ABSTRACT

FAULKNER, VALERIE. Predicting Student Eighth Grade Mathematics Class Placement. (Under the direction of Dr. Cathy Crossland).

The purpose of this study was to investigate student background characteristics, including student mathematical performance and documented teacher ratings of student mathematical performance, and the impact these variables have on eighth grade mathematics placement. The ECLS-K longitudinal data set was used to investigate how each of the following predicted placement in eighth grade Algebra or above: 1) cognitive math performance in third and fifth grade; 2) fifth grade teacher rating of student ability; 3) student race/ethnicity, particularly Black/African American and Hispanic; and 4) student receipt of special education services. The relative impact of mathematical performance versus teacher rating was analyzed as well. Students who receive special education services and students who are Black/African American were found to have reduced odds of being placed in Algebra by the eighth grade when controlling for background characteristics. In general, this trend remains in place for students in these categories who are also high achieving. When predicting for eighth grade math placement in Algebra or above, teacher rating of student performance appears to play a larger role with these students than with their peers.

Predicting Student Eighth Grade Mathematics Class Placement

by
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DEDICATION

To the memory of my mother

Frances Rawhouser Faulkner (1928-2007)

who taught me to respect and enjoy the gifts of all students,

and to

Dr. Christy Falba (1949-2010)

who took me under her wing and mentored me through this process.

BIOGRAPHY

Valerie Ness Faulkner was born in Pennsylvania and raised in Massachusetts and New Jersey. She earned a Bachelor of Arts degree in Anthropology in 1985 from Duke University. In 1994, she earned the Master of Education degree in Special Education from North Carolina State University. She is a candidate for the Ph.D. degree in Curriculum and Instruction with a formal minor concentration in Mathematics Education. Valerie began her teaching career in the Durham Public School System in Durham, North Carolina working with students with special needs as a cross–categorical teacher who taught several subjects. During that time she developed a special interest in supporting and tutoring students in mathematics. Valerie then taught for several years in a public separate setting, serving students placed in residential treatment at a state psychiatric hospital in North Carolina. During the years of her doctoral program she worked as a coordinating teacher for the Wake County Public School System in Raleigh, North Carolina, where she specialized in supporting all teachers in the district with their mathematics instruction and as a consultant for the North Carolina Department of Public Instruction. Throughout this time, Valerie taught as an adjunct lecturer at North Carolina State University and developed a graduate level course in the Special Education curriculum on Mathematics and the struggling learner. In the fall semester of 2010, she accepted an appointment as a full-time Lecturer in the Department of Elementary Education at North Carolina State University where she specializes in teaching mathematics education courses.

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An oak tree is just a nut that held its ground – Author Unknown

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Chapter One - Introduction

The progressive side of the American public education system was fashioned on the notion that intellectual freedom is the primary cornerstone of the system that underpins the development of a democratic society. Within this paradigm, the recognition and encouragement of student autonomy, intellectual potential, and academic achievement is espoused as the desirable outcomes of a meaningful public education. In the early 1900's, certain states within the nation began the process of "tracking" students in high school thereby differentiating instruction and permitting access to certain courses within the curriculum to some and not others. By the 1970's the idea of tracking students was even more widespread, with the initiation of Federal laws that mandated public special education services to students and the practice of large scale testing to measure the academic progress of students in standards-based curricula across the country. Certainly, by the early 1990's when Massachusetts implemented the *Education Reform Act* and subsequently developed a rather rigid curriculum and assessment approach (*Massachusetts Comprehensive Assessment System)* the die appeared to have been cast for the beginning of state-wide high stakes testing to determine placement in academic classes, i.e. a formalized tracking system wherein performance at one grade level supposedly determined placement in academic subjects at the next. This "testing movement" not only reignited the long-standing debate about what it means to have a public education, but also the issues of equal access to opportunities by ability, race, and gender. Proponents of high-stakes testing argued that one of the benefits would be the elimination of teacher perceptions and judgments about access to educational opportunity, and would cause decisions about educational placement to be objective, thereby allowing data-based decision making. This movement has been reiterated anew with the data-driven Response to Instruction movement within special and general education.

In this era of data-driven decision-making it is important to understand if student performance indicators are indeed driving important placement decisions for students. This may be particularly true for students who have been often disenfranchised by teacher or societal perceptions and have become under-represented in higher leveled classes. Nowhere is this more pronounced than in the areas of math and science (Moses, 2001; Stiff & Harvey, 1988). The purpose of the present research is to investigate whether the interplay of teacher perceptions of student mathematical performance, actual student mathematics performance, and eventual eighth grade placement in Algebra I exhibit patterns that are different for different students. In particular, do teacher impressions of student performance appear to hold a disproportionate influence in the mathematics course-taking trajectories of certain students. This juncture has become critical because the level of placement in middle school mathematics classes often is the primary determinant of how a student will be tracked in high school mathematics courses, and this in turn has a large influence on student educational outcomes (Burris, Heubert, & Levin, 2004, 2006; Catsambis, 1994; Dauber, Alexander, & Entwistle, 1996; Gamoran & Mare, 1989; Geiser & Santelices, 2006; Hallinan, 2003; Oakes, 1990). A Mathematics Course Trajectory table has been created to provide the reader context for the terms and assumptions built into this paper (Table 1.1). This Trajectory table is a depiction of which classes students take in high school as an extension of what classes were taken at the middle school level. As can be seen by this table, Algebra by the eighth grade is a critical point in these trajectories: students who take Algebra by eighth grade are the students who are both projected to take and do take honors and advanced mathematics courses. Overwhelmingly, students who do not take Algebra by eighth grade do not take these classes (Johnson & Stiff, 2009). This study will analyze the extent to which Elementary teacher impressions about student mathematical performance compares to actual student mathematical achievement as factors which predict student trajectories in mathematics for students who may be perceived to have weaker mathematical potential because of group membership. This research addresses important equity issues in the determination of access to advanced mathematics courses, and therefore, access to enriched opportunities of higher education and career development.

Table 1.1

Mathematics Course Trajectories: Who takes Honors and Advanced Placement Math? (Adapted and used with permission from EdStar Analytics, Inc.)

6th	7th	8th	HS Sequences	Course 1	Course 2	Course 3	Course 4	Course 5	Course 6
6th Math	7th Math	8th Math	A	Introductory Math (elective)	Algebra I Part 1 (elective)	Algebra I Part 2	Geometry or Algebra II	Geometry or Algebra II	Discrete Math
6th Math or 6th Advanced	7th Math or Pre-Algebra	8th Math or 8th Math Plus	B	Algebra I Part 1 (elective)	Algebra I Part 2	Geometry or Algebra II	Geometry or Algebra II	Discrete Math	Advanced Functions & Modeling
6th Math or 6th Advanced	7th Math or Pre-Algebra	8th Math or 8th Math Plus	C	Algebra 1	Geometry or Algebra II	Geometry or Algebra II	Advanced Functions & Modeling	Analytic Geometry & Trig	Introduction to College Math
6th Math or 6th Advanced	Pre-Algebra	Algebra I	D	Algebra 1 Plus (elective)	Honors Geometry or Algebra II	Honors Geometry or Algebra II	Pre-Calculus	AP Stats	
6th Math or 6th Advanced	Pre-Algebra	Algebra I	E	Algebra 1 Plus (elective)	Honors Geometry or Algebra II	Honors Geometry or Algebra II	Pre-Calculus	AP Calc AB	AP Calc BC
6th Math or 6th Advanced	Pre-Algebra	Algebra I	F	Honors Geometry or Algebra II	Honors Geometry or Algebra II	Pre-Calculus	AP Stats	AP Calc AB	AP Calc BC
Pre-Algebra	Algebra I	Geometry	G	Honors Algebra II	Pre-Calculus	AP Stats	AP Calc AB	AP Calc BC	Math Analysis

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It is important to policymakers and school-based personnel alike that these issues be understood. If student data are not driving academic trajectories, recommendations and safeguards will be needed to protect and ensure the objective means by which such crucial educational decisions are rendered.

This study investigates multiple factors in the processes that appear to determine placement in eighth grade mathematics courses, with a particular emphasis on how actual student ability (as measured by mathematics performance) affects placement, compared to teacher perception of student ability (as measured by teacher rating scale of math ability). There is substantial evidence supporting the claim that student class placement is not exactly a neutral proposition; rather the decision is a composite of several factors. Studies have shown repeatedly, and for decades, that the placement of students in classes or subgroups is part of a process involving dynamic interactions between teacher expectations (Elder, 2000; T. L. Good, 1987), student self-efficacy (Schunk, 1991), socioeconomic status (Oakes, 1990; Rist, 1970) and race (Dauber et al., 1996; Gamoran & Mare, 1989). Demystifying this process is complicated further by evidence that elementary school teachers may often play a critical (albeit sometimes “hidden”) role in placement decisions (Dauber et al., 1996). The impact of elementary school placement decisions for the first year of middle school may well extend into late middle school although ostensibly made by teachers with whom a student has interacted more recently. An example of this type of *sub rosa* decision-making might well be present to a significant extent in the selection process related to which students are placed in what levels of mathematics throughout middle school, into the eighth grade and beyond.

Academic placement decisions in mathematics have become a dynamic process with many complicating factors and it is understood that these decisions have a substantial impact on student outcomes (Burris et al., 2006; Gamoran & Hannigan, 2000; Hallinan, 2003; Hanushek & Wofmann, 2006). It remains critical that the longitudinal influences leading to these placement decisions be brought into line with the spirit and expectations of current law and the practice of data driven decision-making.

Statement of Problem

Teachers form opinions about the potential of their students that results in both minor and major decisions that can have an immediate impact on the academic paths and placements for individuals and, collectively, for groups (Dreeben & Barr, 1988; Finley, 1984; Hallinan, 1988, 1994, 2003; Rist, 1970; Soodak & Podell, 1993). It is well established that these placements, in turn, have a lasting impact on student outcomes (Eder, 1981; Geiser & Santelices, 2006; Hanushek & Wofmann, 2006; Rist, 1970; Rowan & Andrew W. Miracle, 1983). These are undeniable patterns in the cultural and professional undertaking of educating our nations' children. Much of the inquiry regarding these well-established phenomena regarding teacher impressions, grouping students, and student performance outcomes has been focused on populations at *either* elementary or secondary school levels. Furthermore, much of the research has focused on literacy skills (specifically, reading). The present research is designed to extend the understanding of these phenomena by focusing on longitudinal issues of teacher impressions and student mathematics performance including the important middle years of upper elementary *and* middle school. As part of this study, high-performing students will also be analyzed in order to minimize clichéd assumptions about all students who belong to a sub-group that has a history of relatively poorer performance than their peers. In other words, a high performing subset of students from student groups (Black/African American, Hispanic, students with an Individualized Education Plan (IEP)) will be analyzed to test whether these high performing students are being placed in line with sub-group stereotypes or in line with their individual performance level.

Purpose

The primary purpose of this study is to better understand student trajectories towards placement in mathematics in late middle school, with a specific emphasis on the roles of teacher impressions/judgment and actual mathematics performance on such trajectories. The results of the study will contribute to the body of literature regarding the use of data-based indicators as a valid and reliable means to interpret disproportionality issues in mathematics classes. The national and longitudinal nature of the study will allow for an examination of a phenomenon that has remained largely uninvestigated, i.e., whether, how and to what extent the judgment of elementary school teachers affects the eligibility and placement of certain students in middle school math classes, which in turn determines the placement trajectory in high school math courses.

Primary Research Question and Hypotheses

How accurate are the impressions/judgments of teachers regarding student mathematics ability and do these impressions/judgments differentially predict for some subgroups (Black/African American, Hispanic, and students with an IEP) which students will be placed in Algebra or above by eighth grade?.

Hypotheses:

H_1: High performing third and fifth grade students with an IEP in place will have significantly lower odds of being placed in Algebra or above in eighth grade than high performing students without an IEP.

H_2: High performing third and fifth grade Black/African-American or Hispanic students will have significantly lower odds of being placed in Algebra or above in eighth grade than high performing students who are not Black or Hispanic.

H_3: For students with an IEP in place, fifth grade teacher rating of student ability will be a stronger predictor of placement in eighth grade mathematics classes than student performance.

H_4: For students who are Black/African-American or Hispanic, fifth grade teacher rating of student ability will be a stronger predictor of placement in eighth grade mathematics classes than student performance.

Analyses will be run to find significance levels and odds ratios and to test the contribution of individual regression coefficients. Further investigation will involve analyses of interactions and prediction equations for student placement in eighth grade mathematics based on teacher rating and mathematics performance.

Limitations and Assumptions

A national and longitudinal database, *Early Childhood Longitudinal Study-Kindergarten, 1998-1999 (ECLS-K),* will be used to generate information that examines the relationships between teacher impressions/judgment, student performance, race/ethnicity, and disability status. A predictive model will be generated to contribute to an understanding of these dynamics as they relate to student trajectories.

While this study seeks to inform educational practitioners and policy-makers regarding the eventual placement of students in eighth grade mathematics classes, there are limiting factors worthy of note. The ECLS-K data set is used because of its large national scope and because of its detailed teacher ratings of student performance and cognitive data for student performance in mathematics. The set does not, however, include a variable indicating when, how, or specifically by whom a student is placed into an eighth grade mathematics class. This is a process that may, for any given child, begin or end with a guidance counselor, a parent advocate, a teacher, a principal, a special educator, or a committee comprised of all of the above. The mathematics portion of the Teacher Academic Rating Scale (RATE) is used to approximate the impressions and judgments of teachers about student mathematical ability that would affect placement recommendations made as students are moved from one grade to another. These teacher impressions are used as a type of proxy for this decision-making process and to represent the discussions regarding student placement that occur within and on the part of the school system as this decision is being made; therefore, there will be no direct data to indicate that a teacher rating caused a student placement or that teacher impressions are a one-to-one indicator of teacher decisions about student placement.

While all students will be analyzed in order to better understand the data and trends within the data set, analysis of high-performing students serve as a second focus. In order to better understand this dynamic of placement, impressions, and mathematical ability it is important to account for students who may be perceived to be low-performing because they truly are performing poorly. These students would not contribute to analysis of whether other students' performance is being rated in accordance with negative class associations rather than positive performance indicators. In other words, as well as analyzing the placement of all students with disabilities, and all students who are Black/African American, etc. those students who are in these sub-groups but are performing against stereotype (i.e. high-performing) will also be specifically analyzed. This stands in contrast to studies that follow all students of a certain sub-group and report trends for the entire group.

An assumption of the study is that teacher's impressions may be unwittingly biased with cultural misunderstandings that may perpetuate the same discriminative classifications that occur towards certain groups in other aspects of society. It is an assumption of the study that such cultural misunderstandings contribute to the well documented achievement gap within certain groups compared to benchmark curriculum expectations. It is further assumed that, if resistance to utilizing performance-based indicators for student placement decisions is to be affected, it is critical that data be presented to counterbalance assumptions about student characteristics and student performance. Therefore, the trajectories of strong performing students can serve to tell a story not told by statistics that focus on poor performance and achievement gaps currently in existence.

Students who are inconsistently high-performing will also be analyzed. These students are, by definition, more difficult to analyze and assess as to their mathematical ability. These students are likely to be the most affected by and/or vulnerable to teacher impressions and judgments because their performance, again by definition, is not providing clear indication of ability. For this reason, these students may also be the most vulnerable to being judged according to other characteristics such as race or disability status.

Operational Definition of Key Terms

In this research, the following terms are defined with respect to the ECLS-K data set and current research project.

Teacher Academic Rating Scales – Mathematics: These scales are completed by teachers on individual students and are a detailed measure of the teacher's understanding of the student's mathematical ability level. The teacher rating scale variable (RATE) will serve as a record of teacher impression of student mathematical ability.

Student Cognitive Test - Mathematics: This test is a cognitive achievement test designed by the Institute of Education Sciences-National Center for Education Statistics (IES-NCES) for the purposes of measuring student ability in mathematics. The cognitive test variable (MathCOG) will be utilized herein as the mathematical performance indicator.

High-performing student: Students are categorized into three different high performing groups for analysis. The mathematics performance assessment collected as part of ECLS-K data collection will be used to determine high-performance in mathematics. The first high achieving group, referred to as the group of all high-performers, scored at or above .5 standard deviations from the mean (top 31 percent) on either the third or the fifth grade mathematics performance assessment. The second group, referred to as consistently high performing, scored at or above .5 standard deviations from the mean (top 31 percent) on both the third and the fifth grade mathematics performance assessment. The third group, the inconsistent high performers, scored between .5 and 1 standard deviation (in top 31 percent but not above top 16 percent) above the mean on either the third or fifth grade mathematics performance assessment, but NOT on both.

Eighth Grade Mathematics Placement: This information is a part of the ECLS-K collection data for all students and was collected at the student-level by students' math teachers. Students are categorized as either being in Algebra (or above) by eighth grade or not.

Special Education Placement: At the third and fifth grade levels each student was coded in the ECLS-K data set regarding whether or not the student was in receipt of special education services. This variable will be used to determine if the student is a student with an Individualized Education Plan (IEP).

Race: A composite variable for race/ethnicity is utilized. At the fifth and eighth grade levels, race information was not collected for the ECLS-K and instead the ongoing variable was recorded on the basis of information collected in previous parent interviews. The race information used in this study, therefore, is derived from a composite variable that utilizes both parent responses when available and data collected by field staff in the computerized Field Management System (FMS) to complete data missing from parent interview. At the third grade level student-level race information is requested specifically in parent interviews and also collected through the FMS as a back up to parent data. Five race categories were used (White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander). Parent/Respondents were allowed to indicate that their child belonged to more than one of these dichotomous categories. Another dichotomous variable was created for those who indicated that their child was biracial or multiracial. Data were collected on Hispanic ethnicity and this was combined with the race data to create a composite variable. This combined race/ethnicity data yields the following race/ethnicity categories: White, non-Hispanic; Black or African American, non-Hispanic; Hispanic, race specified; Hispanic, no race specified; Asian; Native Hawaiian or other Pacific Islander; American Indian or Alaska Native, and more than one race specified, non-Hispanic.

These categories are then combined for this research into the following categories: White, non-Hispanic (WH), Black or African American, non-Hispanic (B/AA), Hispanic, race specified + Hispanic, no race specified (HSP). Other race categories will not be specifically analyzed through the hypotheses, but will be used as co-variates and reported as Asian and PINt+1 (students identified as Pacific Islander, Native American, or more than one category).

Socioeconomic composite: A composite scale score is provided within the ECLS-K for each student based on socioeconomic indicators of both prestige and wealth. These indicators are: Father/male guardian's education; Mother/female guardian's education; Father/male guardian's occupation; Mother/female guardian's occupation; and Household income. This composite socioeconomic variable will be utilized (SES) and run as a co-variate.

Gender: As with race, gender data is not collected after the third grade year. In order to assure that gender reports are accurate, ECLS-K staff has crosschecked data and a composite variable created to reflect student gender based on most-common responses through third grade. This data is then crosschecked with FMS data and a judgment on student gender is rendered based on the totality of the evidence collected. This composite variable, designed to avoid simple human error in the data, is used as the co-variate for gender.

Overview of the Dissertation

Following this introductory chapter to the current research is the literature review. The review is divided into three sections: tracking and mathematics placement; teachers and mathematics placement; and special education and mathematics as it relates to the current study.

The third chapter, Methodology, begins with a description of the ECLS-K data set and issues pertinent to this research such as how participants were identified, how research was conducted regarding the collection of data and what procedures were in place throughout the study. This section then describes the dependent and independent variables utilized. Details regarding the use of logistic regression to create predictive values and investigate the hypotheses are also provided.

In the fourth chapter, Results, the outcomes of the analysis outlined in Chapter Three are presented. This includes presenting the predictive values for teacher impressions and student ability utilizing logistic regression.

Chapter five, Discussion, explores the implications of the results as they relate both to our understanding of the dynamics of student placement and to efforts to make practice and policy changes to close the achievement gap. Finally, the limitations of this study and suggestions for future research are discussed.

Chapter Two – Review of Research

Introduction to the Review of Research

Research on the teachers' role in placing students along an academic trajectory in mathematics is limited, particularly with respect to the transition from elementary to middle school. In 1990, Oakes characterized studies that investigate teacher judgment of student intellectual ability and the impact of that judgment on outcomes as "an often neglected key to understanding the distribution of critical features" of mathematics (and science) classrooms (p. 17)(Oakes, 1990). Around the same time, Garet and Delaney conclude that "researchers should give more attention to the school level processes involved in matching students to courses" (p. 76) (Garet & Delany, 1988). In the twenty years since these observations were made there has been research designed to understand patterns of how students are academically tracked in mathematics but their remains little focus on the teachers' specific role in this phenomenon. The transition from elementary to middle school is an area particularly important for further research as it is in this time frame that critical academic decisions are made regarding a student's placement in mathematics (Dauber et al., 1996; Useem, 1992).

For decades, researchers have investigated issues that arise when students are tracked into different groups or classes according to perceived ability. Initially research focused on macro-analyses of the sociological and academic causes and effects of schooling and of tracking students (Bowles & Gintis, 2002; Cahan & Linchevski, 1996; Gamoran & Mare, 1989; Hallinan, 1994; Oakes, 1990). These studies led to a general understanding that tracking practices may be affecting students differently according to socioeconomic status and race. During the same general period, the “at risk” model was popularized as a means of finding students in need of intervention by considering socioeconomic status and race (Donnelly, 1987; Slavin, 1987). Eventually, and concurrently, researchers began to investigate smaller-scale issues regarding tracking and student academic placement, issues that are best investigated at the teacher and classroom level (Eder, 1981; Finley, 1984; Rist, 1970; Ritts, Patterson, & Tubbs, 1992; Useem, 1992). This included research on teacher expectations of student performance (Brophy & Good, 1986; T. Good & Brophy, 1974; T. L. Good, 1987). These studies contribute to the understanding of the dynamic of student placement in an academic trajectory. Issues regarding special education dovetail with these issues regarding the dynamics of academic placements for two primary reasons: 1) minority students continue to be identified for special education at a higher rate than majority students (Artiles & Trent, 1994; Services, 2002) and 2) special education students are regularly served in a setting separate from their peers and are thus routinely “tracked” in their own rite (Lipsky & Gartner, 1987). Currently, research and policy recommendations in both special and general education have begun to turn towards academic indicators and responsiveness to academic treatments for assessment of a student’s risks and needs (Fuchs et al., 2005; Fuchs, Fuchs, & Hollenbeck, 2007; Marzano, 2003; Stecker & Fuchs, 2000).

