alcohol Problems" exist (-.21). Thus, there was an expected near full standard deviation (-.99) decrease in the average highest course taken by a student with a disability in schools where drug and alcohol problems as well as group/racial tensions are high. All other school level predictors of composition and climate included in the model were non-significant and dropped.

Model 5. The average progression in the math pipeline was lower (-.35) in schools where variability in math pipeline progression is high. With the effects of curriculum structure (SD math pipeline) accounted for in the model the effect of attendance problems in the school is attenuated. However, average SES composition and average 9th grade academic GPA remain significant predictors of average highest math course taken.

INSERT FIGURE 3 ABOUT HERE

The gap in average math pipeline progression of students with disabilities was larger in schools with more variability in course-taking (-.46). Figure 3 provides an illustration of the large negative effect (-.81) of high variability in course-taking on the average course-taking of students with disabilities. Additionally, the presence of group or racial tension, and drug and alcohol problems in schools remained associated with lower

average course-taking for students with disabilities. However, the effects of the

curriculum structure measure attenuated some of these effects.

INSERT TABLE 4.12 ABOUT HERE

Response to Research Questions 4 and 5

Research question #4 was:

Controlling for 9th grade academic GPA, race, class, and gender do SES

composition, average 9th grade academic GPA, school size, and amount of school

problems affect (a) the 12th grade math achievement and (b) the high school math

course-taking of students with disabilities?

Average 9th grade academic GPA and average SES affect the 12th grade math

achievement and math course-taking levels of all students in schools, including those

with disabilities. Schools with drug and alcohol problems had a narrower gap in math

achievement between students with and without disabilities. More than average levels of

drug and alcohol problems or group and racial tensions in schools had a negative effect

on how far students with disabilities get in the math course-taking pipeline. School size

had no effect.

Research question #5 was:

Do students with disabilities who attend schools with high average course-taking,

and/or low variability in course-taking (a) progress farther in the math pipeline or

(b) have higher math achievement at 12th grade?

Higher average math course-taking and low variability in course-taking were associated with higher average 12th grade math achievement for all students, including students with disabilities. Low variability in course-taking was associated with higher average math course-taking for all students and had an additional significant effect for students with disabilities.

Explained Variance

Table 4.13 displays the proportion of variance explained by the fully conditional between school models of math achievement and course-taking over the fully conditional within school models. The proportion of variance that was attributable to between school differences was .30 for the average math achievement slope and .29 for the average math pipeline slope. The fully conditional models of average math achievement and average course-taking explained 61% and 53% of the between school variance, respectively.

The proportion of variance in the disability/achievement slope that was attributable to between school differences was relatively small (.05) to begin with. Table 4.13 shows that the fully conditional between school effects model explained 20% of the between school variation on the disability/achievement slope of 12th grade mathematics achievement. In other words, the variables in this model explained one third of the difference in math achievement scores of students with disabilities between schools. On the disability/course-taking slope there was considerably more variance between schools (.35) that could be modeled. The fully conditional between-school disability/course-taking model explained 36% of the variation on the disability/course-taking slope. I now turn to Chapter 5, for a discussion of the significance of the findings of this study and recommendations for policy and future research.

INSERT TABLE 4.13 ABOUT HERE

CHAPTER V

Discussion

The purpose of this study was to extend school effects research to explore the influence of specific school-level factors on the math course-taking behaviors and achievement of students with disabilities and to determine whether the level of math courses taken affects the math achievement of students with disabilities. I also sought to examine these effects relative to the performance of students without disabilities. To that end, I examined the ways that school composition, climate and curriculum structure affect the math course-taking and math achievement gap between students with and without disabilities. To complete this study, I conducted a multilevel analysis of data from direct assessments, student-, teacher-, parent-surveys, and student transcripts from the ELS: 2002 panel of students who advanced from 10th to 12th grade in the same school.

In this chapter, I provide a summary of the major findings and discuss the implications of the findings for policy. I also discuss the limitations of the study as well as recommendations for future research. The chapter is divided into 8 sections: (1) characteristics of students with disabilities versus students without disabilities,(2) the gap in mathematics achievement between students with and without disabilities, (3) the gap in mathematics course-taking between students with and without disabilities, (4) variance in

gaps attributable to schools, (5) response to research questions, (6) policy implications, (7) study limitations, and (8) recommendations for future research.

Characteristics of Students with Disabilities versus Students without Disabilities

Students with disabilities in this sample were significantly more likely to be minority, male, and of lower SES than students without a disability, a finding consistent with previous studies (Wagner, Marder, Levine, Cameto, Cadwallader, & Blackorby, 2003). There was also a significant gap in 9th grade academic GPA and 12th grade math achievement between students with and without disabilities. The achievement gap is consistent with other data comparing the math achievement of students with and without disabilities (National Center on Education Statistics, 2007; VanGetson & Thurlow, 2007). For instance, there was a 19% gap in the percent that achieved proficiency between the two groups on the National Assessment of Educational Progress (NAEP) 2005 math assessment (National Center for Education Statistics, 2007). The National Center on Education Outcomes reported that the gap in the percent of students with disabilities who achieved math proficiency in comparison to their peers without disabilities ranged from 17 to 60 percentage points across reporting states (VanGetson & Thurlow, 2007).

It is not surprising that students with disabilities in the sample on average only completed Algebra 1, while the students without disabilities on average completed up to the level of Algebra 3/Trigonometry. Previous research on the course-taking behaviors of students with disabilities has shown that these students enroll in less rigorous courses, particularly in the final two years of high school when most students take advanced level mathematics courses (Wagner, 2003).

Factors Associated with the Mathematics Achievement of Students With and Without

Disabilities

Independent of disability status, several individual demographic characteristics were associated with lower math achievement: minority status, gender, and low SES. These findings are consistent with findings in previous research (Chaney, et al., 1997; Lee, et al., 1997a; Lee, et al., 1998). Further, students both with and without disabilities have higher math achievement at the end of high school if their GPA in 9th grade academic courses was higher or they progress further than average in the math course-taking pipeline. Not surprisingly, this finding suggests that students with disabilities do better if they take more advanced-level math courses in high school.

