Spring 2-25-2014

A Comparative Analysis of the Singapore Math Curriculum and the Everyday Mathematics Curriculum on Fifth Grade Achievement in a Large Northeastern Urban Public School District

Tina L. Powell
Seton Hall University, sketchesbytina@gmail.com

A Comparative Analysis of the Singapore Math Curriculum and the Everyday Mathematics Curriculum on Fifth Grade Achievement in a Large Northeastern Urban Public School District

Tina L. Powell

Dissertation Committee

Gerard Babo, Ed.D., Mentor
Christopher Tienken, Ed.D.
Erin Krupa, Ph.D.
Heather Jackson, Ed.D.

Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Educational Leadership

Seton Hall University
2014

SETON HALL UNIVERSITY
COLLEGE OF EDUCATION AND HUMAN SERVICES
OFFICE OF GRADUATE STUDIES

APPROVAL FOR SUCCESSFUL DEFENSE

Doctoral Candidate, **Tina L. Powell,** has successfully defended and made the required modifications to the text of the doctoral dissertation for the **Ed.D.** during this **Spring Semester 2014**.

DISSERTATION COMMITTEE
(please sign and date beside your name)

Mentor:
Dr. Gerard Babo 2/25/14

Committee Member:
Dr. Christopher Tienken 2/25/14

Committee Member:
Dr. Erin Krupa Erin E. Krupa 2/25/14

Committee Member:
Dr. Heather Jackson Heather Jackson 2/25/14

The mentor and any other committee members who wish to review revisions will sign and date this document only when revisions have been completed. Please return this form to the Office of Graduate Studies, where it will be placed in the candidate's file and submit a copy with your final dissertation to be bound as page number two.

ABSTRACT

This study examined the differences between the achievement effects of one proposed Common Core State Standards-aligned mathematics program, Math in Focus: Singapore Math, and one NCTM-aligned mathematics program, Everyday Mathematics, on Grade 5 mathematics performance. An explanatory non-experimental research design was employed using post hoc pre- and post-treatment data from 2010 NJ ASK3 and 2012 NJ ASK5 administrations, respectively. The study examined the achievement outcomes of 205 Grade 5 general education students across several independent variables (race/ethnicity, gender, SES, attendance). Statistical analyses revealed fairly consistent results regarding differences in student performance on the 2012 NJ ASK5 in schools implementing Singapore Math and in schools implementing Everyday Mathematics. Generally, across all analyses, there were no substantial differences in performance based upon treatment status. Similarly, there were no patterns of differential treatment effects across the dimensions of race/ethnicity, gender, and SES. Overall, treatment was found to be the weakest predictor of student performance, whereas student background characteristics (race/ethnicity and SES), and attendance accounted for the greatest proportion of variation in the performance of certain subgroups.

ACKNOWLEDGMENTS

I am thankful for the extraordinary support embodied within my network of family, friends, cohort-mates, and colleagues. This has been an extraordinary undertaking, and I must take this opportunity to acknowledge those individuals who willingly became my travel mates at varying points in this journey:

Dr. Gerard Babo, you were the ultimate “coach” during this entire process, representing a healthy balance of encouragement, reassurance, prodding, critique, and approbation. I admire your attention to detail, your vast knowledge of statistical methods, your professionalism and responsiveness. It was, undeniably, those qualities that *got me through* this process.

Dr. Christopher Tienken, you inspired an entire cohort of present and future “influencers” of policy to “think critically,”--to never be swayed by rhetoric and trends but instead to ask the tough and often unfashionable questions. It was to this standard that I engaged in this study. I am pleased that this study, as did our coursework, ends not with a period of conclusiveness, but with a question mark of future prospect. There is so much more to come from all whom you have inspired.

Dr. Krupa and Dr. Jackson, throughout this entire process, you helped me solidify my thinking to produce a comprehensive, cohesive, and scholarly research study. You offered suggestions and perspectives that encouraged me to explore bodies of work that helped not only in writing my dissertation but also in other arenas of my professional life. Thank you.

Anthony Brown, Dr. Carlos Lee, and Naseed Gifted, you define friendship. You wanted completion for me as much as I did, often sacrificing your own schedules to ensure that I had the support I needed.

And finally, I must acknowledge my Cohort XIV family. We will always be connected by the cohesive bonds of shared effort, support, and the scholarly kinship conceptualized in Dr. Caufield's model for this program. The analogy of the giant redwoods of Sequoia National Park comes to mind. The redwoods' interlocking root system supports and sustains the trees under the surface, providing strength, longevity, and height. Our paths will cross again either in our casual interactions, through career endeavors, or when we're reading journals that feature the work of our cohort-mates. Either way, I'll see you soon!

Thank you to all.

DEDICATION

Sixty thousand two hundred and one words . . . and I dedicate every single one to James and Jerry Powell, my parents.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF EQUATIONS

CHAPTER I

INTRODUCTION

Background of the Study

Science, technology, engineering, and mathematics fields (STEM fields) have been a strong focus of recent education reform efforts. The National Academies, in its congressionally prompted study of America's global competitiveness, *Rising above the Gathering Storm* (National Research Council [NRC], 2007), attributes as much as 85% of measured U.S. income per capita growth to technological change (NRC, 2007). In 2007, the Department of Labor issued its landmark report, The STEM Workforce Challenge, as a call to inspire long-term, concerted efforts towards increasing the "supply and quality of 'knowledge workers' whose specialized skills enable them to work productively within the STEM industries and occupations" (p. 5). Under the U.S. Department of Education's American Recovery and Reinvestment Act (ARRA) of 2009, $4.35 billion was allocated to "education innovation and reform" (USDOE, p. 2) in competitive Race to the Top grant funding. The grant encourages and rewards states for effecting "high-quality plan[s] to address the need to offer rigorous course[s] of study in mathematics, the sciences, technology, and engineering [in cooperation with] STEM-capable community partners . . . " (p. 4). The grant aspires to increase the proportions of students taking courses in STEM fields and at their advanced levels.

Beyond ensuring that U.S. students are adequately prepared for college and the workplace, current educational reform policies and efforts in the United States encourage states to address the academic challenges of historically underrepresented groups:

disadvantaged, minority, and high-poverty populations of students (National Science Board [NSB], 2010a; NRC, 2011; USDOE, 2009).

National data support a well-founded focus on the educational opportunities of disadvantaged groups. According to the NSB's (2012) reporting of NAEP data available from 1990 through 2009, higher proportions of White and Asian/Pacific Islander students scored at or above the basic and proficient levels compared with Black, Hispanic, and American Indian/Alaskan Native students and students from lower income families at each assessed grade level in mathematics. Overall, Black students represented the lowest performing subgroup, having the fewest number of students scoring at or above the basic level and at or above the proficient level. Special analyses conducted by the National Center for Education Statistics (NCES) in 2009 and 2011 showed that Black and Hispanic students trailed their White peers by an average of more than 20 test-score points on the NAEP in mathematics at Grades 4 and 8, representing a difference of roughly two grade levels (NCES, 2009, 2011).

These findings are consistent with high school graduation attainment data comparing student population groups: Black/White, Hispanic/White, and high-poverty/low-poverty. Recent changes to federal regulations require states to hold districts accountable for the high school graduation rates of students in various subgroups (race/ethnicity, language, poverty, and disability). According to the Editorial Projects in Education Research Center's annual *Diplomas Count* (2011) report, while each major racial and ethnic group had more students graduate as of the class of 2008, massive gaps continue to persist between the different subgroups. "[Whereas] 82.7% of Asian students and 78.4% of White students in the class of 2008 graduated on time, the same was the case for only 57.6% of Hispanic, 57% of Black and 53.9% of American Indian students" (Achievement Gap, 2011, para. 6). In addition, while high school mathematics achievement data reflect an upward trend (NCES, 2009), the 2010 ACT report of all 11th grade students who took the ACT as part of their statewide assessment program found the percentage of students meeting or exceeding the College Readiness Benchmark in Mathematics to be between 33% and 42% for each category of the standard (Number & Quantity, Algebra, Geometry, Functions, Statistics and Probability); the range for African American and Hispanic students was between 8% and 22% and 16% and 32%, respectively. According to the NCES (2009) data, white and Asian American students are at least twice as likely to take mathematics classes considered academically rigorous than Black and Hispanic students. Of the total number of high school seniors planning to attend college, only 6% of Black and 8% of Hispanic students had participated in rigorous courses (e.g., precalculus) in 2009 (NCES, 2009).

As racial/ethnic disparities in performance continue to gain national attention as a major impediment to U.S. competitiveness, U.S. policy goals are becoming increasingly directed toward broad-based educational reform efforts around standards and assessments. One such effort resulted in the development of a common set of standards for mathematics and English.

In 2009, a group of 48 states, led by the National Governors Association's (NGA) Center for Best Practices and the Council of Chief State School Officers (CCSSO), developed the Common Core State Standards Initiative (CCSSO/NGA, 2009). Beginning with the formative years of elementary instruction, the Common Core State Standards

(CCSS) outline a body of knowledge, skills, and fluencies students must master at each grade level to graduate from high school "college and career ready" in the 21st century.

The standards seek to (1) clarify what students are expected to learn in each grade, (2) permit cross-state comparisons, and (3) improve student achievement by increasing the rigor of coursework required to meet the standards (Fine, 2010). According to a recent survey, the majority of the states and districts adopting the Common Core State Standards plan to adopt new curriculum materials, assessments, instructional practices, teacher induction and professional development programs, and teacher evaluation systems based on the standards (Kober & Rentner, 2011).

Theoretical Framework

Given the central role that curriculum materials play in teaching and learning, it stands to reason that differences across curricula can lead to differences in student achievement. This study looks at two mathematics programs that differ pedagogically with regards to content, organization, and the treatment of topics.

Developing an authentic understanding of mathematics–thinking conceptually, not just procedurally; using logical reasoning and common sense to find mathematical solutions; using experimental thinking; taking risks and accepting failure as part of the learning process (Conley, 2003); and applying formulas and algorithms of computation– is the ultimate objective of mathematics instruction as students are expected to move sensibly between everyday problems and mathematical formulations.

The development of number concepts has long been seen as the core of many mathematics programs for young children. "Number concepts are the foundation that children must have in order to achieve high standards in mathematics as a whole"

(Richardson, 2012 p. xii). In its utility for describing quantities and relationships, for representing numerical ideas, and for collecting information about the world in which we live, a foundation in number sense ultimately impacts every other succeeding area of mathematics instruction. This deep understanding of number concepts and relationships does not develop quickly. Raising achievement in mathematics in ways that allow children to build on what they know underscores the importance of children's understanding of number. This thinking has been codified in the Common Core State Standards for Mathematics (CCSSM) (Common Core State Standards Writing Team, 2011).

Because this study intends to reveal how the implementation of two elementary mathematics programs aligned to different sets of standards and having pedagogically different approaches relates to students' acquisition of mathematics skills and understandings, it is important to know not only the factors that make a difference in the early grades, above and beyond intelligence and other abilities, but also the characteristic differences between elementary mathematics programs that potentially impact cognitive growth and development in early mathematics.

Statement of the Problem

The recent movement toward using scientifically or empirically-based research in education since the No Child Left Behind (NCLB) Act of 2001 (U.S. Department of Education, 2002) has yielded a growing emphasis for providing evidence of what works in schools and school districts (Dynarski, Clarke, Cobb, Finn, Rumberger, & Smink, 2008; Slavin, 2008). However, while the curriculum market is diverse, "in the case of elementary mathematics, for example, the What Works Clearinghouse (WWC) has identified over 70 different curriculum options" (Bhatt & Koedel, 2012, p. 392), there are few rigorous, empirical evaluations of curricular effectiveness.

Currently, of the abundance of available elementary mathematics programs, only a small number dominate elementary math instruction, many of which were developed to align to The National Council of Teachers of Mathematics (NCTM) standards (1989, 2000). According to a 2008 survey, these curricula continue to dominate market share, representing 91% of curricula used by K-2 educators (Resnick, Saliso, & Oda, 2010). Still, little rigorous evidence exists to support one approach over another, thereby providing educators little useful information about choosing one mathematics curriculum over another.

Within the state of New Jersey and at the time of this study, the vast majority of elementary and secondary teachers of mathematics were aligning their instructional practices to the New Jersey Core Curriculum Content Standards (NJCCCS) for mathematics (NJDOE, 1996, 2004, 2008) and have been doing so since the New Jersey State Board of Education's initial adoption of the standards in 1996. The NJCCCS for mathematics were philosophically aligned with the NCTM's Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) but went beyond the NCTM standards in a number of ways, adjusting for conditions specific to New Jersey (e.g., specifying what should be done by the end of certain grade levels, repeating strands across grade levels, and adding strands at each grade level to progress competencies along Bloom's taxonomy) (NJDOE, 2008). After the NCTM's publication of *Principles and Standards for School Mathematics* (NCTM, 2000), which replaced preceding publications, New Jersey realigned its standards; however, it retained the content of its prior release, thereby presenting no major departure from what was tested on the statewide assessments while revising, primarily, the presentation of the standards (NJDOE, 2008). The NJCCCS' adoption authorized New Jersey's district boards of education to establish standards-based curricula and instructional methodologies, thereby providing students with the constitutionally-mandated system of "thorough and efficient" public school instruction (N.J. Const. (1844) art. IV, § 7, ¶ 6 (as amended in 1875)).

In 2004, as district boards of education were mandated to ensure that curriculum, instruction, and professional development were aligned to the New Jersey standards and statewide assessments, a district, referred to in this study as the Large Northeastern Urban Public School District, embarked on a district-wide overhaul of its K-5 mathematics curriculum and implemented the Everyday Mathematics program (currently published by the Wright Group/McGraw-Hill) in its more than 60 elementary schools, using district budgets and grant dollars funded by the National Science Foundation's (NSF) Systemic Initiative Program. At that time, only 10% of all schools nationwide were using one of three commercially published programs developed under NSF funding: Everyday Mathematics, Math Trailblazers, or Investigations in Number, Data, and Space (Sconiers, Isaacs, Higgins, McBride, & Kelso, 2003). By 2008, Everyday Mathematics was the most widely used of the NSF-supported reform curricula (Slavin &Lake, 2008). In 2010, the developers of the Everyday Mathematics curriculum reported that the curriculum was used in more than 175,000 classrooms by approximately three million students. Unfortunately, evidence of its effectiveness is limited (What Works Clearinghouse [WWC], 2010). Of the 72 studies reviewed by the WWC investigating the effects of Everyday Mathematics on student performance, 71 failed to meet either the WWC's evidence standards or eligibility screens. Only one study met the evidence standards, but with reservations, finding a positive effect of the Everyday Math curriculum.

This begs the question, “How can there be limited conclusive data available for a program that dominates market share?” Bhatt et al. (2012), in their study of the curricular effectiveness of the three most popular curricula in Indiana, found the program with the highest market share to be the least effective of the three programs studied, also finding that the program did not lose market share during the state’s most recent adoption cycle. The researchers attributed this to the decision makers’ lack of knowledge around effective curricula, a practice that Chingos and Whitehurst (2012) describe as “choosing blindly” (Chingos et al., 2012, title page).

The lack of information on curricular effectiveness has become more problematic with the enactment of the Common Core State Standards. According to a recent survey, the majority of the states and districts adopting the Common Core State Standards plan to adopt new curriculum materials, assessments, instructional approaches, teacher induction and professional development programs, and teacher evaluation systems based on the standards (Kober & Rentner, 2011). Generally, curricular materials mediate the degree to which content standards influence classroom instruction. Education decision makers will need reliable evidence of curriculum effectiveness to make informed and “economically sensible” decisions around new adoptions. This and similar studies provide what Bhatt et al. refer to as “proof of concept” (Bhatt et al., 2013), demonstrating the value of smaller, well-designed studies lending to larger inquiries of curricular effectiveness and suggesting broader statewide systems for collecting longitudinal data on the instructional materials currently in use (Chingos et al., 2012).

Purpose of the Study

The primary purpose of this study was to determine how two different curricula aligned to two different sets of standards (NCTM and CCSSM) impacted fifth grade performance on the New Jersey Assessment of Skills and Knowledge. This study contributes to the larger body of research on curricular effectiveness and provides education decision makers with valid, informative, and credible data to guide their selection, development, and refinement of instructional programs.

Although many factors affect mathematics learning, one factor over which schools have more immediate control is the mathematics program chosen to be implemented by teachers (Slavin, Lake, & Groff, 2009). This sentiment is reaffirmed in the opening line of NCTM's research brief, *Selecting the Right Curriculum*, "One of the most critical decisions educational leaders make is the selection of a mathematics curriculum" (p. 1) and again in the NRC's 2004 review of curriculum evaluation data which notes that "knowing how effective a particular curriculum is, and for whom and under what conditions it is effective, represents a valuable and irreplaceable source of information for decision makers . . ." (p. 1). While many of the debates have centered on "traditional" pedagogical approaches that emphasize "teacher-led instruction where students receive step-by-step guidance for problem solving and are drilled in implementation" (Bhatt et al., 2012, p. 393) versus "reform-based" curricula that emphasize "student inquiry, real-world applications of problems, and the use of visual aids for understanding" (p. 393), this study contributes to research that views curricular effectiveness as an integrated judgment based upon of a series of independent evaluations from multiple contexts (Bhatt et al., 2012; NRC, 2004; Slavin et al., 2009) and expands its scope beyond "traditional-based" versus "reform-based" curricula comparisons. The release of publications such as the NCTM Curriculum Focal Points (2006), the National Mathematics Advisory Panel's report (2008), and the Common Core State Standards (2010), which communicate the mutually reinforcing balance between conceptual understanding, computational and procedural fluency, and problem solving skills, will cause the lines to blur when defining new and revised curricula seeking to strike that balance.

Curriculum Descriptions

This study used student performance data from the 2011-2012 school year to evaluate the curriculum effectiveness of two philosophically-dissimilar elementary school mathematics curricula, *Math in Focus: Singapore Math* (published by Houghton Mifflin Harcourt, 2010) and *Everyday Mathematics*, 3rd edition (currently published by the Wright Group/McGraw-Hill, 2007) on Grade 5 mathematics performance in the Large Northeastern Urban Public School District. One hundred Grade 5 general education students in the four district public schools denoted as Singapore Math Experimental Treatment sites and 105 Grade 5 general education students in the four district public schools denoted as Everyday Math Alternative Treatment sites comprise the qualifying samples (see Research Design/Methods).

The two curricula share similarities with regard to their emphasis on problem solving and the use of visual aids for learning, two characteristics often associated with "reform-based" instruction. Beyond the dimension of pedagogy, there are many other differences between the curricula related to the organization and structure of the programs, the treatment of topics, and the coverage of higher order topics.

Singapore Math

The Houghton Mifflin Harcourt-published *Math in Focus: Singapore Math* program is referenced as Singapore Math within this study. The program is the United States' culturally sensitive translation of the Singapore version, *My Pals Are Here! Maths*, 2nd Edition (Marshall Cavendish, 2008). The U.S. enhancements include the addition of customary measurement, a teacher's edition, a kindergarten component, enhanced technology components, differentiated resources for reteaching and enrichment, and transition components to address student deficiencies. The descriptive information for the Singapore Math program was obtained from publicly available information on the program publisher's website and the What Works Clearinghouse's (WWC) intervention report. Some of the more critical analyses regarding the structural characteristics of Singapore Math and Everyday Mathematics as cited in recent research and policy reports are captured in Table 1. The Singapore Math program is organized in a mastery framework where emphasis is distributed amongst the development of conceptual understanding, procedural fluencies, and problem solving skills (Houghton Mifflin Harcourt, 2011). The Singapore Math curriculum covers a relatively small number of topics in depth and emphasizes essential math skills recommended in the NCTM Curriculum Focal Points (NCTM, 2006), the National Mathematics Advisory Panel (2008), and the Common Core State Standards (2010), though generally introducing topics at earlier grade levels than set by Common Core State Standards[1].

---

[1] The 2010 Singapore Math program was aligned to the March 9, 2010, public draft of the CCSS for Mathematics© Copyright 2009 National Governors Association and Council of Chief State School Officers. Schools involved in the Singapore Math pilot aligned lessons, instruction, and formative assessment to the final version of the Common Core State Standards for Mathematics released June 2, 2010. Teachers were provided additional curriculum articulation documents (e.g., curriculum guides) to support alignment to the new standards.

Table 1

Differences between Everyday Mathematics and Singapore Math

Everyday Mathematics	*Singapore Math*
Emphasizes reasoning, representation, connections and problem solving, using problem-based learning methods and real-world situations	Emphasizes the development of conceptual understanding through solving structured, multistep mathematical problems
Introduces concepts broadly and integrates them into real-life situations	Tightly connects concrete and pictorial examples within its presentation of mathematical ideas to help students understand and apply mathematical abstractions
Embeds philosophies aligned to discovery- and constructivist-based approaches, encouraging students' own construction of knowledge	Embeds a balance of conceptual, computational, and strategic problem-solving skills
Deemphasizes the utilization of standard algorithms in advocacy of non-traditional methods and the "invented procedures" approach to algorithm development	Establishes a strong foundation in numbers in Grades 1-6; incorporating use of the standard algorithms (e.g., multi-digit addition, subtraction, multiplication and division) at specific grade levels
Integrates the use of calculators in the early grades to perform basic functions	Embeds heuristic strategies for solving problems (e.g., use of a diagram or model).
Arranges topics in a helix, whereby practice is distributed rather than massed; topics, to a significant degree, repeat content across grades	Specifies and bounds mathematical topics and outcomes in a sequence across grades with a spiral approach that limits topic repetition, building outward on prior content. Emphasizes within-grade proficiency and mastery of mathematical priorities

(Braams, 2003; Ginsberg et al., 2005; Hoven & Garelick, 2007; Isaacs, Carroll, & Bell, 2001; Klein, 2000; Wang & Birdwell, 2001)

The textbooks are designed to build a "deep understanding of mathematical concepts with concrete illustrations that demonstrate how abstract mathematical concepts are used to solve problems from different perspectives" (Ginsburg et al., 2005, p. xii). The Singapore Math textbooks have a consistent emphasis on problem solving and model drawing. Related topics are presented in self-contained units (massed approach), encouraging the mastery of prior content.

At present, there are no published peer-reviewed studies analyzing the impact of the Singapore Math approach on student achievement in an urban setting. The U.S. Department of Education Institute of Education Sciences, through its research arm, the WWC (2009), looked at 12 Singapore Math effectiveness studies released between 1983 and 2008, all of which were analyzed under the Middle School Math review protocol. The WWC concluded that none of the subject studies met its evidence standards. Since the studies were impossible to evaluate realistically, the WWC could not definitively qualify the methodology as effective or ineffective.

Everyday Mathematics

According to the University of Chicago's Comprehensive Summary of the Scientific Research & Evidence of Effectiveness for the Everyday Mathematics program (UCSMP, 2007), the Everyday Mathematics program is founded on three core principles:

> (a) Students acquire knowledge and skills, and develop an understanding of mathematics from their own experiences. Mathematics is more meaningful when it is rooted in real-life contexts and situations, and when children are given the opportunity to become actively involved in learning. Teachers and other adults play a very important role in providing children

> with rich and meaningful mathematical experiences. (b) Children begin school with more mathematical knowledge and intuition than previously believed. A K-6 curriculum should build on this intuitive and concrete foundation, gradually helping children gain an understanding of the abstract and symbolic and (c) Teachers, and their ability to provide excellent instruction, are the key factors in the success of any program. Previous efforts to reform mathematics instruction failed because they did not adequately consider the working lives of teachers (UCSMP, 2007, p. 5).

Of the 72 studies reviewed by the WWC (2010) investigating the effects of Everyday Mathematics on student performance, 71 failed to meet either the WWC's evidence standards or eligibility screens. Only one study met the evidence standards but "with reservations," finding a positive effect of the Everyday Math curriculum.

Slavin and Lake (2007) reviewed four studies of Everyday Mathematics that met their standards of review within their best-evidence synthesis of elementary programs in mathematics. Of the four, only one small study used a prospective matched design (Woodward & Baxter, 1997) and reported no significant differences between Everyday Mathematics and control students (ES= -0.25).

The Riordan and Noyce (2001) post-hoc study of all Massachusetts schools that had used Everyday Mathematics for two or more years, in comparison to matched schools, reported modest results (ES= 0.15) for schools using the program for 2-3 years, but reported a more significant effect size (ES= 0.35) among 19 schools that had used the program for four or more years.

Research Questions

Curricula play a vital role in educational practice, providing “a crucial link between standards and accountability measures” (NRC, 2004, p. 2).

This research sought to answer the question, “What is the impact of implementing a proposed CCSSM-aligned mathematics program, Singapore Math, on the mathematics achievement of Grade 5 general education students as measured by the 2012 Grade 5 NJ ASK (NJ ASK5), in comparison to the mathematics achievement of Grade 5 general education students using a NCTM-aligned elementary mathematics program, Everyday Mathematics, in the Large Northeastern Urban Public School District?” Using composite data of student performance in major categories–namely (a) overall achievement (b) gender, and (c) subgroup (as defined by the NJDOE, 2010) economically disadvantaged, White, African-American, Asian/Pacific Islander, American Indian/Native American, Hispanic, and other–yields the following subsidiary research questions:

Subsidiary Question 1

How much variance in the 2012 NJ ASK5 mean scale score can be explained by the predictor variables treatment, attendance, gender, race/ethnicity, and SES?

Subsidiary Question 2

Is there a statistically significant difference in the 2012 NJ ASK5 performance level of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment when controlling for attendance?