Investigating the patterns surrounding students who perform against stereotyped expectations allows for hypotheses about the possible relationship between teacher impressions and student academic placement in mathematics. The literature relevant to this study will include studies that investigate the issues of student placement particularly as they relate to mathematics. Studies that establish the tendency of current practice to disadvantage stereotyped demographic populations (specifically Black/African-American students and Hispanic students) studies regarding special education and mathematics, and studies that investigate teacher's evaluative impressions of students will be highlighted. The review is divided into three sections: tracking and mathematics; the teacher and mathematics placement; and special education and mathematics.

Longitudinal studies provide information regarding the impact that placing a student in a given group, class, or track has on longer-term academic outcomes. Large-scale and district wide studies provide information about differential impacts on students from different demographic backgrounds. Studies designed to investigate classroom dynamics provide insight into the specifics of classroom decision-making and teacher involvement in the process of student academic placement.

Conceptual considerations

As the issues of race, socioeconomics, and disability are reviewed and investigated herein, it is important to note the vast experiences that we bring to bear in interpreting findings. In particular, conceptual considerations of race are invoked just by using Black/African-American, White, and Hispanic as variables. The structure of research questions and discussions are prone to two fundamental approaches to identity (O'Connor, Lewis, & Mueller, 2007). One is to identify black students as either embodying an entire cultural experience that stands in contrast to the normative ‘white’ experience. The other is to “collapse conceptually the statistical relationships they document between race and the moderating variable under study” (p. 542). I ask the reader to interpret the literature and research presented with a finer brush and to resist any tendency to over-interpret statistical data as it relates to the experience of any individual student. The problematic nature of over-interpretation is demonstrated by Koretz& Kim (2007) in their analysis of ECLS-K data. They analyze relationships in gap patterns nationally and then across three different states and find very low correlations with respect to patterns in differential item analysis and student responses (Arkansas v. Alabama, r = .33; Arkansas v. Michigan, r = .36; Alabama v. Michigan, r =. 25). They find that, while national references to an achievement gap may represent a certain overall pattern, it is misleading to assume that this pattern is consistent across region, state and (by extension) individual experience and warn against making local inferences based on the national data. (Koretz & Kim, 2007). In the current study, high-performing students are disaggregated in order to better understand trends and experiences within the sub-groups.

Among the four recommendations made by O’Connor and her colleagues are to (b) bring attention to the way race is a product of educational settings as much as it is something that students bring with them and (c) focus on how everyday interactions and practices in schools affect educational outcomes (p.546). (O'Connor et al., 2007). Clearly it is the intention herein to focus on how the everyday interaction of teachers' impressions of student ability may contribute to students' educational outcomes. It may be less obvious that it is also a focus here to consider how race may be a product of the educational setting, but this paradigm is also pertinent. To the degree that race plays a part in a teacher's decision-making process it is the teacher who is creating the "product" of race. Actions based on a conception of race are outside of the control of the student even though he or she is the ostensible bearer of that 'race'. I would argue that the same paradigms are in play as we consider the issue of disability status, as well. Namely, that impressions about a class or group held by the teacher contributes to the de facto "product" of that group.

Tracking and Mathematics Placement

Overview of tracking

This section provides an overview of tracking practices and the impact of tracking practices on student populations. The section includes first the findings of two literature reviews on the effects of tracking and ability grouping through the late 1990s and in the United States. For context, a study that investigates the issue of tracking on an international level is also included.

Gamoran (1992) summarized the research on grouping and tracking practices and its effect on student performance. He concluded that, while grouping and tracking do not promote overall achievement in schools, they do promote inequity. In his own 1987 study, Gamoran found that achievement gaps widened more for high school students who remained in school but in different tracks than for those who dropped out compared to those who did not. Elementary school studies also demonstrate that student learning inequalities increase over time with a grouping model in place. In explanation of this increasing inequity, Gamoran sites studies that point to differences in instruction as well as differences in student attitudes and behaviors in the different groups or tracks. Gamoran concludes that tracking should be reduced or eliminated and that ability grouping should be improved to incorporate those practices that have been found effective in that setting.

Looking specifically at math and science and the practice of tracking, Haury and Milbourne (1999) site Mullis' 1991 estimation that by eighth grade over two-thirds of students in the United States are tracked into differentiated math classes (Haury & Millbourne, 1999) . These authors characterize the repeated demonstration of a connection between demographic grouping and ability grouping as troublesome. Bringing the practice of tracking into context, these authors cite the United States' poor performance in international comparisons and the National Assessment of Educational Progress to argue against any reason for continuing existing practices. These authors conclude that given the preponderance of the evidence, any marginal benefits found for the highest achieving students are more than counteracted by losses among other students.

Hanushek and Wofmann use a differences in differences approach to analyze the affect of tracking both within a country over time and also between countries. The International Mathematics and Science Studies (TIMSS) and Program for International Student Assessment (PISA) measures from primary and secondary school are used as measures of performance. Elementary grouping practices are not considered in this study and tracking practices are identified in each country based on the time that differential placements in separate classes begin. Elementary school student scores are used as pre-test, and secondary scores of the same students as post-test to analyze the effect of tracking practices within a given country. The primary school scores are then used as a control and comparing performance differences between primary and secondary school scores across early-tracked and late-tracked countries identifies the effect of tracking. Variance in performance is also used as an indicator of the effect of tracking on student performance over time. The authors find that the differences between early-tracked and late-tracked countries are systematic and substantial. The data "suggest that early tracking practices increase educational inequity" within a country and are associated with a tendency to "reduce mean performance" between countries (p. 63) (Hanushek & Wofmann, 2006).[1] When controlling for economic differences between countries the effects of tracking are substantially unchanged. What's more, there is no evidence that stronger performing students gain from a system of early tracking, as these students also experience a reduction in expected gain from their elementary scores consistent with the overall reduction in gains found for students in early-tracking countries as a whole.

Social and academic factors and predictors

This section will review studies that analyze relationships between mathematics

[1] In this study, because the effects of broad-scale tracking are being measured (and not within-class grouping) the United States is categorized as a late-tracking country. The U.S. demonstrates a relatively high variance in achievement even at the elementary level, but this variance does not grow to the degree that these variances grow in early tracking countries. Therefore, the U.S. is in line with the general findings of the study that, regardless of initial variance among students, initiating whole-scale tracking later reduces the expansion of this variance over time.

placement and social and academic characteristics of students. Two studies are reviewed. In a longitudinal post hoc study involving more than 4,000 subjects and representing six schools in a mid-western region, Hallinan (2003) investigates student class placement and academic outcomes over the course of three years[2]. Student scores on a statewide-standardized achievement test are used to measure achievement outcomes and represent the dependent variable. A regression model[3] is utilized to analyze the effect of various independent/control variables (for instance, class placement (track), previous test scores, gender, race, inclusion in a free lunch program, age, and school) on the dependent variable. The researchers identified five levels of placement for mathematics classes: Advanced, Honors, Regular, Basic and Very Basic.

The author comments extensively on the initial descriptive statistics for the mathematics groups (See Table 2.1). She points out how students with virtually any given achievement score could be placed in one of at least three different class levels. Hallinan (2003) summarizes a primary concern for this overlap pattern as follows:

> The extent of the overlap in the ability group distributions also suggests that not all the assignment criteria used by schools are designed to maximize group homogeneity. While it is often believed that schools rely primarily on test scores and grades to make ability group placements, these data suggest a heavy influence of nonacademic criteria as well. (p.114)

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[2] Students with exceptional needs and students learning English as a second language are excluded from the study analysis.

[3] A censored regression model (tobit) is used to account for the limiting factor inherent in percentile test scores ending at 1 and 99.

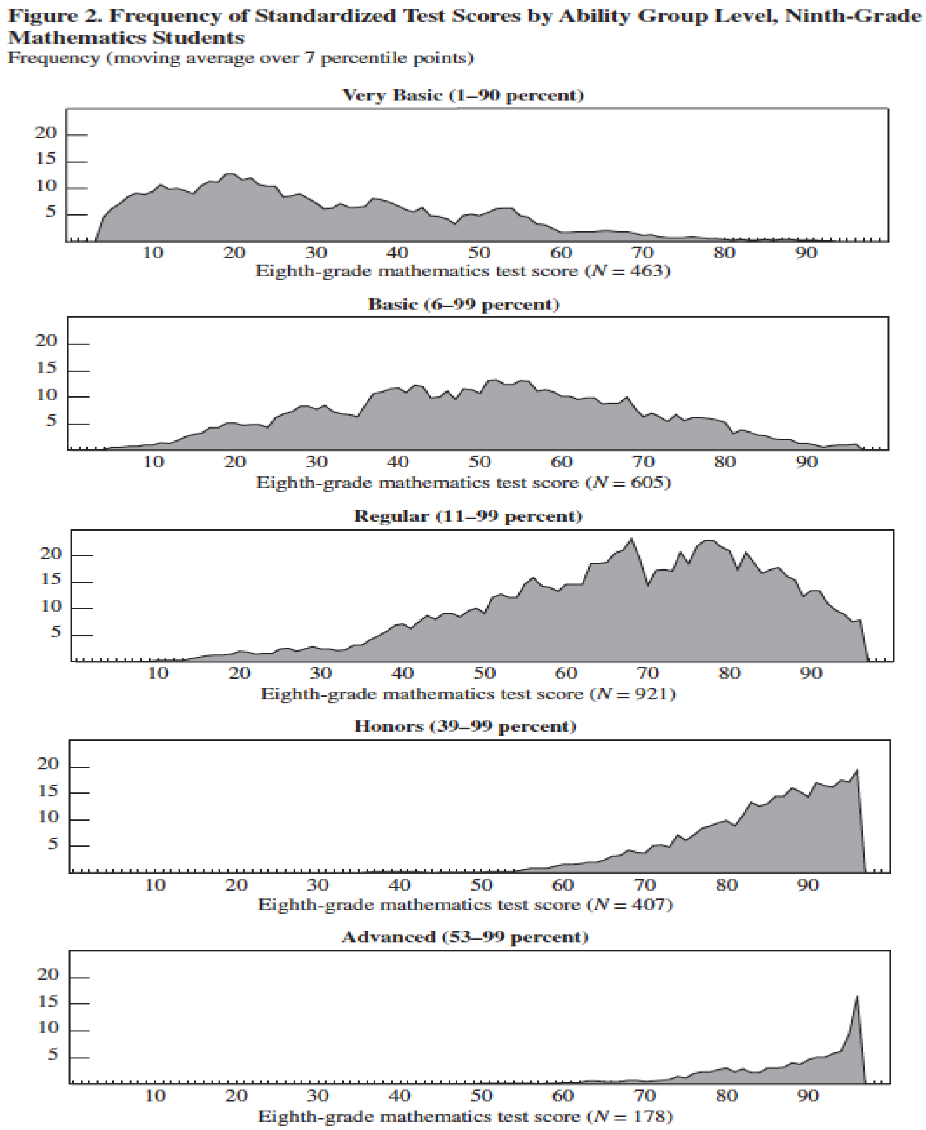

Figure 1 Data demonstrating extensive overlap between student mathematics performance and ninth grade mathematics placement. From Hallinan, 2003

A prediction model is also utilized to estimate outcome scores for students had they been placed in different classes. Predictive scores indicate that, in virtually every instance, a student of like background would gain in achievement by virtue of a higher class placement. For instance, students placed in the Regular level scored on average 61.4. Like students are predicted to score 67.6 (Honors) and 76.1 (Advanced) if Placed in a higher track (Hallinan, 2003).

In a longitudinal study that spanned 9 years (from first through eighth grade) Dauber, Alexander and Entwistle (1996) analyzed the tracking patterns in place in an urban school district with a majority of African-American students. They utilized logistic regression to analyze data from the Beginning School Study (BSS), a longitudinal study of school children in Baltimore. In particular, the researchers were interested in analyzing placement patterns in English and Mathematics from elementary into sixth grade and tracking these patterns through eighth grade placement. The outcome variables relevant herein included placement in three possible categories of eighth grade mathematics: remedial, regular or advanced. Predictor variables included 1) background characteristics such as race and mother's educational background, 2) academic records, including scores on fifth grade achievement testing, and 3) parent and student academic expectations as measured by questions within the BSS. (Dauber et al., 1996). The only academic placement wherein student expectations neared significance was for eighth grade math placement (odds ratio .80, $p < .10$). Parental expectations were significant for sixth grade math placement (odds ratio 1.47, $p < .05$) but not for eighth grade placement (odds ratio .53, $p > .10$). At the same time, only a "weak articulation" was found between academic records in elementary school and middle school math placement. Once in middle school, however, the relationship between sixth grade math placement and eighth grade math placement is both strong and significant (odds ratio 3.00, p

< .05). Socioeconomic status was found to be a significant factor for placement in advanced math classes in sixth grade (odds ratio 2.04, $p < .01$) but not at the eighth grade (odds ratio .74, $p > .10$). Moreover, the correlation for race and advanced math placement was less reliable in eighth grade (odds ratio -1.46, $p <. 10$) than at the sixth grade (odds ratio 1.25, $p < .05$). The authors take extensive time to analyze these findings in their conclusion noting that, when analyzing placement at the eighth grade level alone, the strong correlation between sixth grade placement and eighth grade placement may serve to hide from view the actual affects of background characteristics. Because sixth grade placement affects performance in middle school math achievement, eighth grade students will perform substantially in line with their track placement thus obscuring the effects of factors found earlier. This concern and argument is identical to the one presented by Rist (1970) when he discussed the self-fulfilling prophecy created by kindergarten group placements that were then perpetuated through the second grade. Initial patterns are obscured and socioeconomic patterns solidified as students are differentially affected by tracking opportunities.

Interested specifically in students who were English language learners (ELL), Callahan (2005) investigated the impact of several independent variables on academic outcomes such as grades and performance on standardized achievement tests. In a diverse California school all ELL students in the school (N = 355) were analyzed. Of these students, 89% were Spanish language speakers. In this analysis, tracking practices showed a stronger impact on student outcomes than did student knowledge of English. Whereas knowledge of English demonstrated a reliable correlation close to zero on both the SAT9 (r = .181, $p > .01$) and the California High School Exit Exam (CAHSEE) (r =. 158, $p > .01$), student track placement had a moderate and reliable relationship on math academic performance measures (SAT9: r = .274, $p < .001$; CAHSEE: r = .317, $p < .01$). The author concludes that tracking plays “ a much larger role than previously believed in predicting English learners’ academic achievement” (p. 324) (Callahan, 2005).

In a report for the Center on Education Policy, Kober (2001) conducts a review of the achievement gap between white and minority students and provides policy recommendations. Among these recommendations is expanding access to advanced courses in high-minority schools. Raudenbush, et al (1998) analyze state-by-state data within the National Assessment of Educational Progress (NAEP) for mathematics. They conclude that providing greater access to academic resources that predict success (among them teacher emphasis on mathematical reasoning and students taking algebra) is clearly an issue that needs policy consideration in efforts to close the achievement gap (Raudenbush, Fotui, & Cheong, 1998). While advanced classes and course-taking patterns do seem strongly related to issues regarding race, socioeconomic status, mathematics, and academic achievement, some researchers question the role of course taking as a mechanism for closing the achievement gap.

More recently, in a review of NAEP data and other pertinent literature Lee (2002) reports that the course-taking gap has closed from 1.2 in 1978 to 1.0 in 1999 for white versus black students, meaning that the same percentage of students who are white and black take advanced courses. This gap narrowed from 1.4 to 1.1 for Hispanic students in the same time frame. Lubienski & Shelley (2003) analyzed data from the 1990, 1996 and 2000 rounds of the NAEP to uncover trends related to race and socioeconomic status. With respect to course taking patterns, they conclude that any gap is largely explained by SES rather than by race. They further cite the large difference in achievement scores for 12th grade students who take calculus (white 344, black 314, and Hispanic 318) to argue that course taking is a correlate to, but not a solution to, reversing the achievement gap.

It is of note, however, that the articulation of advanced course-taking patterns in the NAEP may itself explain these conclusions. As noted in Lee (2002) the NAEP data defines ‘advanced’ courses as taking any one of a number of standard high school classes (algebra 1, geometry, etc.) by 17 years of age. This definition does not ground these courses in the context of place (resource class, lower-level, general, or honors) or time (eighth grade, ninth grade, eleventh grade, etc.). Lubienski and Shelley’s own descriptive statistics using the NAEP data from 2000 suggest that there *is* a course-taking gap (for instance, 14% of white students, 5% of black students and 6% of Hispanic (sic) 12th grade students report taking calculus). Students who take calculus by 12th grade would fit into an advanced course-taking pattern consistent with definitions of such found in studies such as Hallinan (2003) and Dauber, et al. (1996) cited above, as well as the present study. Without factoring in issues related to drop-out, it appears that white students are at least 2.3 – 2.8 times more likely than their Hispanic and Black/African-American peers to be taking courses that are in the advanced math track as it is defined herein.

Summary

Tracking practices do not appear to benefit schools or students with regard to increased academic achievement. Prediction models indicate that students who are placed in lower tracks will tend to perform lower than they might have had they been in a higher track.

Furthermore, tracking practices appear to differentially affect students according to socioeconomic status and race. Students who are Black/African-American and Hispanic continue to take advanced mathematics classes (such as calculus) at rates well below their white peers. Furthermore, recent studies indicate that an achievement gap persists between white students and their minority peers. The mechanisms for these phenomena are not fully understood, although differences in schooling opportunity at the secondary level may play a part.

Teachers and Student Mathematics Placement

In this section the role that teachers play in the process of placing students in different mathematics classes will be reviewed. Several constructs exist that are related to the role of teacher's as evaluators of student ability in mathematics. These constructs include teacher expectations for student performance, teacher beliefs regarding mathematics, and teacher impressions and judgment of student ability in general. These constructs will all be explored in order to frame the issue of teacher impressions of student mathematics ability and how it may affect the student placement process.

Teacher expectations

In a review of two decades of research on teacher expectation effects, Good (1987) defined teacher expectations as "inferences that teachers make about the future behavior or academic achievement of their students, based on what they know about these students now" (p. 32). Teacher expectation is further defined by including two specific types of expectation effects. These are 1) *self-fulfilling prophecy effect* wherein teachers believe something that is substantively untrue about the child until that belief becomes actuated, and 2) *sustained belief effect* whereby a teacher maintains an outdated belief about a child in spite of newer evidence. Good notes that while the former of these two is more potentially powerful, the latter is likely more commonplace. Good characterizes the body of research on teachers' expectation effects as leading to a consensus that they "can and sometimes do affect teacher-student interaction and student outcomes" and notes that the processes involved are "much more complex than originally believed" (p. 33). Good maintains that teacher expectation analysis is quite complex due to the fact that teachers hold multiple beliefs and students possess multiple characteristics (T. L. Good, 1987).

Regarding teachers' development of an understanding of student ability, Good summarized that teachers do make reasonable assessments of student ability levels. While background factors such as race and disability status can affect teacher impressions of a student, teachers "usually develop accurate expectations about their students, and they tend to change these expectations as more or better information becomes available" (p. 34). These findings imply that the impact of self-fulfilling prophecy effects are delimited and tend to occur when students are new to a teacher, as in the beginning of the school year. These findings do not preclude an impact from sustained belief effects, however, because teachers may hold onto initially accurate impressions of unambiguous student behaviors and then maintain their initial expectations for students (T. L. Good, 1987).

In spite of teachers' relative strength in originally developing expectations for students, particularly with regard to behaviors that are relatively unambiguous, teachers do demonstrate differential behaviors towards different students. This appears to contribute to effects of the sustained belief type. For instance, Good cites Anderson and Levitt's (1984) finding that teachers interpret ambiguous student behavior or performance based on their differing expectations of student performance. Good maintains that these ambiguous events compose the bulk of classroom interactions and have the potential to have a substantial impact on students. Good cites several studies that support the notion that student presentation (timing of misbehaviors, language use) also contribute to teachers' tendency to maintain certain expectations about students. In general, teacher beliefs, impressions and expectations about their own teaching effectiveness, student effort and ability, and curriculum pedagogy (among a myriad of other definable characteristics) are all part of an interplay that can effect student outcomes (T. L. Good, 1987)

Teacher beliefs and mathematics tracking

The general merit of tracking or grouping students according to mathematical ability level appears to be a common belief among teachers. Oakes (1990) finds that the use of tracking and ability grouping in mathematics (and science) is widespread and believed by educators to be appropriate because of different ability levels within the students. Cahan, et al summarize neatly the research on this belief specifically as it relates to mathematics:

> The main justification for using ability grouping is the need to adapt content, level, pace and teaching methods to students who function at varied levels (Slavin, 1988, 1990; Sorenson & Hallinan, 1986). Such a didactic fit is considered particularly important in mathematics, not only because ability is seen as the central factor explaining differential achievements in this domain (Lorenz, 1982), but also because mathematics is perceived as hierarchical, serial, or cumulative (Ruthven, 1987), which makes it difficult to work with heterogeneous groups. Thus, while more than 80% of mathematics teachers believe that their subject is inappropriate for teaching groups of students of mixed ability, only 16% science teachers and 3% of English teachers hold this view about their own subjects (Her Majesty's Inspectorate, 1978, 1979, 1980).