In terms of school effects, schools that had higher proportions of students with higher SES and higher 9th grade academic GPAs also had higher average 12th grade math achievement among all students. Schools where students progressed further on the math pipeline and where there was little variability in the kinds of math courses they took also had higher average 12th grade math achievement among all students. Thus, it appears that a curriculum structure that encourages all students to take higher-level math courses results in higher average math achievement. This finding, in large part, aligns with earlier school effects literature (Lee, et al., 1997a; Lee et al., 1998). For instance, Lee, et al., (1998) reported that schools with higher average math course-taking were also schools with higher average math achievement. Lee, et al. (1997b) also reported that low variability in course-taking was associated with a narrower gap in the SES/math achievement gap.

The effects of school-level factors on the size of the math achievement gap between students with and without disabilities were less pronounced. Independent of its effect on all students in schools, curriculum structure did not have an effect on the size of the gap in 12th grade math achievement between students with and without disabilities. However, the average math achievement gap between students with and without disabilities was narrower in schools that reported higher than average numbers of drug and alcohol problems. Though unexpected, this finding may underscore a complex relationship in the schooling process for students with disabilities. Schools where administrators report drug and alcohol problems may have depressed achievement among all students. Additionally, the heightened awareness of drug and alcohol problems may result in greater attention, through services, to students with disabilities. Specifically, students with disabilities might be more segregated in these schools thereby shielding them from the effects of some school problems. Notwithstanding these possibilities, this study did not model the variables necessary to understand such a complex relationship; therefore, the model does not provide an explanation for the narrowing of the achievement gap.

Disability status was a significant predictor of between-school variation in average math achievement even after accounting for school composition, climate, and curriculum structure. This suggests that the disability designation itself explains some of the gap in 12th grade math achievement. However, there may also be other school level factors not included in the model that explain the disability/achievement gap.

Factors Influencing Mathematics Course-Taking of Students with and without

Disabilities

Similar to the findings related to the gap in math achievement, minority status, gender, and low SES were significantly related to lower progression in the math course-taking pipeline independent of students' disability status. The two largest effects on math pipeline progression were disability status and 9th grade academic GPA. Both had nearly equivalent effects on how far a student would be expected to progress in math course-taking.

For all students we would expect higher math pipeline progression in schools that limit course-taking behaviors rather than allow students to take a wide-range of courses. School composition and climate were related to differences in the average math course-taking of both students with and without disabilities. Students with and without IEPs in schools with higher average 9th grade GPA and higher average SES composition took more math courses and more higher level math courses.

For students with disabilities, progression on the math pipeline is stunted by both a higher than average presence of group or racial tensions and drug and alcohol problems in schools. It appears that in schools with these types of problems, students with disabilities are more likely to take lower-level math courses. It should be noted however that schools that experience group or racial tensions may not be the same types of schools that experience drugs and alcohol problems, and therefore the effects of these climate variables may not be additive for students with or without disabilities.

In schools with a "cafeteria-style" curriculum (e.g., highly variable course-taking behaviors) students with disabilities have significantly lower average progression on the

math pipeline. In fact, while high variability in course-taking affects all students in schools, its negative effect for students with disabilities is twice that of students without disabilities. This suggests that students with disabilities in schools with cafeteria-style curriculums take more low-level math courses. This finding aligns with reports from the NLTS-2 that suggest that students with disabilities take less rigorous coursework, particularly during the last two years of high school when students might be expected to take advanced level math courses (Wagner, 2003).

Even after accounting for school effects and controlling for students' demographic characteristics, disability status remained a strong predictor of how far a student would progress in math course-taking. It is likely then that a significant portion of the variability in course-taking among students with disabilities across schools is attributable to their disability status. Specifically, the individualization of programming for students with disabilities may make them more likely to be encouraged to take lower-level math courses. It may also suggest that there are other school-level effects that were not modeled in this study that explain some portion of the variance in math course-taking behaviors between students with and without disabilities.

Variance in Achievement and Course-Taking Gaps Attributable to Schools

Despite the relative size of the achievement and course-taking gaps attributable to disability status, I found that between 5% and 35% of the variability in the math achievement and course-taking behaviors, respectively, of students with disabilities was accounted for by the characteristics of the schools they attended. This finding suggests that disability status alone does not explain the achievement and course-taking behaviors of students with disabilities. The organization of schools affects outcomes for students

with disabilities relative to their peers without disabilities. Also, similar to previous school effects studies, I found that more variability in achievement was explained within schools than between schools.

Policy Implications

The findings of this study are important for several reasons. First, the findings confirm that schools do matter for students with disabilities just as they do for their peers without disabilities. For instance, scores for all students in schools with a higher SES, 9th grade achievement and a constrained curriculum were better, even though the achievement gap between students with and without disabilities did not narrow. It points to the conclusions of Malmgren, et.al., (2005), that a rising tide may in fact raise all boats. This contradicts the deficit-model view of disability that assumes that disability and its effects on outcomes are fixed within individual students. Further, these findings challenge traditional notions of disability by revealing that variance in outcomes for students with disabilities are influenced by school factors in the same way as their peers without disabilities.

The findings also have implications for course-taking opportunities provided to students with disabilities. The findings related to the gap in math course-taking between students with and without disabilities offer several policy implications. The cafeteria-style curriculum appears to be even more harmful to students with disabilities than students without disabilities. This was illustrated in the finding of a larger gap between students with and without disabilities in schools with highly variable course-taking. Thus, a policy of a constrained curriculum seems to be particularly important for tracking

students with disabilities away from low-level math coursework to advanced-level math course-taking.

Traditionally, special education has focused on individualizing education to the needs of the student. To that end we may believe that greater variety in course offerings would be beneficial to the educational opportunities of students with disabilities. However, the findings of this study suggest that, at least for students with high-incidence disabilities, a constrained curriculum might be better for their academic progress and success. Implementing a constrained curriculum for students with disabilities requires middle schools to ensure that all students are algebra ready, since high school math course-taking is directly related to prior math course-taking (NCTM, 2000).

Compositional effects for average SES and average 9th grade academic GPA were also found in this study. The type of students that attend schools determines school composition. Since school attendance, particularly in public schools, is usually determined by geographic districting, compositional effects are less amenable to school or district level policy initiatives (Lee, Bryk, & Smith, 1993). However, the findings of equivalent compositional effects for both students with and without a disability further illustrate that school organization affects all students.