Subsidiary Question 3

To what extent do differences in performance exist when data are analyzed according to 2012 NJ ASK5 performance levels (Partially Proficient, Proficient, and

Advanced Proficient) and treatment status; and is there significant interaction between the performance levels and treatment?

Subsidiary Question 4

Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic); and is there significant interaction between treatment status and race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic)?

Subsidiary Question 5

How much variance in the 2012 NJ ASK5 mean scale score of Black students can be explained by the predictor variables treatment, attendance, gender, and SES?

Subsidiary Question 6

How much variance in the 2012 NJ ASK5 mean scale score of Hispanic students can be explained by the predictor variables treatment, attendance, gender, and SES?

Subsidiary Question 7

Is there a statistically significant difference in the 2012 NJ ASK5 performance of Hispanic students based on SES classification and treatment status when controlling for attendance; and is there significant interaction between treatment status and SES classification for Hispanic students when controlling for attendance?

Significance of the Study

The Large Northeastern Urban Public School District (LSD), the focus for this study, has been at the center of reform and improvement efforts in New Jersey for the better part of 12 years. The results of these efforts are significant in that the district has made substantial progress over the last few years, but it also has a long way to go before it attains the level of excellence comparable to State benchmarks and beyond.

The district is a comprehensive system that serves the entire city, with 75 public schools, 7,000 employees, and just under 40,000 students making it the largest school system in New Jersey. As of the 2010 United States Census, there were 94,542 households, 277,140 people, and 61,641 families residing in the city with a racial makeup of 52.35% African American, and 33.83% Hispanic or Latino (US Census Bureau, 2010).

At present, the district, one of the poorest in the United States, is classified by the New Jersey Department of Education (NJDOE) as being in District Factor Group (DFG) "A," the lowest, socioeconomically, of the eight groupings (NJDOE, 2004).

The city's public schools continue to be among the lowest performing statewide, even subsequent to its state government taking over management of the city's schools in 1995, this done under the presumption that improvement would follow. As of 2003, only 64% of its residents 25 years and over had graduated from high school and only 11% had a bachelor's degree or higher. Among its residents 16 to 19 years old, 10% were dropouts who had either never enrolled in school or had not graduated from high school (U.S. Census Bureau, 2010). The data become even more sobering given that 98% of the district's college enrollees need remediation before they can go on to regular credit-bearing math coursework at the local community college.

Existing research shows that the correlations between socioeconomic status and cognitive ability as measured by educational performance are often quite significant (Brooks-Gunn, Duncan, Klebanov, & Sealand, 1993; Brooks-Gunn, Guo, & Furstenberg, 1993; Gottfried, Gottfried, Bathurst, Guerin, & Parramore, 2003; Smith, Brooks-Gunn, &

Klebanov, 1997). “Significant gaps in achievement between student population groups–the Black/White, Hispanic/White, and high-poverty/low-poverty gaps—are often close to 1 standard deviation in size” (Bloom, Black, & Lipsey, 2008, p. 172). This compels district leaders to look critically at ways of ensuring that underserved low-income and minority students are equitably represented and are successful within the K-16 continuum and in seminal courses of study.

Slavin and Lake (2007) found that one such way of reducing mathematics achievement gaps and improving overall achievement is by providing “low-performing schools training and materials known to be markedly more effective than typical programs. No Child Left Behind, for example, emphasizes the use of research-proven programs to help schools meet their annual goals” (p. 3). Yet for such a strategy to be effective, “knowing how effective a particular curriculum is, and for whom and under what conditions it is effective, represents a valuable and irreplaceable source of information for decision makers . . .” (NRC, 2004, p. 1). As this study intends to interpret, compare, and summarize the achievement effects of two philosophically-dissimilar enacted mathematics programs, it will contribute to current studies that attempt to identify the essential organization, structure, and treatment of topics in mathematics that serve as the necessary foundation for success as students progress toward more complex topics in mathematics. In a system where educational decision making is undertaken primarily at the state and local levels, state and local decision makers will need valid, informative, and credible data on curricular effectiveness. The results from this study could inform the district’s central administration of the potential impact of mathematics programs on student performance and teacher practice, particularly in urban environments where reducing achievement gaps and improving mathematics achievement are often district-wide priorities.

Research Design/Methods

This investigation employed an explanatory non-experimental research design using post hoc pre- and post-test data from 2010 NJ ASK3 and 2012 NJ ASK5 administrations, respectively. The study compared the mean mathematics scale scores for sample populations on the 2012 NJ ASK5 and used 2010 NJ ASK3 scores to analyze pre-treatment performance. Attention is given to various subgroups of general education students within the study. The analyses are performed at the treatment level throughout. The participants in this study were a group of Grade 5 students during the 2011-2012 school year from select schools within the Large Northeastern Urban Public School District. As third grade students in 2009-2010, and presumably years prior, both groups (Singapore Math Experimental Treatment and Everyday Math Alternative Treatment) received math instruction using the NCTM-aligned program, Everyday Mathematics. The Everyday Mathematics program was first used in all of the schools within the district in the fall of 2004. Table 2 provides treatment level data (*attendance*, *SES*, *race/ethnicity*, and performance). The measure of achievement is the New Jersey Assessment of Skills and Knowledge (NJ ASK). The NJ ASK is a standards-based, criterion-referenced test administered in mathematics and language arts, and is administered in Grades 3-8. The mathematics portion of the NJ ASK assesses student skills in four content clusters: (1) Number and Numerical Operations; (2) Geometry and Measurement; (3) Patterns and Algebra; (4) Data Analysis, Probability, and Discrete Mathematics; and one cluster assessing the Mathematical Processes. During the 2010-

2011 and 2011-2012 school years, the experimental treatment sites implemented the Singapore Math program in all K-5 classrooms. During the same span of years, the alternative treatment sites continued using the Everyday Mathematics program in all of its K-5 classrooms.

Table 2

Treatment Level Data

	Everyday Math	Singapore Math
N (Students)	105	100
Attendance Rate	95.92	94.58
Percent free/reduced lunch	86.7	85.0
Percent Male	41.9	39.0
Percent Female	58.1	61.0
Percent Black	47.6	51.0
Percent Hispanic	38.1	37.0
Percent White	13.3	11.0
Percent Other	1.0	1.0
Percent Proficient-NJ ASK3	74.3	66.0
Percent Proficient-NJ ASK5	85.7	71.0

Researcher Bias

At the time of the study, I was employed in the same district in which the study took place as the district's K-12 Director of Mathematics. My responsibilities included the review, implementation, monitoring, and evaluation of all existing mathematics curricula used within the district, thereby placing me in direct contact with all school administrators and teachers in both the experimental and alternative treatment schools. Beyond the district-wide, needs-driven professional development offered to the entire district throughout each school year, I coordinated ongoing on-site and off-site professional development to the experimental treatment sites for teachers, administrators, and school-based professional development teams to support the 2010-2011 and 2011-2012 implementation of the Singapore Math program. Professional development in year one of the Singapore Math pilot provided teachers with in-depth, hands-on experiences with the program.

Grade level workshops introduced participants to the philosophy, components, mathematics content, and pedagogy of the Singapore Math curriculum. Participants worked with the fundamentals of the program, learning the essential math concepts at their grade level. Special emphasis was placed on the structure of each lesson, alignment to the Common Core State Standards for mathematics, and anticipating the obstacles that might occur when teaching the Singapore Math pedagogy.

Professional development in year two of the pilot built on the first year's trainings and emphasized job-embedded practices presented in three professional development formats: coaching, demonstration lessons, and lesson studies. Emerging research shows that professional development training has the highest impact on classroom practice when it is supported with demonstration lessons and classroom coaching (Ai & Rivera, 2003; Neufeld & Roper, 2003; Poglinco et al., 2003). Whereas this study did not control for variables relating to teacher quality, teacher knowledge of mathematics, or their varying levels of professional development, the professional development providers and the district's existing classroom monitoring and accountability systems sought to support implementation of curricula in all district schools in ways consistent with typical district practices.

Limitations

In this study, groups were not assigned through the mechanism of randomization. Samples were selected from already existing populations. The study used eight intact, matched comparison groups considered similar as the experimental treatment and alternative treatment groups. The Everyday Mathematics alternative treatment sites had been using iterations of the program as their core curriculum since district-wide adoption in school year 2004-2005. The four experimental treatment sites using the Singapore Math program as their core program had been doing so since school year 2010-2011.

This study did not control for the additional variables relating to teacher affect, teacher quality, teachers' knowledge of mathematics, or the varying levels of professional development related to mathematics instructional topics. There are no formal observations data of classroom instruction related specifically to the level of implementation for either treatment group; and while the district did not mandate a minimum or maximum level of implementation, the professional development providers and the district's existing classroom monitoring and accountability systems sought to support implementation in ways consistent with typical district practices.

While reading level may contribute to variances observed (Sconiers et al., 2002), this study did not control for reading level.

This study did not control for additional variables relating to the impact of student intelligence beyond prior mathematics achievement. According to Embretson (1995), general intelligence, described as the ability to think logically and systematically, is the best individual predictor of achievement across academic domains, including mathematics (Deary, Strand, Smith, & Fernandes, 2007; Jensen, 1998; Stevenson, Parker, Wilkinson, Hegion, & Fish, 1976; Taub, Floyd, Keith, & McGrew, 2008; Walberg, 1984). In a five-year prospective study of more than 70,000 students, Geary (2011) found that general intelligence, assessed at age 11 years, explained nearly 60% of the variation on national mathematics tests when assessed at age 16 years. Despite the high heritability of intelligence and the correlation between intelligence and mathematics achievement (Kovas, Harlaar, Petrill, & Plomin, 2005), "findings such as these do not indicate educational interventions will not affect academic outcomes" (Geary, p. 1540).

There is a two-year difference between the pre-test assessment and the post-test assessment. While normal maturation could account for gains over the two-year period, summative evaluations used in examining curricular effectiveness for curricula that are "discontinuous with traditional practice, [require that care] be taken to ensure that adequate commitment and capacity exists for successful implementation as change" (NRC, 2004, p. 61). It can take "up to three years for a dramatic curricular change to be reliably implemented in schools" (p. 61).

While it is a common practice to measure students' performance over a period of time or to analyze the trend of a subject in a particular grade over different years (Leung, 2003), the NJDOE does not claim that the NJ ASK assessments are vertically equated; cautioning schools and districts to use the NJ ASK results "along with other indicators of student progress, to identify those students who may need instructional support in any of the content areas" (NJDOE, p. 3). Therefore, cross-grade comparisons cannot be made (NJDOE, 2011, 2013).

Although each of the participating schools is required by the district to provide math instruction a minimum of five days per week and for a minimum of 50 minutes each day (District File code: 6156 instructional planning/scheduling), this study did not address actual "seat time" extending beyond the 50-minute mandate.

At the time of this study, the NJ ASK tests were aligned to New Jersey State's Core Curriculum Content Standards[2] (NJCCCS). Since the NJCCCS for mathematics were philosophically aligned with the NCTM standards (1989, 2000), as is the Everyday Mathematics program, the Everyday Math Alternative Treatment group have a presumed degree of advantage over the Singapore Math Experimental Treatment group.

A final limitation of the study reflects the relatively small sample size, which potentially impacts statistical power, type II error, and statistical significance (Cohen, 1988). High levels of student mobility and restricting the analysis to in-district Grade 5 general education students who were administered both the 2010 NJ ASK3 and the 2012 NJ ASK5 at their respective sites reduced the qualifying sample sizes by 14.7% - 28.7%. Restricting the sample leaves a total sample size of 205 students. For this reason it may not be possible to make generalizations about the findings to the broader community based on this study alone.

[2] The 2012-2013 NJ ASK (Grades 3-5) measured the CCSS within the current NJ ASK blueprint. The 2013-2014 NJ ASK (Grades 3-8) will measure the CCSS within the NJ ASK blueprint.

Delimitations

The scope of this study is the comparison of two elementary mathematics instructional programs, Singapore Math and Everyday Mathematics, and the analysis of the differences among NJ ASK mean scale scores for Grade 5 general education[3] students in regular education classroom settings. The study delimited the population to general education students who, at the time of the administration of the NJ ASK3 and NJ ASK5, were not identified as (a) having less than one year in the school district (b) special education[4] classified (b) Limited English Proficient[5] classified (d) taking the Spanish version of the NJ ASK3 for mathematics, (e) having less than one year in the school, (f) out-of-district placement, and (g) out-of-residency placement. The study further delimited the sample population to students who were administered both the 2010 NJ ASK3 and the 2012 NJ ASK5 at their respective sites.

The analyses of individual clusters were not included in the design due to the reported 2012 NJ ASK5 reliability coefficient alphas with ranges from .41 - .78 per cluster (NJDOE, 2013).

---

[3] General education students received no special testing accommodations during NJ ASK administration (NJDOE, 2011, 2013).

[4] Students with Disabilities not exempted from taking the NJ ASK can be tested with accommodations (in setting and/or scheduling) and/or modifications (in testing materials and/or testing procedures) as specified by their Individualized Education Programs (IEP) or 504 plans (NJDOE, 2011, 2013).

[5] Limited English Proficient students who do not take the Spanish form of the NJ ASK can be tested with accommodations (e.g. 150% additional administration time, translation of directions in student's native tongue, and/or use of a bilingual dictionary) (NJDOE, 2011, 2013).

Definition of Terms

Alignment – Curriculum Alignment is an agreement of what is written, taught, and tested and reflects a mapping of the curricular objectives addressed in the materials to the national, state, or local standards or curricular frameworks. See definitions for CCSS-aligned NJCCCS-aligned that follow. Based on a review of literature (La Marca, Redfield, & Winter, 2000), several dimensions of alignment have been identified. The two overarching dimensions are content match and depth match. Content match refers to topical correspondence, while depth alignment refers to the match between the cognitive complexity of the knowledge/skill prescribed by the standards (Webb 1997, 1999).

College and Career Readiness – The level of preparation a student needs in order to enroll and succeed—without remediation—in a credit-bearing course at a postsecondary institution that offers a baccalaureate degree or transfer to a baccalaureate program, or into a high-quality certificate program that enables students to enter a career pathway with potential future advancement (Conley, 2007).

Common Core State Standards – The Common Core State Standards (CCSS) outline a body of knowledge, skills, and fluencies students must master at each grade level to graduate from high school "college and career ready" in the 21st century.

Common Core State Standards-Aligned (CCSS-aligned) – The K–8 Publishers' Criteria for the Common Core State Standards for Mathematics outlines a set of 10 criteria centered on focus, coherence, and rigor as the main themes that serve to inform purchases and adoption of, and modifications to, new and existing published resources. The criteria can be used to "test claims of alignment" (Daro, McCallum, & Zimba, 2012, p. 6).

Curriculum – Curriculum, in this study, is used to refer to a set of materials for use at each grade level. It generally includes accompanying ancillary materials (e.g., teacher's guides, resources for differentiation, homework, assessments, materials for parents, and so forth). The materials include recommendations for pacing of lessons and the sequencing of topics. Within this study, the term is used interchangeably, where fitting, with "program.'"

District Factor Grouping (DFG) – A system for ranking New Jersey school districts by their socioeconomic status (SES). Introduced by the NJDOE in 1975 based on 1970 Census data, identified groupings are periodically updated, taking into account new Census data. The most recent revision took place in 2004, using the 2000 Census. From lowest socioeconomic status to highest, the categories are A, B, CD, DE, FG, GH, I, and J (New Jersey Department of Education, 2004).

Enacted Curriculum – The actual curricular content in which students engage in the classroom. The enacted curriculum highlights the content that students have the opportunity to learn.

Ethnicity – A student's racial designation as reported to the State of New Jersey based on information gathered upon student registration in a school district. New Jersey School Report Cards include the designations White, Black, Asian/Pacific Islander, American Indian/Alaska Native, Hispanic, and Other.

Everyday Mathematics Program – Originally developed in 1985, Everyday Mathematics is a Kindergarten through Grade 6 mathematics curriculum developed by the University of Chicago School Mathematics Project. It was based on principles typical of NSF-supported reform curricula; and its design, generally, is reflective of constructivist theories of learning (Steffe & Cobb, 1988; Steffe & Gale, 1995). The Everyday Mathematics program reflects alternative perspectives to teaching, asserting that students are capable of inventing and applying their own efficient procedures (Kamii & Domenick, 1998), and encourages the delay of introducing formal algorithms, fearing delays in the development of number sense and problem solving skills.

General Education – Students not included as LEP or special education in the reporting of NJ ASK assessment data.

Large Northeastern Urban Public School District Regions – As a part of the 2009 reorganization, oversight for the district's geographical areas was divided according to regions – North, South, East/Central and West. Theoretically, the reorganization allowed more support to students by bringing resources closer to the schools through the four regional offices. Each regional office is led by a Regional Superintendent. High Schools were merged with the elementary feeder schools to encourage a K-12 articulation.

Limited English Proficient (LEP) – In New Jersey, Limited English Proficient students are those whose performance on an approved test of listening, speaking, reading, and writing of English identifies them as needing additional, specialized English instruction from an appropriately certificated teacher.

National Assessment of Educational Progress (NAEP) – Also known as “The Nation’s Report Card,” the NAEP has charted U.S. student performance for the past three decades (Campbell, Hombo, & Mazzeo, 2000) and is the only nationally representative, continuing assessment of what students know and can do in a variety of academic subjects, including reading, writing, civics, science, and mathematics in Grades 4, 8, and 12 (National Science Board, 2004). The NAEP’s mathematics framework contains five broad content strands (number sense; properties and operations; measurement; geometry and special sense; data analysis, statistics, and probability; and algebra and functions). The assessment also tests mathematics abilities (conceptual understanding, procedural knowledge, and problem solving, and mathematics power (reasoning, connections and communication).

New Jersey Assessment of Skills and Knowledge (NJ ASK) – The NJ ASK tests are a series of state assessments aligned to the New Jersey Core Curriculum Content Standards and are administered to New Jersey public school students in Grades 3-8 to determine the level of student achievement in language arts, mathematics, and science. The NJ ASK tests were implemented in 2003 in response to the requirements of NCLB legislation. The assessment is a standardized test given to all New Jersey public school students in grades 3-8 during March, April, and/or May and is administered by the New Jersey Department of Education.

New Jersey Core Curriculum Content Standards (NJCCCS) – The New Jersey Core Curriculum Content Standards[6] (NJDOE, 1996, 2004, 2008) were originally adopted in 1996 in an effort to define what students should know and be able to do at the end of their K-12 public school education. The Standards seek to articulate the important knowledge and skills all students should master (New Jersey Department of Education, 2008a).

New Jersey Core Curriculum Content Standards–Aligned (NJCCCS-aligned) – Those textbooks, curricula, philosophies, and instructional methodologies mapped to curricular objectives addressed in the New Jersey Core Curriculum Content Standards (NJDOE, 1996, 2004, 2008) and its accompanying curricular frameworks.

---

[6] The 2012-2013 NJ ASK (grades 3-5) measured the CCSS within the current NJ ASK blueprint. The 2013-2014 NJ ASK (grades 3-8) will measure the CCSS within the NJ ASK blueprint.

No Child Left Behind (NCLB) – Public Law 107-1 10 passed by the U.S. Congress and signed into law on January 8, 2002. The No Child Left Behind Act of 2001 (U.S. Department of Education, 2002) was originally put forth by President George W. Bush on January 21, 2001. The law reauthorized the Elementary and Secondary Education Act of 1965.

Race to the Top – The American Reinvestment and Recovery Act provides $4.35 billion for the Race to the Top Fund, a competitive grant program designed to reward states that create conditions for education innovation and reform, achieve significant improvement in student outcomes, and implement ambitious plans in core areas of education reform (standards, instruction, assessment, data, teacher/principal recruitment, retention, evaluation, and school turnaround).

Singapore Math Program – The Houghton Mifflin Harcourt-published *Math in Focus: Singapore Math* program is referenced as Singapore Math within this study. The Singapore Math program is a kindergarten through eighth grade mathematics instructional curriculum developed by Marshall Cavendish/Singapore Ministry of Education. The program is organized in a mastery framework in which emphasis is distributed among the development of conceptual understanding, procedural fluencies, and problem-solving skills (Houghton Mifflin Harcourt Specialized Curriculum Common Core Overview, 2011).

Socioeconomic Status (SES) – A student's socioeconomic status is defined as economically disadvantaged or non-economically disadvantaged under New Jersey Department of Education guidelines. Economically disadvantaged is the status attributed to a student qualifying for free or reduced-price lunch and is based upon family income level, parents' educational attainment, and parents' occupation as defined by the U.S. government under the National School Lunch Program (NLSP).

Students with Disabilities – A broadly defined group of students with physical and/or mental impairments such as blindness or learning disabilities that might make it more difficult for them to do well on assessments without accommodations or adaptations. Students with disabilities are protected under the Individuals with Disabilities Education Act (IDEA), a federal law that ensures public schools serve the educational needs of students with disabilities. IDEA requires that schools provide special education services to eligible students as outlined in a student's Individualized Education Program (IEP).

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

A broad literature search was conducted in an attempt to locate literature that (1) provides the historical background for my research, (2) positions this work within its related and current context, (3) informs relevant theories and concepts underpinning my research, (4) illustrates how this research challenges, expands, or addresses gaps within the current bodies of related work, and (5) underlines the significance of the bodies of work relating to the problem presented (Ridley, 2008). This included obtaining reviews of mathematics programs, searches of educational databases (JSTOR, ERIC, EBSCO, Dissertation Abstracts), and examinations of peer-reviewed journals, edited volumes, government reports, web-based repositories, and mathematics education publishers' websites.

Chapter II begins with an examination of the two historically significant sets of mathematics standards that influenced the development and refinement of the curricula evaluated in this study–the National Council of Teachers of Mathematics (NCTM) standards and the Common Core State Standards for mathematics (CCSSM). The NCTM standards (1989, 2000), the predecessor of the two, presented opportunities for systemic improvement in mathematics education in the United States and influenced new curriculum projects and changes to existing state standards. The CCSSM, emerging roughly 20 years later, built on the work of the NCTM standards (2006) to define a kindergarten through high school progression and promote college and career readiness. As research supports that success in mathematics, particularly at the higher levels, yields college and career options, and increases prospects for future income (Bozick, Ingels, & Owings, 2008; Carnevale & Desrochers, 2003; Cuoco, Goldenberg, & Mark, 1997; Gamoran & Hannegan, 2000; Rose & Betts, 2001), Chapter II includes research on algebraic readiness (a specific aim of the CCSSM) as a pre-determinant of college and career readiness and the additional high priority content in the elementary and secondary grades that converges to a study of "a full body of algebraic material" (NMAP, 2008, p. xvii). Cognitive development is then discussed as it relates to the specific mathematical competencies that have been found to have a sustained impact on mathematical understandings. The development of effective strategies for improving the educational trajectory of early math learners is contingent on identifying areas of early quantitative knowledge that influence later mathematics achievement (Duncan et al., 2007; Geary, 2011; Jordan, Kaplan, Ramineni, & Locuniak, 2009; Locuniak & Jordan, 2008). Because this study intends to reveal how the implementation of elementary school mathematics curricula is related to mathematics skill acquisition, it is important to know not only the factors that make a difference in the early grades above and beyond intelligence and other abilities, but also the defining characteristics of programs introduced in the elementary grades that consistently result in sustained cognitive growth in mathematics. A portion of the Review of Literature is devoted to curriculum effectiveness studies, particularly those that are current and seminal in the field of curriculum effectiveness, and then outlines current findings relating specifically to the mathematics programs explored in this study and their documented impact on student achievement. Chapter II concludes with a discussion of the variables that have, historically, linked significantly to mathematics performance (gender, SES, race/ethnicity, and attendance).

Evolution of the NCTM Standards

The release of the controversial documents *Agenda for Action* in 1980 and *A Nation at Risk* in 1983 focused media attention on educational policy, particularly the status of mathematics education in American schools (Dindyal, 2009) and contributed to the perceptions that the United States is failing its students. *A Nation at Risk* (1983) presented concerns about the state of U.S. public education and challenged the U.S.'s status of preeminence in commerce, industry, science, and technological innovation. The report declared that minimum-competency exams had "become the maximum thus lowering educational standards for all" (p. 63) and recommended that "high school graduation requirements be strengthened" (p. 70). Consequently, high school exit exams gained popularity among employers and policymakers as a means of ensuring that students who received high school diplomas had mastered basic skills in reading, writing, and mathematics (Amrein & Berliner, 2002; Dorn, 2003; Thurlow & Esler, 2000). *Educating Americans for the 21st Century* (1983) called for local districts to "revise their elementary school schedules to provide consistent and sustained attention to mathematics, science, and technology" (The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, 1983, p. x). In 1991, the Secretary's Commission on Achieving Necessary Skills (SCANS, 1991) echoed these concerns; asking schools to "determine new standards, curricula, teaching methods, and materials" (p. 16) for teaching the core subjects (history, geography, science, English, and mathematics).

In 1994, following President George H. W. Bush's 1989 Educate Summit Conference, The Goals 2000: Educate America Act (P.L. 103-227) was signed by Congress, marking a shift from state to federal control of educational standards. The legislation required increased outcome-based measures of accountability for public education. As noted by Horn (2005), the result was a set of "voluntary" national standards for all core content areas, "expanded graduation requirements and, more recently, a stringent system of institutional checks and consequences, outlined by the 2001 NCLB legislation" (p. 5).