While the exact nature of how this belief may affect teacher impressions of student ability has not been fully studied, it seems more than plausible that this strongly held presumption about the nature of mathematics would have an impact on teacher assessment of student learning and ability in mathematics. It is unclear if this belief is in any way helpful in evaluating student ability or if teachers are consistent in how they see mathematics as a discipline and how they assess mathematics as a learning task.

Nathan & Koedinger (2000) studied teacher beliefs about mathematics curriculum and did find that teachers' latent beliefs correlated with assessment of algebraic tasks rather than their self-reported beliefs. One hundred and seven kindergarten through twelfth-grade teachers who teach mathematics were interviewed regarding their own beliefs about mathematics and also asked to analyze algebra problems based on difficulty level in order to understand how these beliefs are applied to mathematics in the classroom. These researchers found that teachers' self-reported beliefs about mathematics are consistent with National Council of Teachers of Mathematics (NCTM) reform principles (developing meaning, analyzing solutions, etc.). This self-report of what matters in mathematics and how the students access mathematics revealed a conceptual orientation on the part of the teachers. Teacher beliefs were also inferred from how teachers ranked the hierarchical difficulty (for students) of 6 different algebra problems (Nathan & Koedinger, 2000). Unlike their self-report, teachers analyzed problems based on what the authors label a 'symbol-precedent' construct (as opposed to an organization based on concept difficulty). In other words, teachers thought they were prioritizing concepts as a way to access mathematics, but their task analysis of math tasks prioritized the manipulation of symbols. Consistent with their findings regarding teacher assessment of how students will perform on given mathematical tasks, the authors cite several studies (for instance, Cheng, Holyoak, Nisbett & Oliver, 1986;

Kahneman & Tversky, 1973) indicating that people do not necessarily follow logic or probability when making decisions (Nathan & Koedinger, 2000). In this case, the teachers' own beliefs about how they see mathematics did not match their latent beliefs as manifested in their analysis of mathematical problems. Moreover, the authors found that there was a pronounced difference in the teachers' ability to predict student difficulty with algebra problems when analyzed by those who teach elementary, middle or high school. The middle school teachers were the best at predicting student performance on algebra tasks. The high school teachers, who demonstrated the strongest correlation to the symbol-precedent construct, were the weakest at predicting student ability with actual problems and were the least aware of effective alternate solution strategies (Nathan & Koedinger, 2000).

There is also evidence that teachers may sometimes play a role in the student assessment and placement process that is entirely outside the scope of student ability itself. In a study designed to investigate social issues inherent in tracking practices, Finley (1984) utilized a case-study approach in a suburban high school. Eighteen teachers were interviewed and observed. Finley concludes that teachers, in effect, competed for higher tiered classes that contained largely "privileged Anglo families" (p. 242). She contends further that the tracking system itself was, at least in part, not the result of student need but a teacher-motivated desire to create and maintain a status hierarchy within teachers' professional control (Finley, 1984).

Teacher impressions and judgment of student ability

In a 1990 National Science Foundation report, Oakes summarized the effects of tracking practices as they related specifically to race, class, mathematics and science. The author analyzed mathematics and science classrooms using the 1985-1986 National Survey of Science and Mathematics Education (NSSME) and combined this information with a review of other literature on the topic. Through cross-tabulations, correlation analyses and analysis of variance, schools serving different populations of students were analyzed. Multivariate analyses were also used to isolate specific variables related to classroom distributions (Oakes 1990). Germane to this section is the review and analysis of teacher judgment about student ability and the impact this has on grouping students.

Oakes characterizes studies that investigate teacher judgment of student intellectual ability and the impact of that judgment on outcomes as "an often neglected key to understanding the distribution of critical features" of mathematics (and science) classrooms (p. 17). Issues of teacher judgment are deemed particularly important for poor and minority students, as these students were more likely to "experience initial learning difficulties" and be judged with 'low ability.'[4] Oakes reports further that this is also reflected at the class level as elementary classes with disproportionately minority students were *seven times more likely to be identified as low-ability than high-ability* (emphasis in original p. 23). At the high school level, classes with predominately white students are described by school personnel as high ability 57% of the time whereas classes with a majority of non-white students are described as high ability 9% of the time.

As well as her own studies, Oakes cites several other studies regarding teacher judgment. These studies serve to accentuate Oakes' point regarding a lack of focus on

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[4] If we invoke Good's distinction for teacher expectation, we see here that an initially accurate assessment of ability may predispose these students to be limited by the *sustained belief effect*.

teacher judgment. While these studies involve student placement in different tracks, none of these studies refer specifically to teacher judgment and impressions of student mathematical ability as it relates to student outcomes. One study does find that *student* perceptions of their own track placement affects their own outcomes (Gamoran, 1987).

Although not with regard to mathematics, other studies have dealt specifically with teacher impressions of students and how this affects their judgment of student ability. In an extensive review of the literature on teacher impressions regarding student physical attractiveness, Ritts and colleagues (1992) review specifically the literature on teacher impressions and include discussion of other variables studied within this context (Ritts et al., 1992). They found one study (Morrow & McElroy, 1984) that investigated the affects of student attractiveness on teacher rating of student academic performance. This study did not find an effect for attractiveness when teachers were rating expected performance. Past performance itself accounted for the greatest variation in ratings. Physical attractiveness does not appear to mitigate that judgment.

Several studies are reviewed that consider race within physical attractiveness studies, and here, on the other hand, it was concluded that race was a “potent source of input into teachers’ impressions” (p. 421). Ritts and colleagues summarized the conclusions of this sub-set of the research and found that teachers: (a) rated black students less favorably, (b) treated black students less favorably in the classroom and (c) held lower academic expectations for black students than for white students (p. 421). The race of the teacher did not appear to matter in these constructions as Cross and Cross (1971) found that this was true for both black and white teachers (Ritts et al., 1992).

A more recent line of investigation, commonly referred to as stereotype threat, is the effect of students' knowledge of racial and gender stereotyping concurrent with knowledge of inclusion within a stereotyped group and the impact this has on performance (Steele & Aronson, 1995, Steele, 1997). In a recent review of stereotype threat literature Aronson conducted an extensive search of studies utilizing "stereotype threat" "intervention" and "achievement gap" as search variables to identify studies that have utilized information about stereotype threat to develop counteracting interventions (Aronson et al., 2009). Three high-quality studies were identified from these searches and one of these studies includes information about mathematics and teacher impressions. This study by Blackwell, Trzesneiwski, and Dweck (2007), utilized an experimental design in an urban 7th grade setting (54% Black, 45% Hispanic, 3% White or Asian). They identified 91 low-achieving students who were then assigned to the control or intervention group. The intervention was 200 minutes of instruction on the nature of intelligence along with strategies for developing their own intelligence. Whereas both groups had been on a significant downward trajectory as measured by standardized math scores before the intervention (spring grade 6, 2.86; fall grade 7, 2.33; spring grade 7, 2.11), only the control group continued that spiral after the intervention. The intervention had a significant positive effect ($b = .53$, $t = 2.93$, $p < .05$) on math scores during the course of their 7th grade year. The math teachers of these students did not know which students had been in the intervention or control groups. There was a significant difference in reports of positive impressions regarding motivational change in students in the experimental group. Whereas 27% of students in the experimental group received reports from teachers that they made positive changes, only 9% received positive reports in the control group (Aronson et al., 2009). Teachers then, were documented to have adjusted their impressions of these students' attitudes consistent with students' improved performance in mathematics.

Elementary to middle school considerations

Researchers have indicated that the middle school years (Useem, 1992) and the transition into middle school (Dauber et al., 1996) are critical times in a student's academic path in mathematics. But this transition must start with an articulation of student performance at the elementary level and concomitant recommendations for middle school placement. In her research on ability grouping and reading, Eder concluded that "the lack of accurate measures of academic aptitude in early grades is particularly important since it increases the likelihood of ethnic and class bias in ability group assignment" p. 161 (Eder, 1981). While skill-specific and nationally normed measures may now exist in reading as a tool to minimize this bias, this is not the case in mathematics where strong assessment measures are still sparse (Chard et al., 2005; Gersten, Clarke, & Jordan, 2007; Gersten, Jordan, & Flojo, 2005; Methe, 2009). Elementary teachers, then, do not have the assessment tools they may need to fully understand student ability and to intervene in mathematics. It is unclear how this may be affecting their overall judgment of student mathematical ability.

Summary

Teacher expectations, beliefs, impressions and judgments about student behavior appear to be connected to student outcomes. Teachers' beliefs about mathematics may have an impact on the belief that tracking practices are neutral and that they are the result of, rather than a cause of, student differences in ability. There is a lack of normed assessments and indicators of mathematics performance at the elementary level, which may hamper teachers' ability to assess and intervene in mathematics. Furthermore, it is not clear that NCTM reform efforts have had an impact on how teachers understand mathematics and student ability to solve problems. There is also mixed evidence as to whether teacher expectations and beliefs are strongly connected to student academic performance or whether they are significantly influenced by other considerations including race. While teachers have demonstrated an ability to judge unambiguous student ability with some level of accuracy, there is indication that race, socioeconomic factors and non-academic behaviors play a role in teachers' sustained expectancy for student performance and in teacher assessment. This may be particularly true when behaviors are ambiguous or undesirable. Finally, how student ability is evaluated in elementary school may play an important and hidden role in students' middle school placement and eventual performance in mathematics.

Special Education and Mathematics

There is notoriously little research on special education and mathematics (Gersten & Chard, 1999; Kroesbergen & Luit, 2003; Swanson, 1999; VanGarderen, Scheuermann, Jackson, & Hampton, 2009). There is decidedly less on specific topics such as the present study investigating elementary teacher impressions and their impact on the middle school mathematics placement of students identified with a disability. General mathematics studies often drop special education as a category, citing low numbers for special education students (see for example, Dauber, 1996). Studies regarding special education and mathematics have focused on teaching techniques (VanGarderen et al., 2009). One study (Maccini & Gagnon, 2002) was found that draws attention to special educators and their mathematics curriculum knowledge and is among several studies that will be addressed briefly to create a context for current issues in special education as they relate to mathematics. Two syntheses of the research on special education and mathematics (Hughes & Smith, 1990; Lubienski & Bowen, 2000) will also be addressed.

Special Education instruction and mathematics

Maccini and Gagnon (2002) found that more than half of special educators indicated they were not aware of the National Council of Teachers of Mathematics (NCTM) Standards, a critical document in outlining mathematics curriculum. As a result, these authors have called for “intensive teacher training” in mathematics for special educators (Maccini & Gagnon, 2002). Similarly, in a study that surveyed the Individualized Education Programs (IEP) of 76 fourth and eighth grade students, Shriner, Kim, Thurlow, and Ysseldyke (1993) found that students with disabilities are not receiving access to the mathematics driven by the standards set forth by the NCTM. In this research study, IEPs were requested from one school district in the Southwest region and one in the mid-Atlantic region. The following dimensions were measured: Level of Mastery (based on Bloom’s revised taxonomy), Nature of the Material, and the Operations required to complete the work. The researchers concluded that the IEP goals of these students were grounded almost wholly in basic arithmetic computation with less than 15% of the goals addressing applications and the problem solving process. They call on special educators to strengthen their current level of instruction: “There is a need for special educators to prepare students to be problem solvers and critical thinkers. Teachers of students with disabilities must address a broader array of topics and skills than they appear to be covering” (p.23).

Anderson (1992) questions whether the NCTM reform math standards, new at the time, were being implemented in a way that addressed the needs of students with disabilities at all. More current studies on reform programs continue to indicate that the needs of students with disabilities are not being met in general education elementary classrooms (Baxter, Woodward, & Olson, 2001; Woodward, Baxter, & Robinson, 1999). There is reason to believe that students with disabilities are not being served to a high standard in mathematics.

Students with disabilities and mathematics

Students with disabilities[5], in general, have demonstrated a long history of poor performance and outcomes in mathematics. Even students with mild disabilities have a poor track record in mathematics performance and perform lowest in math at the secondary level compared with other academic subjects. They leave school with mathematics skills approximating the fifth or sixth grade level (Cawley, Parmar, Foley, Salmon, & Roy, 2001). An analysis of performance of over 1,000 third through eighth grade students on a battery of mathematical tasks found that students with disabilities (math or otherwise) had less developed math vocabulary and lower rates of automaticity of single-digit math facts. Computational fluency, while noted to be weak in the population as a whole, was considerably weaker for the students with mild disabilities. Furthermore, this study found, consistent with decades of research, that students with mild disabilities are considerably more prone to word problem errors involving the use of extraneous information (Cawley et al., 2001).

[5] Note that, while approximately 5-8% of students are identified with having a specific mathematics disability, the current study is concerned with the approximately 12-15% of students who have an IEP in place and therefore may be identified with any sort of disability.

The current study is focusing on students with an IEP in general, but also focusing on students with an IEP who have performed well in mathematics through elementary school. One article (Reis, Neu, & Mcguire, 1997) was found that reviewed research on students with learning disabilities who are also gifted, but this study did not focus on mathematics. Nevertheless, these reviewers found that students who are both gifted and facing a disability are often discouraged from considering college and may face limited educational opportunities because of teachers' stereotyped understandings of these students (Reis et al., 1997).

In the absence of research on high performing students in receipt of special education services specific to mathematics, research on students with learning disabilities (LD) in college will serve as a proxy. Hughes and Smith (1990) synthesized two decades of literature on the cognitive and academic performance of college students with disabilities. They located 106 articles on the topic of college students and learning disabilities and found 26 that pertained specifically to cognitive and academic characteristics of the population. The authors cite several studies that found students with LD had measured levels of intellectual functioning comparable to their non-disabled peers (Barsch, 1981; Birely & Manley, 1980; Worden & Nakamura, 1982). Measured ability levels for mathematics varied widely from study to study, but there is a consistent tendency for students with disabilities to score below their peers in mathematics achievement. Dalke (1988) found significant differences between students with LD (Woodcock-Johnson Psychoeducational Battery Part I: Tests of Cognitive Ability (WJTCA) math cluster 89.81) and their peers (WJTCA math cluster 113.19). Similarly, Gajar (1987, 1982) found significant differences in average percentile scores between the two groups on this same measure (Students with LD: 26th percentile; Students without LD 59 percentile). The authors conclude that the preponderance of evidence indicates that many college students with LD demonstrate difficulties with mathematics. The authors utilize the information gathered in their review to speculate about the instructional cycle that may lead to these persistent difficulties. Particularly germane to the current study is the observation that special educators have few mathematics related support strategies to assist students with special needs in mathematics. The strategies that do exist tend to be "task specific" (p. 73) and deal with mathematics at the elementary level. These basic computation strategies, the authors conclude, are not sufficient support for students taking higher-level mathematics. Interestingly, in spite of the average to above average intelligence extant in these college students with LD, the authors suggest the following: "Accordingly, for at least some students, the *best assistance* would be tutorial in nature, or *astute advisement about which courses to take and which to avoid*" (emphasis added, p. 73). This advice, to avoid certain math classes, is the summation sentence in the mathematics section of Hughes and Smith's literature review (Hughes & Smith, 1990) and supports the conclusion drawn by Reis, et al, 1997.

It has been established that students in minority groups are overrepresented in special education (Artiles & Trent, 1994; Services, 2002). In spite of this consistent finding, there has been little research on the interplay and interactions between mathematics, ethnicity, class, and the special education student. Lubienski and Bowen (2000) conducted a broad study of mathematics research in order to provide "concrete evidence regarding the attention given to equity groups and topics by the mathematics education research community" (p.

627). They used the ERIC database as their data source and then narrowed their study to include only studies published from 1982-1998 and found in 48 “major educational research journals” (p. 627). Using over 100 mathematics related descriptors they found 3,011 studies pertaining to mathematics. From there, the authors examined the attention provided to ethnicity, gender, social class and disability. Of the 3,011 total mathematics studies, 623 related to one of these four equity categories, with gender receiving the most attention (323 articles) followed by special education (193), ethnicity (112) and class (52). The authors also considered the “unions and intersections” (p. 628) of research into these equity groups. While 437 articles related to at least one of these groups, only 3 of the 3,011 articles related to all three groups. Furthermore, among disability-related articles only 1 pertained also to ethnicity and none to class. The authors also found that disability research peaked at the elementary school level.

More general topics were also considered in this review. Among the topics most pertinent to the current study, Teacher actions (20% of studies) and student characteristics (15%) were found to be relatively popular topics of investigation. Other topics pertinent to this study, namely student assessment (5%), educational environment (5%) and students in classrooms (4%) “received the least attention” (p. 628).

The authors analyzed the trends regarding mathematics education research and issues of equity, instruction, environment and context. The authors concluded, “researchers look primarily at outcomes of these equity groups and rarely examine how schooling experiences contribute to these outcomes” (p. 631). The authors also found the results to support claims that there is a lack of attention to class, interactions among equity groupings, and classroom processes as they relate to these groupings. In particular, they find the dearth of research that considers disabilities as they relate to class and race to be “disturbing” (p. 632). They suggest that Mathematics education research related to disabilities needs to be broadened to include issues of context, culture and educational environment (Lubienski & Bowen, 2000).

Summary

Research studies regarding students with disabilities and mathematics have focused on cognitive issues and student weakness in mathematics as well as strategies to affect student outcomes at the elementary level. Little to no research has focused on interactions between disabilities and issues of context such as race and class, on secondary mathematics and students with disabilities, or on studies regarding classroom processes, special educator competence with secondary mathematical issues, and students with disabilities and mathematics. The current study will contribute to literature on the context and interactions at play with regard to mathematics, disability, class and ethnicity. While this study does not deal with classroom processes per se, it will provide information about student experiences and context by investigating elementary school teacher impressions, student performance, eighth grade mathematics placement, ethnicity, and disability status and their intersections and interactions.

Not all students with disabilities struggle with mathematics and many individual students perform at high levels. It is reasonable to conjecture, however, that individual students with disabilities may be presumed (or stereotyped) to take on the features of this class of students. In other words, they may be vulnerable to judgments about their ability that do not reflect their individual performance level but instead reflect an understanding of students with disabilities in general. This problem may be compounded for these students if special educators are not able to provide sufficient support and strategies appropriate to higher-level math classes and are likewise not well versed in the issues regarding mathematics curriculum.

Conclusion

Teacher impressions, student performance and mathematics

Research is limited on teacher impressions of student ability and mathematics placement outcomes through eighth grade. There are virtually no studies that investigate the compound effects of race, class and disability status with regard to mathematics performance and/or teacher impressions of student ability (Lubienski & Bowen, 2000). There is some evidence that teachers may not assess student mathematics problems consistent with their beliefs about mathematics which may affect their assessment of student skills (Nathan & Koedinger, 2000). At the same time, there is a body of evidence that teachers tend to judge unambiguous student ability accurately (T. L. Good, 1987), and can adjust their judgment when there is a demonstrated change in student affect and performance (Aronson et al., 2009). There is also evidence, however, that these judgments are affected when considering race (Ritts et al., 1992) and disability (Reis et al., 1997). Perhaps not merely coincidental to this is the consistent finding that students are affected differentially when tracked by purported ability levels: Students who are not Asian or White are disproportionately tracked into lower levels (Callahan, 2005; Gamoran & Mare, 1989; Hallinan, 1994, 2003; Oakes, 1990). Similar patterns are demonstrated with respect to social class (Finley, 1984; Oakes, 1990; Rist, 1970; Useem, 1992). There is indication that students with disabilities do not have access to mathematics instruction that supports their mathematical achievement (Maccini & Gagnon, 2002) and that students with disabilities persist in mathematical performance below the level of their peers (Cawley et al., 2001; Hughes & Smith, 1990). Finally, these issues of teacher impressions and judgment of student ability may affect student placements in the middle grades and this factor may be hidden by studies that focus on either elementary school or middle school and not the transition from one to the other (Dauber et al., 1996).

ECLS-K studies

Recently, the ECLS-K database has been utilized to provide more information regarding students and issues related to mathematics in the United States. In order to ground the current study in the context of other studies utilizing the ECLS-K to investigate similar issues, a brief overview of these studies is presented to conclude this section.

An ERIC search of ECLS-K studies and mathematics yielded 28 studies. Of these studies most studies focused on issues through Kindergarten (12) or first grade (5). A few other studies focused on policy issues (3). The remaining studies considered longitudinal issues through grades three (2), five (5), and eight (1). One other ECLS-K study was found through the references within these eight studies (Fryer & Levitt, 2004). These studies, pertinent to late elementary through eighth grade, will be briefly reviewed below.

Several of these studies investigated issues surrounding the achievement gap, with differing conclusions. Fryer & Levitt (2004) raise the concern that the achievement gap appears to widen over time from kindergarten through third grade. This conclusion is refuted, however, by evidence provided by Koretz & Kim (2007) who argue that the ECLS-K assessment is not an ideal measure to provide information regarding a growing gap across skill levels. A differential item functioning analysis provides a more accurate view of gap patterns over time. They conclude that differences in performance do not appear to grow over time and that Fryer & Levitt's findings are not replicated using a different national database.

Students with more 'risk factors' (lower SES, ethnic minority, English as a second language, etc.) demonstrate lower school achievement through third grade (Rathbun, West, Walston, 2005). The average scale score for mathematics was lower for Black students than White or Hispanic students, and only 11% of Black students scored in the upper third in the mathematics performance assessment at fifth grade (Princiotto & Hausken, 2006). Likewise, students living in poverty scored lower than their counterparts who did not (Princiotto & Hausken, 2006). In general, students whose mothers did not attain a high school diploma scored significantly lower on average than their peers did on the eighth grade mathematics assessment (Walston, Rathbun & Hausken, 2008). On the other hand, language minority students whose mother did not have a high school education were found to make greater gains through fifth grade than their peers for whom English is the primary language in the home (IES brief, 2008).