The presence of group or racial tensions and drug and alcohol problems are, by themselves negative characteristics that must be attenuated in schools. These types of negative school climate factors affected the math course-taking of students with disabilities in this study and have been found to have negative effects on student performance in general (Pallas, 1988). An examination of factors associated with these negative climate characteristics and policies to address them is warranted.

Study Limitations

There were a number of limitations to the generalization of findings of this study. As noted in Chapter 1, the ELS: 2002 was not intended to be a survey of students with disabilities. Thus, a number of issues arose from attempting to explicitly model variability in the achievement and course-taking of students with disabilities. The extensive missing data on students' IEP status resulted in a loss of approximately 41% of students that were part of the original ELS: 2002 sample. There was also a small chance that some participants identified as having a disability using the logical imputation were not receiving special education services. However, the methods used for the imputation make this somewhat unlikely.

Each limitation of my sample resulted in a loss of students and schools from my sample. The largest loss being for students whose disability status was unknown. Bias analyses revealed that, in general, students included in my final analytic sample had slightly lower achievement and course-taking than those excluded. The schools attended by the students in my sample were not significantly different from excluded schools with the exception of a slightly higher average percent of students receiving services for special education. The findings of the bias analyses suggest that students in these excluded schools were less likely to have a disability than included schools.

The bias analyses appear to indicate that my sample did not greatly differ from the ELS: 2002 sample of students and schools. On the other hand, another study design choice does significantly limit the generalizability of findings. I limited the sample to students who attended 10th through 12th grade in the same school. Yet, 34% of students with disabilities drop-out of high school (USDOE, 2007) and only 52% of these students

graduate from high school with a regular diploma. Thus, students retained in my sample may be likely to be among the highest achieving students with disabilities. Therefore, caution should be exercised in generalizing the findings in this study to the larger group of secondary students with disabilities and to recognize that these findings apply only to those that complete high school.

The overall sample size used in this study was large. Further, the number of students with disabilities included in the sample was large and provides considerable power. However, another limitation was that the parameter estimates in the multilevel models were taken from approximately 11 students per school.

The measure of prior achievement (9th grade academic achievement) used in this study also presents a number of both theoretical and analytical limitations. Unfortunately, 9th grade academic GPA was the best available measure of prior achievement in the ELS: 2002 dataset. As noted in Lee & Bryk (1989), use of the 10th grade math achievement score could mask the effects of schools on the distribution of achievement since curricular track placement may be fixed beyond 9th grade. As a measure, GPA taps student academic as well as non-academic behavior, as well as teacher beliefs about grading and grading policies. Further, the GPA included all coursework. For students with disabilities, the relationship between GPA and academic achievement may be particularly complex as suggested by Blackorby, et al.(2003), WHAT DOES HE SAY??. The limitations of GPA as a predictor were displayed in the models of math achievement and course-taking as they relate to student gender. In both within school models, 9th grade academic GPA suppressed the effect of gender on the outcome variable.

Finally, measures of prior achievement and other controls on student characteristics are limited. The model used in this study cannot account for the cumulative effects of school or disability prior to high school. Further, my measure of achievement was cross-sectional and does not provide information on the trajectory of learning over time. Understanding what influences growth in achievement for students with disabilities is essential to addressing the known gaps in achievement between students with and without disabilities,

Recommendations for Future Research

The findings and limitations of this study provide direction for future research. Researchers in special education are beginning to explore the characteristics and achievement of students with disabilities using large-scale databases. Currently, conducting research on students with disabilities using large-scale data is extremely problematic, particularly when examining school effects. Sampling methods employed for the sole national longitudinal study of students with disabilities, the NLTS-2, make the data inappropriate for multilevel modeling and thus inadequate for studying school effects. Alternatively, the ELS: 2002 does not attempt to examine issues relative to students with disabilities.

The narrow focus on general education in the ELS: 2002 survey resulted in a number of limitations to modeling variance and generalizing findings. Future surveys of school policy, processes, and student outcome data should collect valid information on student disability status as well as achievement and other variables relevant to the unique experiences of students with disabilities. This is particularly important, as current

education policy increasingly demands the examination of the experiences and achievement of students with disabilities in comparison to their peers without disabilities.

Limitations in the national datasets may necessitate alternative data sources for conducting school effects research on students with disabilities. Researchers should consider working with state and district education systems to identify data that can be used to model the effects of school policies, organization, and processes on the outcomes of students with disabilities. Alternatively, researchers might also consider a series of school-level case studies.

Future school policy, process, and outcome surveys should also anchor student achievement data on more precise measures of prior achievement. For example, if available, I would have included 8th grade mathematics assessment in my model as the measure of prior achievement. At the least, this would have eliminated the problems I encountered with relationship between GPA and gender. These surveys should also include valid measures, such as school record data, on behavior referrals, suspensions, and expulsions. These are important student outcome measures for understanding school policies and processes. Further, measures of school exclusion are particularly important for students with disabilities because they are removed from schools at a higher rate than students without disabilities.

Curriculum research suggests that teachers of less rigorous courses view students more negatively and also that peer groups affect classroom behaviors (Gamoran, 1987; Gamoran & Berends, 1987). This study found that students with disabilities took lower-level math courses in schools where math course-taking was highly variable. This

suggests the need to model the processes (e.g., teacher and peer effects) that occur within low-rigor math classes in these types of high schools.

In closing, the results of this study clearly challenge the assumption that special education policy can continue to be informed without taking into account the ways that schools affect students with disabilities. Thus, while recognizing the role that individual difference plays in student outcomes, special education researchers must begin to examine the role of context in outcomes for students with disabilities.