Concurrently emerging during this time was a renewed interest in cognitive theories and social aspects of learning, thereby paving the way for more qualitative, student-centered, inquiry-based approaches in mathematics education. Constructivism, as presented by Confrey and Kazak (2006), "served as a means of prying mathematics education from its sole identification with the formal structure of mathematics as the sole guide to curricular scope and sequence. It created a means to examine that mathematics from a new perspective, the eyes, mind and hands of the child" (p. 306).

Constructivism evolved and became, in practice, a way of addressing "students' weak conceptual understanding with over-developed procedures and students demonstrated difficulties with recall and transfer to new tasks" (NRC, p. 306).

Constructivism focused teaching, more so, on the active involvement and participation of children and the strengths and resources they brought to the tasks. In practice, it rejected prior theories that placed emphasis on set language, properties, proofs, and abstractions that characterized the "New Math" era of the 1960s and further deemphasized arithmetic computation, rote memorization of algorithms and basic arithmetic facts–competencies that characterized the “Back to Basics” movements of the late 1970s and early 1980s. Favored by The National Council of Teachers of Mathematics (NCTM), constructivist thinking established the context for the emergence of the Curriculum and Evaluation Standards for School Mathematics (1989) (which will be referred to as the NCTM Standards).

The 1989 NCTM Standards codified what had been outlined in the Council’s earlier policy release, *An Agenda for Action* (1980). The standards, “viewed as a promising new approach for translating and infusing research results into classroom practice” (NRC, 2004, p. 12), (a) shifted teaching toward new child-centered, minimal guidance approaches, (b) placed problem solving at the forefront of mathematics instruction, (c) eschewed any practices that could potentially hinder access to problem solving (e.g., paper-pencil calculations for numbers with more than 2 digits, mastery of basic skills, emphasis on standard algorithms), and (d) supported practices that would make problem solving more accessible (e.g., use of calculators and manipulatives). Advocates of the NCTM Standards were the catalysts for successive NCTM documents that set guidelines for mathematics teaching and assessment: The Professional Teaching Standards for Teaching Mathematics published in 1991 and the Assessment Standards for School Mathematics published in 1995. The NCTM’s triadic reaction slowly reformed the manner in which mathematics was taught in the United States (Ward, 2009). By 1997 the vast majority of state departments of education had adopted mathematics standards closely aligned with the NCTM standards.

The reauthorization of the NCTM standards in 2000 placed increased emphasis on critical thinking and problem solving and stimulated the development of reform-based curriculum programs. These reform programs were designed to increase students' conceptual understandings within the five content standards–numbers and operations, algebra, geometry, measurement, and data analysis and probability–and through five process standards–problem solving, reasoning and proof, communication, connections, and representation (NCTM, 2000).

As standards reform efforts gained in popularity, a number of National Science Foundation (NSF)-funded curriculum projects, aligned to the new standards, emerged. Between 1988 and 1999, three NSF-supported elementary mathematics curriculum projects were developed to promote widespread implementation of mathematics curricula reflective of the NCTM Standards: Investigations in Number, Data and Space (Technical Education Research Centers, 1998), Math Trailblazers: A Mathematical Journey Using Science and Language Arts (Institute for Mathematics and Science Education, 1999), and University of Chicago’s Everyday Mathematics (Bell et al., 1988-1996).

Between 1990 and 2007, the NSF devoted approximately $93 million to the development and revisions of thirteen mathematics curricula in an effort to accomplish their initial goal: “to stimulate the development of exemplary educational models and materials . . .” (NSF, 1989, p. 1).

Evolution of the Common Core State Standards

In 2009, under President Obama’s administration, Secretary of Education Arne Duncan tied eligibility for the four billion dollar Race to the Top program of competitive federal grants to participation in the Common Core effort. The federal government invested additional financial support to the Common Core Initiative by setting aside $350

Most like CCSSM ↑	Alabama Michigan	California Minnesota	Florida Mississippi	Georgia Oklahoma	Indiana Washington
	Idaho Utah	North Dakota	Oregon	South Dakota	Tennessee
	Alaska Massachusetts Pennsylvania	Arkansas New Mexico South Carolina	Colorado New York Texas	Delaware North Carolina Vermont	Hawaii Ohio West Virginia
Least like CCSSM	Connecticut Montana	Illinois Nebraska	Maine New Hampshire	Maryland Virginia	Missouri Wyoming
	Arizona Nevada	Iowa New Jersey	Kansas Rhode Island	Kentucky Wisconsin	Louisiana

Figure 1. Degree of Congruence between State Standards and the CCCSM

million for the Common Core State Standards' accountability measure, assessments tied to national standards (U.S. Department of Education, 2009). The aim of this bipartisan movement was to upgrade and unify elementary and secondary school standards to ensure college and career readiness, offering the benefits of shared expectations and improved focus and efficiency that would extend to other sectors of education; e.g., teacher development, the development of curricular materials, pre-service teacher education, and the delivery of quality electronic and computer-adaptive assessments (Hwang, McMaken, Porter, & Yang, 2011).

According to Hwang et al. (2011), the Common Core State Standards "represent an unprecedented shift away from the disparate content guidelines found across individual states in the areas of English language arts and mathematics" (p. 103) and present a less than modest shift away from current practice (see Figure 1).

Managed by the National Governors Association Center for Best Practices (NGA) and the Council of Chief State School Officers (CCSSO) and prompted by the United

States Department of Education and support from the Bill and Melinda Gates Foundation, by June 1, 2011, the Common Core State Standards Initiative [CCSSI], had been adopted by 44 states, the District of Columbia, and the U.S. Virgin Islands (CCSSI, 2010). The initiative represented the first significant attempt in the nation's history to systematically align common K-12 mathematics standards across the states, building upon previous efforts to create a national vision for mathematics education, including that of the National Council of Teachers of Mathematics' standards documents (NCTM, 1989, 2000, 2006).

The case for national standards can be made by the need to level academic expectations for all students. Predictably, the Common Core State Standards for Mathematics (CCSSM) will become more entrenched in state education policy and will inevitably stimulate significant and immediate revisions in state mathematics assessments, curriculum materials (Porter, McMaken, Hwang, & Yang, 2011), and eventually teacher practice.

According to Corcoran, Mosher, and Rogat (2011), the "standards-based reform movement of the last few decades attempted to shift the norms of teaching away from just delivering the content and towards taking more responsibility for helping all students at least to achieve adequate levels of performance in core subjects. Initial state-wide content standards, as they have been tied to grade levels, can be seen as a first approximation of an order in which students should learn the required content and skills" (p. 16).

However, current state standards tend to be more prescriptive than they are descriptive. They define the order in which, and the time or grade by which, students should learn specific content and skills. Typically, state standards have not been deeply rooted in empirical studies exploring the ways in which children's thinking and understanding of mathematics actually develop in interaction with instruction. "Rather they usually have been compromises derived from the disciplinary logic of mathematics itself, experience with the ways mathematics has usually been taught, as reflected in textbooks and teachers' practical wisdom, and lobbying and special pleading on behalf of influential individuals and groups arguing for inclusion of particular topics or particular ideas about 'reform' or 'the basics'" (p. 16).

Corcoran et al. (2011) emphasize that "absent a strong grounding in research on student learning, state standards tend, at best, to be lists of mathematics topics and some indication of when they should be taught grade by grade without explicit attention being paid to how those topics relate to each other" (p. 17). They advocate, instead, for a more focused approach by which students have the opportunities over time to "develop a coherent understanding of core mathematical concepts" (p. 17). Because of the cumulative nature of mathematics, "a weak curriculum can limit and constrain instruction beyond the K-12 years" (NRC, 2004, p. 13).

Schmidt et al. (1997) found that countries with more focused curriculum designs outperformed the United States on the 1995 Third International Mathematics and Science Study. Subsequent studies (Schmidt et al., 2001, 2005) drew similar conclusions, noting that higher achieving countries, later termed A+ countries (Schmidt, Wang, & McKnight, 2005), focused deliberately on fewer topics and the more rigorous cognitive domains (Darling-Hammond & McCloskey, 2008). Porter, Politkoff, and Smithson (2009) found that state standards, in general, tend to favor the coverage of "laundry lists of small topics" (p. 240).

Schmidt et al. (2005) identified three defining common characteristics exemplified throughout the national standards of the A+ countries (e.g., England, Finland, Hong Kong, Japan, and Singapore): focus, rigor, and coherence. Their recent study (2012) revealed a high degree of alignment between the CCSSM and the standards of the highest-achieving nations on the 1995 TIMSS (Schmidt et al., 2012, p. 294).

In the course of developing the CCSS, the CCSS writing team consulted numerous international models, including those from Ireland, Finland, New Zealand, Australia (by state), Canada (by province), Singapore, the United Kingdom, and others (CCSSI, 2010). Ginsburg, Leinwand, and Decker (2009) note the benefit of allowing high-performing countries to influence benchmarks, writing "the composite standards [of Hong Kong, Korea and Singapore] have a number of features that can inform an international benchmarking process for the development of K–6 mathematics standards in the United States. First, the composite standards concentrate the early learning of mathematics on the number, measurement, and geometry strands with less emphasis on data analysis and little exposure to algebra" (NGA, CCSSO, 2009, p. 2).

The CCSSM were built on progressions that bridge core mathematical topics across a number of grade levels whereby grade placements for specific topics were made "on the basis of state and international comparisons" (CCSSI, 2010b, p. 5). These progressions were informed both by research on children's cognitive development and by the logical structure of mathematics and echo the definition of coherence defined by Schmidt et al. (2005), "Standards that are articulated over time as a sequence of topics and performances that are logical and reflect, where appropriate, the sequential and hierarchical nature of the disciplinary content from which the subject matter derives" (p. 528). Further, an inherent aspect of the design of the CCSSM is that they "map back" to the K-12 grades from the college and career-ready secondary standards.

The Common Core State Standards codify a set of benchmarks, deemed "international benchmarks" (CCSSI, 2010b, p. x) designed to serve as the anchor for every state's system of high school completion assessments and graduation requirements.

Research supports that a strong grounding in high school mathematics, particularly through algebra or higher, correlates with increased career options and prospects for future income (Bozick, Ingels, & Owings, 2008; Carnevale & Desrochers, 2003; Cuoco, Goldenberg, & Mark, 1997; Gamoran & Hannegan, 2000; National Mathematics Advisory Panel, 2008; Rose & Betts, 2001).

Mathematics in the Earlier Grades

In his 1997 publication entitled *How the Mind Works,* Steven Pinker writes, "Mathematics is ruthlessly cumulative, all the way back to counting to ten" (p. 341).

The evidence concerning college and career readiness shows clearly that the knowledge, skills, and practices important for readiness include a great deal of prerequisite mathematics. As much of the highest priority content for college and career readiness comes from Grades 6–8 (Partnership for Assessment for Readiness of College and Careers [PARCC], 2011, Appendix A), the mathematics that children learn from preschool through the middle grades provides the basic foundation for algebra and more advanced mathematics coursework.

Prior to enrolling in a formal education system, “children have important, but often inchoate, pre-mathematical and general cognitive competencies and predispositions at birth or soon thereafter that support and constrain but do not absolutely direct subsequent development of mathematics knowledge” (Sarama & Clements, 2009, p. 22). Other general cognitive and meta-cognitive competencies make children, from birth, active participants in their learning and development (Clements & Sarama, 2004b).

Most children, prior to entering kindergarten, develop a considerable knowledge of numbers and other aspects of mathematics. The mathematical knowledge that children bring to school influences their math learning for many years thereafter, and probably throughout their education (NMAP, 2008).

The NMAP (2008) advises that children, by the end of Grade 5 or 6, “should have a robust sense of number. This sense of number must include an understanding of place value and the ability to compose and decompose whole numbers, a grasp of the meaning of the basic operations of addition, subtraction, multiplication, and division, the use of the commutative, associative, and distributive properties, computational facility, and the knowledge of how to apply the operations to problem solving” (p. 17).

Recent studies designed to identify the early mathematical knowledge needed to support learning through the elementary school years have found varying aspects of understanding number and quantity as a necessary foundation for success as students progress to more complex topics (Booth & Siegler, 2006; Geary, Bow-Thomas, & Yao, 1992; Ginsburg & Baroody, 2003; Jordan et al., 2009; Locuniak & Jordan, 2008; Passolunghi et al., 2007).

An understanding of number and quantity, as specific competencies, has been found to have a sustained impact on subsequent mathematical understanding beyond the early grades. The development of effective strategies for improving the educational trajectory is contingent on identifying areas of early quantitative knowledge that influence later mathematics achievement. Relevant longitudinal studies have tracked the relationship between early mathematics achievement and later achievement (Duncan et al., 2007); early quantitative knowledge and later achievement (Jordan, Kaplan, Ramineni, & Locuniak, 2009; Locuniak & Jordan, 2008); and early cognitive abilities, such as working memory, and later achievement or later performance on specific quantitative tasks (Bull, Espy, & Wiebe, 2008; Krajewski & Schneider, 2009).

National achievement data (NCES, 2009) show that elementary school students in the United States, particularly those from low socioeconomic backgrounds, have weak math skills. In fact, data show that, even before they enter elementary school, children from disadvantaged backgrounds are behind their more advantaged peers in basic competencies such as number-line ordering and magnitude comparison (Rathbun &West, 2004). Furthermore, after a year of kindergarten, disadvantaged students still have less extensive knowledge of mathematics than their more affluent peers (Denton & West, 2002).

It is important to know not only the factors that make a difference in the early grades, above and beyond intelligence and other abilities, but also the defining characteristics of mathematics programs introduced in the elementary grades that consistently result in sustained cognitive growth in early mathematics. Aforementioned results from other recent longitudinal projects (e.g., Jordan et al., 2009) indicate that the critical early quantitative competencies that children must possess to learn mathematics include an understanding of the relationship between number words, Arabic numerals, and the underlying quantities they represent, as well as skill at fluently manipulating these representations, knowledge of the mathematical number line, and basic skills in arithmetic (i.e., skilled use of counting procedures, decomposition, and fact retrieval in problem solving). The early elementary grades, therefore, become the most important level for the evaluation because early quantitative knowledge is closely associated with later achievement (Rathbun & West, 2004).

Studies of Curriculum Effect in Mathematics

Seminal Large-Scale Studies of Mathematics Curricula

The Second International Mathematics Study ([SIMS], 1987) was a large-scale, comprehensive, international survey conducted during 1981 and 1982 authorized by the International Association for the Evaluation of Educational Achievement to explore variables such as intended curriculum, opportunities to learn, and instructional practices and their possible influence on student outcomes. The study involved approximately 7,000 8th grade students (Population A: students aged 13 in most of the surveyed countries; students aged 12 in Hong Kong and Japan) and approximately 5,000 12th grade students (Population B: students enrolled in their final year of college-preparatory math courses) in roughly 20 nations around the world. The results of the study were documented in the publication *The Underachieving Curriculum: Assessing U.S. Math from an International Perspective* (McKnight et al., 1987). The SIMS assessed students on an international consensus of topics in mathematics (arithmetic, algebra, geometry, statistics, and measurement). U.S. students in Population A scored slightly above the international average in arithmetic but well below in problem solving (McKnight et al., 1987). U.S. students in Population B scored well below the international average. Japan and Hong Kong represented the highest performing nations in both groups. Beyond achievement differences, the survey revealed large differences in the math content of typical U.S. textbooks, finding that U.S. textbooks, in comparison to the higher performing nations, included a great deal of repetition and review, less rigorous topics, and more arithmetic-driven topics. The authors recommended that the United States engage in curriculum renewal that addresses both the “form and substance” (p. 15) of its elementary mathematics curriculum materials by eliminating excess repetition, refocusing the organizing of topics, and intensifying and broadening content to better prepare students for high school mathematics.

The Third International Mathematics and Science Study ([TIMSS], 1995), a more ambitious international effort assessing over 400,000 students worldwide at Grades 4, 8, and 12, provided the educational community with additional methodologies for comparison, including videotaped studies, over 200 classroom observations, and over 1,100 reviews of texts and curricula across 41 nations. On the 1995 TIMSS assessment, U.S. students scored above the international average in mathematics in grade 4 and below the international average in mathematics in Grades 8 and 12.

Similar to the SIMS, the TIMSS found the U.S. mathematics curriculum to be less focused and less advanced with a heavier focus on topics in arithmetic. The survey (renamed *Trends in International Mathematics and Science Study* in 2003) has been administered every four years since 1995 through 2011 (12th grade testing was concluded after 1995) and continues to serve as a mechanism for “identifying unforeseen weaknesses in national programs and for discovering exemplary programs that can be investigated in an effort to improve domestic teaching" (Siegal, 2006, p. 11).

In one of the largest experimental studies around early elementary curriculum effectiveness, Agodini et al. (2009) examined four commercially-available elementary mathematics curricula (1) Investigations in Number, Data, and Space (Investigations), an NSF-funded reform program; (2) Math Expressions, which blended teacher- and student-centered approaches; (3) Saxon Math (Saxon), a teacher-directed program using a more traditional approach; and (4) Scott Foresman-Addison Wesley Mathematics (SFAW), which also used a more traditional, teacher-directed approach, to determine "whether some early elementary school math curricula are more effective than others at improving student math achievement, thereby providing educators with information that may be useful for making AYP" (p. xvii). The study analyzed results based on first grade curriculum implementation during the 2006-2007 school year in the 39 cohort-one schools and first and second grade curriculum implementation in 71 additional schools that joined the study during the 2007-2008 school year. The study, using paired-comparisons, found statistically significant differences in performance, as measured by the Early Childhood Longitudinal Study-Kindergarten (ECLS-K), at the first-grade level in favor of students using the Math Expressions program. Math Expressions students scored 0.11 standard deviations higher than both Investigations and SFAW students. At the second-grade level, statistically significant differences in performance favored students using Math Expressions and Saxon. Math Expressions and Saxon students scored 0.12 and 0.17 standard deviations higher than SFAW students, respectively. No other curriculum-pair differentials were statistically significant (Agodini et al., 2009).

Bhatt et al., (2012), in their study examining which early elementary school math curricula are more effective than others at improving student math achievement in disadvantaged schools, used data from one of the few states where information on curriculum adoptions is available, Indiana, to empirically evaluate differences in performance across three elementary-mathematics curricula, two of which were Saxon and SFAW. These three curricula accounted for 86% of all curriculum adoptions in Indiana at the time of the study: Saxon Math (Saxon), Silver-Burdett Ginn (SBG) Mathematics, and Scott Foresman–Addison Wesley (SFAW). Large differences were found in effectiveness between the curricula, most notably between the two that held the largest market shares in Indiana, Saxon and SFAW. The researchers found that the average math achievement of students taught using Saxon was 0.09 standard deviations lower than that of students using SFAW. These results conflict with those found in the Agodini et al., study (2009). Key insights from their analysis were (1) that there can be large differences in effectiveness between curricula that share the same pedagogical approach, suggesting that while much attention is devoted to the debate over traditional- versus reform-based mathematics instruction, findings suggest that other differences in curriculum design are substantively important and (2) that decision makers have virtually no information about which curricula are most effective.

Seminal Meta-analytic Studies of Mathematics Curricula

Since being introduced by Gene V. Glass in 1976, and spurred by the recent movement toward the policy-making process using scientifically or evidence-based research in education since the No Child Left Behind (NCLB) Act of 2001 (U.S. Department of Education, 2002), the number of meta-analyses conducted in education has proliferated. Meta-analytic techniques have been emphasized for providing evidence of what works with regard to programs, products, practices, and policies (IES, 2013) in education in schools and school districts (Dynarski et al., 2008; Slavin, 2008).

In 2002, the NRC convened a blue-ribbon panel to review studies on the effectiveness of mathematics curriculum materials, covering all grade levels K-12. Of the 147 studies initially meeting the panel's minimum standards of quality and ranging in type (content analysis, case studies, comparative analysis, and synthesis studies), 63 quasi-experimental comparative studies were considered. The 63 studies reflected 13 NSF-funded programs (35 of which analyzed the Everyday Mathematics program), and 6 commercially generated mathematics programs. The authors of the NRC (2004) found that 59% of the NSF-supported programs had significantly positive effects, 6% had significantly negative effects, and 35% found no differences. Most of these studies involved elementary and secondary programs of the University of Chicago School Mathematics Project. Of the commercial, non-NSF-supported programs, the corresponding percentages were 29%, 13%, and 59%, thereby suggesting that NSF-funded programs had better outcomes. However, because none of the studies embedded a content analysis conducted by mathematics educators and mathematicians, the NRC chose not to describe the outcomes it found in the 63 evaluations that met its minimum standards and did not report the outcomes of any particular program. The committee reported that, as a whole, across the 19 programs studied, the findings were inconclusive, prohibiting the panel from determining "conclusively, whether the programs, overall, were effective or ineffective" (p. 4). The committee precluded a second phase of evaluations of any program based upon data contained in their existing database (NRC, 2004), entreating curriculum evaluators to apply a more rigorous standard of evaluation, writing, "The committee recommends that a curricular program be designated as scientifically established as effective only when it includes a collection of scientifically valid evaluation studies addressing its effectiveness that establish that an implemented curricular program produces valid improvements in learning for students, and when it can convincingly demonstrate that these improvements are due to the curricular intervention" (p. 5).

In 2007, funded by the Institute of Education Sciences, U.S. Department of Education, researchers Slavin and Lake (2007) from Johns Hopkins University published their study examining research on three prevailing types of math programs that are available to elementary educators today: mathematics curricula, computer-assisted instruction, and instructional process programs. Their intention was to place all types of programs on a common scale and "to look broadly for factors that might underlie effective practices across programs and program types, and to inform an overarching theory of effective instruction in elementary mathematics" (Slavin & Lake, 2007, p. 4). The review applied a technique called "best-evidence synthesis" (Slavin, 1986, 2007), which sought to identify unbiased, meaningful quantitative information from experimental studies. Best-evidence synthesis closely resembles meta-analysis (Cooper & Lindsay, 1998; Lipsey & Wilson, 2001), but requires "more extensive discussion of key studies instead of primarily pooling results across many studies" (Slavin & Lake, 2007, p. 6). The studies involved elementary (K-5) children and sixth graders if they were in the studied elementary schools. Of the 87 studies meeting the criteria, the researchers placed the 13 evaluated math curricula into three categories: (1) programs developed under funding from the National Science Foundation that emphasize a constructivist philosophy, with a strong emphasis on problem solving, manipulatives, and concept development, and a relative de-emphasis on algorithms, (2) back-to-the-basics curriculum that emphasizes building students' confidence and skill in computations and word problems, and (3) traditional commercial textbook programs (Slavin & Lake, 2007). Their most conclusive findings were that more well-structured randomized trials extending beyond one year are greatly needed, and major limitations in the methods and quality of existing research further reduce the amount of available evidence supporting one curriculum over another (Slavin & Lake, 2007).

A Comparison between Singapore Math and Everyday Mathematics

As this study intends to reveal how the implementation of the elementary school mathematics curriculum, Singapore Math, is related to student achievement as assessed by the Grade 5 New Jersey Assessment of Skills and Knowledge (NJ ASK) as compared to Everyday Mathematics, a New Jersey Core Curriculum Contents Standards (NJCCCS)-aligned program in a district classified one of the poorest in the United States, it is important to present the more compelling and discernible differences between the two programs. The descriptive information for the Singapore Math program was obtained from publicly available information obtained from the program publisher's website and the What Works Clearinghouse's (WWC) intervention report. Some of the more critical analyses regarding the structural characteristics of Singapore Math and Everyday Mathematics as cited in recent research and policy reports are captured in Table 1 (see Table 1, p. 22).

Singapore Math

The Houghton Mifflin Harcourt-published *Math in Focus: Singapore Math* program is referenced as Singapore Math within this study and is aligned to the Singaporean standards for mathematics (Singapore Ministry of Education, 2006) as well as the March 9, 2010, public draft of the CCSS for Mathematics, copyright 2009 National Governors Association and Council of Chief State School Officers. The standards were designed to develop proficiency in a relatively small number of important mathematics topics, as validated by a recent analysis conducted by Ginsburg et al. (2005). The appeal of emphasizing fewer important mathematics topics in greater depth has also been recognized by some U.S. educators (NMAP, 2008). According to Achieve (2011), the Singapore Math syllabus is well aligned to CCSSM, and its learning expectations for students are comparable to the CCSSM in terms of rigor, coherence, and focus (Achieve, 2011). As are the CCSSM, the Singapore Math program is organized in a mastery framework where emphasis is distributed among the development of conceptual understanding, procedural fluencies, and problem solving skills (Houghton Mifflin Harcourt Specialized Curriculum Common Core Overview, 2011). Unlike the organization and structure of the Everyday Mathematics program, the Singapore Math curriculum covers a relatively small number of topics in depth. Students are expected to master prior content. "Each semester-level Singapore Math textbook builds upon preceding levels, and assumes that what was taught need not be taught again. The textbooks are designed to build a deep understanding of mathematical concepts with concrete illustrations that demonstrate how abstract mathematical concepts are used to solve problems from different perspectives" (Ginsburg et al., 2005, p. xii). The

Singapore Math textbooks have a consistent emphasis on problem solving and model drawing, with a focus on in-depth understanding of the essential math skills recommended in the NCTM's Curriculum Focal Points (NCTM, 2006), the National Mathematics Advisory Panel report (2009), and the Common Core State Standards (2010). "Singapore Math students begin solving simple multi-step word problems in third grade, using a technique called the 'bar model' method. Later grades apply this same method to more and more difficult problems, so that by sixth grade they are solving very difficult problems" (Hoven & Garelick, 2007, p. 28).