Two studies analyzed student growth and performance in mathematics with relation to skill and ability. Bodovski and Farkas (2007) found that students who came into kindergarten with the weakest skills also demonstrated the least growth through third grade. They also found that the effect of student engagement was the strongest in this lowest performing group and recommend efforts to increase engagement in order to increase growth and performance for these initial low achievers (Bodovski & Farkas (2007). Students identified with a math disability in kindergarten demonstrate lower growth rates through fifth grade than their peers not identified with a math disability (Morgan, Farkas, Wu, 2009).

No studies were found that investigated the issues specific to this study, in particular the nexus between teacher impressions, student mathematical performance, and mathematics placement over time.

Chapter Three - Methodology

This chapter highlights the research methods used in this study and consists of the following sections: research design overview, sample selection, data collection procedures, research variables, research instruments, statistical analysis and a summary.

Research Design Overview

This research is a secondary analysis utilizing the Early Childhood Longitudinal Study-Kindergarten 1998-1999 national database. This study followed students from their entry into kindergarten through eighth grade. The initial kindergarten sample is nationally representative and 21,260 children throughout the country were participants. This study includes a vast amount of information regarding schools, teachers and students. The U.S. Department of Education and the National Center for Education Statistics, along with Westat and the Educational Testing Service conducted the initial study (NCES, 2001). The conceptual model for the ECLS-K is guided by an emphasis on the interaction between children and their families, schools, and teachers. Children were asked to participate in activities designed to measure their school-based abilities including cognitive and non-cognitive skills. As children became old enough, they were also asked to report on their own experiences. Teachers were asked to provide information about their classrooms and students. This includes information regarding their impression of individual student ability levels.

The data used herein is from the third (2002), fifth (2004) and eighth grade (2007) waves of the Early Childhood Longitudinal Study-Kindergarten, 1998-1999 (ECLS-K).

The relationships between teacher impressions, student performance, demographic context and eighth grade math placement will be investigated herein. Independent variables used in this study include both a direct cognitive assessment of student mathematical performance at third and fifth grade (MathCOG3, MathCOG5) and a third and fifth grade teacher rating of these same students' mathematical ability (RATE-3, RATE-5). The average of the two mathematical performance scores will also be utilized when analyzing from the fifth grade (AvgMathCOG). This provides a more stable measure and also aligns with the idea that fifth grade teachers have information regarding student performance from earlier years. The data collection tools themselves will be discussed further herein under research instruments. The dependent variable is student placement in eighth grade mathematics. The two categories for placement are Algebra or above (placed) versus below Algebra (not placed). Generally speaking, continuous criteria that measure student performance in mathematics and teacher impression of student ability in mathematics will be utilized to predict a categorical placement into eighth grade mathematics classes.

Sample Selection

A multi-stage probability design was used to select a nationally representative sample of students attending kindergarten in 1998-1999 for the ECLS-K study. The first stage involved determining geographic sampling units. The second and third stage units were schools and then students within those selected schools.

An existing multi-purpose frame that utilized 1990 census data was used as a starting point. Census data from 1994 was used to update the population framework to reflect the most current population data available for five year olds. Primary sampling units (PSUs) were created from this information. These PSUs are geographic areas designated by county or groups of counties. The minimum size of a PSU in the multipurpose frame was 15,000 people. Smaller PSUs (< 320 five-year olds) were collapsed with an adjacent PSU to ensure that numbers within the PSU were high enough to account for anticipated school response rates as well as the number of schools and students to be sampled. Once counties were collapsed to meet minimum size requirements, the final ECLS-K sampling frame contained 1,335 records.

Asian and Pacific Islander (API) students were over-sampled in order to maintain a representative sample of students from this group. A weighted measure of size was utilized to account for this oversampling.

In all, 100 PSUs were selected for the ECLS-K. Of these, the largest 24 PSUs were designated as self-representing (SR) and were designated for use in the sample without further adjustment. The remaining 76 PSUs were first stratified according to metropolitan (MSA) or non-metropolitan (Non-MSA) status and by region. Further stratification then accounted for race-ethnicity, size, and 1988 income level. Using Durbin's Method, two PSUs were selected without replacement from each non-SR stratum. The Durbin method was used "because it allows variances to be estimated as if the units were selected with replacement" (NCES, 2001). See Table 3.1 for details on final PSU selections by region and type.

Table 3.1

Distribution of the ECLS-K PSU sample by self-representing (SR) status, metropolitan (MSA) status, and census region

SR Status	MSA Status	Census Region				
		Northeast	Midwest	South	West	Total
SR	MSA	6	5	6	7	24
Non-SR	MSA	10	12	18	12	52
Non-SR	Non-MSA	2	8	10	4	24
Total		18	25	34	23	100

Schools were sampled using existing databases that tracked schools. These were the 1995-1996 Private School Universe Study (PSS) and the 1995-1996 Common Core of Data (CCD). This information was updated using 1998 data. Furthermore, information from the Bureau of Indian Affairs (BIA) and the Department of Defense (DOD) was utilized to ensure proper representation of these groups in the sample.

As with the PSUs, schools were clustered as needed to ensure minimum representation of students. These minimums were 24 kindergarten students (public schools) and 12 kindergarten students (private schools) per school or school cluster (both of which will be referred to simply as ‘school’). Public and private schools were separated into distinct sampling strata. Proportional weighting was used to establish the number of schools allocated to each PSU. A minimum of one school per PSU was established to ensure representation from smaller PSUs. Using a “traditional two-stage design”(NCES, 2001), further allowances were made for the over-sampling of API and religious versus non-sectarian private schools.

Finally, students were chosen within each school. To ensure that over-sampling of API goals were met, each school was split into two strata, one that contained API students and the second one containing all other students. Within each stratum, students were selected using equal probability systematic sampling. This initial nationally representative sample included 21,260 kindergarten students.

Data Collection Procedures

Base-year

The ECLS-K study received the endorsement of many national associations including those that represented the community and school organizations. Before data was collected cooperation was sought at the state, district and school level and appropriate permissions put into place. An administrator from each school selected a school coordinator to act as a liaison between the school and ECLS-K personnel. During the pre-assessment period in the summer of 1998 parent permissions were collected, teacher questionnaires distributed and ECLS-K field staff were trained. Data collection began in the fall of 1998. The data collection response rate for all schools was 68.8%, and includes a public school response rate of 70.1, and a response rate among schools with 90%-100% minority students enrolled of 78.5%. Among the participating schools child assessment completion rates were 89.8% (NCES, 2001). The sample was freshened during the following year to include students who had not attended kindergarten in the United States. 165 new students were added to the sample through this first-grade freshening process. While this sample is not the one used in this study, per se, all future samples were drawn from this initial and freshened sample of schools and students.

Third and fifth grade school years

Preparations for spring data collection began in the fall of 2001 (third) and 2003 (fifth). Fall preparation included contacting schools and identifying a school liaison to communicate with data collection personnel. Field Supervisors (FS) were also trained to oversee the collection of data. This included three days of training in the details of accurately locating students, managing field data and organizing schedules. Both FS and Assessors also participated in a five-day training regarding the cognitive assessment data to be collected in the spring. Assessment certification was only given once Assessors demonstrated mastery of the assessment material. Of the assessors trained, 98.2% (337) passed the assessor training with a score of 85% or above at the third grade wave and 99% (320) passed these assessment standards with a score of 85 or above during the fifth grade round. These scores were derived from both their ability with the cognitive assessment material and their ability to accurately score student responses.

At the third grade level, no new children were enlisted through a freshening process. Students who continued enrollment at their original school were maintained in the sample as well as 50% of students who moved to a different school or district. These 'movers' were identified through randomly sampling from the students identified as no longer at their original school. From the initial sample of responders in fall of Kindergarten (19, 684) there were now 15,305 students at the third grade wave. Cognitive assessments and teacher questionnaires were collected as in previous rounds (Table 3.2).

Table 3.2

Child level assessments and ratings completed in third grade

Questionnaire Type	Completes	Completion rates	
Child-Level		Weighted	Unweighted
Child Assessment	14,349	80.8	86.1
Teacher Questionnaire	11,884	62.0	69.7

All children who were initially assessed in kindergarten or included through the first grade freshening process were eligible for fifth grade data collection with four exceptions. These four exceptions were (1) children who became ineligible through moving out of the country or through death, (2) children who moved out of their original schools and were not sub-sampled to be followed, (3) children whose parents presented 'hard refusals' in any of the data collection rounds since spring-kindergarten, and (4) children in the third-grade sample for whom there are neither first-grade nor third-grade data.

To minimize attrition in the fifth grade round of data collection, efforts to include as many students as possible were made. This included a search of all students who were deemed 'unlocatable' during the third grade round. This search located 305 of the 829 students who were unlocatable in third grade. Further efforts included locating students who had transferred to another school or who were withdrawn from school for some reason. Finally, written notice and follow-up phone calls were made to families involved in the study. By December of 2003, 75% of student families responded to these location efforts.

Fifth grade student level teacher data was collected in the spring of 2004 using written questionnaires. Approximately half of the teachers completed math and half science questionnaires about individual student performance (mathematics: n = 5,339; science n = 5,405). Fifth grade student cognitive data was collected in February through June of 2004 using computer assisted personal interviewing (CAPI). The fifth grade round of student data collection included 11,368 students and 93.6% of these students completed a child level cognitive assessment (Table 3.3).

Table 3.3

Child level Questionnaires complete in fifth grade

Questionnaire Type	Completes	Completion rates	
Child-Level		Weighted	Unweighted
Child Assessment	11,260	84.7	93.6
Mathematics teacher	5,339	78.1	89.3

Eighth Grade Year

Data collection proceeded in the eighth grade year as before, with appropriate permissions and training for data collection field staff in place. The data from the eighth grade round herein includes student placement in eighth grade mathematics class. This data was gathered via the child level section of the teacher questionnaire (Table 3.4).

Table 3.4

Child level Questionnaires complete in eighth grade

Questionnaire Type	Completes	Completion rates	
Child-Level		Weighted	Unweighted
Mathematics teacher	4,449	71.6	75.2

Research Variables

The variables used in this study, the variable codes used in the ECLS-K study and their definitions are presented in Table 3.5. These ECLS-K variables, for teacher rating and student cognitive math performance, were all transformed into Z-Scores so that comparisons between them could be drawn.

Table 3.5

Study variables, Definitions, and Corresponding ECLS-K Variables

Study variable	Definition	ECLS-K Variables
RATE3	Teacher Academic Rating Scale 3rd Math Continuous	T5ARSMAT
RATE5	Teacher Academic Rating Scale 5th Math Continuous	T6ARSMAT
MathCOG3	Math T-Score 3rd Continuous	C5R4MTSC
MathCOG5	Math T-Score 5th Continuous	C6R4MTSC
AvgMathCOG	(ZC5R4MTSC + ZC6R4MTSC) ÷ 2	
PLACE8	In Algebra or above at Eighth grade Dichotomous	M7COURSE*

* Note that the ECLS-K often, but not always, uses numbers to refer to the round of data collection, and not the student grade level. That is the case here for M7COURSE. Variables that are collapsed for this study will always use numbers to refer to grade level.

Independent variables

Teacher impression of student math ability

The Teacher Academic Rating Scale (TARS: T5ARSMAT, T6ARSMAT) is used as a measure of the teacher's impressions of an individual student's mathematical ability. These scales are completed by teachers on individual students and are a detailed measure of the teacher's understanding of the student's mathematical ability level. The TARS itself will be further detailed below under Research Instruments. The TARS is a continuous variable and is recorded as an average rating (1-5) of student skills on various math topics as evaluated by the teacher. These scores are transformed into a Z Score for the study variables, RATE3 and RATE5.

Student mathematical performance

This test, utilized to measure student mathematical ability, is a cognitive achievement test designed by the Institute of Education Sciences-National Center for Education Statistics (IES-NCES). These cognitive tests given at third and fifth grade (C5R4MTSC, C6R4MTSC) are continuous and reported as a T-Score. These scores are transformed into a Z-Score and reported here as MathCOG3 and MathCOG5. The math cognitive assessments are further detailed below under Research Instruments. For fifth grade predictions, it is presumed that teachers in general have some knowledge of a given student's past performance (through discussions with other teachers and student records). In order to have a more stable representation of the student's cognitive performance at late elementary, the average of the third and fifth grade scores (AvgMathCOG) are used for predictions from fifth grade.

Dependent variable

Eighth grade mathematics placement: PLACE8

This information is a part of the collection data for all students and was collected at the student-level by students' math teachers at the eighth grade year. Teachers choose from a list of possible course titles to designate the student's enrollment (Table 3.6). Any class listed after Algebra is either the equivalent to, or a higher course in the mathematics course taking sequence. Note that 'Integrated or Sequential mathematics' is equivalent to the first year of Algebra at schools that integrate Algebra and Geometry into one course sequence.

Because this study focuses on the critical placement in *Algebra or above* by eighth grade, the information from this question/variable is turned into a dichotomous variable (PLACE8) (Table 3.7).

Table 3.6

Teacher Questionnaire, ECLS-K –Student's Mathematics placement: M7COURSE

14. Which of the following best describes this mathematics course?

MARK ONE RESPONSE ONLY—IF THE STUDENT IS ENROLLED IN MORE THAN ONE MATHEMATICS COURSE, PLEASE ANSWER FOR THE COURSE THAT YOU CONSIDER MOST ADVANCED.

☐ General Mathematics

☐ Introduction to Algebra/Pre-algebra

☐ Algebra

☐ Integrated or Sequential mathematics

☐ Algebra II

☐ Geometry

Table 3.7

Creating Dichotomous variable PLACE8 from ECLS-K variable M7COURSE

Not placed:	0	General Mathematics
	0	Introduction to Algebra/Pre-algebra
Placed:	1	Algebra
	1	Integrated or Sequential mathematics
	1	Algebra II
	1	Geometry

Demographic Information

Receipt of Special Education services

At the third and fifth grade level students have been coded in the ECLS-K data set for whether or not the child was in receipt of special education services and has an individualized educational plan (IEP). This is based on the presence or absence of a link to a special educator in the ECLS-K computerized Field Management System (FMS) database filed for the child. This information was gathered from the student record abstract conducted by ECLS-K field staff in conjunction with school personnel. These ECLS-K variables (F5SPECS and F6SPECS) are referred to as IEP3 and IEP5 within this study (Table 3.8).

Race/ethnicity

A composite variable for race/ethnicity is utilized and described herein. At the fifth and eighth grade levels, race information is no longer collected for the ECLS-K and is instead based on information collected in previous parent interviews. The race information used here is derived from a composite variable that utilizes parent responses when available and data collected by field staff in the computerized Field Management System (FMS) to fill in missing parent data.

At the third grade level, student-level race information is requested specifically in parent interviews and also collected through the FMS as a back up to parent data. Five race categories were used (White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander). Parent/Respondents were allowed to indicate that their child belonged to more than one of these dichotomous categories. Another dichotomous variable was created for those who indicated that their child was biracial or multiracial. Data were collected on Hispanic ethnicity and this was combined with the race data to create a composite variable. This combined race/ethnicity data yields the following race/ethnicity categories: White, non-Hispanic; Black or African American, non-Hispanic; Hispanic, race specified; Hispanic, no race specified; Asian; Native Hawaiian or other Pacific Islander; American Indian or Alaska Native, and more than one race specified, non-Hispanic.

These categories are then combined for this research into the following categories: White, non-Hispanic (WH), Black or African American, non-Hispanic (B/AA), Hispanic, race specified + Hispanic, no race specified (HSP). Other race categories will not be specifically analyzed through the hypotheses, but will be used as co-variates and reported as Asian and PINt+1 (students identified as Pacific Islander, Native American, or more than one category).

Socioeconomic status

A composite scale score is provided within the ECLS-K for each student based on socioeconomic indicators of both prestige and wealth. These indicators are: Father/male guardian's education; Mother/female guardian's education; Father/male guardian's occupation; Mother/female guardian's occupation; and Household income. This composite socioeconomic variable will be utilized here (SES) as a co-variate.

Gender

As with race, gender data is not collected after the third grade year. In order to assure that gender reports are accurate, ECLS-K staff has crosschecked data and a composite variable created to reflect student gender based on most-common responses through third grade. This data is then crosschecked with FMS data and a judgment on student gender is rendered based on the totality of the evidence collected. This composite variable, designed to avoid simple human error in the data, will be used in this study as the co-variate for gender.

Table 3.8

Demographic Background variables and co-variates

Study variable	Definition/Study Coding		ECLS-K Variables
RACE	Student Race Composite		W3RACETH
	WH – 1	B/AA - 2	W5RACETH
	HSP – 3		
	Asian – 5	PINt+1 – 6	
IEP3	Receipt of Special Ed Services		F5SPECS
IEP5	Student has an IEP		F6SPECS
SES3	Student SES Composite		W3SESL
SES5	Continuous		W5SESL
GENDER	Student Gender		GENDER

Research Instruments

Teacher Academic Rating Scales - Mathematics (TARS)

These TARS scales are completed by teachers on individual students and are a detailed measure of the teacher's understanding of the student's mathematical ability level. The TARS data is transformed as described above and is reported here as the RATE3 and RATE5. The RATE variable will serve as a record of teacher impression of student mathematical ability (Table 3.9, sample questions; Appendix A, full rating scales).

Table 3.9

Teacher Academic Rating Scale – Mathematics Grade Three, sample questions (See also, Appendix A)

	CIRCLE ONE FOR EACH ITEM					
	Not yet	Beginning	In progress	Intermediate	Proficient	Not applicable
3. Creates and extends patterns – for example, extends an alternating pattern involving addition and subtraction (+3, -1, +3, -1, +3… or +5, -3, +5, -3…) or creates a complex visual pattern (aabc)………………..	1	2	3	4	5	N/A
4. Uses a variety of strategies to solve math problems – for example, adds 100 and then subtracts 4 when doing the mental math problem 467 + 96, or writes the algorithms or equations needed to solve a word problem, or orders steps sequentially in a multi-step problem…………………………………….	1	2	3	4	5	N/A

These items were chosen according to research regarding skills that predict later achievement and are clearly linked with current curricular standards. In order to reduce speculation, items were also prioritized that were highly specific and intended to reduce the need for teacher inference (IES & NCES, 2005). These items were field tested at both the third and fifth grade levels. At the third grade level items were revised after extensive field-testing because the field-testing revealed a ceiling effect in place for the questions as originally conceived. These adjustments were made and a TARS including more difficult items was eventually used. At the fifth grade level 545 fourth and fifth grade teachers administered the TARS to four students in their class. At both grade levels, statistical analysis was utilized to define the final test items which were chosen "consistent with the item statistics and representativeness of the content" (p. 2 – 32, third grade; p. 2 – 35, fifth grade) (IES & NCES, 2003, 2005)

Student cognitive test (MathCOG)

This test is a cognitive achievement test designed by the Institute of Education Sciences-National Center for Education Statistics (IES-NCES) for the purposes of measuring student ability in mathematics. The transformed variables, MathCOG3, AvgMathCOG (as described above), will be utilized herein as the mathematical performance indicators.

The ECLS-K cognitive assessments were designed to measure student growth in mathematics and assesses skills that are typically taught and considered developmentally important at a given grade level. The ECLS-K utilized nationally recognized standards put in place by national organizations including the National Assessment of Educational Progress (NAEP), the National Council of Teachers of Mathematics, the American Association for the Advancement of Science, the National Academy of Science, and the scope and sequence documents from state assessments. The ECLS-K assessments included items that were "specifically created for the study, items adapted from commercial assessments with copyright permission, and other NCES studies including items from NAEP (disclosed items), NELS:88, and ELS:2002" (IES & NCES, 2010).

The ECLS-K direct cognitive assessments are two-stage adaptive tests with an initial routing test followed by a three level second stage form. These second stage forms target the student's performance level, but include overlap to ensure that student performance level is captured. The mathematics assessment is designed to measure the Standard Course of Study skills that students are expected to acquire through schooling. These include both student problem solving approach and content knowledge. While all of the basic aspects of mathematics are addressed in this measure (including algebra, geometry, measurement, etc.), questions regarding number sense, properties, and operations is the most represented of all the content strands at all grade level assessments, including the third and fifth grade levels utilized herein (IES & NCES, 2010).

In order to measure student growth over time, these cognitive assessments needed to be linked and this was accomplished through the development of Item Response Theory scales. These IRT scale scores were utilized along with *r*-biserial scores to determine inclusion and exclusion of test items. With a few exceptions made to ensure coverage of all framework items and continuity between grade levels, all items with an *r* at or above .40 and an IRT score at or above 1.00 were retained.

Statistical Analysis

Weights and design effect

The Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999 (ECLS-

K) data set was utilized. This data set represents students from across the United States. The original data set was a nationally representative sample of kindergarten students and included over 19,000 participants. This data set was designed specifically for inquiries such as the one outlined herein that aim to understand the relationship between early school experiences and later school performance (NCES, 2009). Nevertheless, in order to reduce costs, the IES utilized a complex sample design to collect data for the ECLS-K. This requires adjustment in order to ensure that appropriate inferences are made. In particular, weights must be applied to the data to maximize inferences about national trends. It is important to note that the Kindergarten wave of data collection uses a multi-stage probability design to select a nationally representative sample of students attending kindergarten in 1998-1999. As the students age, attrition affects the sample to the point that it is no longer a nationally representative sample. In order to maximize our ability to make inferences from the sample extant in the third, fifth and eighth grade, weights are applied to account for this attrition. These weights sum to the population totals not the sample totals. SPSS software was utilized for analysis and adjustments will be made to these population totals by utilizing appropriate multipliers to report sample totals.