APPENDIX A:

ELS: 2002 Instruments

TABLES

TABLE 2.1

Studies Included in Critical Review

Citation	Purpose	Dataset
Chaney, Burgdorf & Atash (1997)	Determine the effect of graduation requirements on course-taking	NAEP:1990
Everson & Millsap (2004)	Determine the direction and structure of relationships between organization, schooling, and math achievement on SAT	College Board-SAT (1995)
Lee, Burkam, Chow-Hoy, Smerdon, & Geverdt (1998)	Test the extent to which a constrained curriculum results effects math course-taking and achievement	NELS:1988
Lee, Croninger, & Smith (1997)	Test the extent to which a constrained curriculum results effects math course-taking and achievement	NAEP:1990
Lee & McIntire (1999)	Organization of schooling in rural vs. nonrural schools and math achievement.	NAEP:1996
Lee, Smith & Croninger (1997)	Determine the organization of high schools associated with higher and equitably distributed math achievement	NELS:1988
Teitelbaum (2003)	Determine the effect of graduation requirements on course-taking and achievement	NELS:1988

TABLE 2.2

Selected Significant Findings on School-Level Effects

Author	Average Achievement	Average SES	School Size	High Minority Concentration	Curriculum Structure
Chaney, et al., (1997)	X				X
Everson & Millsap (2004)				X	
Lee, et al., (1998)	X	X			X
Lee, Croninger, & Smith (1997)	X	X			X
Lee & McIntire (1999)		X	X		X
Lee, Smith & Croninger (1997)			X		X
Teitelbaum (2003)					

TABLE 3.1

IEP Status No Imputed Data

Base Year IEP Status	Frequency	Percent
Missing	7,375	45
No	7,112	43.4
Yes	1,031	6.3
Non-Respondent	855	5.2
Total	16,373	100

TABLE 3.2

IEP Status with Imputed Data

Base Year IEP Status	Frequency	Percent
Missing	6,693	40.9
No	6,441	39.3
Yes	2,513	15.3
Non-Respondent	726	4.4
Total	16,373	100

TABLE 3.3

Math Pipeline Variables

Variables	Highest Level Math Completed
1. No Math	N/A
2. Non-Academic	General 1 or 2/ Basic 1, 2, or 3/ Consumer/ Technical/ Vocational/ Review
3. Low Academic	Pre-Algebra/ Algebra 1 Pt. 1/ Algebra 1 Pt. 2/ Geometry-Informal
4. Middle Academic I	Algebra 1/ Plane Geometry/ Unified 1 or 2/ Other
5. Middle Academic II	Algebra 2/ Unified 3
6. Advanced I	Algebra 3/ Algebra-Trig/ Algebra-Analytic Geometry/ Trigonometry/ Trig-Solid Geometry/ Analytic Geometry/ Linear Algebra/ Probability/ Statistics/ Other/ Independent Study
7. Advanced II	Calculus-Introduction-Analysis
8. Advanced III	AP Calculus/ Calculus-Analytic Geometry/ Calculus

Adapted from Burkam, Lee, and Smerdon (1997)

TABLE 3.4

HLM Outcome Variable Properties

	Math Achievement	Math Pipeline
Within School Variance	0.73	0.76
Between School Variance	0.25	0.27
Intraclass Correlation	0.26	0.26
Reliability	0.65	0.65

TABLE 4.1

IEP Status Known versus Unknown			
	Status Known Mean	*Status Unknown Mean*	*F*
Prior Achievement	2.67*	2.70	200.73**
12th Grade Math IRT	49.11*	50.14	9386.14**
Socioeconomic status	0.14*	0.17	354.56**
Math pipeline	5.48*	5.73	5470.48**

* p. < .001 (t-test)
** p. < .001 (Levene's test)

TABLE 4.2

Sample	Mean	Standard Deviation	Effect Size
Analytic			
Socioeconomic Status	0.16	0.63	
Prior Achievement	2.71	0.85	
12th Grade Math IRT	49.57	15.32	
Math Pipeline	5.56	1.57	
Excluded			
Socioeconomic Status	0.16	0.63	.00
Prior Achievement	2.65*	0.90	.07
12th Grade Math IRT	49.55	14.50	.00
Math Pipeline	5.62*	1.54	.04

Analytic vs. Excluded Sample

*p. < .001

TABLE 4.3

Analytic vs. Full Sample			
	Mean	*Standard Deviation*	*Effect Size*
Analytic Sample			
Socioeconomic Status	0.04	0.72	
Prior Achievement	2.68	0.86	
12th Grade Math IRT	48.55	15.47	
Math Pipeline	5.49	1.58	
Full Panel			
Socioeconomic Status	-0.005	0.72	.07
Prior Achievement	2.55	0.92	.15
12th Grade Math IRT	48.49	15.04	.00
Math Pipeline	5.34	1.63	.09

TABLE 4.4

Included vs. Excluded Schools

Schools	Mean	Standard Deviation	Effect Size
Included			
Percent Female	49.9%		
Percent Minority	34.4%		
Percent Receiving SPED	7.38%		
School Size	1247.92	829.12	
Socioeconomic Status	0.1220	0.35	
Prior Achievement	2.60	0.52	
12th Grade Math IRT	48.70	7.98	
Math Pipeline	5.39	0.81	
Excluded			
Percent Female	49.7%		
Percent Minority	34.4%		
Percent Receiving SPED	5.40%**		
School Size	1188.25	935.14	.07
Socioeconomic Status	0.187	0.38	.18
Prior Achievement	2.56	0.42	.08
12th Grade Math IRT	49.52	9.10	.10
Math Pipeline	5.42	1.18	.03

*p. < .05
**p. < .001

TABLE4.5

Missing School Problems Data Bias Analysis		
	Achievement Model	*Course-Taking Model*
Variable	*Coefficient*	*Coefficient*
Intercept	-.14	-.18**
Composition & Climate***		
Average SES	.18**	.23**
Average 9th Grade Academic GPA	.15**	.10*
Climate (Attendance Problems)		-.02
Climate Missing Data Flag		.03
Curriculum Structure		
Average Math Pipeline	.10*	
SD Math Pipeline	-.19**	-.35**
Disability Slope		
Intercept	-.26*	-.57*
Composition & Climate***		
Climate (Drugs & Alcohol Problem)	.09*	.25*
Climate (Group or Racial Tension)		.23*
Climate Missing Data Flag	.09	.16.
Curriculum Structure		
Average Math Pipeline	.06	
SD Math Pipeline	.08	.44
Fixed Effects		
Minority	-.13**	-.12**
Gender	-.28**	-.12**
SES	.10**	.09**
9th Grade Academic GPA	.26**	.47**
Math Pipeline	.48**	