Reform curricula typically embed ideologies that either directly or indirectly influence instructional practice. For example, Everyday Mathematics, originally developed in 1985, was based on the principles common to the NSF-supported reform models, and its curriculum design is reflective of constructivist theories of learning (Steffe & Cobb, 1988; Steffe & Gale, 1995). The Singapore Ministry of Education used a graphic to represent its vision for mathematics teaching–a pentagon, with problem solving in the center and five interdependent elements surrounding it: concepts, skills, processes, attitudes, and metacognition. The pentagon represents a "balanced set of mathematics priorities centered on problem solving" (Ginsburg et al., 2005, p. xi), whereby computation skills and conceptual understandings are mutually emphasized.

To engage all learners, "Singapore Math uses minimal text and simple, direct visuals. As a result, all students, regardless of language skills, focus on the math lesson. To allow all students to reach high levels of conceptual understanding and use of skills, a consistent approach of concrete to pictorial to abstract pedagogy is repeatedly employed" (Great Source, 2009, p. 2).

This use of scaffolding is found throughout the program. Students are given increasingly more intricate problems for which they draw on prior knowledge as well as recently acquired concepts and skills as they combine problem solving strategies with critical thinking skills.

Everyday Mathematics

Initially funded in 1983 by a six-year grant from the AMOCO Foundation, Everyday Mathematics began as a kindergarten program. Continued development through Grade 3 (from 1989 to 1992) was possible due to funding from the GTE Corporation and the Everyday Learning Corporation. Afterwards, funding from the NSF led to the completion of the program through Grade 6 (Carroll, Isaacs, & Bell, 2001).

According to the University of Chicago's Comprehensive Summary of the Scientific Research & Evidence of Effectiveness for the Everyday Mathematics program (UCSMP, 2007), the Everyday Mathematics program is founded on three core principles (p. 5):

> (1) Students acquire knowledge and skills, and develop an understanding of mathematics from their own experiences. Mathematics is more meaningful when it is rooted in real-life contexts and situations, and when children are given the opportunity to become actively involved in learning. Teachers and other adults play a very important role in providing children with rich and meaningful mathematical experiences; (2) children begin school with more mathematical knowledge and intuition than previously believed. A K-6 curriculum should build on this intuitive and concrete foundation, gradually helping children gain an understanding of the

abstract and symbolic; and (3) teachers, and their ability to provide excellent instruction, are the key factors in the success of any program. Previous efforts to reform mathematics instruction failed because they did not adequately consider the working lives of teachers.

Structurally, Everyday Mathematics' design was developed to encourage students to frequently work collaboratively while exploring mathematical concepts. Manipulatives such as counters, pattern blocks, or the hundreds grids were encouraged to help scaffold students' thinking during problem solving exercises and discussions (Kamii & Joseph, 1989).

Organizationally, the developers of the program used a spiral approach through which ideas are continuously reviewed, practiced in varied contexts, and build in complexity. The organization of the program was due largely to the breadth of the mathematics topics covered. More recent research (Ginsberg, Leinwand, Anstrom, & Pollock, 2005) asserts that it is the very nature of the program's spiraled organizational framework that causes the curriculum to do a relatively poor job of systematically developing mathematical concepts.

Ginsberg et al. (2005) found that on average, Everyday Mathematics instructional materials present about one lesson on a narrowly focused topic every two days. CCSS reformers support the idea of paring down the number of major topics and subtopics taught, thereby allowing teachers to focus on essential content and the development of the conceptual frameworks necessary for transferring knowledge to new contexts.

Curriculum Effectiveness Studies: Singapore Math

At present, there are no conclusive data indicating the impact of Singapore Math on student achievement in low-performing, high-poverty school districts. The U.S. Department of Education Institute of Education Sciences through its research arm, the What Works Clearinghouse (WWC) identified 12 studies of Singapore Math that were published between 1983 and 2008. Six studies had ineligible designs and six studies were out of the scope of the review protocol for reasons other than study design. The WWC concluded that none of the subject studies met its evidence standards, thereby disqualifying their methodologies as effective or ineffective.

Since 2008, three larger-scale studies on the effectiveness of Singapore Math have been released. However, the studies, based upon the WWC's criteria for eligibility (U.S. Department of Education's Institute of Education Sciences, n.d.), may lack essential components needed to satisfy WWC requirements for a well-designed randomized controlled trial, quasi-experimental, regression discontinuity, or single subject research design. Further, it is difficult to differentiate market research from scientifically valid evaluation studies.

A quasi-experimental, pretest/posttest study was conducted by the Educational Research Institute of America (2010a) in the 2009-2010 school year, sampling second and fourth graders enrolled in Old Bridge Township School District; one of the largest suburban school districts in the State of New Jersey with a student population of just over 10,000. The district is classified by the New Jersey Department of Education as being in District Factor Group "FG", the fourth highest of eight groupings of socioeconomic status.

The district used the Singapore Math program, Math in Focus, as part of a district pilot and showed significant increases in math achievement over one academic year, as measured by the Stanford Achievement Test, Ninth Edition (SAT 9). In the year before the pilot began, all 678 students in all 12 elementary schools in the district used the same alternative program. In a subsequent study which extended the 2009-2010 pilot, 2010 state test mathematics scores were used to determine if similar gains were reflected within results from the Grade 4 NJ ASK.

One hundred twenty-five fourth graders in Old Bridge Township School District were engaged in the Singapore Math pilot during the 2009-2010 academic year; comprising the experimental group. The remaining 553 students in the district enrolled in Grade 4 during the same period used an alternative instructional mathematics program and comprised the control group for this study. Mathematics scores from the NJ ASK administered in the spring of 2009 and the spring of 2010 were analyzed to determine if the students who used Singapore Math made significant gains over the course of the pilot year. The score gains attained by the experimental group were also compared to those attained by the control group students.

Analyses of spring 2009 NJ ASK mathematics scores, which represent achievement prior to the Singapore Math pilot, show that there were no significant differences in performance between those students who the following year used Singapore Math (the experimental group for this study) and those students who did not (the control group). The analysis of the spring 2010 NJ ASK mathematics scores showed that the average score of the experimental group, those students using Singapore Math, was significantly higher than that of the control group students who did not use the program. Both chi-square analyses and analyses of variance were used to evaluate gains. Analyses of performance-level achievement showed that when the experimental group was divided into subgroups of students who scored at the Advanced Proficient Level, the Proficient Level, and the Partially Proficient Level on the NJ ASK math test, all three subgroups made statistically significant gains, whereby the Partially Proficient Level students increased the most.

In a 2008 curriculum effectiveness study, researchers from the School of Education and Department of Mathematics and Computer Science at North Georgia College and State University (NGCSU) conducted a large-scale study evaluating the implementation of Singapore Math in all 21 elementary schools in Hall County during the 2008-2009 and 2009-2010 school years, using descriptive statistics to communicate their findings. While findings generally showed overall increases in the percentage of students within the control group (using Singapore Math) meeting and exceeding state and local benchmarks, no statistical analyses were done to show statistical significance, correlation, or effect size. Further, the authors did not specify which publication/edition of Singapore Math was used in the study.

In 2009, Goldman, Retakh, Rubin, and Munnigh conducted a longitudinal, statistical study which analyzed the impact of Singapore Math (*Primary Mathematics*, 3rd edition, and later, U.S. edition) on student performance in North Middlesex Regional School District (NMRSD), a Massachusetts school district serving the suburban towns of Pepperell, Townsend, and Ashby, Massachusetts, and enrolling approximately 5,000 pre-K-12 students within one high school, two middle schools, and four elementary schools (Goldman et al., 2009). Beginning in the 2000-2001 school year, NMRSD implemented

Singapore Math in six classrooms. By 2007-08, the district reached 100% Singapore Math participation in all of its K-8 classrooms. Results from the Massachusetts Comprehensive Assessment System (MCAS), which evaluates student, school, and district mathematics performance, revealed that the NMRSD student scores were higher than those of Massachusetts students (using a different math program) in all but three of the 24 grade-years. These results are significant by analysis of variance (ANOVA) ($F=56.069$, $P<0.001$, $df=1, 32$). NMRSD results for Grades 5, 6, 7, 8, and 10 were significantly better than the Massachusetts results. While NMRSD's third-grade results are also better than the Massachusetts results, this difference is not statistically significant. Overall, results showed that (a) participation in Singapore Math classes had a positive impact on student MCAS test scores, (b) the duration of student participation in Singapore Math classes had a greater positive impact on test score gains than Singapore Math participation at any particular grade level and, (c) beginning Singapore Math in early grades improved the curriculum's effectiveness (Goldman et al., 2009).

Curriculum Effectiveness Studies: Everyday Mathematics

The amount of research evidence about Everyday Mathematics makes it one of the most scrutinized elementary mathematics programs (NRC, 2004).

Waite (2000), in his quasi-experimental study of the impact of Everyday Mathematics on student academic performance, analyzed assessment results of 732 third-, fourth-, and fifth-grade students in six schools using Everyday Mathematics and a comparison group of 2,704 third-, fourth-, and fifth-grade students in 12 similar schools, matched on baseline math achievement scores, student demographics, and geographical location. The schools in the experimental group were in their first year of implementing the first version of Everyday Mathematics. The comparison group used a traditional mathematics curriculum. This quasi-experimental study found Everyday Mathematics to have significant positive effects on overall math achievement as measured by the math portion of the Texas Assessment of Academic Skills. However, the WWC, after recalculating levels of significance reported by the study's author for purposes of clustering and multiple comparisons, found no statistically significant differences between the two treatment groups on specific outcome measures (overall performance on the Texas Assessment of Academic Skills, concepts, operations, and problem solving) and considered the extent of evidence (the indicator of how much evidence supported the findings) for Everyday Mathematics for elementary students to be small for math achievement.

Carroll (2001) compared the performance of 12,880 third-grade Everyday Mathematics students and 11,213 fifth-grade Everyday Mathematics students on the 1999 Illinois Standards Achievement Test (ISAT) to 47,742 third grade non-Everyday Mathematics students and 50,023 fifth-grade non- Everyday Mathematics students. The study found that Everyday Mathematics students significantly outperformed comparison students, even after controlling for all other significant variables. The study also found that "the differences favoring the Everyday Mathematics curriculum were largest in schools with a higher percentage of low-income students" (p. 5).

The Riordan and Noyce (2001) post-hoc study of all Massachusetts schools that had used Everyday Mathematics for two or more years, in comparison to matched schools, reported modest results (ES= 0.15) for schools using the program for two to three years but reported a more significant effect size (ES= 0.35) among 19 schools that had used the program for four or more years, suggesting a positive longitudinal effect on achievement.

Sconiers, Isaacs, Higgins, McBride, and Kelso (2003), in a tri-state study funded by the NSF, compared the performance of 39,701 students who had studied with Everyday Mathematics for at least two years to 38,481 students carefully matched by reading level, socioeconomic status, and other variables. The study compared the scores on all the topics tested at all the grade levels tested (Grades 3-5) in each of the three states (Massachusetts, Illinois, and Washington) finding that the average scores of the Everyday Mathematics students were significantly higher than the average scores of students in their matched comparison schools with small-moderate effect sizes ranging from 0.07 to 0.12. Of 34 comparisons across five state-grade combinations, 29 favored the Everyday Mathematics students, five showed no statistically significant difference, and none favored the comparison students. The results held across all income and racial subgroups, except for Hispanic students, where Everyday Mathematics students had higher (but not statistically significantly higher) average scores.

While the research evidence on Everyday Mathematics is generally positive, challenges relating to uneven quality and flawed methodological design make determining the effectiveness of Everyday Mathematics to a high degree of certainty difficult.

Of the 72 studies reviewed by the What Works Clearinghouse (WWC), a program of the federal Institute of Education Sciences investigating the effects of Everyday Mathematics on student performance, 71 failed to meet either the WWC's evidence standards or eligibility screens. Only the Waite study (2001) met the evidence standards but with reservations, finding a positive but small effect of the Everyday Math curriculum. The WWC reported these findings after recalculating levels of significance reported by the study's author for purposes of clustering and multiple comparisons, finding no statistically significant differences between the two treatment groups on specific outcome measures (overall performance on the Texas Assessment of Academic Skills, concepts, operations, and problem solving).

Slavin and Lake (2007) reviewed four studies of Everyday Mathematics within their best-evidence synthesis of elementary programs in mathematics that met their standards of review. Of the four, only one small study among 38 low-performing children used a prospective matched design (Woodward & Baxter, 1997), reporting no significant differences between Everyday Mathematics and control students (ES= -0.25). The three remaining studies (SRA/McGraw, 2003; Riordan and Noyce, 2001; Waite, 2000) all used post-hoc matched designs and varied in reported outcomes. Generally, based on the researchers' findings, across all of the studies, there was "no pattern of differential effects by measure," a surprising finding given the focus on concepts and problem solving. There were also no differences by ethnicity, except that in the SRA/McGraw (2003) and Waite (2000) studies, where "effects for Hispanic students were near zero" (p. 14).

Factors Influencing Mathematics Achievement

Gender

Historically, research has drawn significant correlations between gender and mathematics performance, often finding that the mathematics achievement of girls, across different contexts and underlying factors, is lower than that of boys (Leder, 1992; Rothman & McMillan, 2003). In a meta-analysis of 100 studies published between 1963 and 1988, examining gender differences in mathematics performance, Hyde, Fennema, and Lamon (1990) found insignificant gender differences in the lower elementary grades (d = -0.05). However, significant differences existed at the high school level, around complex problem solving and in favor of boys (d = 0.29). This finding was possibly explained by the underrepresentation of girls in higher levels of mathematics and science classes at the time of their analysis. Since the 1990 study, Hyde, Else-Quest, and Linn (2010) conducted a larger-scale meta-analysis using statewide data, examining 242 studies published between 1990 and 2007 of gender differences in mathematics performance. The researchers also analyzed larger national data sets based on probability sampling (National Education Longitudinal Study, 1988; National Center of Educational Statistics, n.d.). Combined, the data revealed, conclusively, that girls performed similarly to boys in mathematics across all grades analyzed (2–11) with uniform effect sizes <0.10 across all grades (Hyde et al., 2010).

Socioeconomic Status

In research of academic achievement, a number of recent studies show quite significant correlations between socioeconomic status (SES) and general cognitive ability as measured by educational performance (Brooks-Gunn et al., 1993; Coleman, Ernest, Campbell, Hobson, McPartland, Mood, Weinfeld, & York, 1966; Gamoran, 1987; Gottfried et al. 2003; Jencks et al., 1972, 1979; Lee, Bryk, & Smith, 1993; Smith et al., 1997). While SES may be a proxy for a composite of family processes (income, ability, culture, parenting styles, parents' education level, and parents' involvement in child's education), SES remains a strong predictor of student mathematics achievement. Research has also shown that SES plays an important role on children's early and later mathematics achievement (Crosnoe & Cooper, 2010; Jordan, Kaplan, Locuniak, & Ramineni, 2007). The Rothman and McMillan (2003) report noted that "the effects of socioeconomic status on student achievement [in numeracy] were significant at two levels. There were small but significant effects of SES within schools, and larger significant effects of SES between schools" (p. 30). The authors assert that SES, by far, "is the greatest influence on between-school differences" (p. 30). Smith, Brooks-Gunn, and Klebanov (1997) found that "family income has selective but, in some instances, quite substantial effects on child and adolescent well-being" (p. 55). The findings suggest that family income is more strongly related to children's ability and achievement (in reading and math) than to other outcomes (emotions), whereas children who live in extreme poverty over several years perform significantly worse. Halle, Kurtz-Costes, and Mahoney (1997) in a sampling of low-income minority families found that achievement in math and reading was related to the level of expectations parents set for their children's academic achievement. More specifically, parents with higher education attainment levels held more positive beliefs and success expectations for their children (Halle et al., 1997). Jordan, Kaplan, Locuniak, and Ramineni (2007). In their study of the predictors of first grade mathematics achievement, found that "compared to their middle-income peers, children from low-income households entered school with a generally low level of number sense" (p. 37). This finding was substantiated by the caregivers of low-income children who reported "fewer home experiences with numbers as well as with literacy" (p. 37). The researchers also found that the income-gap widened over the course of the school year although the students were exposed to the same curriculum.

Race/Ethnicity

SES is often closely related to racial/ethnic background (Atweh et al., 2004). The concern over achievement gaps–for example, those between racial/ethnic groups–has been addressed within recent (No Child Left Behind [NCLB], 2002) legislation which reauthorized Title I, the largest federal funding program designed to distribute funding to schools and school districts with high percentages of students from low-income families.

> The NCLB (2002) states the purpose of Title I: To ensure that all children have a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging state academic achievement standards and state academic assessments. This purpose can be accomplished by . . . closing the achievement gap between high- and low-performing children, especially the achievement gaps between minority and nonminority students, and between disadvantaged children and their more advantaged peers . . . (1001 NCLB 3).

Research has consistently shown that Black and Latino students are more likely to have lower standardized test scores than White students. Research has offered several explanations for why these minority groups have lower scores, including parental involvement (Delgado-Gaitan, 1991, 1992); institutionalized inequities (Fordham & Ogbu, 1986); stereotype (Steele & Aronson, 1998); individual-level factors such as personal aspirations (Bohon, Johnson, & Gorman, 2006; socioeconomic factors (Brooks-Gunn, Duncan, & Aber, 1997); mood differences (Davies & Kandel, 1981), etc.

Though racial/ethnic gaps have narrowed (Campbell, Hombo, & Mazzeo, 2000; Cook & Evans, 2000; Grissmer et al., 1994; Hedges & Nowell, 1999; Jencks & Phillips, 1998; Koretz, 1986, 1992), the average achievement gap between different racial/ethnic groups remains large and varies across tests, grades, and subject areas. "Significant gaps in achievement between student population groups: the Black/White, Hispanic/White, and high-poverty/low-poverty gaps are often close to one standard deviation in size" (Bloom et al., 2008, p. 172).

According to the NSB's (2012) reporting of NAEP data available from 1990 through 2009, higher proportions of White and Asian/Pacific Islander students scored at or above the basic and proficient levels compared with Black, Hispanic, and American Indian/Alaskan Native students and students from lower income families at each assessed grade level in mathematics. Overall, Black students represented the lowest performing subgroup, having the fewest number of students scoring at or above the basic level and at or above the proficient level. Special analyses conducted by the NCES in 2009 and 2011 showed that Black and Hispanic students trailed their White peers by an average of more than 20 test-score points on the NAEP in mathematics at Grades 4 and 8, representing a difference of roughly two grade levels (NCES, 2009, 2011).

Attendance

There is general consensus that chronic school absenteeism negatively impacts student performance. The amount of time actually spent in the classroom is in direct correlation to a student's access to education (Dekalb, 1999). Research generally supports a positive relationship between attendance and performance, specifically in mathematics (Balfanz & Byrnes, 2012). A study conducted by Roby (2004) that examined annual building attendance averages and student achievement in Grades 4, 6, 9, and 12 as measured by the Ohio Proficiency Tests found a moderate to strong positive relationship between attendance and student achievement. Gottfried (2009) used multilevel, longitudinal data sets of all second- through fourth-grade students in the Philadelphia School District from 1994-2000 to study the impact of attendance on achievement, discerning attendance by type (excused and unexcused). The researcher found that, regardless of type, absence is negatively associated with academic performance. Additionally, the researcher noted that students with higher proportions of unexcused absences are placed at academic risk, particularly in math achievement and as early as elementary school.

Synthesis

As this study analyzes the achievement effects of two elementary school mathematics curricula whose development was influenced by two different sets of standards, Chapter II began with an examination of the NCTM standards (1989, 2000) and the Common Core State Standards for Mathematics (2010). If curriculum has the potential to alter classroom practice, then, as Ball and Cohen (2003) acknowledge, it can "translate research findings and authoritative recommendations into classroom reality" (p. 1). The theoretical framework of the Everyday Mathematics program communicates the vision of the early NCTM standards--focusing teaching on child-centered approaches and embedding philosophies aligned to constructivist-based approaches that encourage students' own construction of knowledge. The program distributes practice across a broader range of topics and emphasizes reasoning, representation, and connections, using problem-based learning methods.

The theoretical framework of the Singapore Math program aligns to the major principles of the CCSSM, presenting a framework that supports the three major shifts embodied within the standards: focus, coherence, and rigor. The program emphasizes the development of conceptual understanding through structured, multistep mathematical problem solving; establishes a strong foundation in number and quantity in grades K-5, incorporating use of standard algorithms at specific grade levels; and bounds mathematical topics and outcomes within a mastery approach whereby topic repetition is limited.

Both programs in Grades K-5 address specific foundational understandings and skills characteristic of early mathematics (place value concepts; the commutative, associative, and distributive properties; composing and decomposing whole numbers; the basic operations of addition, subtraction, multiplication, and division; and the knowledge of how to apply the operations to problem solving). The Everyday Math program develops foundational skills and understandings in a spiral curriculum, distributing learning over time. The program frequently revisits topics, concepts, and skills and in a variety of contexts, interspersing various review lessons throughout its chapters (e.g., angle measure, time, probability, volume). In contrast, the Singapore Math program develops foundational mathematical concepts through a more concentrated approach attained through daily reinforcement and scaffolding concepts. In Grades K-5, the program's focus is on number concepts and topics in geometry. Numerous studies support the understanding of number and quantity as a necessary foundation for success as students advance to more complex topics. Structural and organizational distinctions between the Everyday Mathematics and Singapore Math curricula, though not a central focus of this study, transition this study into a new reform dialogue. While many of the earlier school mathematics curriculum debates can be characterized as "traditional" versus "reform-based," this study, though subtly stated, introduces a comparison of two distinct reform philosophies (CCSS versus NCTM). The broad discussion of the SIMS and TIMSS helped in positioning this work within its current context. In a call to "restructure and revitalize" (p. 134) mathematics curricula in U.S. schools, authors of *The Underachieving Curriculum: Assessing U.S. School Mathematics Performance from an International Perspective* (McKnight et al., 1987) cited the mathematics curriculum as the primary culprit of producing a "nation of underachievers" (p. 22), writing:

> Something appears to be wrong with the way the content and goals are distributed in school mathematics in U.S. schools. Content is spread throughout the curriculum in a way that leads to very few topics being intensely pursued. Goals and expectations for learning are diffuse and unfocused. Content and goals linger from year to year so that curricula are driven and shaped by still unmastered mathematics content begun years before.

Recommendations stemming from the Second International Mathematics Study and the Third International Mathematics and Science Study suggested that the United States engage in curriculum reorganization and renewal that result in curricula that better resemble what is found in higher performing nations such as Japan, Hong Kong, and later, Singapore (an island country whose fourth and eighth grade students have been top or near-top performers in the world in each of the major studies carried out by the International Association for the Evaluation of Educational Achievement (IEA) from 1995 to 2003 (Dindyal, 2006)). Schmidt et al. (1997) found that countries with more focused curriculum designs outperformed the United States on the 1995 Third

International Mathematics and Science Study. Subsequent studies (Schmidt et al., 2001, 2005) drew similar conclusions, noting that higher achieving countries focused deliberately on fewer topics and the more rigorous cognitive domains (Darling-Hammond et al., 2008). Challenges such as these establish the footing for this research.

Overall research on curriculum effect has offered little if any conclusive direction for decision makers. Recent large-scale comparative studies (Agodini et al., 2009; Bhatt et al., 2012) underscore additional complexities in the field of curriculum effectiveness: (1) large differences in effectiveness can exist between curricula that share the same pedagogical approach, (2) while much attention has been devoted to the debate over traditional versus reform-based mathematics, other differences in curriculum design are substantively important, and (3) the same curricula can produce contrasting results in new conditions or environments.

While there have been numerous studies on the outcomes of particular approaches to mathematics education, such as use of educational technology (Becker, 1991; Chambers, 2003; Kulik, 2003; Murphy, Penuel, Means, Rorbak, Whaley, & Allen, 2002), calculators (Ellington, 2003), and math approaches for at-risk children (Baker, Gersten, & Lee, 2002; Kroesbergen & Van Luit, 2003; Slavin et al., 2007), there are few comprehensive reviews of research on mathematics programs available to educators. Adding to existing complexities in the field of curriculum effectiveness are the major limitations in the methods and quality of existing research which further reduces the amount of available evidence supporting one curriculum over another (IES/USDOE, n.d.; NRC, 2004; Slavin & Lake, 2007).

Meta-analyses conducted around curriculum effectiveness in mathematics, though largely yielding inconclusive findings, have produced unexpected benefits that potentially advance the field of curriculum study. Meta-analyses, such as that conducted by the NRC (2004), have resulted in the establishment of more rigorous frameworks for curriculum evaluation that promote the idea that curriculum effectiveness should be established via a "collection of scientifically valid evaluation studies" (p. 5). Therefore the Review of the Literature section synthesizes the more recent studies related to the two programs analyzed in this study. In light of the available literature addressing the effectiveness of the Everyday Mathematics and Singapore Math programs, this study is unique. The curriculum field is thin in terms of available research on the impact of the Singapore Math program used in this analysis, *Math in Focus: Singapore Math* (published by Houghton Mifflin Harcourt, 2010). Of the 12 studies of Singapore Math published between 1983 and 2008 and reviewed by the What Works Clearinghouse, none of the subject studies met its evidence standards, thereby disqualifying their methodologies. Since 2008, three larger-scale studies on the effectiveness of Singapore Math have been released. However, each of the studies lacks essential components, further qualifying the methodology used in this study.

The Old Bridge study (2010a) closely resembles market research and failed to either establish adequate initial comparability of the control and treatment groups or make statistical adjustments to establish adequate comparability. The Old Bridge study did not identify the two alternative curricula by name. Although a number of statistical analyses were employed (Chi Square, ANOVA, regression), effect sizes were not reported.