Another consideration regarding inference is the variance of the population given the sampling design. The variance is likely to be diminished with multi-stage clusters such as those used in the ECLS-K. This consideration does not effect the odds ratios reported but does effect the Standard Errors and thus the confidence with which the odds ratios can be interpreted (NCES, 2009). Design Effect adjustments[6] allow for this difference and reduce the possibility of Type 1 (false positive) errors. Some of the cell sizes in this study will be relatively small because students are analyzed at the tail end of this nine-year longitudinal study and may increase the likelihood of Type 2 (false negative) errors. To balance these considerations results will be reported *without* the design effects (to reduce false negatives). Any results that are insignificant are not affected by the design effect adjustment as this adjustment would merely further reinforce the insignificant finding. Any highly significant results are negligibly affected by the DEFF multiplier and therefore remain highly significant results. Any results with a significance level between .03 and .05 will be reported in section 5 to aid the reader in making decisions about the confidence with which conclusions can be drawn. Furthermore, the level of significance will be noted for the reader throughout the results section, drawing attention to any results that are near the accepted significance level.

Unit of analysis

The unit of analysis used throughout this study is the individual child. The study is designed to see how child level performance and child level teacher impressions predict child level placement in eighth grade mathematics class.

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[6] The DEFT is the square root of the Design Effect (DEFF) and is multiplied by the Standard Error to adjust for design effects. In the case of this study, the multiplier is 1.8 (Tourangeau, Nord, Le, Sorongon, & Jajarian, 2009). For references' sake consider the following p values with and without the DEFF:

highly significant		*near significance*	
w/o DEFF	*w/DEFF*	*w/o DEFF*	*w/DEFF*
p = .0001	p = .0002	p = . 035	p = .063
p = .01	p = .02	p = .05	p = .09

Analysis

Generally speaking, continuous criteria (RATE, MathCOG, AvgMathCOG) will be utilized to predict a categorical placement (PLACE8). Binary Logistic Regression analysis will be utilized for several reasons. First, the criterion measure in this study will be binary: Yes or No placement in Algebra or above in eighth grade and therefore appropriate to the assumptions made in logistic analysis. Second, logistical regression analysis allows for differential affects across predictor levels. Rather than assuming that predictive power is the same across a constant linear model, logistic regression allows for different predictive power at different points of access. In this case, the assumed sigmoid shape of the relationship fits nicely with an assumption that the very highest scoring and very lowest scoring students being studied would likely be less affected by other variables than those students in the middle. A third benefit of logistic regression will be the ability to model odds of placement based on predictive criteria.

Data preparation

As required for logistic regression, the observations are independent: third and fifth grade teachers complete the RATE ratings, third and fifth grade students take the MathCOG tests, and eighth grade class placement is (ostensibly) decided at seventh or eighth grade.

As described further in Chapter Four cases used for analysis were pulled from the entire population of students remaining for study at the eighth grade level. The cases used were all students with eighth grade mathematics data who attended a school where Algebra is available to eighth graders but is not mandatory. There were 3,052 students who qualified for analysis by virtue of having eighth grade math placement data and attending a school that offers Algebra to less than 100% of eighth graders (See Table 4.1 below).

While not a requirement for logistic analysis, it strengthens the power of results if continuous variables demonstrate normality. After removing outliers (due to codes for missing data) the dependent variables were renamed to those used and reported above (RATE and MathCOG). The variables were then checked for normality. All four dependent variables demonstrated normal distributions with both skew and kurtosis below one and close to zero. No transformations were needed to prepare this data for logistic regression analysis (Table 3.10).

Table 3.10

Data Preparation:

Normality of continuous independent variables: RATE and MathCOG

Variable	*Skew*	*Kurtosis*	*Transformation*
RATE3	.22	.39	*not needed*
RATE5	.14	.15	*not needed*
MathCOG3	-.28	.02	*not needed*
AvgMathCOG	-.36	-.11	*not needed*

The dependent variable in this study is whether students are placed in Algebra or above at the eighth grade. The ECLS-K data set includes information regarding the student's math class (M7COURSE). Analysis of this variable reveals that 19% of students are in general mathematics and 39% are in a pre-algebra course. For students placed in algebra or above, 35% are in Algebra, 3% in Integrated or Sequential Mathematics, .5% are in Algebra 2, and 3% are in Geometry. For this analysis, a new dichotomous variable was created (PLACE8) that collapses these variables into the dichotomous Algebra or above (43%) or Below Algebra (57%). Descriptive statistics ensure that the new variable yields information consistent with the M7COURSE variable from which it was derived (Table 3.11).

Table 3.11

Data Preparation:

Descriptive statistics for dependent variable:M7COURSE→PLACE8[*]

Variable	*General*	*Pre-Alg*	*Algebra*	*Integrated*	*Alg2*	*Geometry*
M7COURSE						
N= 3,055						
N	566	1188	1102	78	15	106
Percentage	19%	39%	35%	3%	.5%	3%

Variable	*Below Algebra*	*Algebra or Above*
PLACE8		
N= 3,055		
N	1754	1301
Percentage	57%	43%

[*] Any apparent mismatch in numbers is due to rounding error.

Background variables were also analyzed with descriptive statistics. The variables for socioeconomic status (SES3 and SES5) were created from an ECLS-K composite variable for SES (W3SESL and W5SESL as described above). For this analysis, missing variables were dropped from the set and the new variables created. Both SES3 and SES5 demonstrated normality, with skew and kurtosis below one and close to zero (Table 3.12).

Table 3.12

Data Preparation:

Normality of continuous background variables

Variable	*Skew*	*Kurtosis*	*Transformation*
SES3	.31	-.04	*not needed*
SES5	.24	-.02	*not needed*

Student IEP data indicate that approximately 10% of the students in the study sample were in receipt of special education services and thus had an IEP on file at the elementary level. Note here that the student is coded as having an IEP if that IEP was in place at the time the teacher is rating the student, not at time of eighth grade placement. Therefore, the third and fifth grade data, not eighth, is used to determine IEP status. This ensures that the RATE is in line with the IEP at a given grade level. This also avoids inclusion of students who were not in receipt of special education services at the time the teacher rated their elementary mathematics ability, but were in receipt of services at the eighth grade. Approximately 6-10% of participants were missing information on whether they were associated with a special education teacher. ECLS-K names these variables F5SPECS and F6SPECS. Here, the variable names IEP3 and IEP5 will be utilized for clarity. Descriptive statistics for this variable are presented in Chapter Four.

Sample: All students and High-performing students

The students analyzed in this study are those for whom eighth grade mathematics data has been collected and who attended a school that offered algebra but did not require it. These schools were located through the administrator questionnaire (S7ALGEBR). High performing students are categorized into three different high performing groups for analysis. The first high achieving group, referred to as the group of all high-performers, scored above .5 standard deviations from the mean on either the third or the fifth grade MathCOG. The second group, referred to as consistently high performing, scored at or above .5 standard deviations from the mean on both the third and the fifth grade MathCOG. The third group, the inconsistent high performers, scored between .5 and 1 standard deviation (inclusive) above the mean on either the third or fifth grade MathCOG, but NOT on both. These groups are further outlined and described below in the Overview of Sample section in Results, Chapter Four.

Research questions

Standardized coefficients and statistical significance tests will be used in concert with the binary logistic regression analysis to calculate adjusted predictions based on RATE and MathCOG as well as receipt of special education services and race. Gender and socioeconomic status will serve as co-variates. This approach will create a gauge for the relative magnitude of the impact of certain variables on outcome status (King, 2008) and is outlined for each hypothesis.

> H_1: High performing third and fifth grade students with disabilities will have significantly lower odds of being placed in Algebra or above in eighth grade than high performing students not identified with a disability.
>
> H_2: High performing third and fifth grade Black/African-American or Hispanic students will have significantly lower odds of being placed in Algebra or above in eighth grade than high performing students who are not Black or Hispanic.

These questions will be addressed using Wald t tests to assess the significance level of each independent variable. This will be done for both 3rd and 5th grade separately. Significance levels will be reported for each test. Effect sizes will be reported in the form of odds ratios and confidence intervals.

> H_3: For students with disabilities, fifth grade teacher rating of student ability will be a stronger predictor of placement in eighth grade mathematics classes than student performance.
>
> H_4: For students who are Black/African-American or Hispanic, fifth grade teacher rating of student ability will be a stronger predictor of placement in eighth grade mathematics classes than student performance.

For these questions, comparative analysis of effect sizes and significance will be used. Both RATE and MathCOG have been standardized to allow for direct comparison of effects. Student likelihood of placement in Algebra by eighth grade will be further analyzed by charting log odds of placement in eighth grade algebra for different levels of RATE and MathCOG. Interaction analysis will also be applied and charted. All students as well as student subsets will be addressed.

Summary

The present research is an analysis of student mathematical performance, teacher impression of student performance and eighth grade math placement. The ECLS-K database is utilized to investigate the longitudinal effects of these factors from late elementary through eighth grade. In particular, the independent variables of teacher rating (RATE), student mathematical performance (MathCOG), race, and receipt of special education services will be analyzed to understand relationships between these variables and eventual placement in Algebra by the eighth grade. Socioeconomic status, and gender will be utilized as co-variates.

Chapter Four - Results

Overview of Results

After presenting descriptive statistics of the sub-groups analyzed and bivariate correlations for the variables of interest, the results will be organized by the research questions. The first two questions, regarding the probability of placement in Algebra for high-performing students with special needs and the probability of placement for high performing students whose race/ethnicity is Black/African-American or Hispanic, will be addressed in order. Within each research question trends for the group of all students will be presented followed by results from the high achieving sub-groups.

The third and fourth research questions, which address the relative power of fifth grade teacher impressions versus mathematical performance for predicting placement outcomes, will be addressed together and organized by sub-group analyzed. Here, results for the entire population will be presented followed by results related to the sub-groups.

Overview of sample

As discussed in the methods section, four groupings of students are used for analysis. The first group is composed of all students with eighth grade data who attend a school where Algebra is available to eighth graders but is not mandatory. There were 3,052 students who qualified for analysis by virtue of having eighth grade math placement data and attending a school that offers Algebra to less than 100% of eighth graders (Table 4.1).

A sub-group of all students is the high performing students. High performing students are defined as students who perform at or above a half standard deviation from the mean on the third and/or fifth grade cognitive math assessment. This cut-off point was chosen because over 40% of all students in the study were placed in algebra and .5 SD represents students who scored in the top 30 percent of all students at least one time in third or fifth grade. These students, then, would seem likely candidates for Algebra by the eighth grade based on their performance alone. Sub groups from this set of high-achieving students are then defined to evaluate trends found within this set of high performers.

Table 4.1

Students from ECLS-K analyzed for eighth grade math Placement outcomes

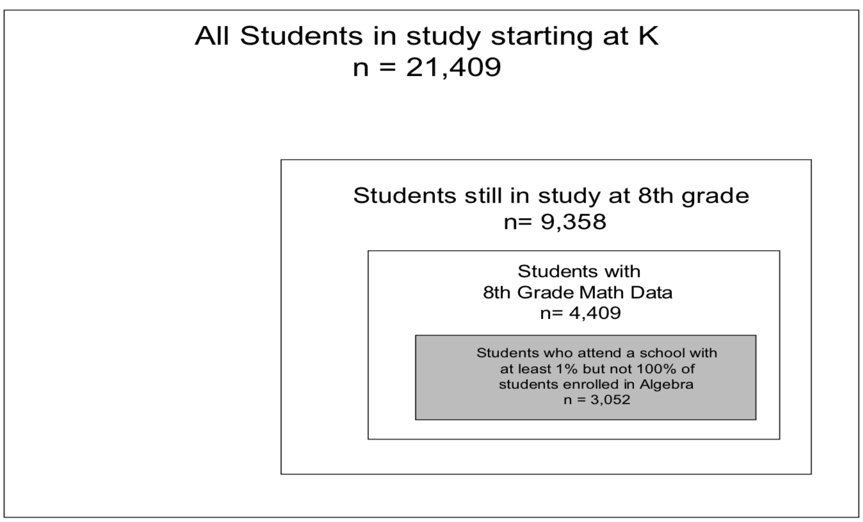
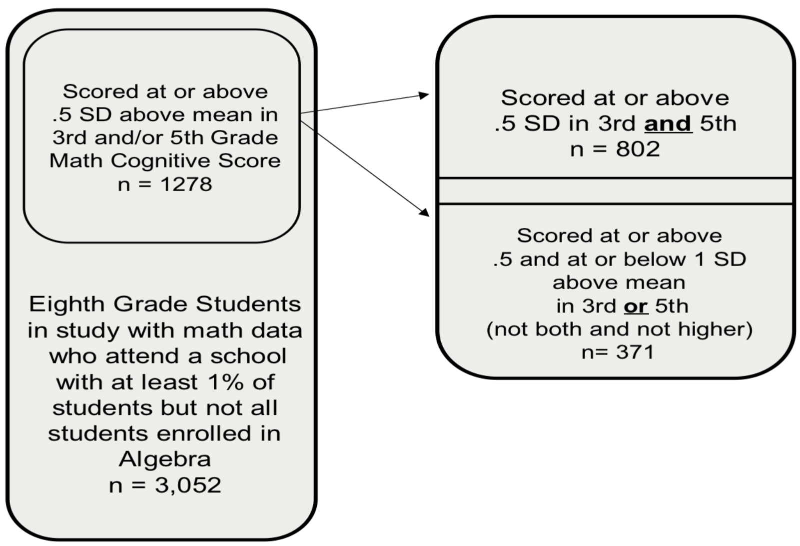


Table 4.2

High achieving students and subgroups



performance levels. One group of students performed at or above .5 SD from the mean (top 30%) on the Math Cognitive test in both third *and* fifth grade and are presumed to be strong candidates for Algebra by the eighth grade. This is a group who demonstrates *consistently* high-performance on the two measures given in late elementary school. A second, and distinct, group is composed of students who had one score *between* .5 and 1 standard deviation (inclusive) above the mean in either the third *or* fifth grade, but not both. This represents students who scored in the top 30 percent once, but never in the top 15 percent. In other words, this is a group of high-performers who demonstrated the potential to succeed, but had not done so consistently (Table 4.2). This group is presumed to have demonstrated more ambiguous academic behaviors that are more difficult for the teacher to interpret. It is presumed then, that teacher judgment might come into play more in this group of students whose performance is less consistent and whose academic potential in mathematics may be more difficult to gauge through performance measures.

Approximately eight to nine percent of students analyzed received special education services. Two to three percent of students in the high achieving groups received special education services (Table 4.3).

Table 4.3

Student Categories:

Frequencies and Percentages by the presence of Special Education Identification

		Number and percentage per category			
	N	*IEP 3rd*		*IEP 5th*	
All*	3055	234	7.7%	281	9.2%
Math T-Score ≥ .5 third and/or fifth	1278	29	2.3%	33	2.6%
Math T-Score ≥ .5 both: third and fifth	802	17	2.1%	17	2.1%
.5 ≤ Math T-Score ≤ 1 once: third or fifth	371	10	2.7%	14	3.8%

*All is defined here and forward as all eighth grade students with math data who attend a school with at least 1% of eighth grade students enrolled in Algebra but less than 100% of eighth grade students enrolled in Algebra.

White students account for 66% of the students in this study while Black/African American students comprised 7% of the students, and Hispanic students 14% (Table 4.4).

Table 4.4

Student Categories:

Frequencies and Percentages by Race

		Number and percentage of students in specific group and category				
Category	*N*	*White*	*B/AfAm*	*Hisp*	*Asian*	*PINt+1*
		N / %	*N / %*	*N / %*	*N/%*	*N/%*
All	3055	2009/66%	198/ 7%	432/14%	134/4%	143/5%
Math T-Score ≥ .5 third and/or fifth	1278	970/76%	38/ 3%	122/ 10%	68/5%	47/4%
Math T-Score ≥ .5 both: third and fifth	802	622/78%	19/ 2%	69/ 9%	48/ 6%	28/4%
.5 ≤ Math T-Score ≤ 1 once: third or fifth	371	269/73%	17/ 5%	42/11	17/5%	11/3%

For all students in a school where Algebra is offered but not universal, students are placed in Algebra or higher at a rate of 43 percent. This rate increases to 68, 75 and 53 percent for the three high-achieving categories defined for this study (Table 4.5).

Table 4.5

Student Categories:

Percentages Placed in Algebra or Above at Eighth Grade

	N	*% of analyzed students*	*Percentage of specific group Placed in:*			
			Algebra or above		*Regular or below*	
Category			*N*	*%*	*N*	*%*
All	3055	100%	1301	43%	1754	57%
Math T-Score ≥ .5 third and/or fifth	1278	42%	874	68%	404	30%
Math T-Score ≥ .5 third and fifth	802	27%	604	75%	198	25%
.5 ≤ Math T-Score ≤ 1 third or fifth	371	12%	198	53%	173	47%

Correlations

Correlational analyses of the data set reveal moderately strong correlations between teacher ratings and math performance scores within a grade level (third grade teacher rating to math performance, r = .59, $p < .001$; fifth grade teacher rating to math performance, r = .64 , $p<.001$). Variables used as predictors within this study showed a moderate relationship to student placement in eighth grade mathematics and all with a p value at less than .001 (third grade teacher rating, r =.36, fifth grade teacher rating r = .44, third grade math performance, r =.47, fifth grade math performance, r = .49). (Table 4.6)

Table 4.6

Correlations: Teacher Ratings, Student Math Performance and Placement:

$p < .001$ for all r	3rd RT	5th RT	3rd MTH	5th MTH	AVMTH	Place8
3rd RATE		.519	.589	.568	.596	.360
5th RATE			.629	.642	.655	.444
3rd MATH				.871	.967	.470
5th MATH					.967	.486
AveMATH						.492

Correlations between fifth grade teacher rating and math performance for students in different race categories, students with an IEP, and students with inconsistent performance were also analyzed to understand if teacher ratings were less accurate for certain subsets of students. Correlations between fifth grade teacher rating and fifth grade student math performance were found to be consistently moderately strong across racial subsets and for students with an IEP and in line with the correlation found for all students (.64) (Table 4.7). Finally, as might be expected, teachers were not strong predictors of student math performance for the subset of students defined herein as inconsistent performers ($.5 \leq$ Math T-Score ≤ 1 for third or fifth grade). (Table 4.7)

Table 4.7

Correlations: Fifth grade teacher rating versus fifth grade student math performance by race, IEP status, and inconsistently high performance

	r	p
All Students	.64	<.001
White	.63	<.001
Af/Am	.62	<.001
Hisp	.69	<.001
W/IEP	.61	<.001
.5 ≤ Math T-Score ≤ 1 third OR fifth	.11	.026

High performing students receiving Special Education services

H_1: High performing third and fifth grade students with disabilities will have significantly lower odds of being placed in Algebra or above in eighth grade than high performing students not identified with a disability.

All students receiving Special Education services

In general, students with disabilities have reduced odds of placement in Algebra at the eighth grade compared to their peers. When controlling for cognitive math score, teacher rating, socioeconomic status, sex and race, the odds of placement, compared to their peers, in Algebra by the eighth grade are reduced by approximately half for these students. This finding is strong and highly significant when predicting from third grade (B = .56, $p \leq .004$) and fifth grade (B = .60, $p \leq .005$) (Table 4.8).

High Performing students receiving Special Education services - Third grade

There were no significant findings for high performing third grade students identified with special education in any sub-category (Table 4.9).

High Performing students receiving Special Education services - Fifth grade

At the fifth grade, analysis of the largest group of high performing students (Math T-Score $\geq .5$ third and/or fifth grade) demonstrates a near-significant result that odds of students with special education identification being placed in Algebra are approximately half that of their peers when controlling for other variables (B = .63, $p \leq .09$) (Table 4.9).

There was not a significant finding for students in the group of consistently high-performers (T-Score $\geq .5$ third and fifth grade).

Both the significance level and the effect size increase dramatically, however, when the smaller group of high performing students, those with the inconsistent performance ($.5 \leq$ Math T-Score ≤ 1, third or fifth grade) is analyzed. For this sub-group and when controlling for background variables, including average cognitive performance, the odds of placement in Algebra by eighth grade is approximately one-fifth that of their peers (B = .18, $p \leq .0001$) (Table 4.9).

Table 4.8

All students

Logistic Regression Predicting Student Placement in Algebra or above at Eighth Grade—Special Education as a predictor for Eighth grade Placement in Algebra or above while controlling for Race, Gender, SES, Math T-score and Teacher Rating.

Variable	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p ≤*
IEP3	.675	.062	119	.56	.38 - .82	.004
IEP5	.518	.355	22	.60	.42 - .84	.0001

Table 4.9

High Achieving Third and Fifth grade students

Special Education as a predictor for Eighth grade Placement in Algebra or above while controlling for Math T-score and Teacher Rating, Race, Gender and SES

Variable *Sub-category*	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	$p \leq$
IEP3						
Math T-Score ≥ .5 third and/or fifth	.391	.339	1.33	.68	.35 – 1.31	.249
Math T-Score ≥ .5 third and fifth	.520	.590	.78	.59	.19 - 1.89	.80
.5 ≤ Math T-Score ≤ 1 third or fifth	.725	.517	1.965	.48	.18 – 1.34	.16
IEP5						
Math T-Score ≥ .5 third and/or fifth	.459	.270	2.90	.63	.37 – 1.07	.09
Math T-Score ≥ .5 third and fifth	-.122	.465	.069	1.13	.50 - 2.81	.80
.5 ≤ Math T-Score ≤ 1 third or fifth	1.690	.460	13.52	.18	.07 - .50	.0001

High performing students who are Black/African-American or Hispanic

H_2: High performing third and fifth grade Black/African-American or Hispanic students will have significantly lower odds of being placed in Algebra or above in eighth grade than high performing students who are not Black or Hispanic.