* $p < .05$; ** $p < .001$

TABLE 4.6

Student Characteristics

(n= 6,398)	Mean	SD
Female	.50	0.50
Minority Status	.30	0.46
SES	.04	0.72
9th Grade Academic GPA	2.68	0.86
12th Grade Achievement	48.57	15.47
Math Pipeline	5.49	1.58

TABLE 4.7

School Characteristics

(n$_j$ = 608)	Mean	SD
Percent Female	49.91	0.16
Percent Minority	33.55	30.51
Average School Size	1247.92	829.12
Average SES	0.12	0.35
Average 9th Grade Academic GPA	2.59	0.42
Average 12th Grade Math Achievement	48.69	7.98
Average Math Pipeline Progression	5.39	0.80

TABLE 4.8

Student Characteristics by Disability Status

$(n_i= 6{,}398;\ n_j = 608)$	No Disability $(n_i = 4{,}798)$			Disability $(n_i = 1{,}600)$			
	Mean	*t*	*SD*	*Mean*	*t*	*SD*	*Effect Size*
Female	.53	6.02	0.50	.44*	6.04	0.50	
Minority Status	.26	-9.97	0.44	.39*	-9.44	0.49	
SES	.04	14.50	0.72	-.30*	14.41	0.73	.47
9th Grade Academic GPA	2.82	15.09	0.82	2.46*	14.47	0.89	.42
12th Grade Achievement	52.56	26.03	14.16	41.54*	24.44	16.07	.73
Math Pipeline	5.90	24.05	1.41	4.86*	21.66	1.74	.66

*p < .001

TABLE 4.9

Within School Math Achievement

Fixed Effects	Model 1	Model 2	Model 3	Model 4
	Disability	*Disability & Demographic*	*Disability Demographics, & Prior Achievement*	*Disability, Demographics, Prior Achievement & Course-Taking*
Variable	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*
Intercept	-.19**	-.12**	-.17**	-.20
Disability	-.80**	-.70**	-.54**	-.33**
Minority		-.34**	-.21**	-.13**
Gender		-.14	-.33**	-.28**
SES		-.32**	.17**	.12**
9th Grade Academic GPA			.47**	.25**
Math Pipeline				.47**

Chi-Square Table			
Parameter	Variance	df	Chi-Square
Model 1			
Intercept	.27	253	1454**
IEP Slope	.16	253	413**
Model 2			
Intercept	.12	253	690**
IEP Slope	.09	253	376**
Model 3			
Intercept	.23	253	1528**
IEP slope	.14	253	417**
Model 4			
Intercept	.30	253	2518**
IEP slope	.05	253	364**

* $p < .05$; ** $p < .001$

TABLE 4.10

Within School Course Taking

Fixed Effects	Model 1 *Disability*	Model 2 *Disability & Demographics*	Model 3 *Disability, Demographics, & Prior Achievement*
Variable	*Coefficient*	*Coefficient*	*Coefficient*
Intercept	-.24*	-.18*	-.23**
Disability	-.72*	-.61*	-.45**
Minority		-.23*	-.15*
Gender		.07	-.11*
SES		.26*	.12**
9th Grade Academic GPA			.46**

Chi-Square Table			
Parameter	Variance	df	Chi-Square
Model 1			
Intercept	.29	253	1305**
IEP Slope	.33	253	444**
Model 2			
Intercept	.19	253	931**
IEP Slope	.26	253	409**
Model 3			
Intercept	.29	253	1603**
IEP slope	.36	253	490**

* p < .05; ** p < .001

TABLE4.11

Between School Math Achievement

	Model 5	Model 6
	Composition & Climate	*Composition, Climate & Curriculum Structure*
Variable	*Coefficient*	*Coefficient*
Intercept	-.15	-.14**
Composition & Climate***		
Average SES	.24**	.18**
Average 9th Grade Academic GPA	.19**	.15**
Curriculum Structure		
Average Math Pipeline		.10*
SD Math Pipeline		-.19**
Disability Slope		
Intercept	-.30*	-.26*
Composition & Climate***		
Climate (Drugs & Alcohol Problem)	.08*	.10*
Curriculum Structure		
Average Math Pipeline		.06
SD Math Pipeline		.07
Fixed Effects		
Minority	-.12**	-.13**
Gender	-.28**	-.28**
SES	.10**	.10**
9th Grade Academic GPA	.26**	.26**
Math Pipeline	.48**	.48**

Chi-Square Table			
Parameter	Variance	df	Chi-Square
Model 5			
Intercept	.15	251	1233**
IEP Slope	.04	253	352**
Model 6			
Intercept	.12	248	1174**
IEP Slope	.04	249	356**

* $p < .05$; ** $p < .001$; ***Non-significant effects dropped from model

TABLE 4.12

Between School Course Taking		
	Model 4	Model 5
	Composition & Climate	*Composition, Climate & Curriculum Structure*
Variable	*Coefficient*	*Coefficient*
Intercept	-.17**	-.18*
Composition & Climate***		
Average 9th Grade Academic GPA	.10*	.09*
Average SES	.25**	.23**
Climate (Attendance)	-.05*	-.02
Curriculum Structure		
SD Math Pipeline		-.35**
Disability Slope		
Intercept	-.51**	-.58**
Composition & Climate***		
Climate (Group/Racial Tension)	-.27*	-.23*
Climate (Drugs & Alcohol Problems)	-.21*	-.24*
Curriculum Structure		
SD Math Pipeline		-.46**
Fixed Effects		
Minority	-.12*	-.12*
Gender	-.12*	-.12*
SES	.09*	.09*
9th Grade Academic GPA	.48**	.47**

Chi-Square Table			
Parameter	Variance	df	Chi-Square
Model 4			
Intercept	.14	250	1019**
IEP Slope	.31	252	523**
Model 5			
Intercept	.14	248	1244**
IEP Slope	.23	249	515**

*p. < .05, **p. < .001; Non-significant effects dropped from model

TABLE 4.13

Proportion of Variance Explained

Model	Average Math Achievement		Average Course-Taking		Disability /Math Achievement Slope		Disability /Course-Taking Slope	
	Variance	*R² %*	*Variance*	*R² %*	*Variance*	*R² %*	*Variance*	*R² %*
Full Within School Model	.30	.	.29	.	0.05	.	0.35	.
Full Between School Model	.12	.61	.14	.53	0.04	.20	0.23	.36

FIGURES

FIGURE 1.
Math Course-Taking, Disability, and Achievement-Concept Model

Figure 2.