The NGCSU study (2008) used descriptive analyses versus statistical analyses to measure impact. Therefore, metrics indicating statistical significance, correlation, or effect size were not reported. Also, the authors did not specify which publication/edition of Singapore Math was used in their study.

While the Goldman et al. study (2009) presented a more scientifically sound analysis of data, the experimental treatment differed from the one presented in this study. *Primary Mathematics*, 3rd edition (and later, U.S. edition) was the Singapore Math publication used in the Goldman study.

While the Everyday Mathematics program is reportedly one of the most scrutinized elementary mathematics programs (NRC, 2004) whereby the findings are generally positive, consensus is that its effectiveness cannot be determined to any high degree of certainty due to the uneven quality and flawed methodological designs of much of the available research (NRC, 2004; USDOE, 2010; Slavin et al., 2007). This study sought research that underscores the significance of the problem presented within the study and strives to establish a sound methodology to provide valid, informative, and credible data on curricular effectiveness that contributes to the larger body of research on program impact.

In order to strengthen the conduct of this comparative analysis, this analysis studied variables historically linked to differences in mathematics performance: gender, socioeconomic status (SES), race/ethnicity, and attendance). As captured in this review, SES, race/ethnicity, and attendance were projected to have a greater impact on student performance, possibly predicting significant differences in achievement between student population groups (the Black/White, Hispanic/White, and high-SES/low-SES gaps) and within subgroups having greater variation in attendance. Gender comparisons, on the other hand, were expected to reveal minor differences (Hyde et al., 2010).

This study's complete research design, results, and findings are discussed in the chapters that follow.

CHAPTER III

METHODOLOGY

Introduction

Many mathematics curricula adopted by states, districts, and schools continue to be purchased and used without outcome-based, empirically derived evidence of effectiveness. As states and school districts transition from their former NCTM-aligned standards and programs into Common Core States Standards–aligned systems (curriculum, assessment, and professional development), significant investments in resources are inevitable in order to enact the expectations of the standards documents. The potential for a new round of large-scale investments in resources and the impact on student achievement warrants improved evidence-based selections of programs and instructional materials.

The intent of this study was to use research-based methodology to provide valid, informative, and credible data on curricular effectiveness, specifically data on the effectiveness of the two elementary school mathematics curricula presented within this study. Within the larger body of research on program impact, this study may provide indications for future study.

This study examines the differences between the achievement effects of one proposed Common Core State Standards-aligned mathematics program, *Math in Focus: Singapore Math* (published by Houghton Mifflin Harcourt, 2010), and one NCTM-aligned mathematics program, *Everyday Mathematics* (currently published by the Wright Group/McGraw-Hill, 2007), on mathematics achievement as measured by the mathematics section of the 2012 administration of the Grade 5 New Jersey Assessment of Skills and Knowledge (NJ ASK5).

The scope of this study is the comparison of the differences in NJ ASK5 mean scale scores for general education fifth grade students in general education classroom settings across the eight schools included in the study.

Setting for the Study

The study took place within the Large Northeastern Urban Public School District, a district categorized within District Factor Group A, the lowest rating, indicative of the district's relative socioeconomic status. In October of 2010, the Large Northeastern Urban Public School District's Advisory Board approved the district's request to pilot a revised local mathematics curriculum, Houghton Mifflin Harcourt-published *Math in Focus: Singapore Math* program within four schools, thereby replacing the K-5 *Everyday Mathematics* program within the piloting sites' kindergarten, Grade 1, Grade 2, Grade 3, Grade 4, and Grade 5 classrooms. The district's intention in piloting the new program was to identify a K-5 curriculum framework aligned to the newly adopted CCSSM that clearly identified mathematical priorities and content grade by grade, addressed student achievement gaps in elementary-level mathematics, and would be considerable for district-wide adoption. In November 2010, The Large Northeastern Urban Public School District launched the Singapore Math program in the four designated pilot sites.

Initial selection of the four pilot schools was based upon three broad criteria: (1) demographic factors (socioeconomic factors, racial/ethnic composition, mobility rates, etc.), (2) prior mathematics performance as measured by the New Jersey

Assessment of Skills and Knowledge in Grades 3, 4 and 5, and (3) within-school factors, such as leadership, shown to correlate to quality of implementation.

Demographic Composition

Each of the four pilot schools is situated in a different Large Northeastern Urban Public School District region (North, South, East-Central, and West). Demographic data used in the initial selection of the pilot sites included faculty, student, and school data. Each pilot school is generally comparable to the demographic composition of the region in which it is situated.

Prior Mathematics Performance

With the exception of one school, the pilot schools performed below 2010 NJ ASK district and/or State averages (Grades 3, 4, and 5).

Within-School Factors

In a quantitative analysis of the factors influencing the quality of implementation of school-wide programs, Cooper (1998) revealed six within-school factors: (1) creation of a supportive culture for institutional change, (2) overcoming program resistance, (3) a commitment to implementing program structures, (4) having a strong school-site facilitator, (5) the concern level of teachers regarding an increased workload, and (6) the availability of program materials. At the inception of the Singapore Math implementation in the four sites, school leadership was receptive to the new adoption. Underscoring Factors 1, 4, and 6, piloting principals actively encouraged their teaching staff to participate in initial Singapore Math exposure sessions. Each pilot site was staffed with an onsite mathematics coach who received additional training on the program's theoretical framework and components. All program materials (teacher editions, student materials, web-based technologies, manipulative kits) were supplied by the district to each school prior to training and implementation.

Shortly after the launch of the Singapore Math pilot, district leadership selected and paired four additional schools (with similar past performance trends, demographic compositions, and within-school factors) to each piloting site. The additional sites continued to use Everyday Mathematics as their core program in Grades K-5 and acted as "control" sites for the purpose of district-level analysis and reporting. This study retained the four sites as alternative treatment sites. Comparability of the paired sites is discussed in Chapter IV.

Treatment

The two curricula discussed within this study share similarities with regard to their emphasis on problem solving and the use of visual aids for learning, characteristics often associated with "reform-based" instruction. Beyond the dimension of pedagogy, there are other differences between the curricula related to the organization, structure, and treatment of topics.

Everyday Mathematics

Everyday Mathematics, 3rd Edition (McGraw-Hill Education, 2007) is a kindergarten through sixth grade mathematics instructional curriculum developed by the University of Chicago School Mathematics Project (UCSMP), is reflective of the NCTM Standards, and emphasizes the priorities expressed in the Standards documents: a de-emphasis on performing paper and pencil calculations, greater emphasis on "operation sense" and the "collection and organization of data" (NCTM, 1980, as cited by Klein, 2007, p. 22). The program emphasizes nontraditional methods and the "invented procedures" approach to algorithm development. It arranges topics in a helix, whereby practice is distributed rather than massed. Topics, to a significant degree, repeat content across grades. The program's design was developed to encourage students to frequently work collaboratively. Manipulatives encourage scaffolded thinking during problem solving exercises and discussions (Kamii et al., 1989). *Everyday Mathematics*, 2nd Edition (SRA/McGraw-Hill, 2002) was implemented within the district and used as the core instructional mathematics program in Grades K-5 from 2004 to 2007. *Everyday Mathematics*, 3rd Edition (McGraw-Hill Education, 2007) replaced the earlier edition in school year 2007-2008 and has been used continuously in all K-5 classrooms within the district since. The treatment is referenced as the Everyday Math Alternative Treatment throughout this study.

Singapore Math

The Houghton Mifflin Harcourt-published *Math in Focus: Singapore Math* program is the United States' culturally sensitive translation of the Singapore version, *My Pals Are Here! Maths*, 2nd Edition (Marshall Cavendish Singapore, 2008). U.S. enhancements include the addition of customary measurement, a teacher's edition, a kindergarten component, enhanced technology components, differentiated resources for reteaching and enrichment, and transition components to address student deficiencies. The Singapore Math program is organized in a mastery framework, where emphasis is distributed amongst the development of conceptual understanding, procedural fluencies, and problem solving skills (Houghton Mifflin Harcourt, 2011). The Singapore Math curriculum covers a relatively small number of topics in depth and emphasizes essential math skills recommended in the NCTM *Curriculum Focal Points* (NCTM, 2006), the

National Mathematics Advisory Panel (2008), and the proposed Common Core State Standards (2010).

The Singapore Math textbooks have a consistent emphasis on problem solving and model drawing. Related topics are presented in self-contained units (massed approach), encouraging the mastery of prior content. The treatment is referenced as the Singapore Math Experimental Treatment throughout this study.

Participants

Singapore Math Experimental Treatment Sample

The experimental treatment sites implemented the Singapore Math program as their core instructional mathematics program in all K-5 classrooms for two successive years beginning in school year 2010-2011. One thousand six hundred and eighty-two (1,682) students in kindergarten through Grade 5 from the four experimental treatment sites were involved in the Singapore Math pilot during the 2011-2012 school year (862 male, 820 female; 11.47% White, 44.89% Black, 43.22% Hispanic, and 0.42% other). Three hundred six (306) Grade 5 students from the four experimental treatment sites comprised the experimental treatment population (see Table 3).

After delimiting the qualifying experimental treatment sample to general education students enrolled within their respective treatment site during schools years 2010-11 and 2011-12 with mathematics score data from both the 2010 NJ ASK3 and the 2012 NJ ASK5, the qualifying Singapore Math Experimental Treatment sample reflected 100 Grade 5 students instructed in the *Math in Focus: Singapore Math* program in Grades 3-5 from school years 2010-2011 to 2011-2012 (see Table 4).

Everyday Math Alternative Treatment Sample

One thousand five hundred and fifty-four (1,554) students in kindergarten through Grade 5 from the four alternative treatment sites were instructed in the Everyday Math program during the 2011-2012 school year (773 male, 781 female; 15.44% White, 39.90% Black, 44.34% Hispanic, and 0.32% other). Two hundred eighty-two (282) Grade 5 students from the four alternative treatment sites using the Everyday Math program comprised the alternative treatment population (see Table 3). After delimiting the qualifying alternative treatment sample to general education students enrolled within their respective treatment site during the 2010-11 and 2011-12 schools years with mathematics score data from both the 2010 NJ ASK3 and the 2012 NJ ASK5, the qualifying Everyday Math Alternative Treatment sample reflected 105 Grade 5 students who had been instructed in the program, *Everyday Mathematics*, 3rd Edition (McGraw-Hill Education, 2007) in Grades 3-5 from school years 2010-2011 to 2011-2012 (see Table 4).

Table 3

Grade 5 Population Sizes- Experimental Treatment and Alternative Treatment

	EXP (1)	ALT (1)	EXP (2)	ALT (2)	EXP (3)	ALT (3)	EXP (4)	ALT (4)	EXP (T)	ALT (T)	EXP+ALT (T)
TOTAL	55	71	108	42	81	104	62	65	306	282	588
Male	22	30	56	15	33	45	38	31	149	121	270
Female	33	41	52	27	48	59	24	34	157	161	318
White	0	2	0	0	34	30	0	0	34	32	66
Black	55	31	24	41	9	4	62	60	150	136	286
Hispanic	0	36	82	1	37	67	0	4	119	108	227
Other	0	2	2	0	1	2	0	1	3	5	8
Spec Ed	11	15	15	9	17	14	23	9	66	47	113
LEP	0	11	26	2	20	13	0	2	46	28	74
Low SES	34	66	92	37	63	91	59	58	248	252	500

Table 4

Grade 5 Sample Sizes- Experimental Treatment and Alternative Treatment

	EXP (1)	ALT (1)	EXP (2)	ALT (2)	EXP (3)	ALT (3)	EXP (4)	ALT (4)	EXP (T)	ALT (T)	EXP+ALT (T)
TOTAL	24	19	31	15	27	48	18	23	100	105	205
Male	7	8	15	5	10	20	7	11	39	44	83
Female	17	11	16	10	17	28	11	12	61	61	122
White	0	0	0	0	11	14	0	0	11	14	25
Black	24	11	7	15	2	2	18	22	51	50	101
Hispanic	0	8	24	0	13	31	0	1	37	40	77
Other	0	0	0	0	1	1	0	0	1	1	2
Low SES	17	19	29	13	23	41	16	18	85	91	176
NJ ASK5 Proficient	12	15	19	12	27	46	13	17	71	90	161

Research Questions

This research sought to determine if the implementation of a K-5 CCSSM-aligned mathematics program, Singapore Math, is related to differences in performance on the New Jersey Assessment of Skills and Knowledge (NJ ASK) for Grade 5 general education students in comparison to students using a NCTM-aligned elementary mathematics program, Everyday Mathematics, and asks the question "What is the impact of implementing a proposed CCSSM-aligned mathematics program, Singapore Math, on mathematics achievement of Grade 5 general education students as measured by the 2012 Grade 5 NJ ASK (NJ ASK5) in comparison to the mathematics achievement of Grade 5 general education students using a NCTM-aligned elementary mathematics program, Everyday Mathematics, in the Large Northeastern Urban Public School District?"

Measuring student performance data according to (a) overall performance (Advanced Proficiency, Proficiency, Partial Proficiency); (b) gender; and (c) subgroup, as defined by the NJDOE, 2010 (economically disadvantaged, White, African-American, Hispanic, and other, including Asian/Pacific Islander, American Indian/Native American within this study) yields the following subsidiary research questions:

Subsidiary Question 1

How much variance in the 2012 NJ ASK5 mean scale score can be explained by the predictor variables treatment, attendance, gender, race/ethnicity, and SES?

Subsidiary Question 2

Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment when controlling for attendance?

Subsidiary Question 3

To what extent do differences in performance exist when data are analyzed according to 2012 NJ ASK5 performance levels (Partially Proficient, Proficient, and Advanced Proficient) and treatment status; and is there significant interaction between the performance levels and treatment?

Subsidiary Question 4

Is there a statistically significant difference in the 2012 NJ ASK5 performance level of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on *race/ethnicity* (Black, Hispanic, White, subset of Black and Hispanic); and is there significant interaction between treatment status and race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic)?

Subsidiary Question 5

How much variance in the 2012 NJ ASK5 mean scale score of Black students can be explained by the predictor variables treatment, attendance, gender, and SES?

Subsidiary Question 6

How much variance in the 2012 NJ ASK5 mean scale score of Hispanic students can be explained by the predictor variables treatment, attendance, gender, and SES?

Subsidiary Question 7

Is there a statistically significant difference in the 2012 NJ ASK5 performance level of Hispanic students based on SES classification and treatment status when controlling for attendance, and is there significant interaction between treatment status and SES classification for Hispanic students when controlling for attendance?

This study yielded the following null hypotheses:

Null Hypothesis 1

H_0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, Black&Hispanic/White and SES account for no variation in student performance on the 2012 NJ ASK5.

Null Hypothesis 2

There is no significant difference in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5 when controlling for attendance.

Null Hypothesis 3a

There is no significant difference between the Everyday Math Alternative Treatment's 2010 NJ ASK3 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient) and the Everyday Math Alternative Treatment's 2012 NJ ASK5 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient).

Null Hypothesis 3b

There is no significant difference between the Singapore Math Experimental Treatment's 2010 NJ ASK3 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient) and the Singapore Math Experimental Treatment's 2012 NJ ASK5 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient).

Null Hypothesis 3c

There is no significant interaction between the independent variables treatment and performancelevel2012 (the categorical variable representing the 2012 NJ ASK5 proficiency levels: Advanced Proficient, Proficient, and Partially Proficient).

Null Hypothesis 3d

There is no significant difference between the mean scale scores of those students scoring Proficient on the 2012 NJ ASK5 (scoring 200 and above) in the Everyday Math Alternative Treatment and the mean scale score of those students scoring Proficient on the 2012 NJ ASK5 (scoring 200 and above) in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

Null Hypothesis 3e

There is no significant difference between the mean scale scores of those students scoring Partially Proficient on the 2012 NJ ASK5 (scoring below 200) in the Everyday Math Alternative Treatment and the mean scale score of those students scoring Partially Proficient on the 2012 NJ ASK5 (scoring below 200) in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

Null Hypothesis 4a

There is no significant interaction between treatment status and Black&Hispanic/White performance as measured by the 2012 NJ ASK5.

Null Hypothesis 4b

There is no significant difference between the overall performance of the subset of Black and Hispanic students in the Everyday Math Alternative Treatment and the subset of Black and Hispanic students in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

Null Hypothesis 4c

There is no significant difference between the overall performance of White students in the Everyday Math Alternative Treatment and White students in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

Null Hypothesis 4d

There is no significant interaction between treatment status and Black/Hispanic performance as measured by the 2012 NJ ASK5.

Null Hypothesis 4e

There is no significant difference in the overall 2012 NJ ASK5 performance level of Black and Hispanic students in the Everyday Math Alternative Treatment.

Null Hypothesis 4f

There is no significant difference in the overall 2012 NJ ASK5 performance level of Black and Hispanic students in the Singapore Math Experimental Treatment.

Null Hypothesis 5

H_0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, and SES account for no variation in the performance of Black students on the 2012 NJ ASK5.

Null Hypothesis 6

H_0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, and SES account for no variation in the performance of Hispanic students on the 2012 NJ ASK5.

Null Hypothesis 7a

There is no significant difference in the 2012 NJ ASK5 performance level of Hispanic students based on SES classification and treatment status when controlling for attendance.

Null Hypothesis 7b

There is no significant interaction between treatment status and SES when controlling for attendance.

Students with disabilities and Limited English Proficient students were not included in the primary analyses within this study. Additional populations excluded from the experimental treatment and alternative treatment samples included students having less than one year in the school/district, out-of-district placements, and out-of-residency placements as indicated within the 2010 NJ ASK3 and 2012 NJ ASK5 data reports.

Research Design

This study employed an explanatory non-experimental research design using post hoc pre- and post-test data from the 2010 NJ ASK3 and 2012 NJ ASK5 administrations, respectively. The study used eight intact, matched comparison groups considered similar as the experimental treatment and alternative treatment groups. While non-random designs can impact the potential benefits that an ideal randomization procedure would achieve; namely the maximization of statistical power, particularly in cases of subgroup analyses (Lachin, 1988), observations made by Glazerman, Levy, & Myers (2002) and Torgerson (2006) suggest that high-quality studies with well-matched treatment and control groups produce outcomes similar to those of randomized experiments. The NRC (2002) emphasizes that while randomized controlled trials are widely considered the "gold standard" in the sciences for measuring the impact of a particular treatment, they are often impractical in many areas of social policy, such as education, whereas quasi-experimental approaches that include comparison groups closely matched on key characteristics (prior achievement, demographics, etc.) can be rigorous within their own context (NRC, 2002, 2005). Identification and selection of comparison groups is further discussed in this chapter.

Instrumentation/Data Collection

This investigation compared the 2012 NJ ASK5 mathematics scale score means for sampled grade 5 general education students within the Singapore Math Experimental Treatment (n=100) to the 2012 NJ ASK5 mathematics scale score means for sampled Grade 5 general education students within the Everyday Math Alternative Treatment (n=105).

The NJ ASK tests are a series of state assessments administered to New Jersey public school students to determine levels of student achievement in language arts, mathematics, and science. The assessments, grounded in the state's content standards (the NJCCCS), are standardized tests administered to all New Jersey public school students in Grades 3-8 during March, April, and/or May, and are an extension of federal and state accountability requirements. The results of the elementary-level assessments are intended to measure and promote student acquisition of the state's curriculum standards and provide information about student performance.

The empirical reliability and validity of the assessments are reported within the NJDOE's New Jersey Assessment of Skills and Knowledge Technical Reports (NJDOE, 2011, 2013) and is further explained in the next subsection.

The mathematics assessments include questions in four content clusters (1) Number and Numerical Operations; (2) Geometry and Measurement; (3) Patterns and Algebra; (4) Data Analysis, Probability, Discrete Mathematics, and one cluster assessing the Mathematical Processes. Figure 2 describes the strands associated with each cluster assessed on the NJ ASK. The Mathematics portion of the NJ ASK tests measures students' ability to solve problems by applying mathematical concepts. The Mathematics component measures knowledge and skills in four content clusters corresponding to standards. Questions on the NJ ASK are distributed among three item types: multiple choice, short-constructed, and extended-constructed response items (NJDOE, 2011, 2013). This design is unique given that the format of tasks on many large-scale standardized tests is predominantly multiple-choice, as accuracy of test scores is most likely to be achieved by this format (Darling & McCloskey, 2008).

Abida, Azeem, and Gondal (2011), in their study of multiple choice (MC) and short constructed response (SCR) types, found item format to have significant effects in assessing students' proficiency in mathematics. Their research design included the administration of a 60-item, NAEP-adapted proficiency test to 2,680 students within 134 schools, concluding that, while multiple choice (MC) items are able to assess more content, short constructed (SCR) items "require more thinking than MC items" (Abida et al., p. 145); and more specifically, inclusion of both MS and SCR item formats may improve test reliability (Abida et al., 2011). On the third and fourth grade test, about 40% of the items can be classified as number and numerical operations, and the remaining points are fairly evenly split between geometry and measurement, patterns and algebra, and data analysis, probability, and discrete mathematics. On the fifth grade test, about 36% of the items can be classified as number and numerical operations; about 32% of the items can be classified as geometry and measurement; and the remaining points are equally distributed between algebra, patterns and data analysis, probability, and discrete mathematics. Performance level descriptors are Partially Proficient, Proficient, and Advanced Proficient. See Table 5 for descriptors (NJDOE, 2009).

4.1.	**Number and Numerical Operations**
A.	Number Sense
B.	Numerical Operations
C.	Estimation
4.2.	**Geometry and Measurement**
A.	Geometric Properties
B.	Transforming Shapes
C.	Coordinate Geometry
D.	Units of Measurement
E.	Measuring Geometric Objects
4.3.	**Patterns and Algebra**
A.	Patterns
B.	Functions and Relationships
C.	Modeling
D.	Procedures
4.4.	**Data Analysis, Probability, and Discrete Mathematics**
A.	Data Analysis (Statistics)
B.	Probability
C.	Discrete Mathematics--Systematic Listing and Counting
D.	Discrete Mathematics--Vertex-Edge Graphs and Algorithms

Figure 2. NJ ASK Content Clusters/Standards and their Associated Strands

For this study, publically available 2009-2010 and 2011-2012 enrollment, school performance, statewide assessment, and the historical NJ Report Card data retrieved from the New Jersey Department of Education's website was used. School year 2009-2010 enrollment numbers were based on the October 15, 2009, district enrollment count. The NJDOE suppressed data having cell sizes of less than 11 students, proficiency levels that were greater than 90% Partially Proficient, and other combinations of small cell sizes that might not protect privacy. Asterisks were used on report card data files to indicate that the data were suppressed in order to protect privacy. Student level data were also used for this study. I requested and received approval to collect and use data for the purposes of this study from the Large Northeastern Urban Public School District's internal Institutional Review Board (IRB) and Seton Hall University's IRB. See Appendix A for documentation of IRB approval. Throughout this study, data are reported in aggregate at either the "treatment" level or "school" level.

Instrument Reliability and Validity

As reported by the NJDOE (2011), the NJ ASK assessments were designed under the tenets of Classical Test Theory (CTT). Measurement Incorporated (MI), the contractor for NJ ASK Grades 3-8, uses Cronbach's coefficient alpha for estimating the consistency of individual performance on a single test administration. Based upon published technical reports, the reliability coefficient alphas for the Mathematics portion of the 2011 Grade 5 NJ ASK range from .56 - .86 per cluster; combining all item types (multiple choice, short constructed, and extended constructed response items) with an overall coefficient alpha of .90 and a Standard Error of Measure (SEM) of 3.23.

Table 5

NJ ASK Performance Level Descriptors for Grades 3, 4, and 5

	Grade 3	Grade 4	Grade 5
Partially Proficient 100-199	Students performing at the Partially Proficient level have limited recall, recognition and application of basic facts and informational concepts.	Students performing at the Partially Proficient level have limited recall, recognition and application of basic mathematical concepts, skills, and vocabulary to solve problems involving real world situations.	Students performing at the partially proficient level have limited recognition and understanding of and inconsistently apply basic mathematical concepts, skills, and vocabulary to theoretical and real world situations.
Proficient 200 - 249	Students performing at the proficient level demonstrate recall, recognition and application of facts and informational concepts.	Students performing at the proficient level demonstrate recall, recognition and application of mathematical concepts, skills, and vocabulary to solve problems involving real world situations.	Students performing at the proficient level recognize and understand basic mathematical concepts, skills, and vocabulary and apply them to theoretical and real world situations.
Advanced Proficient 250 - 300	Students performing at the Advanced Proficient level demonstrate the qualities outlined for Proficient performance. In addition, these students determine strategies and procedures to solve routine and non-routine problems.	Students performing at the Advanced Proficient level clearly and consistently demonstrate the qualities outlined for Proficient performance.	Students performing at the advanced proficient level consistently demonstrate the qualities outlined for proficient performance. In addition, advanced proficient students analyze methods for appropriateness, synthesize processes, and evaluate mathematical relationships.

(Source: New Jersey Department of Education, 2009)

MI uses the Kappa index (φ) to estimate how reliably the NJ ASK classifies students into the performance categories (Partially Proficient, Proficient, and Advanced Proficient). The Kappa index indicates "the probability of a consistent classification by chance" (NJDOE, 2011, p. 123). The NJDOE reports the stratified alpha coefficient as .93, the Standard Error of Measure as 2.92, and the Kappa percentage as 80% for the Mathematics portion of the 2011 Grade 5 NJ ASK (NJDOE, 2011).