Considering race/ethnicity for the group of all students

Race/ethnicity is a strong and significant predictor of eighth grade math placement for the categories of all third and fifth grade students. This strong effect is notably different for students who are Black/African American than for students who are Hispanic. African American students' odds of placement are approximately one-half to two-thirds that of their white peers, when controlling for other factors at the third (B = .52, $p \leq .0001$) and fifth grade (B = .68, $p \leq .008$) (Table 4.10). The data for Hispanic students, on the other hand, demonstrates favorable odds of these students being placed in Algebra when controlling for background variables. These students demonstrate approximately one and a half times greater odds of placement than their white peers. Again this is true when predicting from both the third (B= 1.63, $p \leq .0001$) and fifth grades (B= 1.314, $p \leq .016$) (Table 4.10).

High performing Black/African-American Students

Significance was found at the third and fifth grade levels in four of the six different categories for high performing Black/African-American students. In general, the odds of placement compared to their white peers go *down* for African-American students who are performing above average in mathematics. Third grade students in high performing categories have approximately one-fourth to one-third the odds of being placed in Algebra when controlling for background variables when compared to their white peers. From the other perspective, for high-performing white students the odds in favor of being placed in

Algebra are three to four times as large than for their similarly high-performing African-American peers when controlling for background variables including math cognitive performance. This affect is particularly strong and highly significant when considering the largest group of third grade high performing students, those who scored .5 SD above the mean at least once (B= .283, $p \leq .0001$). These findings are consistent with the findings at fifth grade, where strong and significant results (All high performing students: B = .393, $p \leq .0001$; Consistent High: B = .423, $p \leq .01$; Inconsistent High: B = .353, $p \leq .013$) indicate that African-American students in high performing sub groups have odds of placement in Algebra reduced by one-third to two-fifths compared to their white peers (Table 4.11).

High performing Hispanic students

A different trend is evident for students who are Hispanic. Even with the larger sample size for this group, the variability is greater and a near significant result is found only for the highest performing third grade students (B = 1.90, $p \leq .01$). Unlike the African-American students, however, the effect size is a favorable one and is virtually the same for the group of all students as for these high-performing students. The odds for placement in Algebra are consistent and favorable across performance categories for Hispanic students (Table 4.12).

Table 4.10

All third and fifth grade:

Black/African American and Hispanic race as a predictor for Eighth grade placement in Algebra or above while controlling for Race, Gender, SES, receipt of Special Ed services, Math Z-score and Teacher Rating.

Variable	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	$p \leq$
B/A-A 3rd	-.658	.169	15	.52	.37 - .71	.0001
B/A-A 5th	-.390	.145	7	.68	.51 - .90	.007
Hisp 3rd	.487	.121	16	1.63	1.28 – 2.06	.0001
Hisp 5th	.273	.112	6	1.31	1.06 – 1.64	.015

Table 4.11

High performing third and fifth grade students

Black/African American race as a predictor for Eighth grade placement in Algebra or above while controlling for Race, Gender, SES, receipt of Special Education services, Math Z-Score(s) and Teacher Rating.

Sub-category	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p ≤*
B/AfAm 3rd						
Math T-Score ≥ .5 third or fifth	-1.26	.308	16.75	.28	.16 - .52	.000
Math T-Score ≥ .5 Both third and fifth	-1.035	.406	6.50	.36	.16 - .79	.011
.5 ≤ Math T-Score ≤ 1 once: third or fifth	-.992	.639	2.41	.37	.36 – 1.39	.12
B/AfAm 5th						
Math T-Score ≥ .5 third or fifth	-.934	.257	13.18	.39	.24 - .65	.0001
Math T-Score ≥ .5 Both third and fifth	-.860	.331	6.77	.42	.22 - .81	.009
.5 ≤ Math T-Score ≤ 1 once: third or fifth	-.964	.494	3.80	.38	.15 – 1.01	.051

Table 4.12

High performing third and fifth grade students

Hispanic race as a predictor for Eighth grade placement in Algebra or above while controlling for Race, Gender, SES, receipt of Special Education services, Math Z-Score(s) and Teacher Rating.

Sub-category	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p ≤*
Hispanic 3rd						
Math T-Score ≥ .5 third or fifth	.238	.185	1.664	1.27	.88 – 1.82	.20
Math T-Score ≥ .5 Both third and fifth	.642	.260	6.116	1.90	1.14 – 3.16	.015
.5 ≤ Math T-Score ≤ 1 once: third or fifth	-.333	.338	.967	.72	.37 – 1.39	.325
Hispanic 5th						
Math T-Score ≥ .5 third or fifth	.123	.168	.538	1.13	.81 – 1.57	.463
Math T-Score ≥ .5 both third and fifth	.470	.241	3.815	1.60	1.00 – 2.57	.051
.5 ≤ Math T-Score ≤ 1 once: third or fifth	-.145	.280	.269	.87	.50 – 1.50	.604

Fifth grade Teacher Rating versus Cognitive Performance as Placement Predictor

H_3: For students with disabilities, fifth grade teacher rating of student ability will be a stronger predictor of placement in eighth grade mathematics classes than student performance.

H_4: For students who are Black/African-American or Hispanic, fifth grade teacher rating of student ability will be a stronger predictor of placement in eighth grade mathematics classes than student performance.

All students

Cognitive scores are twice as powerful a predictor for eighth grade placement in Algebra than Teacher Rating scores (MathCOG B = 2.96, $p \leq .0001$; RATE B = 1.41, $p \leq .0001$) (Table 4.11). An interaction was found, however, between teacher rating and cognitive score for the data set of all students. For students who are rated high by the teacher, cognitive scores appear to determine placement (Tables 4.12 and 4.13). The interaction indicates, however, that teacher rating is a more powerful predictor of placement for higher performing students than low-performing students. For low-performing students, placement outcomes are virtually the same regardless of teacher rating. As cognitive performance increases, the power of the teacher rating increases. Unlike for low-performing students where teacher rating has virtually no impact on placement odds, the odds of higher performing students with low teacher-ratings are affected (Table 4.13). For students who are rated low by the fifth grade teacher, the interaction trend line indicates that student placement in eighth grade algebra is suppressed, even in the presence of high cognitive scores (Tables 4.14 and 4.15).[7]

[7] In the Placement Prediction Log odds charts and Placement Prediction graphs a regression model is used to analyze placement predictions at different levels. The impact, or Y, of these

Table 4.13

All students - Teacher Rating Versus Cognitive Score as predictor of eighth grade math placement

ALL STUDENTS						
Variable	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p ≤*
5th Grade Teacher Rating	.341	.054	39	1.41	1.26 – 1.57	.0001
Average Math Cog (3rd and 5th)	1.09	.065	280	2.96	2.61 – 3.36	.0001
Interaction	.166	.058	8.18	1.18	1.05 – 1.32	.004

predictors is reported with the log of odds. See footnote 8 for reference points for interpretation.

Table 4.14

Placement Prediction – All students

Log odds of Placement in eighth grade Algebra or above Teacher Rating versus Math Cognitive score (average of 3rd and 5th grade scores) utilizing significant predictors and significant interaction

Significant interaction

Significant cognitive score

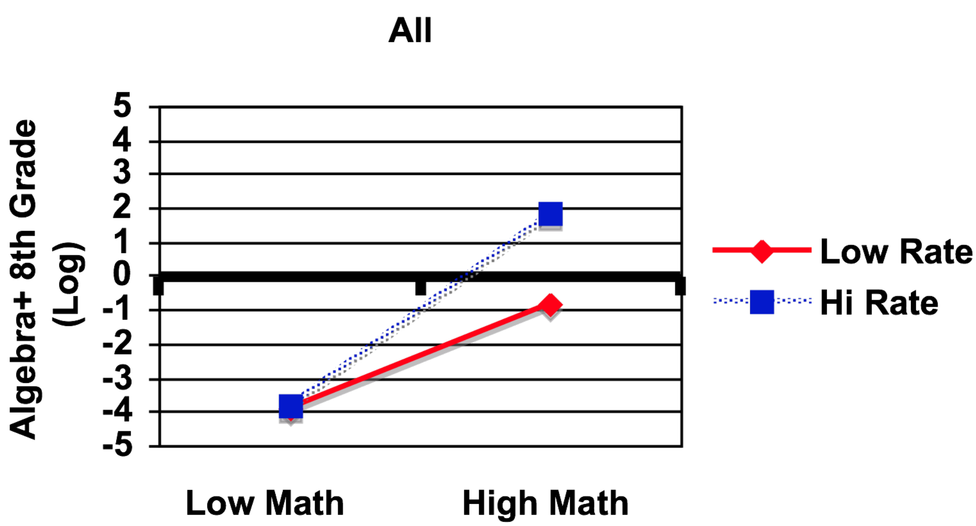
Significant teacher rating

ALL STUDENTS	Low Teacher Rating	High Teacher Rating
$p \leq .001$	-2 S.D.	+2 S.D.
Low Cog Score		
-2 S.D.	-3.87	-3.84
High Cog Score		
+2 S.D.	-.86	+1.83

In general, analysis indicates that cognitive score is a more powerful predictor than teacher rating, but that teacher rating has a greater impact on higher performing students than low performing students (Table 4.15)[8].

Table 4.15

Placement Prediction: All Students – Significant interaction, MathCOG



Fifth grade teacher rating and placement: Students receiving Special Education

[8] The impact, or Y, of these predictors is reported with the log of odds.
Reference points for Log-Odds—
Odds of placement versus person with Ave. Teacher Rating and Ave. Math Cog scores:

Log-odds of 3 = 20:1	Log odds of -3 = .05/1	(or 1/20th the chance)
Log-odds of 2 = 7:1	Log odds of -2 = .14/1	(or 1/7th the chance)
Log-odds of 1 = 3:1	Log odds of -1 = .37/1	(or 1/3rd the chance)
Log-odds of 0 = 1:1	Log-odds of 0 = 1:1	(or same chance)

As reported above, for all students cognitive scores were found to be twice as powerful a predictor as teacher rating. For students receiving special education services, on the other hand, teacher rating and cognitive scores carry virtually the same power as predictors of math placement (MathCOG B = 2.15, $p \leq .009$; Rate B = 2.05, $p \leq .007$) (Table 4.16). As with all students, there is also a significant interaction between teacher rating and MathCOG score for these students (Table 4.16). The interaction effect is significantly more pronounced for these students. Students with an IEP who receive a high teacher rating in the presence of a high cognitive score have greater than a 20 to 1 chance of placement (log odds = +3.23) in Algebra versus a student with an IEP and an average teacher rating and an average cognitive scores (Tables 4.17 and 4.18)[9]. Having an IEP in place and a *low* teacher rating, on the other hand, is virtually prohibitive of placement in algebra even in the presence of high performance (Tables 4.17 and 4.18). These high performing but low-rated students have approximately 1/15th the chance of placement (log odds = -2.85) compared to a student with an IEP in place who has average math cognitive performance and average teacher rating and these chances for the low-rated student with an IEP are not positively affected by greater performance level (Low-rate and low cog yields log odds = -2.68; Low-rate and high cog yields log odds = -2.85)

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[9] The impact, or Y, of these predictors is reported with the log of odds.
Reference points for Log-Odds—
Odds of placement versus person with Ave. Teacher Rating and Ave. Math Cog scores:

Log-odds of 3 = 20:1	Log odds of -3 = .05/1	(or 1/20th the chance)
Log-odds of 2 = 7:1	Log odds of -2 = .14/1	(or 1/7th the chance)
Log-odds of 1 = 3:1	Log odds of -1 = .37/1	(or 1/3rd the chance)
Log-odds of 0 = 1:1	Log-odds of 0 = 1:1	(or same chance)

Table 4.16

Students receiving Special Education services: RATE versus Average MathCOG as predictor of eighth grade math placement

Students w/IEP						
Variable	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p <*
5th Grade						
Teacher Rating	.716	.263	7.4	2.05	1.22 – 3.43	.007
Average Math Cog						
(3rd and 5th)	.763	.291	6.87	2.15	1.21 – 3.80	.009
Interaction	.402	.174	5.32	1.50	1.06 – 2.10	.021

Table 4.17

Placement Prediction - Students with IEP:

Log odds of placement in eighth grade Algebra or above Teacher Rating versus Math Cognitive score (average of 3rd and 5th grade scores) utilizing significant predictors and significant interaction

Significant interaction

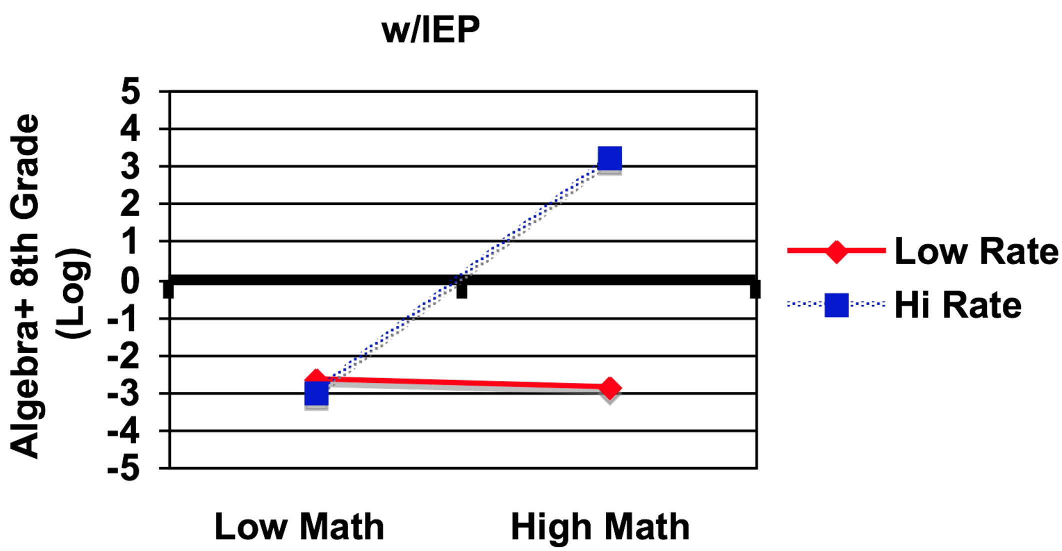
Significant cognitive score

Significant teacher rating

Students	Low Teacher Rating	High Teacher Rating
W/IEP	-2 S.D.	+2 S.D.
$p \leq .021$		
Low Cog Score		
-2 S.D.	-2.68	-3.04
High Cog Score		
+2 S.D.	-2.85	+3.23

Table 4.18

Placement Prediction: Students w/ IEP –Significant interaction, cog score, teacher rating



Teacher rating versus cognitive score as predictor considering race/ethnicity

As with all students, for white students cognitive score is twice as powerful a predictor than fifth grade teacher rating (MathCOG B = 3.09, $p \leq .0001$; RATE B = 1.53, $p \leq .0001$) (Table 4.19).

For Black/African American students, teacher rating is marginally significant and is almost as powerful a predictor as cognitive score rating (MathCOG B = 1.93, $p \leq .001$; RATE B = 1.49, $p \leq .036$) (Table 4.19). This profile is more in line with students receiving special education services than with all students or with white students alone (Table 4.19).

A different profile emerges for Hispanic students. For these students only the cognitive score is a significant predictor of eighth grade math placement in algebra (Cog B = 3.67, $p \leq .0001$; Rate B = 1.09, $p \leq .508$) (Table 4.19). For these students cognitive scores have approximately the same power as for white students but without the impact of teacher rating.

Table 4.19

Fifth grade teacher rating versus cognitive score as predictor of eighth grade math placement for different ethnic groups

White						
Variable	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	$p \leq$
5th Grade						
Teacher Rating	.424	.068	38.92	1.53	1.33 – 1.75	.0001
Average Math Cog						
(3rd and 5th)	1.11	.079	199	3.09	2.60 – 3.53	.0001
Interaction	.157	.075	4.43	1.170	1.01 – 1.35	.035

Table 4.19 Continued

Black/AfAm

Variable	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p ≤*
5th Grade						
Teacher Rating	.396	.189	4.38	1.49	1.03 – 2.15	.036
Average Math Cog						
(3rd and 5th)	.659	.202	10.66	1.93	1.30 – 2.87	.001
Interaction	.237	.193	1.52	1.27	.87 = 1.85	.218

Hispanic

Variable	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p ≤*
5th Grade						
Teacher Rating	.087	.131	.438	1.09	.84 – 1.41	.508
Average Math Cog						
(3rd and 5th)	1.301	.168	60.18	3.67	2.64 – 5.10	.0001
Interaction	-.023	.141	.026	.98	.74 – 1.29	.871

Using significant results to predict odds of placement yields different patterns of placement for different ethnic groups. For white students both cognitive score and teacher rating are significant and there is an interaction between the two (Table 4.19). Predictions for different performance and rating levels demonstrate the interaction present in this data (Tables 4.20-4.23)

Table 4.20

Placement Prediction - Ethnicity/Race: White

Log odds of placement in eighth grade Algebra or above Teacher Rating versus Math Cognitive score (average of 3rd and 5th grade scores) utilizing significant predictors

Significant interaction

Significant cognitive score

Significant teacher rating

White	Low Teacher Rating	High Teacher Rating
$p \leq .035$	-2 S.D.	+2 S.D.
Low Cog Score		
-2 S.D.	- 4.08	- 3.64
High Cog Score		
+2 S.D.	-.90	+ 2.05

Table 4.20 Continued

Significant cognitive score

Significant teacher rating

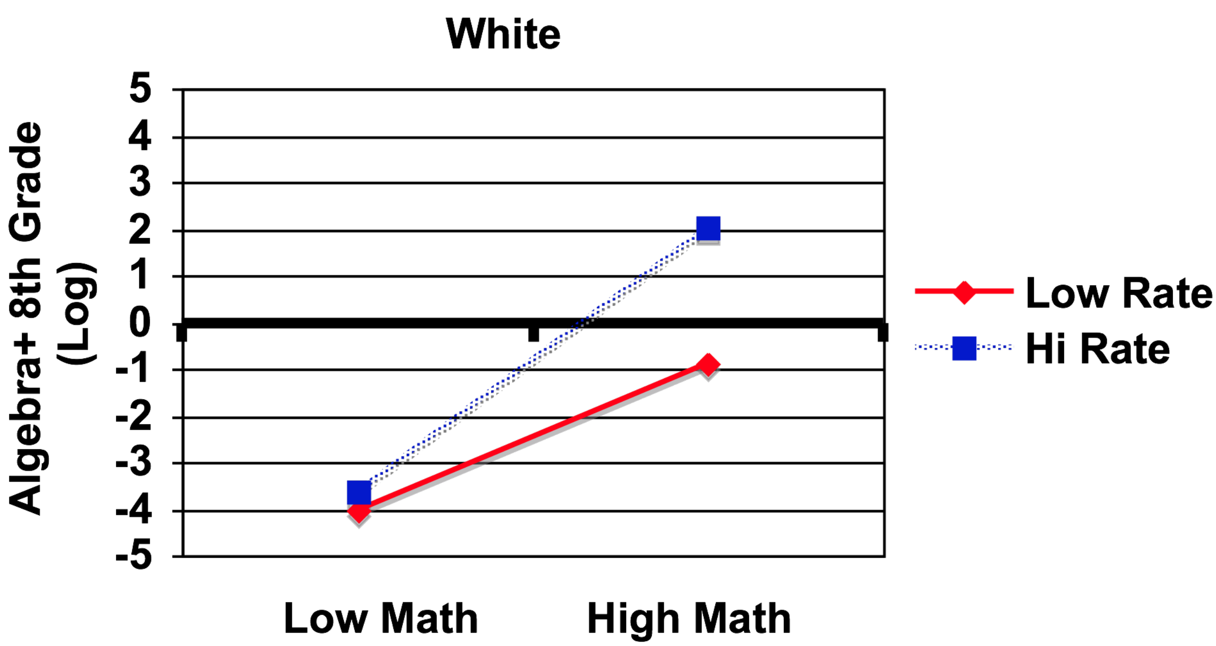
AfAm/Black	Low Teacher Rating	High Teacher Rating
$p < .05$	-2 S.D.	+2 S.D.
Low Cog Score		
-2 S.D.	-.45	-3.25
High Cog Score		
+2 S.D.	-2.40	-.03

Significant cognitive score

Hispanic	
Low Cog Score	
-2 S.D.	-4.6
High Cog Score	
+2 S.D.	.69

Table 4.21

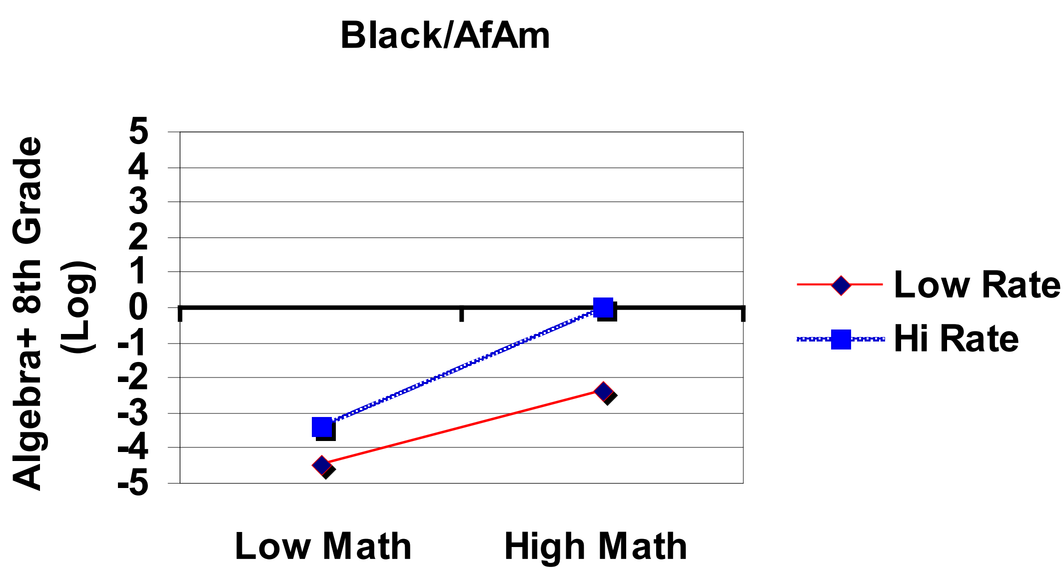
Placement Prediction: White – Significant interaction, cog score, teacher rating



Compared to white students who have an average cognitive score and an average teacher rating, white students who have both a high cognitive score and a high teacher rating have an excellent chance of placement in Algebra or above by the eighth grade (log odds + 2.05) (Table 4.21). These chances are depressed considerably for students with a low teacher rating (log odds = -.90)[10].