Effect of Constrained Curriculum on Math Achievement

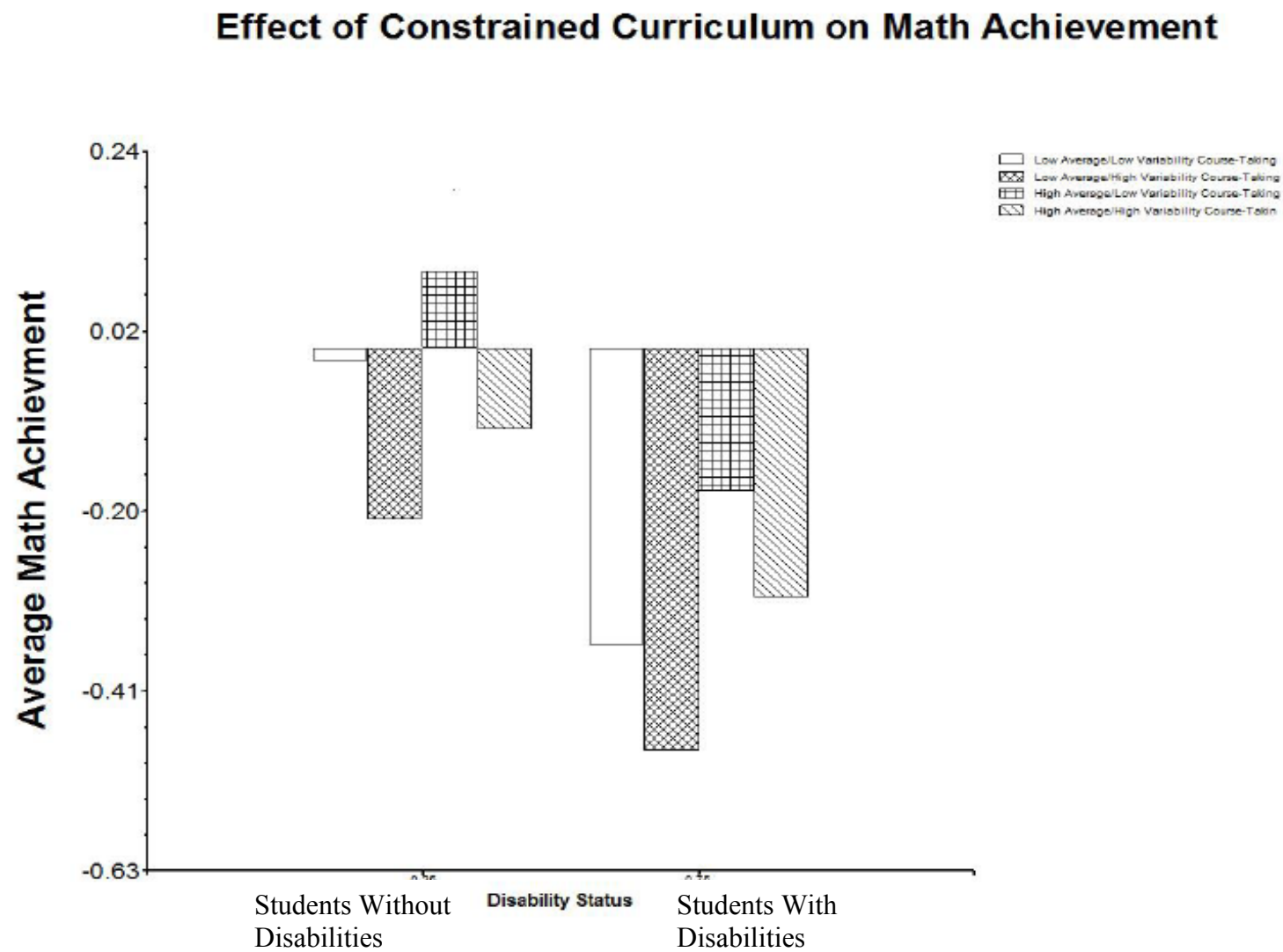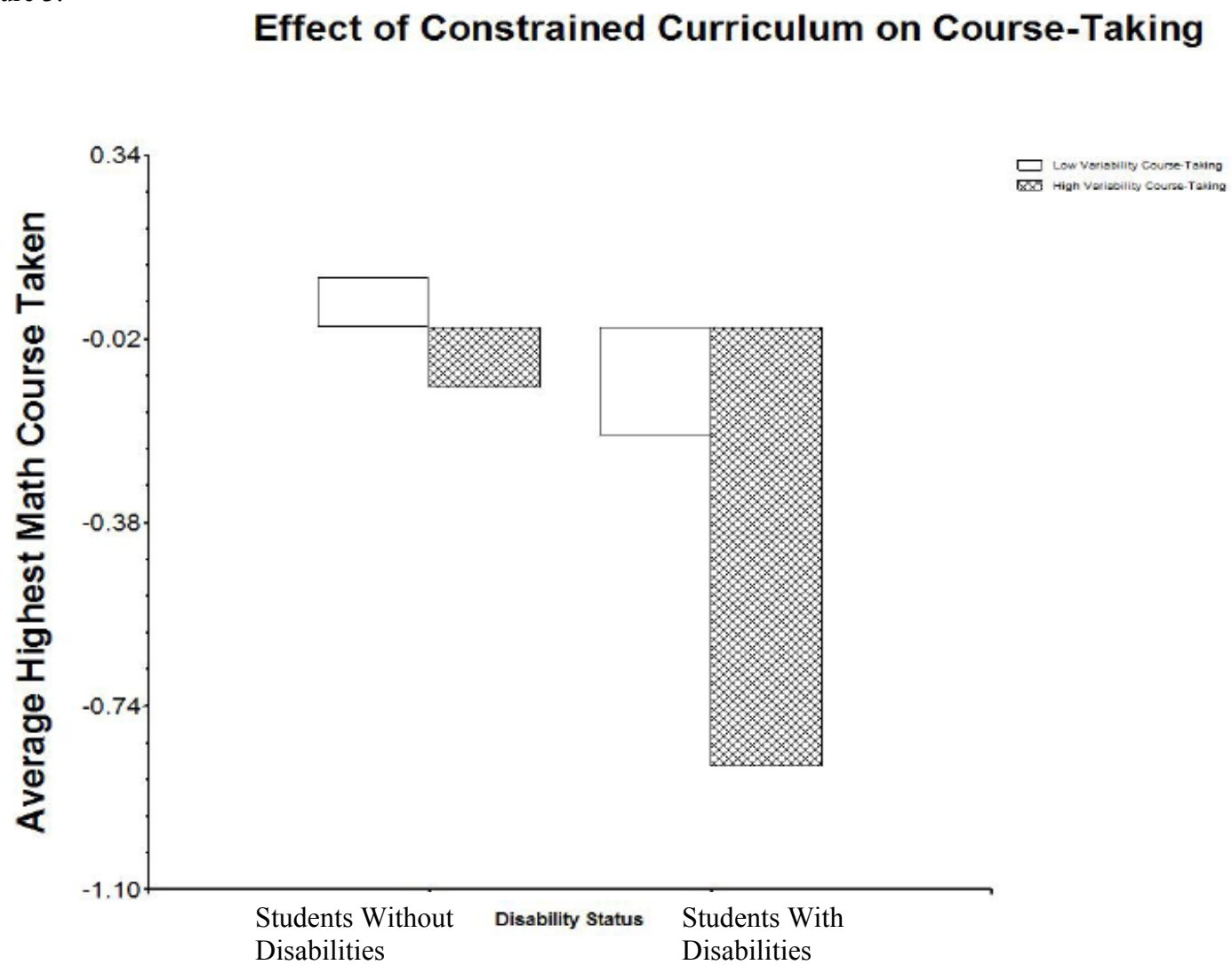Figure 3.