MI calculates a final measure of reliability, rater reliability, based upon the percentages of extended constructed response items scored, on a 0-3 point scoring rubric for math, with exact agreement, adjacent agreement, and resolution needed by grade level and content area. The NJDOE (2011) reports the exact agreement rate for the Mathematics portion of the 2011 Grade 5 NJ ASK as 89.2 for all extended constructed response items.

The state reports Pearson correlations coefficients to address construct validity. Validity details are outlined in the 2011 NJ ASK 3-8 Technical Report (NJDOE, 2012).

Data Analysis

The NRC's Panel on Evaluating Curricular Effectiveness (NRC, 2004), recognizing the complexity of doing research on curricular effectiveness and the need to strengthen the conduct of comparative studies in order to mitigate possible confounding variables, recommended that in all comparative analyses, "explicit attention be given to the following criteria" (p. 7):

- Identify comparative curricula by name
- Employ random assignment, or otherwise establish adequate comparability
- Select the appropriate unit of analysis
- Document extent of implementation fidelity (see Chapter 1, Researcher Bias)
- Select outcome measures that can be disaggregated by content strand[7]
- Conduct appropriate statistical tests and report effect size
- Disaggregate data by gender, race/ethnicity, socioeconomic status (SES), and performance levels, and express constraints as to the generalizablity of the study (p. 7).

---

[7] Analyses of individual clusters were not included in the design due to the reported reliability coefficient alphas of the 2011 Grade 5 NJ ASK with ranges from .56 - .86 per cluster (see Delimitations).

Since this study retained the four alternative treatment sites initially selected by the district to pair with each of the experimental treatment sites, the conduct of this comparative analysis needed to be strengthened (NRC, 2004). At both the school and treatment levels, a series of preliminary analyses were employed to establish adequate comparability of the paired groups and to analyze the interaction and effect of key variables. Several demographic factors that research has connected to student achievement were included in the preliminary analyses and were used to assess comparability between the experimental treatment and alternative treatment groups; percentage of low-income students (Pearl, 2002; Steinberg, Brown, & Dornbusch, 1996), percentage of minority students (African-American and Hispanic), student population (Bouchey & Harter, 2005; Demie, 2001; Tate & D'Ambrosio, 1997), etc. At the paired school level and at the treatment level, simple Chi Square (Goodness-of-Fit), r X k Chi Square, t-tests, and ANOVA were employed in the study to determine whether there were significant differences between the main distributions: race/ethnicity, gender, SES, etc. (see Appendix B: Null Hypotheses 1-7). Additionally, at the treatment level, a Two-Sample t-test (Assuming Unequal Variances) was conducted to compare the 2010 NJ ASK3 performance level between the Everyday Math Alternative Treatment sample and the Singapore Math Experimental Treatment sample to ensure that "treatment status" did not give initial advantage to either group. Results of the preliminary analyses are discussed in Chapter IV.

The primary analyses, linear regression, multiple regression, hierarchical regression, one-way ANOVA, ANCOVA, factorial ANOVA and factorial ANCOVA were employed to determine the effect of the independent variables (treatment, gender, SES, race/ethnicity, and attendance) on the dependent variable, performance on the mathematics portion of the Grade 5 Assessment of Skills and Knowledge (2012 NJ ASK5) (see Figure 3).

One research question, seven subsidiary questions and their accompanying null hypotheses were analyzed using Microsoft Excel's Data Analysis Tools and the IBM's statistical analysis software, SPSS version 21.0. Differences were reported only if the comparisons were statistically significant, using F-ratio statistic to determine statistical significance where $p \leq 0.05$.

Effect Size[8]

In the analyses of correlation and regression, the Pearson R^2 correlation was used to calculate effect sizes of statistically significant outcomes where rough guidelines for determining size is 0.1, small; 0.3, medium; 0.5, large (Cohen, 1988, 1992). For Analyses of Variance, effect sizes are reported as partial eta squared (η_p^2) where rough guidelines for determining size is 0.01, small; 0.06, medium; 0.138, large (Bruin, 2006). For all t-tests, Cohen's d was used to calculate effect sizes of statistically significant outcomes whereby 0.2 equates to a small effect, 0.5 equates to a medium effect, and effects larger than 0.8 equate to large effects (Cohen, 1988).

---

[8] Although rough guidelines for interpreting effect sizes have been included in this study, effect size can also be interpreted as a comparison between the reported effect size and those reported in prior studies of a similar nature (Thompson, 2002a; Vaccha-Haase & Thompson, 2004).

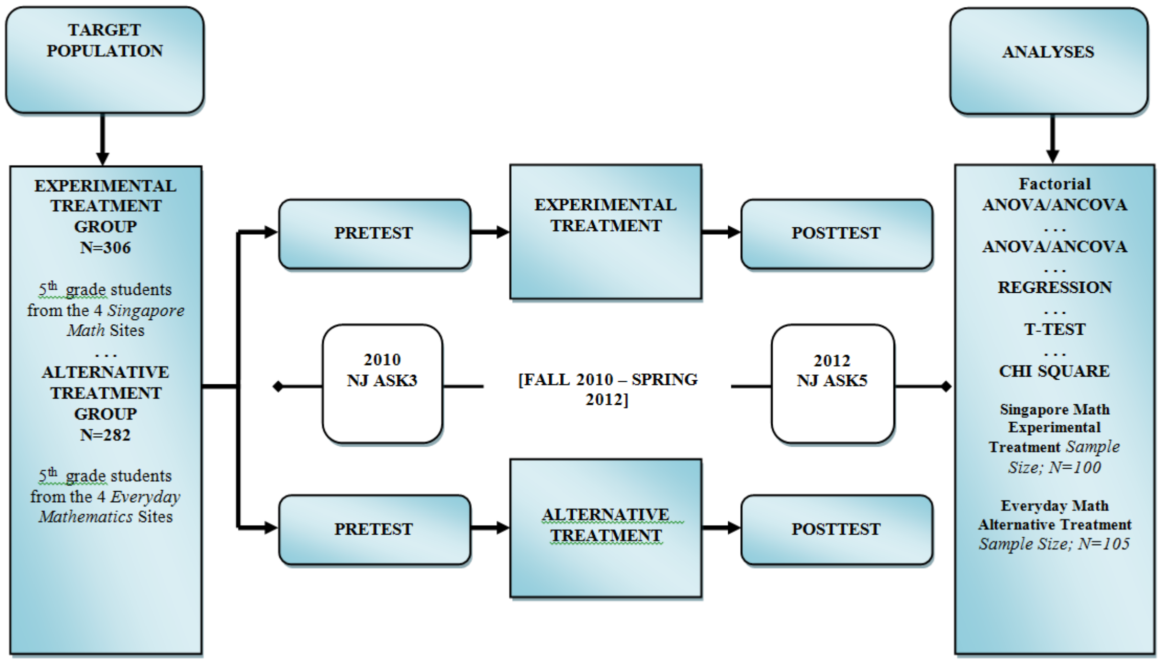


Figure 3. Research Design Schematic

Summary

This study employed an explanatory non-experimental research design using post hoc pre- and post-test data from 2010 NJ ASK3 and 2012 NJ ASK5 administrations. The qualifying experimental treatment and alternative treatment participants were Grade 5 general education students who were administered both the 2010 NJ ASK3 and the 2012 NJ ASK5 at their respective school sites.

A series of preliminary analyses, simple Chi Square (Goodness-of-Fit), r X k Chi Square, t-tests, and ANOVA, were employed in the study to determine comparability of the groups. The primary analyses, linear regression, multiple regression, hierarchical regression, one-way ANOVA and ANCOVA, factorial ANOVA, and factorial ANCOVA were employed to determine the effect of the independent variables (treatment, gender, SES, race/ethnicity, and attendance) on the dependent variable, performance on the mathematics portion of the Grade 5 Assessment of Skills and Knowledge.

As non-randomized designs possess an overall risk of spurious relationships, this design actively sought to isolate the effect of extraneous variables. Confounding variables were either actively excluded or controlled and are reflected in the types of analyses conducted.

The main findings are reported in Chapter IV. In addition, Chapter IV, when applicable, includes the verification of parametric assumptions (normality, linear correlation, homogeneity of regression slopes, homogeneity of variance), dependent variable scores, significance, F-ratio scores, means, and effect sizes.

CHAPTER IV

DATA ANALYSIS

Introduction

Chapter IV presents the results and findings of this study to address the problems posed in Chapter 1. Multiple data analyses were conducted and the results are reported and summarized to answer the primary research questions and test the hypotheses. When appropriate, the magnitude, statistical significance, and validation of results are presented. One ultimate goal drove the collection of the data and the subsequent data analysis for this study. The goal was to use research-based methodology to provide valid, informative, and credible data on curricular effectiveness, specifically data on the effectiveness of the two elementary school mathematics curricula presented in this study, *Singapore Math* (published by Houghton Mifflin Harcourt, 2010) and *Everyday Mathematics,* 3rd edition (currently published by the Wright Group/McGraw-Hill, 2007). The study used the results from the state-mandated NJ ASK mathematics assessment to examine the student achievement outcomes of Grade 5 students across several demographic characteristics (e.g., *race/ethnicity*, *gender*, *SES*). An explanatory non-experimental research design was employed, using post hoc pre- and post-test data from 2010 NJ ASK3 and 2012 NJ ASK5 administrations, respectively. Grade 3 NJ ASK 2010 performance data were used as the measure of pre-treatment achievement. Grade 5 NJ ASK 2012 performance data were used as the outcome measure and were examined at the treatment level. The qualifying experimental treatment sample (N=100) and alternative treatment sample (N=105) were Grade 5 general education students from eight schools within a large urban public school district who were administered both the 2010 NJ ASK3 and the 2012 NJ ASK5 at their respective school sites.

A series of preliminary analyses, simple Chi Square (Goodness-of-Fit), r X k Chi Square, t-tests, and ANOVA, were employed in the study to determine comparability of the groups. The primary analyses, linear regression, multiple regression, hierarchical regression, one-way ANOVA and ANCOVA, factorial ANOVA, and factorial ANCOVA, were employed to determine the effect of the independent variables (treatment, gender, SES, race/ethnicity, and attendance) on the dependent variable, performance on the mathematics portion of the Grade 5 Assessment of Skills and Knowledge. One research question, seven subsidiary questions, and their accompanying null hypotheses were analyzed and discussed in this chapter. Microsoft Excel's Data Analysis Tools and IBM's statistical analysis software, SPSS version 21.0, were utilized for data analysis. Differences were reported only if the comparisons were statistically significant, using the *F-ratio* statistic to determine statistical significance where $p \leq 0.05$. The potential implications for theory, knowledge, practice, policy, and future research are discussed in Chapter V.

Preliminary Analyses

Because this study retained the four alternative treatment sites initially paired by the district to each of the experimental treatment sites, the conduct of this comparative analysis needed to be strengthened (NRC, 2004). The initial intention of the researcher was to make gross comparisons between the paired schools. At both the school and treatment levels, a series of preliminary analyses were employed to establish adequate comparability of the paired groups and to analyze the interaction and effect of key variables. At the paired school level and at the treatment level, chi squares were used to determine whether there were significant differences between the main distributions (treatment, attendance, race/ethnicity, gender, and SES) (see Appendix B). At the treatment level, an Independent Samples t-test (Assuming Unequal Variances) was conducted to compare the 2010 NJ ASK3 performance level between the Everyday Math Alternative Treatment sample and the Singapore Math Experimental Treatment sample to ensure that "treatment status" did not give initial advantage to either group. Results of the preliminary analyses are discussed in the next section.

Summary of Preliminary Analyses

Preliminary chi square analyses performed at the paired school level revealed statistically significant differences in race/ethnicity, gender, and SES level. However, at the treatment level, once delimiting the treatment sample to (1) general education students (2) who were enrolled within their respective treatment site during schools years 2010-11 and 2011-12 (3) with reported mathematics score data from both the 2010 NJ ASK3 and the 2012 NJ ASK5 administrations, no significant differences were found between the qualifying alternative and experimental treatment samples when comparing distributions of race/ethnicity, gender, socioeconomic status (SES), and performance levels (past performance as measured by the 2010 NJ ASK3 data) (see Appendix B).

While it was entirely legitimate to isolate the variance in the post-treatment scores that was not associated with past performance in order to focus the treatment comparisons exclusively on post-treatment effects, preliminary analysis showed homogeneity of the treatment groups with regard to past performance. The Independent Samples t-test (Assuming Unequal Variances) revealed no significant difference in the pre-test mean scale score of the Everyday Math Alternative Treatment (M=221.95, SD=39.99) and pre-test mean scale score of the Singapore Math Experimental Treatment (M=219.44, SD=45.90); t(196)=0.417, p = 0.667, suggesting that there is no significant difference in past performance between the two treatment groups and thereby justifying the exclusion of the covariate in this study. The results are shown in Table 6.

As such, all primary analyses, linear regression, multiple regression, hierarchical regression, one-way ANOVA and ANCOVA, were used in this study to explore Grade 5 performance on the 2012 NJ ASK at the treatment level. Analyses were conducted to examine differences between the main variables that research tells us have influence on student performance (SES, treatment, attendance, gender, and race/ethnicity)(see Table 10). The qualifying Everyday Math Alternative Treatment (N=105) and the Singapore Math Experimental Treatment (N=100) were a representation of Grade 5 general education students residing in one of the four the district regions who remained within their respective schools sites for their third, fourth, and fifth grade years.

Statistical Power and Effect Size[9]

In the analyses of correlation and regression, the Pearson R^2 correlation was used to calculate effect sizes of statistically significant outcomes where the rough guideline for determining size is 0.1, small; 0.3, medium; 0.5, large (Cohen, 1988, 1992). For analyses or variance, effect sizes are reported as partial eta squared (η_p^2) where the rough guideline for determining size is 0.01, small; 0.06, medium; 0.138, large (Bruin, 2006).

[9] Although rough guidelines for interpreting effect sizes have been included in this study, effect size can also be interpreted as a comparison between the reported effect size and those reported in prior studies of a similar nature (Thompson, 2002a; Vaccha-Haase & Thompson, 2004).

Table 6

Independent Samples t-test Assuming Unequal Variances (2010 NJ ASK3 Data)

	Alternative Treatment	*Experimental Treatment*
Mean	221.952381	219.44
Variance	1599.10348	2107.036768
Observations	105	100
Hypothesized Mean Difference	0	
Standard Deviation	39.98879193	45.90247017
df	196	
t Stat	0.416996712	
P(T<=t) one-tail	0.338568584	
t Critical one-tail	1.652665059	
P(T<=t) two-tail	0.677137167	
t Critical two-tail	1.972141222	

For all t-tests, Cohen's d was used to calculate effect sizes of statistically significant outcomes, whereby 0.2 equates to a small effect, 0.5 equates to a medium effect, and effects larger than 0.8 equate to large effects (Cohen, 1988).

Testing the Assumptions

Criterion for dependent variable and the covariates. In this analysis, the dependent variables, 2010 NJ ASK3 performance level and 2012 NJ ASK5 performance level, were measured on a continuous scale (from 100 to 300). Attendance, also used as a covariate variable, was also on a continuous scale (from 0 to 370). Attendance was documented for all participants for school years 2010-2011 and 2011-2012 (the two successive years reflected within this study), and the total possible number of days (370) reported.

Criterion for categorical variables. The independent variables treatment, gender, SES, and Black&Hispanic/White each consisted of two or more categorical, independent groups. Examples of independent variables that meet this criterion include gender (2 groups: male and female), race/ethnicity (2 groups: Black&Hispanic and White), SES (2 groups: low SES and high SES), treatment (2 groups: Everyday Math Alternative Treatment and Singapore Math Experimental Treatment), and so forth.

Independence of observations. There was no relationship between the observations in each group or between the groups themselves. There were different participants in each treatment group with no participant being in more than one group.

Independence. The Durbin-Watson statistic was applied as a measure of autocorrelation between the residuals. In this analysis, Durbin-Watson statistics approximately equal to 2 indicate no serial correlation between the residuals (Durbin and Watson, 1950, 1951). Results of each test for independence are explained within the primary analyses of regression and variance.

Normality. Tests for normality were applied to make inferences as to whether the data sets for the continuous variables, 2010 NJ ASK3 and 2012 NJ ASK5, follow a normal distribution, using either the Shapiro-Wilk statistic or the Kolmogorov-Smirnov statistic when appropriate (see Appendix C). The 2010 NJ ASK3 scale scores of the Everyday Math participants ranged from 128 to 300 (M = 221.95, SD = 39.99) and were normally distributed with skewness of 0.091 (SE = 0.236) and kurtosis of 0.209 (SE = 0.467). The 2012 NJ ASK5 scale scores of the Everyday Math participants ranged from 140 to 300 (M = 225.45, SD = 33.429) and were normally distributed with skewness of 0.125 (SE = 0.236) and kurtosis of 0.111 (SE = 0.467). The 2010 NJ ASK3 scale scores of the Singapore Math participants ranged from 128 to 300 (M = 219.44, SD = 45.902) and were normally distributed with skewness of 0.144 (SE = 0.241) and kurtosis of

-0.796 (SE = 0.478). The 2012 NJ ASK5 scale scores of the Singapore Math participants ranged from 146 to 300 (M = 220.88, SD = 37.752) and were normally distributed with skewness of 0.117 (SE = 0.241) and kurtosis of -0.745 (SE = 0.478).

Homogeneity of variance. Levene's Test of Equality was applied in all analyses of variance and covariance to assess the homogeneity of variance, an inferential statistic used to assess the equality of variances for a variable calculated for two or more groups. The null hypothesis for this statistic assumes that the population variances are equal, indicating that there is a difference between the variances in the population. Results of each test are presented within each analysis. In cases where the assumption was not met ($p < 0.05$), additional analyses were conducted to verify findings.

Descriptive Statistics

Table 7 displays treatment level data. One hundred and five (N=105) Grade 5 students represented the qualifying Everyday Math Alternative Treatment sample. One hundred (N=100) Grade 5 students represented the qualifying Singapore Math Experimental Treatment sample. The attendance rate was 95.92% for the Everyday Math Alternative Treatment and 94.58% for the Singapore Math Experimental Treatment. 86.7% of the Everyday Math Alternative Treatment participants and 85.0% of the Singapore Math Experimental Treatment participants were low SES (receiving free or reduced lunch). 41.9% of the Everyday Math Alternative Treatment participants and 39.0% of the Singapore Math Experimental Treatment participants were male. 58.1% of the Everyday Math Alternative Treatment participants and 61.0% of the Singapore Math Experimental Treatment participants were female. 47.6%% of the Everyday Math Alternative Treatment participants and 51.0% of the Singapore Math Experimental

Treatment participants were Black. 38.1% of the Everyday Math Alternative Treatment participants and 37.0% of the Singapore Math Experimental Treatment participants were Hispanic. 13.3% of the Everyday Math Alternative Treatment participants and 11.0% of the Singapore Math Experimental Treatment participants were White. 1.0% of the Everyday Math Alternative Treatment participants and 1.0% of the Singapore Math Experimental Treatment participants were Other. 74.3% of the Everyday Math Alternative Treatment participants and 66.0% of the Singapore Math Experimental Treatment participants were Proficient on the 2010 NJ ASK3. 85.7% of the Everyday Math Alternative Treatment participants and 71.0% of the Singapore Math Experimental Treatment participants were Proficient on the 2012 NJ ASK5.

Table 8 displays the Grade 3 2010 NJ ASK and Grade 5 2012 NJ ASK performance data disaggregated by treatment, SES status, race/ethnicity, and gender.

Table 7

Grade 5 2012Treatment Level Data

	Everyday Math Alternative Treatment	Singapore Math Experimental Treatment
N (Students)	105	100
Attendance Rate[10]	95.92	94.58
Percent Low SES	86.7	85.0
Percent Male	41.9	39.0
Percent Female	58.1	61.0
Percent Black	47.6	51.0
Percent Hispanic	38.1	37.0
Percent White	13.3	11.0
Percent Other	1.0	1.0
Percent Proficient-NJ ASK3	74.3	66.0
Percent Proficient-NJ ASK5	85.7	71.0

The 2012 NJ ASK5 mean scale score for the Everyday Math Alternative Treatment group (N=105) was 225.45 (SD = 33.43). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment group (N=100) was 220.88 (SD = 37.75). The 2012 NJ ASK5 mean scale score for the Everyday Math Alternative Treatment subgroup low SES (N=91) was 224.73 (SD = 33.82). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment subgroup low SES (N=85) was 220.99 (SD =37. 95). The 2012 NJ ASK5 scale score mean for the Everyday Math Alternative Treatment subgroup higher SES (N=14) was 230.14 (SD = 31.54). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment subgroup higher SES (N=15) was 220.27 (SD =37.93). The 2012 NJ ASK5 mean scale score for the Everyday Math Alternative Treatment subgroup Black (N=50) was 211.60

[10] Attendance Rate is reported as a percentage of the total possible days (370) for the two successive years reflected in this study.

(SD = 29.28). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment subgroup Black (N=51) was 205.94 (SD=29.69). The 2012 NJ ASK5 mean scale score for the Everyday Math Alternative Treatment subgroup Hispanic (N=40) was 233.50 (SD = 33.45). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment subgroup Hispanic (N=37) was 225.92 (SD =37.29). The 2012 NJ ASK5 mean scale score for the Everyday Math Alternative Treatment subgroup, White (N=14) was 251.93 (SD = 25.72). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment subgroup White (N=11) was 267.18 (SD =25.86). The 2012 NJ ASK5 mean scale score for the Everyday Math Alternative Treatment subgroup Other (N=1) was 225 (SD = N/A). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment subgroup Other (N=1) was 287 (SD =N/A). The 2012 NJ ASK5 mean scale score for the Everyday Math Alternative Treatment subgroup females (N=61) was 224.20 (SD = 31.33). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment subgroup females (N=61) was 215.28 (SD =37.51). The 2012 NJ ASK5 mean scale score for the Everyday Math Alternative Treatment subgroup males (N=44) was 227.18; (SD = 36.44). The 2012 NJ ASK5 mean scale score for the Singapore Math Experimental Treatment subgroup males (N=39) was 229.64 (SD =36.904).

Table 8

2010 and 2012 NJ ASK Performance Data by Subgroup

	Everyday Math Alternative Treatment		Singapore Math Experimental Treatment	
	2010 NJ ASK3	2012 NJ ASK5	2010 NJ ASK3	2012 NJ ASK5
Total Students	N=105	N=105	N=100	N=100
Mean	221.95	225.45	219.44	220.88
Standard Deviation	39.989	33.43	45.902	37.75
Low SES	N = 91	N = 91	N = 85	N = 85
Mean	219.09	224.73	218.04	220.99
Standard Deviation	39.334	33.818	47.025	37.945
Higher SES	N = 14	N = 14	N = 15	N = 15
Mean	240.57	230.14	227.40	220.27
Standard Deviation	40.631	31.542	39.390	37.929
Black	N = 50	N = 50	N = 51	N = 51
Mean	212.18	211.60	201.88	205.94
Standard Deviation	33.747	29.275	33.451	29.690
Hispanic	N = 40	N = 40	N = 37	N = 37
Mean	225.58	233.50	225.16	225.92
Standard Deviation	45.112	33.446	49.485	37.287
White	N = 14	N = 14	N = 11	N = 11
Mean	246.79	251.93	274.27	267.18
Standard Deviation	36.358	25.722	28.278	25.864
Other	N = 1	N = 1	N = 1	N = 1
Mean	218	225	300	287
Standard Deviation	.	.	.	.
Females	N = 61	N = 61	N = 61	N = 61
Mean	220.72	224.20	212.67	215.28
Standard Deviation	38.445	31.332	44.804	37.513
Males	N = 44	N = 44	N = 39	N = 39
Mean	223.66	227.18	230.03	229.64
Standard Deviation	39.989	36.437	46.166	36.904

Primary Analyses

Linear regression, multiple regression, hierarchical regression, one-way ANOVA, ANCOVA, factorial ANOVA and factorial ANCOVA were used in this study to explore Grade 5 performance on the 2012 NJ ASK at the treatment level. Independent and dependent variables are described in Table 9.

Research Questions

What is the impact of implementing a proposed CCSSM-aligned mathematics program, Singapore Math, on mathematics achievement of grade 5 general education students as measured by the 2012 Grade 5 NJ ASK (NJ ASK5), in comparison to the mathematics achievement of Grade 5 general education students using a NCTM-aligned elementary mathematics program, Everyday Mathematics, in the Large Northeastern Urban Public School District?

Subsidiary Question 1

How much variance in the 2012 NJ ASK5 mean scale score can be explained by the predictor variables treatment, attendance, gender, race/ethnicity, and SES?

Subsidiary Question 2

Is there a statistically significant difference in the 2012 NJ ASK5 performance level of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment when controlling for attendance?

Subsidiary Question 3

To what extent do differences in performance exist when data are analyzed according to 2012 NJ ASK5 performance levels (Partially Proficient, Proficient, and

Advanced Proficient) and treatment status; and is there significant interaction between the performance levels and treatment?

Subsidiary Question 4

Is there a statistically significant difference in the 2012 NJ ASK5 performance level of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic); and is there significant interaction between treatment status and race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic)?

Subsidiary Question 5

How much variance in the 2012 NJ ASK5 mean scale score of Black students can be explained by the predictor variables treatment, attendance, gender, and SES?

Subsidiary Question 6

How much variance in the 2012 NJ ASK5 mean scale score of Hispanic students can be explained by the predictor variables treatment, attendance, gender, and SES?