Table 4.22

Placement Prediction: Black/AfAm – Significant cog score, teacher rating



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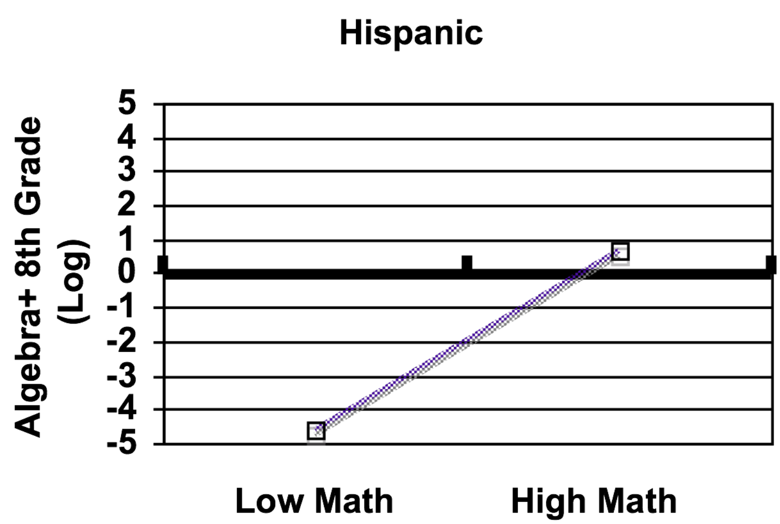
[10] The impact, or Y, of these predictors is reported with the log of odds.
Reference points for Log-Odds—
Chance of placement versus person with Ave. Teacher Rating and Ave. Math Cog scores:

Log-odds of 3 = 20:1	Log odds of -3 = .05/1	(or 1/20th the chance)
Log-odds of 2 = 7:1	Log odds of -2 = .14/1	(or 1/7th the chance)
Log-odds of 1 = 3:1	Log odds of -1 = .37/1	(or 1/3rd the chance)
Log-odds of 0 = 1:1	Log-odds of 0 = 1:1	(or same chance)

B/AA students who have both a high cognitive score and a high teacher rating do not have an excellent chance of being placed in Algebra by eighth grade and instead have essentially the same chance of Algebra Placement (log odds +.03) (Tables 4.20 and 4.22) as black students who have average math score and average teacher rating. There is no interaction between teacher rating and cognitive score for these students, but both variables are significant predictors. The relatively lower power of cognitive performance is evidenced here by the fact that, even in the presence of a high cognitive score, we can predict that these highly rated students will be placed in Algebra at approximately the same rate as their average performing black peers whereas white students have a 7 times greater chance of placement in Algebra or higher by eighth grade compared to their average performing white peers. A low teacher rating for students who are B/AA and high performing reduces these already depressed chances considerably (log odds B/AA student hi cog, low rate: -2.40) and these students would be placed in Algebra or above by eighth grade at a rate 1/10th of that for B/AA students who are average with respect to teacher rating and performance (Tables 4.20 and 4.22).

Table 4.23

Placement Prediction: Hispanic – Significant cog score



For Hispanic students, only cognitive scores are a significant predictor. For these students, a high cognitive score yields an increased chance of placement (log odds: .69), while a low math score results in virtually no chance of placement (log odds: -4.6). This means that a student who is high performing and Hispanic has approximately twice the chance of placement as their average performing Hispanic peers. A student who is low-performing and Hispanic has about a 1 in 60 chance of being placed in Algebra by eighth grade versus their average performing Hispanic peers (Tables 4.18 and 4.23).

Summary

Students who have an IEP in place and students who are Black/African American have reduced odds of being placed in Algebra by the eighth grade when controlling for background characteristics. In general, this trend remains in place for students in these categories (w/IEP or B/AA) who are also high achieving. When predicting for eighth grade math placement in Algebra or above, teacher rating of student performance appears to have a larger impact on students with an IEP and students who are Black-African American than on their White and Hispanic peers.

Chapter Five - Discussion

The purpose of this study was to investigate student background characteristics and experiences, including student mathematical performance and documented teacher ratings of student mathematical performance, and the impact these variables have on eighth grade mathematics placement. In particular, high-achieving students were targeted to gain insight on how demonstrated ability affects teacher rating and placement rates for students with different background characteristics. The ECLS-K longitudinal data set was used to investigate how each of the following predicted placement in eighth grade Algebra or above: 1) cognitive math performance in third and fifth grade; 2) fifth grade teacher rating of student ability; 3) student race/ethnicity, particularly Black/African American and Hispanic; and 4) student receipt of special education services. The relative impact of cognitive performance versus teacher rating was analyzed as well. This study contributes to the research on teacher judgment and impressions of student ability and how this affects student experience, academic course taking, closing achievement gaps, and the interfaces between these topics. This research creates a picture of how objective and subjective data used for critical math placement decisions may be invoked differently for different classes of students.

After a brief summary of results, the topic of middle school Algebra, and its particular position in math course taking patterns and college outcomes, is addressed in a brief summary of related research. The hypotheses will then be addressed and possible conclusions discussed based on the results of this study and related research. Results that were not specific to the hypotheses questions but inform the interpretation of these results, specifically placement rates and teacher ratings of students who are Asian, will also be addressed.

Finally, limitations to the current study and implications for future research will be discussed.

Summary of results

Students who receive special education services and students who are Black/African American have reduced odds of being placed in Algebra by the eighth grade when controlling for background characteristics. In general, this trend remains in place for students who are high achieving. In the case of students receiving special education services, chances are most prominently reduced for inconsistent high achievers. For students who are Black/African American chances are most prominently reduced for consistently high performers. Hispanic students have favorable placement rates, when controlling for other background characteristics, and this appears consistent across ability levels.

Students who are White or Hispanic appear to be placed primarily based on their cognitive performance and to a much lesser extent (White) or not at all (Hispanic) by teacher rating. For students who are identified for special education services or are Black/African American, placement based on cognitive performance is much less evident and teacher rating plays at least an equal role to demonstrated performance. A low teacher rating is virtually prohibitive to placement in Algebra for students with an IEP, even in the presence of high cognitive scores. A high teacher rating, even when combined with a high cognitive score, barely increases Black/AfAm students' chances of being placed in eighth grade mathematics above the rate for students performing at an average level and who are rated at an average level. On the other hand, highly rated and high-performing white students are highly likely to be placed in eighth grade Algebra or above. Whereas these highly rated and high performing Black/African American students are placed at a rate approximately equal to the rate for the average student who is B/AA, students who are white experience seven times the chance of placement for high performance and high rating compared to their average performing and rated white peers. Similar to students with an IEP, high performing Black/African American students have little chance of being placed in Algebra in the presence of a low teacher rating. These students are predicted for placement in Algebra at one-tenth the rate of their B/AA peers with an average math performance and an average teacher rating. White students with a low teacher rating and high performance are much less affected by the low teacher rating as their chances are cut by one-third compared to their average performing and rated white peers.

The importance of middle school mathematics placement

What mathematics classes a student takes and *when they take them* matters. In general, students of like background characteristics gain in achievement by virtue of a higher mathematics class placement in high school (Cahan & Linchevski, 1996; Hallinan, 2003). More importantly, these course-taking patterns in high school also have a considerable impact on student completion of a bachelor's degree. This is particularly true with regard to mathematics and science courses where students who take advanced math classes by the end of high school experience greater success in college (Trusty, 2004). But course taking patterns in high school are difficult to address once a student is actually in high school (Burris et al., 2004). These course-taking trajectories are greatly influenced by course taking patterns in middle school, which are, at their heart, influenced specifically by sixth grade mathematics class placement because of the prerequisite nature of these classes and as evidenced by the extremely high correlation between sixth grade mathematics class placement and eighth grade mathematics placement (Dauber et al., 1996). In general, only students placed in the higher tracks at sixth grade are given the opportunity to enroll in pre-algebra at seventh grade and algebra in the eighth grade. A 'domino effect' emerges in the literature with regard to both mathematics class placements in high school and consequent college outcomes. This effect extends back to the sixth grade mathematics class placement. This is because sixth grade placement has a substantial impact on whether a student is placed in Algebra *before* high school. Taking algebra before high school not only impacts the academic achievement of students by virtue of their higher track placement, but it has an impact on college outcomes as well (Adelman, 1999; Horn & Nunez, 2000). Furthermore, the students own sense of self-efficacy is related to mathematics class placement (Akos, Shoffner, & Ellis, 2007). Given what we know about teacher expectations and sustained beliefs (T. L. Good, 1987), and mathematics teachers beliefs that mathematics courses should be tracked by student ability (Cahan & Linchevski, 1996), it is fair to assume that high school teacher expectation for student performance is also affected by the student class placement itself. All of these outcomes are likely unforeseen by-products of an academic decision made for a student when he or she was eleven years of age. What has not been established is how the transition from elementary school to middle school may impact this trajectory. The essential question raised herein is whether the fifth grade teacher judgment of student mathematical ability affects these placement outcomes differently for different groups of students. Or, in keeping with the domino analogy, is the fifth grade teacher's judgment of student ability a critical link in how these dominoes fall?

The other critical question related to these important middle school placement decisions is the impact of the student's own performance on placement. In a society that fashions itself around ideas of intellectual freedom and democracy, it is no surprise that eventual success is viewed as the result of individual merit 'rising to the top.' The public schools are not an exception to this paradigm and tracking systems are put in place with a purported intent to challenge and reward strong performing students as they rise up through the grade levels. It is not the stated intention of our system, on the other hand, to foster a practice wherein students are chosen for higher-level classes based on the sociological pre-conceptions or preferences of the teacher. There is evidence that tracking does affect different classes of students differently, but there is often an underlying assumption that this is due to sociological factors outside the control of the teacher or the school. If this were the case, one would expect teacher impressions on student placement to be minimal compared to the impact of student's own mathematical performance or their socioeconomic status. If, on the other hand, teacher impressions strongly predict student placement, or do so differentially for different groups of students, then evidence is provided that the forces of sociology outside the control of the school and the forces of student merit have a rival. Furthermore, if ten and eleven year old students who *have demonstrated strong performance in mathematics* are placed at different rates according to non-academic background characteristics (specifically, race and IEP status) there is likewise evidence that a school factor may be at play that inhibits the academic opportunity of these strong performing students. Therefore, another essential question arises: Are high performing students being placed in Algebra in line with their performance levels?

Students who receive special education services

In general, students with an IEP in place have lower odds of placement in Algebra at the eighth grade. For students who have an IEP in place and when controlling for cognitive math score, teacher rating, socioeconomic status, gender, and race, the odds of placement in Algebra by the eighth grade are reduced by approximately one-half. This finding is strong and highly significant when predicting from third grade (B = .56, $p \leq .004$) and fifth grade (B = .60, $p \leq .005$)

At the fifth grade, analysis of the largest group of high performing students (Math T-Score ≥ .5 third and/or fifth grade) demonstrates a near-significant result that the odds of placement in Algebra for students with special education identification are just better than half that of their peers when controlling for other variables (B = .63, $p \leq .09$) (Table 4.7).

Both the significance level and the effect size increase dramatically, however, when the smaller group of high performing students, those with the inconsistent performance (Math T-Score ≥ .5 and ≤ 1, third or fifth grade), is analyzed. These students present a more ambiguous high-performing profile. For this sub-group, and when controlling for background variables including average cognitive performance, the odds of placement in Algebra by eighth grade is approximately one-fifth that of their peers (B = .18, $p \leq .0001$). Seen from the other perspective this odds ratio means that *when controlling for other factors including the student's mathematical performance*, for students not receiving special education services the odds of placement are *5.5 times that of their similarly situated inconsistently high performing peers* who are in receipt of special education.

Given what we know about taking algebra before high school, it can be argued that algebra placement itself has an impact on a student's ability to access all of the social and academic benefits of schooling. If consideration regarding Least Restrictive Environment includes the implications of taking certain classes at certain times, then clearly, *when* students with an IEP take Algebra 1 should be considered. Students in receipt of special education services are placed in algebra by eighth grade at an approximate rate between two and five times lower than their peers and they are also more vulnerable than their peers to teacher judgment. How does this align with special education law and practice? In general, the development of an individualized plan for a student involves assessing multiple sources of data, applying professional judgment, and engaging in team-decision processes in order to protect these students from, among other things, the vicissitudes of test-performance. Is it possible that this team process is, at the very least, not protecting these students and, indeed, may be hindering the special education student with regard to mathematics achievement and placement opportunities? Again, if the protection of student opportunity is a priority, then discussions regarding student potentials should, to the greatest degree possible, be predicated on student demonstrated ability. Furthermore, one might suspect that students with an IEP in place would have a *higher* rate of placement in Algebra before high school when controlling for other factors. This would follow logically: 1) students with disabilities are initially identified because of some difficulty succeeding within the school environment, and 2) protections are put into place to give these students every opportunity to access educational resources in spite of differences that may cause them to underachieve. It is logical to assume that, *once we control for background characteristics including mathematical performance,* students with an IEP would be placed at an equal or higher rate then their peers because these students presumably have a team of educators ‘in their corner’. This is not to say that an IEP provides privilege, only that the IEP should be a safeguard against depressing a student’s potential by virtue of academic and class placement decisions made by the school. The data we have here indicates that a different trend is in place: Students with a demonstrated ability in mathematics equal to their peers have a dramatically lesser chance of enrolling in Algebra before high school if an IEP is in place. What’s more, whereas for other students academic performance strongly predicts their placement, for these students teacher judgment of student ability matches student performance as a predictor for placement (See Tables 4.16 above and 5.2 below). For all students, cognitive scores were found to be twice as powerful a predictor as teacher rating. For students receiving special education services, on the other hand, teacher rating and cognitive scores carry virtually the same power as predictors of math placement. For students with an IEP, a low teacher rating is virtually prohibitive of placement in algebra even in the presence of high cognitive performance (See Table 4.18 above).

In other words, a student who, in spite of a disability that warrants the protections built into an IEP, and *has demonstrated performance equal to their peers*, has a lesser, not greater, chance of algebra placement by eighth grade. The playing field is not being leveled, it would appear, but instead is tilted against the student with a disability.

Considerations regarding findings for students in receipt of special education

This finding, then, should be of real concern for the special education community. Every effort should be put in place to ensure that students with an IEP are given the same opportunity as their peers to take the advanced class at sixth grade that overwhelmingly leads to algebra at the eighth grade. Certainly, it is possible that this is already happening for many of these students, and that it is students themselves who are given this opportunity and then are not able to maintain skills through middle school. Given the greater context that special educators have a demonstrated weakness with regard to current mathematics practice, and self-report that they are not prepared to teach or support secondary mathematics topics (Maccini & Gagnon, 2002), and the inflated role of teacher impression of student performance for these students, other conclusions might also be drawn. It is more than plausible that, faced with a general educator's recommendation that a student is not ready for certain mathematics classes (possibly based on the student's divergent approach to a topic or need for extended time, for example), special educators acknowledge their own weakness and defer to general educator judgment. This would, of course, stand in contrast to their assigned role of knowledgeably advocating for the student. It is also possible that the special educator's admitted weakness with regard to secondary mathematics may impact their understanding of the importance of taking algebra by eighth grade or their willingness/ability to be involved with supporting these students. These findings are also consistent with findings that students who are both gifted and facing a disability are often discouraged from considering college and may face limited educational opportunities because of teachers' stereotyped understandings of these students (Reis et al., 1997). In spite of teachers' relative strength in originally developing expectations for students, teachers do demonstrate differential behaviors towards different students. This appears to contribute to effects of the sustained belief type. For instance, Good cites Anderson and Levitt's (1984) finding that teachers interpret ambiguous student behavior or performance based on their differing expectations of student performance. Good maintains that these ambiguous events compose the bulk of classroom interactions and have the potential to have a substantial impact on students. These findings are consistent with the finding in this study that the students with an IEP demonstrating 'ambiguous' performance (i.e. inconsistent high performance) are the group of students who are hardest hit—their odds of placement are one-fifth that of their inconsistently high-performing white peers without an IEP in place. Good cites several studies that support the notion that student presentation (timing of misbehaviors, language use) also contribute to teachers' tendency to maintain certain expectations about students. Perhaps for students with an IEP other behaviors (besides academic performance) play a larger role in teacher impressions and eventual class placement than for their peers. In general, teacher beliefs, impressions and expectations about their own teaching effectiveness, student effort and ability, and curriculum pedagogy (among a myriad of other definable characteristics) are all part of an interplay that can effect student outcomes (T. L. Good, 1987).

The findings in this study are also consistent with the finding that special educators have few mathematics related support strategies to assist students with special needs in mathematics (Hughes & Smith, 1990; Maccini & Gagnon, 2002) and that the strategies used are not sufficient support for students taking higher-level mathematics. Even Hughes and Smith (1990) consider that, along with tutoring, avoiding certain mathematics classes is among the best assistance available to these students (Hughes & Smith, 1990). There is cause for concern that a depressed rate of placing students with an IEP has more to do with 'solving' the problem of special educators' lack of preparedness in secondary math topics than on what is most appropriate for the student. If special education students are not in Algebra by eighth grade, then middle school special educators are spared the requirement of supporting these students in this more challenging mathematical topic.

Students who are Black/African American

Students who are Black/African American have reduced odds of being placed in Algebra by the eighth grade when controlling for background characteristics. In general, this trend remains in place for B/AA students who are also high achieving with chances most prominently reduced for consistently high performers.

When predicting for eighth grade math placement in Algebra or above, teacher rating of student performance has a larger impact on these students than on their peers. Nevertheless, a high teacher rating, even when combined with a high cognitive score, barely increases Black/AfAm students' chances of being placed in eighth grade mathematics above the rate for all B/AA students. While highly rated and high-performing White students are highly likely to be placed in eighth grade Algebra, highly rated and high performing Black/African American students are placed at a rate that is virtually the same as their average performing B/AA peers. High performance and high teacher rating does not appear to have an impact on placement. Compare this to the dramatic increase in placement rate for high-performing and highly rated white students (log-odds of +2.05) indictaing a rate of placement seven times that of average performing peers. High-performance along with a high teacher rating increases chances of placement significantly for White students.

Similar to students with an IEP, high performing Black/African American students have little chance of being placed in Algebra in the presence of a low teacher rating. These students are predicted for placement in Algebra at a rate considerably lower than their B/AA peers with an average cognitive performance and an average teacher rating. Specifically, their odds of placement is 1/10th that of their average peers. This is compared to high performing and low rated white students whose odds of placement is 1/3rd that of their average performing and average rated white peers.

In this study, socioeconomic status is addressed as a co-variate and is not addressed directly in the four hypotheses. Nevertheless, it is clearly an important factor in placement decisions. In general, SES is a powerful and highly significant predictor of student placement in eighth grade algebra (Table 5.1). Perhaps unexpectedly, while SES approaches significance as a predictor (B = 1.44, $p < .08$), it is *not* a significant predictor for placement in Algebra for students who are Black/African American. While this is worthy of note, these results may be more the result of the lower number of B/AA students than of a different pattern of prediction.

Gender and Black/African American students

While gender was not specifically addressed in the study hypotheses, an analysis of B/AA students by gender is of interest. When controlling for other variables including average cognitive performance, the odds for African American girls placement in Algebra is almost three times that of their male counterparts (B = 2.77, $p < .0001$). This is substantially higher than the gender comparisons of white students (B = 1.40 $p < .0001$) or Hispanic students (B = 1.44, $p < .05$). Moreover, there is no significant difference in the placement of girls who are B/AA versus girls who are white (B = .915, $p = .597$). On the other hand, the odds of placement for boys who are white is almost two and a half times that of their similarly situated B/AA counterparts and this is a highly significant finding (B = 2.44, $p <$ .0001).

Considerations regarding findings for students who are Black/African American

These findings, that B/AA students are placed in Algebra at a rate below their peers, are consistent with many studies (Cahan & Linchevski, 1996; Dauber et al., 1996; Gamoran & Mare, 1989; Oakes, 1990). In order to affect this well substantiated reality, it is important that we better understand what school and social factors influence these disparities. This study validates the thesis that, for these students, even high-performance is not enough to ensure opportunity of placement and, that B/AA students are more affected by teacher impressions of their ability than are their peers. Put another way, there is indication that performance-based, data-driven decision making is not in place for B/AA students to the same degree that it is for their white peers.