Effect of Constrained Curriculum on Course-Taking
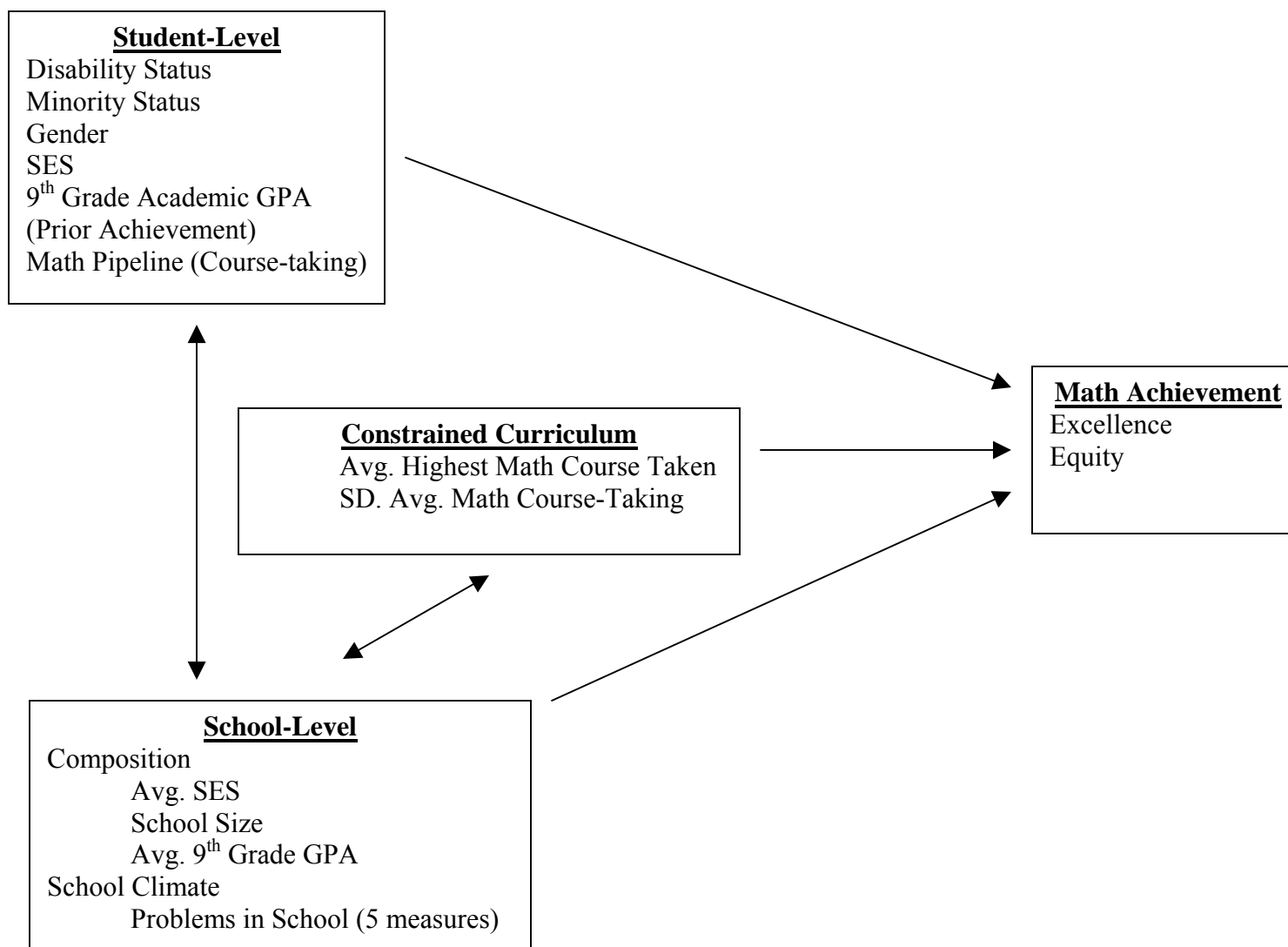
APPENDIX A:

ELS: 2002 Instruments

Direct assessments. The ELS: 2002 math assessment tested students in arithmetic, algebra, geometry, data/probabilities, and advanced topics. The test content was based largely on existing content items from the NAEP, PISA, and NELS:88. Ninety-percent of math test items were multiple-choice. The test achieved a relative balance between test items that were of low, medium, and high difficulty. Student scores on the assessment were estimated using Item Response Theory (IRT)[1]. Thus, student response represents an estimate of the score they would receive if they completed all of the 73-items on the test. The adaptive nature of the test was intended to minimize floor and ceiling effects and thus provide items sensitive to test-taker knowledge across the range of secondary level mathematics abilities.