Subsidiary Question 7

Is there a statistically significant difference in the 2012 NJ ASK5 performance level of Hispanic students based on SES classification and treatment status when controlling for attendance; and is there significant interaction between treatment status and SES classification for Hispanic students when controlling for attendance?

Table 9

Description of the Variables

Field	Description
Dependent Variable	MathScaleScore2012 - Continuous variable representing the 2012 NJ ASK5 scale scores
Independent Variables	
MathScaleScore2010	Continuous variable representing the 2010 NJ ASK3 scale scores
PerformanceLevel2010	Categorical variable representing the 2010 NJ ASK3 proficiency levels; (1-Advanced, 2 – Proficient, 3 – Partial)
PerformanceLevel2012	Categorical variable representing the 2012 NJ ASK5 proficiency levels; (1-Advanced, 2 – Proficient, 3 – Partial)
Treatment	Dichotomous variable of treatment status; Everyday Math Alternative or Singapore Math Experimental
Pass_Fail2012	Dichotomous variable representing 2012 NJ ASK5 performance status; Pass – scoring 200 and above or Fail – scoring below 200
Black&Hispanic/White	Dichotomous variable representing race/ethnicity status; Black/Hispanic or White/Other* **Other* (N=1), in both treatment groups and is combined with *White* in each analysis
Black/Hispanic	Dichotomous variable representing race/ethnicity status; Black or Hispanic
SES	Dichotomous variable representing socioeconomic status; low SES – qualifying for free/reduced lunch; higher SES – not qualifying for free/reduced lunch
Gender	Dichotomous variable representing gender; male or female
Attendance_2yr	Continuous variable representing the total number of days in attendance for school years 2010-11 and 2011-12
2010 Partially Proficient	Continuous variable representing the 2010 NJ ASK3 scale scores of students scoring less than 200 on the 2010 NJ ASK3
2012_ Same2010PP	Categorical variable representing the 2012 NJ ASK5 scale scores of students scoring less than 200 on the 2010 NJ ASK3
2010 Proficient	Continuous variable representing the 2010 NJ ASK3 scale scores of students scoring 200 to 249 on the 2010 NJ ASK3
2012_ Same2010P	Categorical variable representing the 2012 NJ ASK5 scale scores of students scoring 200 to 249 on the 2010 NJ ASK3
2010 Advanced Proficient	Continuous variable representing the 2010 NJ ASK3 scale scores of students scoring 250 and above on the 2010 NJ ASK3
2012_ Same2010AP	Categorical variable representing the 2010 NJ ASK3 scale scores of students scoring 250 and above on the 2010 NJ ASK3

Table 10

Summary of Analyses

Subsidiary Question 1: How much variance in the 2012 NJ ASK5 mean scale score can be explained by the predictors treatment, attendance, gender, race/ethnicity and SES?	**Hypothesis 1**...............	**Multiple & Stepwise Regression**
	Assumptions	Met all assumptions
	Dependent Variable	MathScaleScore2012
	Covariate	None
	Predictor Variables	Treatment, attendance, gender, black&Hispanic/white, SES
Subsidiary Question 2: Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment when controlling for attendance?	**Hypothesis 2**...............	**ANCOVA**
	Assumptions	Met all assumptions
	Dependent Variable	MathScaleScore2012
	Covariate	Attendance
	Independent Variable(s)	Treatment
Subsidiary Question 3: To what extent do differences in performance exist when data is analyzed according to 2012 NJ ASK5 performance levels (Partially Proficient, Proficient, and Advanced Proficient) and treatment status; and is there significant interaction between the performance levels and treatment?	**Hypotheses 3a, 3b**.........	**Independent Samples T-Test**
	Assumptions	Met all assumptions
	Dependent Variable	MathScaleScore2012
	Independent Variable(s)	MathScaleScore2010
	Hypotheses 3c..............	**Factorial ANOVA**
	Assumptions	Met all assumptions
	Dependent Variable	MathScaleScore2012
	Covariate	None
	Independent Variable(s)	Treatment,MathPerformanceLevel2012
	Hypothesis 3d, 3e.........	**ANOVA**
	Assumptions	Met all assumptions
	Dependent Variable	MathScaleScore2012
	Covariate	None
	Independent Variable(s)	Treatment, Pass/Fail (split file)

Subsidiary Question 4: Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity (e.g. black, Hispanic, white, subset of black/Hispanic); and is there significant interaction between treatment status and race/ethnicity (e.g. black, Hispanic, white, subset of black/Hispanic)?	**Hypothesis 4a**............. Assumptions Dependent Variable Covariate Independent Variable(s)	**Factorial ANOVA** Met all assumptions MathScaleScore2012 None Treatment, Black&Hispanic/white
	Hypothesis 4b, 4c......... Assumptions Dependent Variable Covariate Independent Variable(s)	**ANOVA** Met all assumptions MathScaleScore2012 None Treatment, Black&Hispanic/white (split file)
	Hypothesis 4d........... Assumptions Dependent Variable Covariate Independent Variable(s)	**Factorial ANOVA** Met all assumptions MathScaleScore2012 None Treatment, (Black&Hispanic)
	Hypothesis 4e, 4f......... Assumptions Dependent Variable Covariate Independent Variable(s)	**ANOVA** Partially met assumptions (4f) MathScaleScore2012 None Black&Hispanic, Treatment (split file)
Subsidiary Question 5: How much variance in the 2012 NJ ASK5 mean scale score of black students can be explained by the predictors treatment, attendance, gender, and SES?	**Hypothesis 5**.............. Assumptions Dependent Variable Predictor Variable(s)	**Multiple Regression** Met all assumptions MathScaleScore2012 (Black) Treatment, attendance, gender, SES
Subsidiary Question 6: How much variance in the 2012 NJ ASK5 mean scale score of Hispanic students can be explained by the predictors treatment, attendance, gender, and SES?	**Hypothesis 6**.............. Assumptions Dependent Variable Predictor Variable(s)	**Multiple Regression** Met all assumptions MathScaleScore2012(Hispanic) Treatment, attendance, gender, SES
Subsidiary Question 7: Is there a statistically significant difference in the 2012 NJ ASK5 performance of Hispanic students based on SES classification and treatment status when controlling for attendance; and is there significant interaction between treatment status and SES classification for Hispanic students when controlling for attendance?	**Hypothesis 7a**........... Assumptions Dependent Variable Covariate Independent Variable(s)	**ANCOVA** Met all assumptions MathScaleScore2012 (Hispanic) Attendance SES, Treatment (split file)
	Hypothesis 7b........... Assumptions Dependent Variable Covariate Independent Variable(s)	**Factorial ANCOVA** Met all assumptions MathScaleScore2012 (Hispanic) Attendance SES, Treatment

Subsidiary Question 1

How much variance in the 2012 NJ ASK5 mean scale score can be explained by the predictor variables treatment, attendance, gender, race/ethnicity, and SES?

Null Hypothesis 1

H_0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, Black&Hispanic/White and SES account for no variation in student performance on the 2012 NJ ASK5.

Multiple and hierarchical regressions were used as exploratory analyses to determine how strongly a set of predictor variables, when taken together, will predict performance.

A simultaneous regression analysis was conducted to determine the degree to which the predictor variables treatment, attendance, gender, Black&Hispanic/White and SES account for variation in student performance on the 2012 NJ ASK5 and to determine which of the variables, if any, are significant predictors of performance on the 2012 NJ ASK5. Basic descriptive statistics, correlations, model summaries, ANOVA, and regression coefficients are shown in Tables 11 through 14. Collinearity statistics, revealed VIFs less than 2 indicating that there was not a high correlation among the predictor variables (Allison, 1999). The Durbin-Watson statistic was applied as a measure of correlation between the residuals. In this analysis, the value of the Durbin-Watson statistic is 1.743, approximately equal to 2, indicating no serial correlation between the residuals (Durbin & Watson, 1950, 1951).

The current model showed a significant proportion of variance in the *2012 NJ* ASK5 performance (16.5%) was attributed to the combination of predictor variables treatment, attendance, gender, Black&Hispanic/White, and SES with an $R = 0.431$, R^2_{adj}

= 0.165, F(5, 199) = 9.06, p < 0.05. Coefficient statistics revealed that the predictor variables attendance and Black&Hispanic/White were the only variables within the model explaining a statistically significant proportion of variance in performance

- Attendance, β =0.196 (explaining 3.8% of variance), t(205) = 3.006, p<0.05
- Black&Hispanic/White, β =0.354 (explaining 12.5% of variance), t(205) = 5.496, p<0.05

The variables treatment, gender, and SES were not significant predictors of performance in this model. Though treatment was not a significant indicator of performance, it was retained as a fixed or grouping variable in all subsequent analyses.

Table 11

Descriptive Statistics of Multiple Regression Mode l - Treatment, Attendance, Gender, Black&Hispanic/White and SES

Descriptive Statistics

	Mean	Std. Deviation	N
MathScaleScore2012	223.22	35.589	205
Attendance_2yr	352.4829	15.32646	205
SES	.86	.349	205
Gender	.60	.492	205
Black&Hispanic/White	.1268	.33360	205
Treatment	.49	.501	205

Table 12

Model Summary of Multiple Regression Mode l- Treatment, Attendance, Gender, Black&Hispanic/White and SES

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.431[a]	.185	.165	32.522	1.743

a. Predictors: (Constant), Treatment, Black&Hispanic/White, Gender, SES, Attendance_2yr

b. Dependent Variable: MathScaleScore2012

Table 13

ANOVA of Multiple Regression Model - Treatment, Attendance, Gender, Black&Hispanic/White and SES

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	47897.852	5	9579.570	9.057	.000[a]
	Residual	210483.270	199	1057.705		
	Total	258381.122	204			

a. Predictors: (Constant), Treatment, Black&Hispanic/White, Gender, SES, Attendance_2yr

b. Dependent Variable: MathScaleScore2012

Table 14

Coefficient Statistics of Multiple Regression Model - Treatment, Attendance, Gender, Black&Hispanic/White and SES

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	62.389	53.673		1.162	.246					
	Attendance_2yr	.456	.152	.196	3.006	.003	.217	.208	.192	.961	1.041
	SES	.500	6.637	.005	.075	.940	-.021	.005	.005	.964	1.037
	Gender	-7.105	4.669	-.098	-1.522	.130	-.119	-.107	-.097	.982	1.018
	black&Hispanic/white	37.764	6.872	.354	5.496	.000	.366	.363	.352	.987	1.013
	Treatment	-1.592	4.607	-.022	-.345	.730	-.064	-.024	-.022	.973	1.028

a. Dependent Variable: MathScaleScore2012

A stepwise regression analysis was conducted to determine the independent variable(s) best correlated with the dependent variable, 2012 NJ ASK5 performance. Basic descriptive statistics, correlations, model summaries, ANOVA, and regression coefficients are shown in Tables 15 through 18. Collinearity statistics revealed VIFs less than 2 in all cases, indicating that there was not a high correlation among the predictor variables (Allison, 1999). The Durbin-Watson statistic was applied as a measure of correlation between the residuals. In this analysis, the value of the Durbin-Watson statistic is 1.703, approximately equal to 2, indicating no serial correlation between the residuals (Durbin & Watson, 1950, 1951). The analysis presented two statistically significant models. Model 1 showed a significant proportion of variance in 2012 NJ ASK5 performance attributed to the predictor Black&Hispanic/White, R = 0.366, R^2_{adj} = .130, F(1, 203) = 31.47, $p < 0.05$ and β =0.366, t (205) = 5.610, p<0.05. Model 2 showed a significant proportion of variance in 2012 NJ ASK5 performance attributed to the predictor variables Black&Hispanic/White and attendance, R = 0.419, R^2_{adj} = .167, F(2, 202) = 21.460, $p < 0.05$, and each predictor variable within the model is also significant at the level p<0.05

- Black&Hispanic/White, β =0.358 (explaining 12.8% of variance), t (205) = 5.598, $p<0.05$
- Attendance, β =0.203 (explaining 4.1% of variance), t (205) = 3.170, $p<0.05$

In Model 2, the R^2 change= 0.041 was significant with p<0.05. Overall results show that the variables Black&Hispanic/White and attendance account for a significant proportion of variation in student performance. The variables treatment, gender, and SES were not significant predictors of performance in this model.

Table 15

Descriptive Statistics of Stepwise Regression Model - Treatment, Attendance, Gender, Black&Hispanic/White and SES

Descriptive Statistics

	Mean	Std. Deviation	N
MathScaleScore2012	223.22	35.589	205
Attendance_2yr	352.4829	15.32646	205
SES	.86	.349	205
Gender	.60	.492	205
black&Hispanic/white	.1268	.33360	205
Treatment	.49	.501	205

Table 16

Model Summary of Stepwise Regression Model - Treatment, Attendance, Gender, Black&Hispanic/White and SES

Model Summary[c]

Model				Std. Error	Change Statistics					
	R	R Square	Adjusted R Square	of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.366[a]	.134	.130	33.196	.134	31.469	1	203	.000	
2	.419[b]	.175	.167	32.480	.041	10.048	1	202	.002	1.703

a. Predictors: (Constant), Black&Hispanic/White
b. Predictors: (Constant), Black&Hispanic/White, Attendance_2yr
c. Dependent Variable: MathScaleScore2012

Table 17

ANOVA of Stepwise Regression Mode l- Treatment, Attendance, Gender, Black&Hispanic/White and SES

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34678.578	1	34678.578	31.469	.000[a]
	Residual	223702.544	203	1101.983		
	Total	258381.122	204			
2	Regression	45279.294	2	22639.647	21.460	.000[b]
	Residual	213101.828	202	1054.960		
	Total	258381.122	204			

a. Predictors: (Constant), Black&Hispanic/White

b. Predictors: (Constant), Black&Hispanic/White, Attendance_2yr

c. Dependent Variable: MathScaleScore2012

Table 18

Coefficient Statistics of Stepwise Regression Model - Treatment, Attendance, Gender, Black&Hispanic/White and SES

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
1 (Constant)	218.263	2.481		87.967	.000					
Black&Hispanic/White	39.084	6.967	.366	5.610	.000	.366	.366	.366	1.000	1.000
2 (Constant)	52.448	52.365		1.002	.318					
black&Hispanic/White	38.193	6.823	.358	5.598	.000	.366	.366	.358	.998	1.002
Attendance_2yr	.471	.149	.203	3.170	.002	.217	.218	.203	.998	1.002

a. Dependent Variable: MathScaleScore2012

Subsidiary Question 2

Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment when controlling for attendance?

Null Hypothesis 2

There is no significant difference in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5 when controlling for attendance.

An ANCOVA was conducted to determine whether there were statistically significant differences in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5 when controlling for attendance. The results are shown in Tables 19 through 22. The resulting p-value ($p>0.05$), allowed the null hypothesis of equal variances to be accepted, and it is concluded that there are no differences in the variances of the sample populations. Results are reported in Table 20. All other assumptions for ANCOVA were met for this analysis (see Appendix C).

The mean scale score of the Everyday Math Alternative Treatment (N = 105) was 225.45 (SD = 33.43); the mean scale score of the Singapore Math Experimental Treatment (N = 100) was 220.88 (SD = 37.75). Results showed that the covariate attendance, was statistically significant with a p-value < 0.05; $F(1, 76) = 9.343$, $\eta_{\rho}^{2} = 0.044$, $p = 0.003$. The effect of treatment was not statistically significant. Estimated marginal means are reported in Table 22.

Table 19

Descriptive Statistics of ANCOVA - Overall Performance, Controlling Attendance

Descriptive Statistics

Dependent Variable: MathScaleScore2012

Treatment	Mean	Std. Deviation	N
Alternative Treatment (Everyday Math)	225.45	33.429	105
Experimental Treatment (Singapore Math)	220.88	37.752	100
Total	223.22	35.589	205

Table 20

Levene's Test of Equality of ANCOVA - Overall Performanc, Controlling Attendance

Levene's Test of Equality of Error Variances[a]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
2.070	1	203	.152

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Attendance_2yr + Treatment

Table 21

Tests of Between-Subjects Effects of ANCOVA- Overall Performance, Controlling Attendance

Tests of Between-Subjects Effects

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	12443.437[a]	2	6221.719	5.110	.007	.048	10.220	.818
Intercept	906.359	1	906.359	.744	.389	.004	.744	.138
Attendance_2yr	11374.837	1	11374.837	9.343	.003	.044	9.343	.860
Treatment	224.410	1	224.410	.184	.668	.001	.184	.071
Error	245937.685	202	1217.513					
Total	10472906.000	205						
Corrected Total	258381.122	204						

a. R Squared = .048 (Adjusted R Squared = .039)

b. Computed using alpha = .05

Table 22

Estimated Marginal Means of ANCOVA - Overall Performanc, Controlling Attendance

Dependent Variable: MathScaleScore2012

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Alternative Treatment (Everyday Math)	224.254[a]	3.428	217.496	231.013
Experimental Treatment (Singapore Math)	222.133[a]	3.513	215.206	229.060

a. Covariates appearing in the model are evaluated at the following values: Attendance_2yr = 352.4829.

Subsidiary Question 3

To what extent do differences in performance exist when data are analyzed according to 2012 NJ ASK5 performance levels (Partially Proficient, Proficient, and Advanced Proficient) and treatment status; and is there significant interaction between the performance levels and treatment?

Null Hypothesis 3a

There is no significant difference between the Everyday Math Alternative Treatment's 2010 NJ ASK3 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient) and the Everyday Math Alternative Treatment's 2012 NJ ASK5 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient).

An Independent samples t-test was conducted comparing the Everyday Math Alternative Treatment's 2010 NJ ASK3 performance at each performance level (Partially Proficient, Proficient, and Advanced Proficient) prior to treatment and the performance of the same cohort (scoring Partially Proficient, Proficient, or Advanced Proficient on the 2010 NJ ASK3) after treatment. There was a statistically significant difference between the mean scale score of students scoring Partially Proficient (N=27) on the 2010 NJ ASK3 (M=172.15, SD=19.13) and the 2012 NJ ASK5 mean scale score of the same cohort of students (M=192.56, SD=25.861); t(27)= -4.018, p = 0.000, d =0.897. There was a statistically significant difference between the mean scale score of students scoring Advanced Proficient (N=26) on the 2010 NJ ASK3 (M=275.19, SD=19.57) and the 2012 NJ ASK5 mean scale score of same cohort of students (M=262.69, SD=25.884); t(26)= 4.377, p = 0.002, d = 0.545. There was no statistically significant difference between the mean scale score of students scoring Proficient (N=52) on the 2010 NJ ASK3

(M=221.19, SD=11.312) and the 2012 NJ ASK5 mean scale score of the same cohort of students (M=223.90, SD=18.085); t(52)= .495, p = 0.319. The results are shown in Table 23 and 24.

Table 23

Descriptive Statistics of Independent Samples t-test, Performance Level Comparisons for Everyday Math Alternative Treatment

	N	Range	Minimum	Maximum	Mean	Std. Deviation
2010 Partially Proficient	27	68	128	196	172.15	19.127
2012_ Same2010PP	27	102	140	242	192.56	25.861
2010 Proficient	52	45	200	245	221.19	11.312
2012_Same2010P	52	99	188	287	223.90	18.085
2010 Advanced Proficient	26	50	250	300	275.19	19.565
2012 _Same2010AP	26	96	204	300	262.69	25.884

Table 24

Independent Samples, Performance Level Comparisons for Everyday Math Alternative Treatment

Independent Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	2010 Partially Proficient 2012_ Same2010PP	-20.407	26.394	5.079	-30.848	-9.966	-4.018	26	.000
Pair 2	2010 Proficient 2012_Same2010P	-2.712	19.436	2.695	-8.122	2.699	-1.006	51	.319
Pair 3	2010 Advanced Proficient 2012 2012 _Same2010AP	12.500	18.749	3.677	4.927	20.073	3.399	25	.002

Null Hypothesis 3b

There is no significant difference between the Singapore Math Experimental Treatment's 2010 NJ ASK3 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient) and the Singapore Math Experimental Treatment's 2012 NJ ASK5 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient).

An Independent samples t-test was conducted to compare Singapore Math Experimental Treatment's 2010 NJ ASK3 performance at each performance level (Partially Proficient, Proficient, and Advanced Proficient) prior to treatment and the performance of the same cohort of students (scoring Partially Proficient, Proficient, or Advanced Proficient on the 2010 NJ ASK3) after treatment. There was a statistically significant difference between the mean scale score of students scoring Partially Proficien*t* (N=34) on the 2010 NJ ASK3 (M=169.91, SD=18.99) and the 2012 NJ ASK5 mean scale score of the same cohort of students (M=189.85, SD=23.96); t(34)= -5.753, p = 0.000, d = 0.922. There was also a statistically significant difference between the mean scale score of students scoring Advanced Proficient (N=28) on the 2010 NJ ASK3 (M=277.68, SD=19.50) and the 2012 NJ ASK5 mean scale score of the same cohort of students (M=261.21, SD=22.94); t(28)= 4.377, p = 0.000, d = 0.774. There was no statistically significant difference between the mean scale score of students scoring Proficient (N=38) on the 2010 NJ ASK3 (M=220.84, SD=14.689) and the 2012 NJ ASK5 mean scale score of the same cohort of students (M=218.92, SD=28.237); t(38)= 0.495, p = 0.624. The results are shown in Tables 25 and 26.

Table 25

Descriptive Statistics of Independent Samples t-test, Performance Level Comparisons, Singapore Math

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
2010 Partially Proficient	34	68	128	196	169.91	18.990
2012_ Same2010PP	34	96	146	242	189.85	23.964
2010 Proficient	38	45	200	245	220.84	14.689
2012_Same2010P	38	114	160	274	218.92	28.237
2010 Advanced Proficient	28	50	250	300	277.68	19.499
2012 _Same2010AP	28	87	213	300	261.21	22.943

Table 26

Independent Samples t-test, Performance Level Comparisons, Singapore Math

Independent Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	2010PP_Singapore & 2012_Same2010PP	-19.941	20.211	3.466	-26.993	-12.889	-5.753	33	.000
Pair 2	2010P_Singapore & 2012P_Same2010P	1.921	23.943	3.884	-5.949	9.791	.495	37	.624
Pair 3	2010AP_Singapore & 2012AP_Same2010AP	16.464	19.903	3.761	8.747	24.182	4.377	27	.000

Null Hypothesis 3c

There is no significant interaction between the independent variables *treatment* and performancelevel2012 (the categorical variable representing the 2012 NJ ASK5 proficiency levels: Advanced Proficient, Proficient, and Partially Proficient).

To address the null hypothesis, a Factorial ANOVA was conducted incorporating the independent variables treatment and performancelevel2012 (the categorical variable representing the 2012 NJ ASK5 proficiency levels: Advanced Proficient, Proficient, and Partially Proficient). The results are shown in Tables 27 through 30. Levene's Test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$) allowed the null hypothesis of equal variances to be accepted and it is concluded that there are no differences in the variances of the sample populations. Results are reported in Table 28. All other assumptions for ANOVA were met for this analysis (see Appendix C).

The mean scale score of Everyday Math students scoring Advanced Proficient (N=23) was 273.17 (SD = 16.30), scoring Proficient (N= 67) was 220.52 (SD = 13.92), and scoring Partially Proficient (N= 15) was 174.27 (SD = 17.49). The mean scale score of Singapore Math students scoring Advanced Proficient (N=26) was 269.50 (SD = 15.58), scoring Proficient (N= 45) was (221.36, SD = 15.47), and scoring Partially Proficient (N=29) was 176.55 (SD = 14.68). The interaction of treatment and performancelevel2012 was not statistically significant, suggesting that there was no significant difference in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on performance level.

The variable performancelevel2012 was the only statistically significant variable in this analysis with p values < 0.05.