There is evidence that social considerations on the part of the B/AA student (in particular a fear of being seen as ‘acting white’) do have an impact on student effort at high school (Ogbu, 2004). It is certainly important that we understand and consider social issues that may put pressure on decisions eventually made at the school level. At the same time, it is critical that we do not make the mistake of characterizing student placement decisions as driven largely by student choice. Consider this characterization of how students are placed in eighth grade Algebra: “…findings, however, are clouded by selection effects—by the presence of unmeasured factors influencing who takes algebra early and who takes it late. Schools routinely assign incoming eighth graders to math courses based on how much math students already know. Moreover, it is no surprise that excellent math students want to take the most challenging math courses available to them and that low-achieving students avoid these courses as long as possible" p. 3 (Loveless, 2008). This characterization is embedded in an article that argues that too many low-achievers are placed in eighth grade algebra. This creates the overall impression that teachers use objective data ("how much math students already know"), students choose according to preference, and any error in placement is skewed towards placing students in too high a class. The findings herein support a more sophisticated characterization of the process that includes understanding the responsibility on the part of the school in placing some students *down* (not up) more readily and differentially in accordance with racial group. The relatively greater impact of teacher rating on B/AA students indicates that factors within the school setting are at play and that the lower rates of placement are, at least in part, initiated by teacher impressions and not the other way around. Notably, these teacher ratings appear to *depress* high-performing B/AA students' chances of placement in algebra but do *not* appear to increase chances for low-performers (See Table 4.22 above). Furthermore, it is possible that the placement of a greater percentage of black students in the eighth grade algebra sequence of courses at the middle school level may make these students more robust to the affects of sociological pressures that discourage academic effort at the high school level.

Table 5.1

SES as a predictor of Placement in Eighth Grade Algebra

SES	*Odds Ratios*	$p \leq$
All Students	1.86	.0001
Students w/ IEP	2.52	.0001
White	1.98	.0001
Hispanic	1.48	.007
Black/AfAm	1.44	.08
Asian	1.25	.57

Students who are Hispanic

Hispanic students have approximately equal or even favorable placement rates, when controlling for other background characteristics, compared to their peers. This appears to be consistent across ability levels as well. Furthermore, Hispanic students' fifth grade teacher rating of student ability is an inconsequential consideration when predicting class placement. When controlling for background variables, cognitive ability alone predicts placement for these students. These findings do not support the hypotheses of this study. What's more, this finding does not at first appear consistent with previous studies that find a reduced placement rate for students who are Hispanic. What may be in play here is the powerful affect of SES and the overlap between students who are Hispanic and students with lower SES standing. This data indicate that, while students who are Hispanic do have a lower rate of placement than their white peers, this lowered rate may be more a factor of SES than ethnic group status.

Students who are Asian

There is one group of students for whom teacher rating appears to matter the most, socioeconomic status the least, and being male is a significant and highly powerful advantage. As addressed above, socioeconomic status is a profoundly reliable predictor with regard to academic placement issues and is a strong predictor for eighth grade math placement for most other student groups in this study. For Asian students, socioeconomic status is not only not a strong predictor (Table 5.1) it is a complete non-factor (B = 1.247, p = .565). Furthermore, students who are Asian are placed in algebra by eighth grade at a rate two and a half times their white peers (B = 2.48, p .0001), when controlling for background factors *including cognitive mathematics performance.* This is a highly significant and powerful finding. Similarly, results for Asian students with regard to gender are likewise inverted. When controlling background characteristics, Asian boys are *four times the odds* of being placed in eighth grade algebra than Asian girls, and *seven times the odds* of being placed compared to white boys. An increase in teacher rating by one standard deviation increases Asian student chances of being placed in algebra by *almost three times* Table 5.2).

When considering cognitive performance, Asian students are placed in Algebra by eighth grade at a rate that exceeds expectations for all students (Table 5.3).

Trends for different groups of students are revealed by creating a ratio of the power of cognitive performance as a predictor to teacher rating as a predictor (Table 5.4). We see here that *only* for students who are Asian is teacher rating a stronger predictor than cognitive performance. Clearly, sociological influences are at play here. While one may suspect that parental pressure or expectation plays a role in the higher rate of placement for Asian boys, the highly influential teacher rating found here argues against this as a sole operator. Instead, these findings indicate that the teacher's judgment, which is in effect a proxy for the social institution of the school itself, plays a large role in this phenomenon. If parental pressure were the primary force at work, one would not expect teacher rating to have such a large predictive influence on placement. To the contrary, an outside sociological pressure should minimize the influence of school-based factors. Indeed, something very compelling is at play here given the lack of finding for economic influence on placement for these students. Perhaps it is the combined expectations of the teacher and the parents that create a situation where Asian students (and Asian boys in particular) are placed in algebra by eighth grade at a rate that far exceeds expectations based on documented performance. These results, while not directly related to the question of high-achieving Black/African American students, Hispanic students, and students with special needs, support the notion that factors other than documented ability are still largely at play with placement decisions. It appears that teacher judgment of student mathematical ability is affected by ambient cultural understandings of student exceptionality and race.

Table 5.2

Teacher rating as predictor of eighth grade math placement for different student groups Controlling for other background characteristics - Listed in descending order from most powerful to least

5th Grade

Teacher Rating	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p ≤*
All Students	.341	.054	39	1.41	1.26 – 1.57	.0001
Asian	1.05	.423	6.15	2.86	1.25 – 6.55	.047
Students w/iep	.716	.263	7.4	2.05	1.22 – 3.43	.007
White	.424	.068	38.9	1.53	1.33 – 1.75	.0001
Black/AfAm	.396	.189	4.38	1.49	1.03 – 2.15	.036
Hispanic	.087	.131	.438	1.09	.84 – 1.41	.508

Table 5.3

Student Math performance as predictor of eighth grade math placement for different student groups controlling for other background characteristics - Listed in descending order from most powerful to least

Ave Cog 3^{rd} and 5th	*b^*	*SEb^*	*Wald t*	*Odds Ratios*	*Conf Int*	*p ≤*
All Students	1.09	.065	280	2.96	2.61 – 3.36	.0001
Hispanic	1.301	.168	60.2	3.67	2.64 – 5.10	.0001
White	1.11	.079	199	3.09	2.60 – 3.53	.0001
Asian	.884	.444	3.96	2.42	1.013 – 5.78	.047
Students w/ IEP	.763	.291	6.87	2.15	1.21 – 3.80	.009
Black/AfAm	.659	.202	10.66	1.93	1.30 – 2.87	.001

Table 5.4

Ratios of significant results: Cognitive Performance/Teacher Rating

	cog/tchr rate		*decimal*
All Students	2.96/1.41	=	2.08
White	3.09/1.53	=	2.02
Black/AfAm	1.93/1.49	=	1.29
Students w/ IEP	2.15/ 2.05	=	1.04
Asian	2.42/2.86	=	.85

Limitations

This study utilizes the ECLS-K 1998-1999 Kindergarten cohort data base to investigate trends regarding teacher impressions of student performance, students mathematical performance, race, IEP status and their effects on placement in Algebra or higher by the eighth grade. Because it is a national data-base and weights are employed to maximize accurate representation of different populations it is hoped that this study will provide information valuable to districts across the country as they assess their own trends and data as it relates to eighth grade math placement. Nevertheless, there are limitations of this study with regard to generalization and results should be read with this knowledge in mind. For one, the ECLS-K is nationally representative only at the Kindergarten level. Beyond that, the cohort group is affected by attrition, and generalizations should be made cautiously. Because in this paper specific populations are investigated at the far end of this longitudinal study, the numbers are greatly depleted from the original 20,000 plus students enlisted in 1998-1999. By the time students are in eighth grade there are a limited number of students (~ 3,000) who meet the criteria for analysis. Cell sizes are further affected when specific groups are analyzed. For instance, Black/African American students who have eighth grade math data in 2007 are chiseled down to 159 students. For students with an IEP this number is 217 (See Table 3. above). Cell numbers are further reduced when only high performing students are considered. These small numbers demand that these results be read with some caution.

While these cell numbers were large enough for analysis, they were small enough to encourage concern regarding Type 2 (false negative) error. It certainly seemed possible that trends that are readily detectable at earlier grades in this study wherein thousands of subjects are available for analysis would be difficult to detect at the later grades. Of course, one can only study issues regarding eighth grade math placement once eighth grade math placement has occurred. In order to avoid underestimating effects, design effect (accounting for the ECLS-K stratified sample versus the presumed random sample) adjustments are not applied to the data reported above. The design effect adjustment does not affect the odds ratios reported, but does affect the standard errors. This means, then, that the data as reported may include some Type 1 (false positive) errors because the p values are slightly suppressed. In order for the reader to make judgments regarding these errors, the p values for many of the results are listed below. In general, for any p values that are highly significant, the design effect adjustment (square root of the design effect, which is 1.8, * standard error) is negligible and inconsequential. For any results that are not significant, the design effect adjustment merely reinforces that result and so is again inconsequential. Several of these types of results are listed for reference. For those results that are significant but close to the accepted significance level of .05, the design effect is enough to change the result from 'significant' to 'not significant.' There are very few of these, but they are reported below so that the reader can better assess the risk of Type 1 and Type 2 errors. Again, recall that the design effect does not affect the calculated odds ratios, only the confidence with which we can accept those odds.

This study is designed not to determine specifically how the process of placement works, but to better understand this process as it relates to different student groups. The supposition built into this study is that, if data-driven decisions are being made, this process should not be complex and should affect different student groups (racial, IEP status) the same, when controlling for background variables such as performance and SES. Academic performance and teacher assessment of performance should predict eventual placement consistently across groups if there are no school-based sociological factors impacting this placement. At the same time, it is understood, that there are outside influences that might affect these predictions and that these influences are outside the control of the school. The balance walked in this study is that sociological influences outside the control of the school should *suppress* the impact of the school-based teacher impression, not heighten it. This is a logical extension of the basic premise in analyzing statistics: If a force not accounted for is *not in line with* the force being studied, that outside force should diminish the ability to find significance with the force being studied. If, on the other hand, an outside force is *consistent* *with* the force being studied this outside force should enhance the possibility of finding significance. Results that demonstrate an increased impact of teacher impressions are either found *in spite of* outside forces or are *consistent with* outside forces. Both of these conclusions are statistically and sociologically logical. What does not make sense, however, would be to conclude that the inflated impact of teacher impressions exists *because of* forces outside teacher control. This would be a negation of the responsibility that a teacher holds in making these judgments and an unwarranted dismissal of the impact the confidential teacher impressions made regarding a student appear to have on future academic placement. So, while acknowledging that this dynamic of school placement in Algebra by eighth grade can appear complex, it is hoped that looking at academic performance and teacher impression will begin to shed light on this dynamic and help school personnel take responsibility and action as indicated. Even as we understand better where these impressions may lay in the greater sociological/statistical scheme, we do not still know that teacher impressions at the fifth grade level actually have any practical implications in the placement process at any given school or for any given child. So, for instance, in the cases where high performing students are not placed at the same rate according to class associations, we can only presume that any possible differences may be associated with negative class associations. The inclusion of the teacher rating helps support this thesis for certain groups, but certainly does not represent direct proof of such.

Table 5.5

Evaluating p values of results with negligible impact due to design effect adjustments: Samples reported as Significant or Non-significant

Sample of Highly Significant Results	*p value ≤ Reported*	*p value ≤ With Deff Adj.*
Students w/IEP Prediction of Placement from fifth grade - eighth (B = .60)	.005	.009
Students w/IEP .5 ≤ Math T-Score ≤ 1 once: third or fifth prediction of Placement from fifth grade - eighth (B = .18)	.0001	.0001
B/AA Students prediction of Placement from fifth grade - eighth (B = .68)	.007	.01
B/AA students		

Table 5.5 Continued

Math T-Score ≥ .5 Both third and fifth prediction of Placement from fifth grade - eighth (B = .28)	.0001	.0001

Sample of Non-Significant Results	*p value ≤ Reported*	*p value ≤ With Deff Adj.*
Hispanic students Fifth grade Teacher rating prediction on Placement (B = 1.09)	.508	.914
Hispanic boys versus girls Prediction for placement (B =.694)	.054	.097
B/AA students SES prediction on Placement (B = 1.44)	.080	.144
Asian students SES prediction on Placement (B =1.25)	.565	1.017

Table 5.6

Evaluating p values of results with impact due to design effect adjustments:

Results reported as Significant or Near-significant

Complete list of Significant and Near Significant Results reported and affected by DEFF adjustment	*p value ≤* *Reported*	*p value ≤* *With Deff Adj.*
B/AA students Math T-Score ≥ .5 third or fifth Prediction of placement (B = .38)	.051	.092
Asian students Cognitive performance Prediction of Placement (B = 2.42)	.047	.085
B/AA students Fifth grade teacher rating Prediction of Placement (B = 1.49)	.036	.065
White students Interaction term Between average cog score and fifth grade teacher rating (B =1.17)	.035	.063

Implications for future research

Several lines of research present themselves as a result of this study. First, replications of these findings using state data sets would be valuable. These data sets are not samples, but a complete set of students who have been tested within a state and therefore contain large enough numbers that specific cell sizes would remain sufficiently large for detailed analysis and power. These data sets often include teacher questions that could be used as a proxy for teacher impressions of student ability (grades, rating of student academic behaviors, etc.). Furthermore, this data could be used to investigate questions regarding high performing students with an IEP and high performing students who are Black/African American to see if there is further evidence that these high performing students are affected by lower placements. Findings regarding particular states would also have greater implications because policy-makers at the state level would have direct evidence regarding students within their jurisdictions.

Specific follow-up studies also present themselves. The finding regarding placement of special education students in algebra are cause for alarm and warrant further quantitative and qualitative research to better understand the processes in place in the transition from elementary school to middle school as it applies to math course-taking opportunities. Are special education teachers unwittingly discouraging advancement of the students they represent? Are general educators interpreting certain behaviors as more critical to mathematics placement than mathematics performance itself? Are the special education supports put in place for later elementary and middle school students ineffective at positioning these students for further success and acceleration? Are IEP goals effectively addressing mathematics?

Follow-up studies regarding racial groups are also suggested by these findings. It is understood within the public health community that first generation Latinas have equal or better birth outcomes than their white peers in spite of lower socio-economic status. In the public health research this is called the Latina paradox and is generally explained as a result of a strong social network built into many Hispanic communities in the United States (McGlade, Saha, & Dahlstrom, 2004). It is possible that this social network may play a role here, somehow creating stronger outcomes for students given equal performance. The mechanisms in play for that possible relationship between a cohesive social unit and school placement decisions could be an interesting area of study.

Another area that warrants further study involves ways to understand issues of teacher judgment and eventual eighth grade mathematics placement regarding students who are African-American/Black. In particular, are *high-achieving* B/AA students consistently under-represented in advanced middle school courses and could teacher judgment of their ability levels be contributing to this under-representation?

The unexpected findings regarding Asian students are particularly compelling as well. Follow-up studies might investigate whether teacher expectations for Asian boys are consistently higher than their work product would suggest thus contributing to a self-fulfilled prophecy for these students that reinforces social stereotypes.

It has been established that students in minority groups are overrepresented in special education (Artiles & Trent, 1994; Services, 2002). In spite of this consistent finding, there has been little research on the interplay and interactions between mathematics, ethnicity, class, and the special education student. Lubienski and Bowen (2000) conducted a broad study of mathematics research in order to provide “concrete evidence regarding the attention given to equity groups and topics by the mathematics education research community”. Using state data banks would also be useful in providing large enough populations to consider more deeply this largely unstudied interplay between different ethnicities, students who are in receipt of special education services and mathematics performance and outcomes.

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Appendix

Appendix A
Teacher Academic Rating Scales

Directions:

Academic Rating Scale – Mathematics
2004 Grade 5 Form

Please rate this child's skills, knowledge, and behaviors in mathematics based on your experience with the child identified on the cover of this questionnaire. This is NOT a test and should not be administered directly to the child. Each question includes examples that are meant to help you think of the range of situations in which the child may demonstrate similar skills and behaviors. The examples do not exhaust all the ways that a child may demonstrate what he/she knows or can do. The examples do, however, indicate the level of proficiency a child should have reached in order to receive the highest rating. Some of these examples describe a very high level of performance (beyond typical standards) in order to be able to evaluate achievement levels of even the high performing students.

The following **five-point scale** is used for each of the questions. It reflects the degree to which a child has acquired and demonstrates the targeted skills, knowledge, and behaviors.

1	=	Not yet	Child has not yet demonstrated skill, knowledge, or behavior.
2	=	Beginning	Child is just beginning to demonstrate skill, knowledge, or behavior but does so very inconsistently.
3	=	In progress	Child demonstrates skill, knowledge, or behavior with some regularity but varies in level of competence.
4	=	Intermediate	Child demonstrates skill, knowledge, or behavior with increasing regularity and average competence but is not completely proficient.
5	=	Proficient	Child demonstrates skill, knowledge, or behavior competently and consistently.
N/A	=	Not Applicable	Skill, knowledge, or behavior has not been introduced in classroom setting.

Rate only the child's **current** achievement. Please use the full range of ratings. If the skill, knowledge, or behavior has been introduced in the classroom, please rate the child using the numbers **1-5**. Circle **"NA"** only if the skill, knowledge, or behavior has not been introduced in your classroom setting.

Third Grade Scale

THIS CHILD...	CIRCLE ONE FOR EACH ITEM					
	Not Yet	Beginning	In progress	Intermediate	Proficient	Not Applicable
7. **Shows understanding of place value with whole numbers** – for example, correctly orders the numbers 19,321, 14,999, 9,900, and 20,101 from least to greatest, or correctly regroups when adding and subtracting.	1	2	3	4	5	N/A
8. **Makes reasonable estimates of quantities and checks answers** – for example, estimates the cost of a list of 8 different items and compares to actual cost, or estimates the perimeter of a bulletin board and then checks with a yardstick.	1	2	3	4	5	N/A
9. **Surveys, collects, and organizes data into simple graphs** – for example, charts temperature changes over time, or makes a bar or line graph comparing the population in different cities of their state, or interprets a pictograph in which each symbol represents 5 people.	1	2	3	4	5	N/A
10. **Models, reads, writes, and compares fractions** – for example, shows that 1/2 of the candy bar is 1/4 + 1/4, or shows that 1/4 of a set of 12 is 3.	1	2	3	4	5	N/A
11. **Divides a 3 digit number by a 1 digit number** – for example, 348÷4 or 228÷6.	1	2	3	4	5	N/A

Fifth Grade Scale

THIS CHILD...	CIRCLE ONE FOR EACH ITEM					
	Not Yet	Beginning	In progress	Intermediate	Proficient	Not Applicable
1. **Subtracts numbers that require regrouping**, for example, 1300 – 579, or 2302 – 947, or 2603 – 1594..........................	1	2	3	4	5	N/A
2. **Reduces fractions to lowest denominator**, for example, reduces 27/63 to 3/7, or 41/6 to 6 5/6.......................................	1	2	3	4	5	N/A
3. **Demonstrates money management skills,** for example, computes savings on a 20% off sale, balances a classroom savings account, or determines profit earned on candy bar sales...	1	2	3	4	5	N/A
4. **Recognizes properties of shapes such as area, perimeter, and volume**, for example, accurately estimates the capacity and volume of a tub or sink, or computes the area of an irregular polygon..........................	1	2	3	4	5	N/A
5. **Uses measuring tools accurately,** for example, measures with rulers to the 1/8 inch or metric sticks to the nearest millimeter, or uses tiles to measure area and cubes to measure volume............................	1	2	3	4	5	N/A
6. **Shows understanding of place value,** for example, compares decimals to the thousandths place (1.04 > 1.009).................	1	2	3	4	5	N/A
7. **Makes reasonable estimates of quantities and checks answers**, for example, estimates the product in a problem such as $19.95 x .75 by mentally multiplying 20 x .8 = 16..	1	2	3	4	5	N/A
8. **Uses strategies to multiply and divide,** for example, estimates a product or quotient and then uses the calculator to check the estimate, or divides by 4 to determine 25% of 32..	1	2	3	4	5	N/A
9. **Divides multi-digit problems with remainders in the quotient,** for example, computes 536 ÷ 30, or 6,135 ÷ 7.................	1	2	3	4	5	N/A
10. **Demonstrates algebraic thinking,** for example, solves for an unknown in an equation such as 16 x A = 48; or expresses a function as a general rule that enables them to determine any term in the sequence.	1	2	3	4	5	N/a

Appendix B
Mathematical Framework used to Develop Cognitive Assessment Mathematics Strands
Outline for Development of ECLS-K Direct Cognitive Assessment

- **Number sense, properties, and operations.** This refers to children's understanding of numbers (whole numbers, fractions, decimals, and integers), operations, and estimation, and their application to real-world situations. Children are expected to demonstrate an understanding of numerical relationships as expressed in ratios, proportions, and percentages. This strand also includes understanding properties of numbers and operations, ability to generalize from numerical patterns, and verifying results.

- **Measurement.** Measurement skills include choosing a measurement unit, comparing the unit to the measurement object, and reporting the results of a measurement task. It includes items assessing children's understanding of concepts of time, money, temperature, length, perimeter, area, mass, and weight.

- **Geometry and spatial sense.** Skills included in this content area extend from simple identification of geometric shapes to transformations and combinations of those shapes. The emphasis of the ECLS-K is on informal constructions rather than the traditional formal proofs that are usually taught in later grades.

- **Data analysis, statistics, and probability.** This includes the skills of collecting, organizing, reading, and representing data. Children are asked to describe patterns in the data or make inferences or draw conclusions based on the data. Probability refers to making judgments about the likelihood of something occurring based on information collected on past occurrences of the event in question. Students answer questions about chance situations, such as the likelihood of selecting a marble of a particular color in a blind draw when the numbers of marbles of different colors are known.

- **Patterns, algebra, and functions.** Consistent with the NCTM kindergarten to fourth-grade curriculum standards, the ECLS-K framework groups pattern recognition together with algebra and functions. Patterns refers to the ability to recognize, create, explain, generalize, and extend patterns and sequences. In the kindergarten test, the items included in this category entirely consist of pattern recognition items. As one moves up to the subsequent grades, algebra and function items are added. Algebra refers to the techniques of identifying solutions to equations with one or more missing pieces or variables. This includes representing quantities and simple relationships among variables in graphical terms. While pattern recognition is heavily emphasized in kindergarten and even first-grade classrooms, the proposed framework tends to de-emphasize the assessment allocation since it is not clear what to expect with reference to longitudinal trends in this skill area.