Student questionnaire. Tenth grade students that were part of the ELS: 2002 sample and whose parent either actively (68.7%) or passively (89.9%) consented to participation completed a 45-minute self-report survey. The self-report had 7 sections and asked students about their location, school experiences, future plans, foreign language use, work, family, and personal beliefs about themselves. Because the focus of this analysis is on high school experiences rather than transition experiences the student questionnaires on school experiences, personal beliefs and family are most relevant to my study as they pertain to experiences during high school.

The section on school experiences was the most extensive part of the survey. In this section students were asked about their schools climate, their level of engagement in school, their perceived curricular track, the learning environment in their school, time

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[1] See Hambelton (1991)

spent on homework, and use of school facilities. The personal beliefs questionnaire includes psychological scales on motivation, beliefs on ability, and interest and self-efficacy in math. The family questionnaire asks students to respond to their perception of the extent to which their parent monitors them in terms of schoolwork, course decisions, and future plans.

Parent questionnaire. The parents of 10th grade students who were included in the sample were asked to voluntarily participate in a parent questionnaire during the base year (2002) of the survey. Both paper mailing and computer assisted telephone interviews (CATI) were used to collect parent data. Eighty-seven percent of sample students parents responded to the questionnaire. The parent questionnaire asks parents about the family background, the school life of their child, the child's family life, the parent's opinions on their child's school, and future plans for their child. Data collected from parents of sample students is intended to provide information on the students family, background, and family influences as they relate to school.

In respect to this study, the sections on family background, the school life of their child, and parent opinions of their child's school are pertinent. The family background section asks parents about their education level, race/ethnicity, religious affiliations, occupation, and primary and or other languages used in the home. The section on the student's school life asks parents to comment on their child's school history, their perception of the child's disability status, behavior problems, contacts with school officials, and a section on parental monitoring that essentially mirrors the questions asked in the student questionnaire. The school opinions questionnaire asked parents their

opinions of the academic rigor of their child's school, safety, and general satisfaction with the school program.

Teacher questionnaire. Both the English and Math teachers of students included in the sample completed teacher questionnaires. The response rate for teachers of students in the sample was 92.4%. Teacher response data were intended to provide information on factors that may influence student performance in school. Teachers completed 2 surveys, the first assessed the academic and behavioral performance of students. This survey included questions about the sample student's class and homework habits, tardiness, absenteeism, and behaviors in class. The second survey asked about teacher background and training. The teacher background questionnaire included questions about the teacher's demographic characteristics, teaching experience, academic background, credentials, job satisfaction, and attribution beliefs on student success.

School administrator questionnaire. School administrators were asked to provide information on school characteristics, the students and teachers within the school, policies, programs, technology, and the school climate. School administrator data were intended to provide contextual information on the schools attended by students in the sample. Among schools that participated in the ELS: 2002 study 98.8% returned a school administrator. As noted above, schools or their districts that did not participate in the study were asked to complete a questionnaire for comparison. Among eligible schools that did not participate in ELS: 2002, 93.2% returned the school administrators questionnaire.

Data collected in the school administrator questionnaire provide information that indicates school organizational or contextual realities in schools. These include school

type, length of school day and year, characteristics of the student and teacher population, policies regarding graduation and competency tests, levels of safety in the school, access to technology, and culture of expectations of for students and teachers.

One of the administrator data points that were of interest in this study was the section on problems that occur in the schools. The base-year administrator questionnaire includes 19 questions on the types of problems that occur in schools (BYA49A…S) (Appendix B). The questions require administrators to respond on a 5-point likert-type scale (1 = Happens daily, 2 = Happens at least once a week, 3 = Happens at least once a month, 4 = Happens on occasion, 5 = Never happens).

Library media center questionnaire. A staff member that was designated by the school administrator completed the media center questionnaire. Library media center questionnaires were collected for 96.4% of the sample. The survey included questions on the size and organization of the schools library/media center. The questionnaire also collected information on the media centers resources, in terms of staffing, technology, and collections. The survey also asked about the extent of use of the media center to supplement the curriculum and instruction.

School facilities checklist. The school administrator of sample schools was asked to complete a checklist to evaluate the school facility environment. Facilities checklist data were obtained for 100% of the study sample. This checklist included questions about the appearance of the school and rooms (hallways, lavatories, classrooms) including the presence of security measures such as metal detectors, security cameras and fencing as well as the level of order in and around the school (e.g., trash, noise, loitering, etc.). The

administrator was also asked to provide information on the surrounding neighborhood

environment.

APPENDIX B:

Base Year Administrator School Climate Questions

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Base Year Administrator School Climate Questions

49.) To the best of your knowledge how often do the following types of problems occur

at your school? (Mark one response on each line)

Responses:

1 = Happens daily

2 = Happens at least once a week

3 = Happens at least once a month

4 = Happens on occasion

5 = Never happens

    a. Tardiness

    b. Absenteeism

    c. Class cutting

    d. Physical conflicts among students

    e. Robbery or theft

    f. Vandalism

    g. Use of alcohol

    h. Use of illegal drugs

    i. Students under the influence of drugs/alcohol while at school

    j. The sale of drugs on the way to or from school and/or on school grounds

    k. Possession of a weapon

    l. Physical abuse of teachers

    m. Student racial tensions

n. Student bullying

o. Student verbal abuse of teachers

p. Widespread disorder in classrooms

q. Student acts of disrespect for teachers

r. Gang activities

s. Undesirable cult or extremist group activities

APPENDIX C:

Principal Component Analysis (School Climate Factors)

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Principal Component Analysis (School Climate Factors)

Principal Component Analysis

	Eigenvalues	*Rotation Sums-Cumulative %*
Drugs and Alcohol in School	6.685	16.41
Disorderly Climate in School	1.720	29.93
Gang and Racial Tension	1.584	42.43
Attendance	1.216	53.58
Theft, Vandalism, and Physical Conflict	1.033	64.41

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