Table 27

Descriptive Statistics of Factorial ANOVA, Treatment and 2012 Performance Level

Descriptive Statistics

Dependent Variable: MathScaleScore2012

Treatment	PerformanceLevel2012	Mean	Std. Deviation	N
Alternative Treatment (Everyday Math)	Advanced Proficient	273.17	16.300	23
	Proficient	220.52	13.919	67
	Partially Proficient	174.27	17.487	15
	Total	225.45	33.429	105
Experimental Treatment (Singapore Math)	Advanced Proficient	269.50	15.578	26
	Proficient	221.36	15.473	45
	Partially Proficient	176.55	14.681	29
	Total	220.88	37.752	100

Table 28

Levene's Test of Equality of Factorial ANOVA, Treatment and 2012 Performance Level

Levene's Test of Equality of Error Variances[a]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
.812	5	199	.543

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Treatment + PerformanceLevel2012 + Treatment * PerformanceLevel2012

Table 29

Tests of Between-Subjects Effects of Factorial ANOVA, Treatment and 2012 Performance Level

Tests of Between-Subjects Effects

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	212832.184[a]	5	42566.437	185.970	.000	.824	929.848	1.000
Intercept	8096800.971	1	8096800.971	35374.335	.000	.994	35374.335	1.000
Treatment	1.402	1	1.402	.006	.938	.000	.006	.051
PerformanceLevel2012	203747.230	2	101873.615	445.078	.000	.817	890.157	1.000
Treatment * PerformanceLevel2012	235.034	2	117.517	.513	.599	.005	1.027	.134
Error	45548.938	199	228.889					
Total	10472906.000	205						
Corrected Total	258381.122	204						

a. R Squared = .824 (Adjusted R Squared = .819)

b. Computed using alpha = .05

Table 30

Estimated Marginal Means of Factorial ANOVA, Treatment and Performance Level

1. Treatment * PerformanceLevel2012

Dependent Variable: MathScaleScore2012

Treatment	PerformanceLevel2012	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Alternative Treatment (Everyday Math)	Advanced Proficient	273.174	3.155	266.953	279.395
	Proficient	220.522	1.848	216.878	224.167
	Partially Proficient	174.267	3.906	166.564	181.970
Experimental Treatment (Singapore Math)	Advanced Proficient	269.500	2.967	263.649	275.351
	Proficient	221.356	2.255	216.908	225.803
	Partially Proficient	176.552	2.809	171.012	182.092

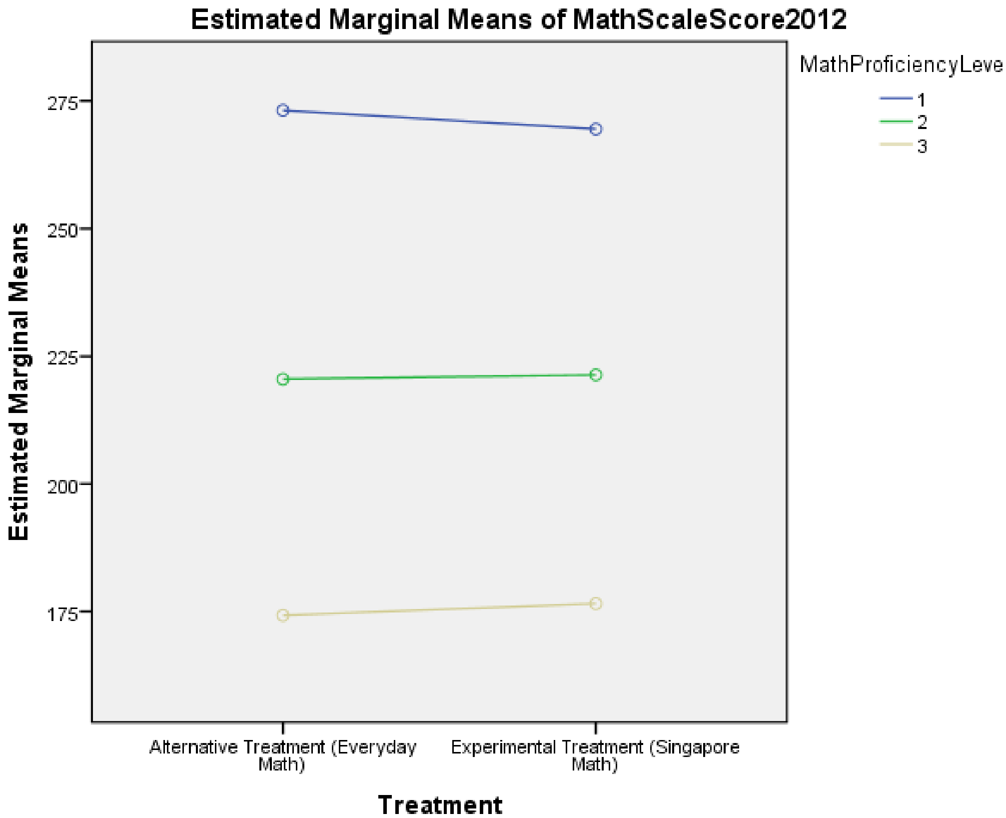


Figure 4. Estimated Marginal Means of MathScaleScore2012 at each Performance Level

Null Hypothesis 3d

There is no significant difference between the mean scale scores of those students scoring Proficient on the 2012 NJ ASK5 (scoring 200 and above) in the Everyday Math Alternative Treatment and the mean scale score of those students scoring Proficient on the 2012 NJ ASK5 (scoring 200 and above) in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

To address the null hypothesis, an ANOVA was conducted comparing the scale scores of those students in each treatment scoring 200 and above on the 2012 NJ ASK5. The results are shown in Tables 31 through 33. Levene's Test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$), allowed the null hypothesis of equal variances to be accepted, and it is concluded that there are no differences in the variances of the sample populations. Results are reported in Table 32. All other assumptions for ANOVA were met (see Appendix C).

The total number of Everyday Math Treatment students meeting the criteria for proficiency by scoring Proficient or Advanced Proficient on the Grade 5 NJ ASK was 90 (M= 233.98, SD = 27. 252). The total number of Singapore Math Treatment students meeting the criteria for proficiency by scoring Proficient or Advanced Proficient on the Grade 5 NJ ASK was 71 (M=238.99, SD = 27.979). Results showed that the effect of treatment was not statistically significant at the $p<0.05$ level.

Table 31

Descriptive Statistics of ANOVA (Proficient)

Descriptive Statistics[a]

Dependent Variable: MathScaleScore2012

Treatment	Mean	Std. Deviation	N
Alternative Treatment (Everyday Math)	233.98	27.252	90
Experimental Treatment (Singapore Math)	238.99	27.979	71
Total	236.19	27.601	161

a. Pass_Fail = Proficient

Table 32

Levene's Test of Equality of Error Variances of ANOVA (Proficient)

Levene's Test of Equality of Error Variances[a,b]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
.385	1	159	.536

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Pass_Fail = Proficient

b. Design: Intercept + Treatment

Table 33

Tests of Between-Subjects Effects of ANOVA (Proficient)

Tests of Between-Subjects Effects[a]

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	995.468[b]	1	995.468	1.309	.254	.008	1.309	.206
Intercept	8878315.816	1	8878315.816	11676.686	.000	.987	11676.686	1.000
Treatment	995.468	1	995.468	1.309	.254	.008	1.309	.206
Error	120894.941	159	760.346					
Total	9103112.000	161						
Corrected Total	121890.410	160						

a. Pass_Fail = Proficient

b. R Squared = .008 (Adjusted R Squared = .002)

c. Computed using alpha = .05

Null Hypothesis 3e

There is no significant difference between the mean scale scores of those students scoring Partially Proficient on the 2012 NJ ASK5 (scoring below 200) in the Everyday Math Alternative Treatment and the mean scale score of those students scoring Partially Proficient on the 2012 NJ ASK5 (scoring below 200) in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

To address the null hypothesis, an ANOVA was conducted comparing the scale scores of those students in each treatment scoring below 200 on the 2012 NJ ASK5. The results are shown in Tables 34 through 36. Levene's Test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$), allowed the null hypothesis of equal variances to be accepted, and it is concluded that there are no differences in the variances of the sample populations. Results are reported in Table 35. The assumption for linear correlation was not met in this analysis. All other assumptions for ANOVA were met (see Appendix C).

The total number of Everyday Math Treatment students not meeting the criteria for proficiency (scoring less than 200) on the Grade 5 NJ ASK was 15 (M= 174.27, SD = 17.487)[11]. The total number of Singapore Math students not meeting the criteria for proficiency (scoring less than 200) on the Grade 5 NJ ASK was 29 (M=176.55, SD = 14.681)[12]. Results showed that the effect of *treatment* was not statistically significant at the $p<0.05$ level.

Table 34

Descriptive Statistics of ANOVA (Partially Proficient)

Descriptive Statistics[a]

Dependent Variable: MathScaleScore2012

Treatment	Mean	Std. Deviation	N
Alternative Treatment (Everyday Math)	174.27	17.487	15
Experimental Treatment (Singapore Math)	176.55	14.681	29
Total	175.77	15.528	44

a. Pass_Fail = Not Proficient

[11] Small sample size (N = 15) could potentially reduce the statistical power of this analysis.

[12] Small sample size (N = 29) could potentially reduce the statistical power of this analysis.

Table 35

Levene's Test of Equality of ANOVA (Partially Proficient)

Levene's Test of Equality of Error Variances[a,b]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
.938	1	42	.338

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Pass_Fail = Not Proficient

b. Design: Intercept + Treatment

Table 36

Tests of Between-Subjects Effects of ANOVA (Partially Proficient)

Tests of Between-Subjects Effects[a]

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	51.622[b]	1	51.622	.210	.649	.005	.210	.073
Intercept	1216749.803	1	1216749.803	4953.758	.000	.992	4953.758	1.000
Treatment	51.622	1	51.622	.210	.649	.005	.210	.073
Error	10316.106	42	245.622					
Total	1369794.000	44						
Corrected Total	10367.727	43						

a. Pass_Fail = Not Proficient

b. R Squared = .005 (Adjusted R Squared = -.019)

c. Computed using alpha = .05

Subsidiary Question 4

Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic); and is there significant interaction between treatment status and race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic)?

Null Hypothesis 4a

There is no significant interaction between treatment status and Black&Hispanic/White performance as measured by the 2012 NJ ASK5.

To address this null hypothesis, a Factorial ANOVA was conducted incorporating the independent variables treatment and Black&Hispanic/White (the dichotomous variable representing the race/ethnicity status, Black and Hispanic or White). The results are shown in Tables 37 through 40. Levene's test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$), allowed the null hypothesis of equal variances to be accepted, and it is concluded that there are no differences between the variances in the sample populations. Results are reported in Table 38. All other assumptions for ANOVA were met (see Appendix C).

Black and Hispanic students in the Everyday Math Alternative Treatment (N= 90) had a mean scale score of 221.33 (*SD* = 32.890). White students in the Everyday Math Alternative Treatment (N= 15)[10] had a mean scale score of 250.13 (*SD* = 25.743). Black and Hispanic students in the Singapore Math Experimental Treatment (N=88) had a mean scale score of 214.34 (*SD* = 34.355). White students in the Singapore Math Experimental

[10] Small sample size (N = 15) could potentially reduce the statistical power of this analysis.

Treatment (N=12)[14] had a mean scale score of 268.83 (*SD* = 25.316). The interaction of treatment and Race (Black&Hispanic/White) was not statistically significant suggesting that there was no significant interaction between Race (Black&Hispanic/White) and treatment with student performance on the 2012 NJ ASK5. The independent variable Black&Hispanic/White was statistically significant, p-value < 0.05, $F(1, 204) = 37.554$; and $\eta_p^2 = 0.157$, indicating that the performance of Black and Hispanic students was significantly different and, in this case, significantly worse than White students. Estimated marginal means are reported in Table 40.

Table 37

Descriptive Statistics of Factorial ANOVA, Treatment and Black&Hispanic/White

Descriptive Statistics

Dependent Variable: MathScaleScore2012

Treatment	Race_coded	Mean	Std. Deviation	N
Alternative Treatment (Everyday Math)	Black&Hispanic	221.33	32.890	90
	White	250.13	25.743	15
	Total	225.45	33.429	105
Experimental Treatment (Singapore Math)	Black&Hispanic	214.34	34.355	88
	White	268.83	25.316	12
	Total	220.88	37.752	100
Total	Black&Hispanic	217.88	33.710	178
	White	258.44	26.789	27
	Total	223.22	35.589	205

[14] Small sample size (N = 12) could potentially reduce the statistical power of this analysis.

Table 38

Levene's Test of Equality of Factorial ANOVA, Treatment and Black&Hispanic/White

Levene's Test of Equality of Error Variances[a]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
1.328	3	201	.266

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Treatment + Race_coded + Treatment * Race_coded

Table 39

Tests of Between-Subjects Effects of Factorial ANOVA, Treatment and Black&Hispanic/White

Tests of Between-Subjects Effects

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	43089.949[a]	3	14363.316	13.410	.000	.167
Intercept	5283899.693	1	5283899.693	4933.151	.000	.961
Treatment	794.710	1	794.710	.742	.390	.004
Race_coded	40224.021	1	40224.021	37.554	.000	.157
Treatment * Race_coded	3827.231	1	3827.231	3.573	.060	.017
Error	215291.173	201	1071.100			
Total	10472906.000	205				
Corrected Total	258381.122	204				

a. R Squared = .167 (Adjusted R Squared = .154)

Table 40

Estimated Marginal Means of Factorial ANOVA, Treatment and Black&Hispanic/White

Treatment * Race_coded

Dependent Variable: MathScaleScore2012

Treatment	Race_coded	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Alternative Treatment (Everyday Math)	Black&Hispanic	221.333	3.450	214.531	228.136
	White	250.133	8.450	233.471	266.796
Experimental Treatment (Singapore Math)	Black&Hispanic	214.341	3.489	207.462	221.220
	White	268.833	9.448	250.204	287.463

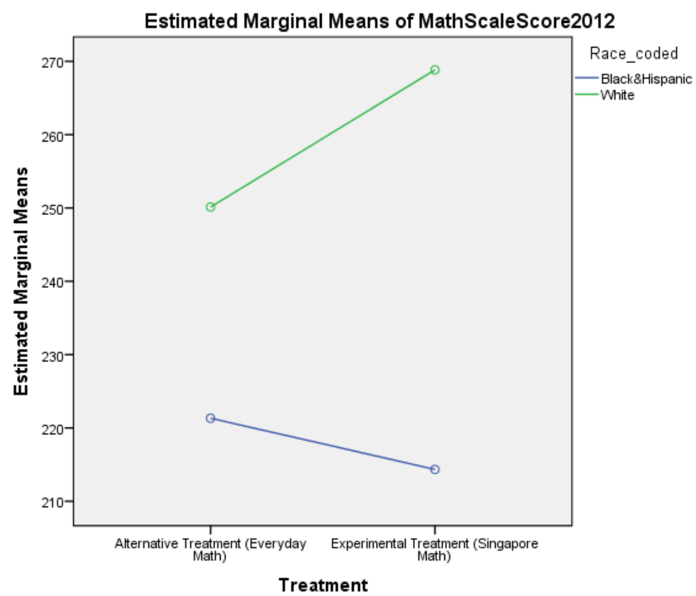


Figure 5. Estimated Marginal Means of MathScaleScore2012 - Black&Hispanic/White

Null Hypothesis 4b

There is no significant difference between the overall performance of the subset of Black and Hispanic students in the Everyday Math Alternative Treatment and the subset of Black and Hispanic students in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

An ANOVA was conducted comparing the 2012 NJ ASK5 mean scale score of the subset of Black and Hispanic students in the Everyday Math treatment to the 2012 NJ ASK5 mean scale score of the subset of Black and Hispanic students in the Singapore Math treatment. The results are shown in Tables 41 through 43. Levene's test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$) allowed the null hypothesis of equal variances to be accepted, and it is concluded that there are no differences between the variances in the sample populations (see Table 42). All other assumptions for ANOVA were met (see Appendix C).

Black and Hispanic students in the Everyday Math Alternative Treatment (N= 90) had a mean scale score of 221.33 (SD = 32.89). Black and Hispanic students in the Singapore Math Experimental Treatment (N=88) had a mean scale score of 214.34 (*SD* = 34.36). The independent variable treatment was not statistically significant with p-values > 0.05, indicating that there was no significant difference in the performance of the subset of Black and Hispanic students in the Everyday Math treatment and the subset of Black and Hispanic students in the Singapore Math Treatment.

Table 41

Descriptive Statistics of ANOVA (Black&Hispanic)

Descriptive Statistics[a]

Dependent Variable: MathScaleScore2012

Treatment	Mean	Std. Deviation	N
Alternative Treatment (Everyday Math)	221.33	32.890	90
Experimental Treatment (Singapore Math)	214.34	34.355	88
Total	217.88	33.710	178

a. Black&Hispanic_White = nonwhite

Table 42

Levene's Test of Equality of ANOVA (Black&Hispanic)

Levene's Test of Equality of Error Variances[a,b]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
1.487	1	176	.224

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. BlackHispanic_White = blk&his

b. Design: Intercept + Treatment

Table 43

Tests of Between-Subjects Effects of ANOVA (Black/Hispanic)

Tests of Between-Subjects Effects[a]

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	2175.508[b]	1	2175.508	1.924	.167	.011	1.924	.281
Intercept	8445569.665	1	8445569.665	7470.809	.000	.977	7470.809	1.000
Treatment	2175.508	1	2175.508	1.924	.167	.011	1.924	.281
Error	198963.773	176	1130.476					
Total	8650822.000	178						
Corrected Total	201139.281	177						

a. BlackHispanic_White = blk&his

b. R Squared = .011 (Adjusted R Squared = .005)

c. Computed using alpha = .05

Null Hypothesis 4c

There is no significant difference between the overall performance of White students in the Everyday Math Alternative Treatment and White students in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

An ANOVA was conducted comparing the 2012 NJ ASK5 mean scale score of the subset of White students in the Everyday Math treatment to the 2012 NJ ASK5 mean scale score of the subset of White students in the Singapore Math Treatment. The results are shown in Tables 44 through 46. Levene's test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$) allowed the null hypothesis of equal variances to be accepted, and it is concluded that there are no differences between the variances in the sample populations. Results are reported in Table 45. All other assumptions for ANOVA were met (see Appendix C).

White students in the Everyday Math Alternative Treatment (N= 15)[15] had a mean scale score of 250.13 (*SD* = 25.74). White students in the Singapore Math Experimental Treatment (N=12)[16] had a mean scale score of 268.83 (*SD* = 25.32). The independent variable *treatment* was not statistically significant with p-values > 0.05, indicating that there was no significant difference in the performance of White students in the Everyday Math treatment and White students in the Singapore Math Treatment.

Table 44

Descriptive Statistics of ANOVA (White)

Descriptive Statistics[a]

Dependent Variable: MathScaleScore2012

Treatment	Mean	Std. Deviation	N
Alternative Treatment (Everyday Math)	250.13	25.743	15
Experimental Treatment (Singapore Math)	268.83	25.316	12
Total	258.44	26.789	27

a. Black&Hispanic_White = White

[15] Small sample size (N = 15) could potentially reduce the statistical power of this analysis.

[16] Small sample size (N = 12) could potentially reduce the statistical power of this analysis.

Table 45

Levene's Test of Equality of ANOVA (White)

Levene's Test of Equality of Error Variances[a,b]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
.006	1	25	.940

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Black/Hispanic_White = White

b. Design: Intercept + Treatment

Table 46

Tests of Between-Subjects Effects of ANOVA (White)

Tests of Between-Subjects Effects[a]

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	2331.267[b]	1	2331.267	3.570	.071	.125	3.570	.443
Intercept	1795509.341	1	1795509.341	2749.227	.000	.991	2749.227	1.000
Treatment	2331.267	1	2331.267	3.570	.071	.125	3.570	.443
Error	16327.400	25	653.096					
Total	1822084.000	27						
Corrected Total	18658.667	26						

a. Black/Hispanic_White = White

b. R Squared = .125 (Adjusted R Squared = .090)

c. Computed using alpha = .05

Null Hypothesis 4d

There is no significant interaction between treatment status and Black/Hispanic performance as measured by the 2012 NJ ASK5.

This analysis differed from the analyses conducted to address Null Hypothesis 4a in that it looked at the performance of Black and Hispanic students separately rather than as a subset of Black and Hispanic students combined. To address this null hypothesis, a factorial ANOVA was conducted incorporating the independent variables treatment and Black/Hispanic (the dichotomous variable representing the race/ethnicity status, Black or Hispanic). The results are shown in Tables 47 through 50. Levene's test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$), allowed the null hypothesis of equal variances to be accepted and it is concluded that there are no differences between the variances in the sample populations. Results are reported in Table 48. All other assumptions for ANOVA were met (see Appendix C).

Black students in the Everyday Math Alternative Treatment (N= 50) had a mean scale score of 211.60 (*SD* = 29.27). Hispanic students in the Everyday Math Alternative Treatment (N= 40) had a mean scale score of 233.50 (*SD* = 33.45). Black students in the Singapore Math Experimental Treatment (N=51) had a mean scale score of 205.94 (*SD* = 29.69). Hispanic students in the Singapore Math Experimental Treatment (N=37) had a mean scale score of 225.92 (SD = 37.29). The interaction of treatment and race/ethnicity (Black/Hispanic) was not statistically significant, suggesting that there was no significant interaction between race/ethnicity (Black/Hispanic) and treatment with student performance on the 2012 NJ ASK5. The independent variable Black/Hispanic was statistically significant; p-value < 0.05, $F(1, 177) = 18.526$; and $\eta_p^2 = 0.096$, indicating that the performance level of Black students was significantly different, and in this case, significantly worse than Hispanic students. Estimated marginal means are reported in Table 50.

Based on the results, two additional analyses were run to determine whether significant differences in the performance of Black and Hispanic students occurred across both treatments (see Null Hypotheses 4e and 4f).

Table 47

Descriptive Statistics of Factorial ANOVA - Treatment and Black/Hispanic

Descriptive Statistics

Dependent Variable: MathScaleScore2012

Treatment	Race	Mean	Std. Deviation	N
Everyday Math_Alternative Treatment	Black	211.600	29.2749	50
	Hispanic	233.500	33.4457	40
	Total	221.333	32.8904	90
Singapore Math_Experimental Treatment	Black	205.941	29.6900	51
	Hispanic	225.919	37.2875	37
	Total	214.341	34.3554	88
Total	Black	208.743	29.4750	101
	Hispanic	229.857	35.3150	77
	Total	217.876	33.7102	178

Table 48

Levene's Test of Equality of Factorial ANOVA - Treatment and Black/Hispanic Scores

Levene's Test of Equality of Error Variances[a]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
2.051	3	174	.109

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Treatment + Race + Treatment * Race

Table 49

Tests of Between-Subjects Effects of Factorial ANOVA - Treatment, Black/Hispanic

Tests of Between-Subjects Effects

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	21391.701[a]	3	7130.567	6.903	.000	.106	20.708	.977
Intercept	8392645.808	1	8392645.808	8124.284	.000	.979	8124.284	1.000
Treatment	1912.973	1	1912.973	1.852	.175	.011	1.852	.272
black/Hispanic	19138.406	1	19138.406	18.526	.000	.096	18.526	.990
Treatment * black/Hispanic	40.324	1	40.324	.039	.844	.000	.039	.054
Error	179747.580	174	1033.032					
Total	8650822.000	178						
Corrected Total	201139.281	177						

a. R Squared = .106 (Adjusted R Squared = .091)

b. Computed using alpha = .05

Table 50

Estimated Marginal Means of Factorial ANOVA - Treatment, Black/Hispanic

Treatment * Race

Dependent Variable: MathScaleScore2012

Treatment	Race	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Everyday Math_Alternative Treatment	Black	211.600	4.545	202.629	220.571
	Hispanic	233.500	5.082	223.470	243.530
Singapore Math_Experimental Treatment	Black	205.941	4.501	197.058	214.824
	Hispanic	225.919	5.284	215.490	236.348

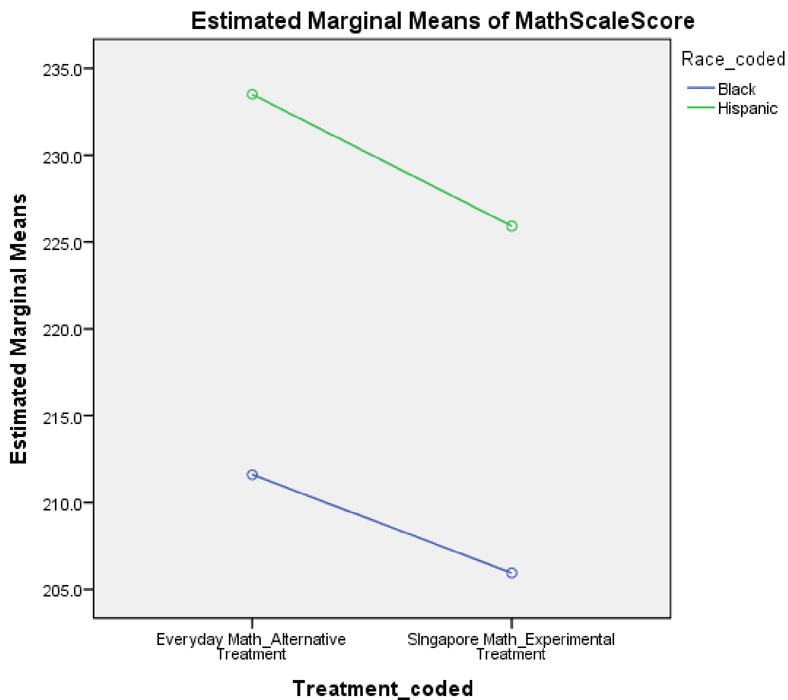


Figure 6. Estimated Marginal Means of MathScaleScore2012 - Black & Hispanic

Null Hypothesis 4e

There is no significant difference in the overall 2012 NJ ASK5 performance of Black and Hispanic students in the Everyday Math Alternative Treatment.

An ANOVA was conducted comparing the 2012 NJ ASK5 mean scale scores of Black students in the Everyday Math Alternative Treatment and Hispanic students in the Everyday Math Alternative Treatment. The results are shown in Tables 51 through 53. Levene's Test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$) allowed the null hypothesis of equal variances to be accepted, and it is concluded that there are no differences between the variances in the sample populations. Results are reported in Table 52. All other assumptions for ANOVA were met (see Appendix C).

Black students in the Everyday Math Alternative Treatment (N= 50) had a mean scale score of 211.60 (*SD* = 29.27). Hispanic students in the Everyday Math Alternative Treatment (N= 40) had a mean scale score of 233.50 (*SD* = 33.45). The independent variable Black/Hispanic was statistically significant; $F(1, 90) = 10.954$, $p < 0.05$, and $\eta_p^2 = 0.111$, indicating that the performance of Black students was significantly different, and in this case, significantly worse than Hispanic students.

Table 51

Descriptive Statistics of ANOVA – Black/Hispanic (Everyday Math)

Descriptive Statistics[a]

Dependent Variable: MathScaleScore2012

Black/Hispanic	Mean	Std. Deviation	N
Black	211.60	29.275	50
Hispanic	233.50	33.446	40
Total	221.33	32.890	90

a. Treatment = Alternative Treatment (Everyday Math)

Table 52

Levene's Test of Equality of ANOVA – Black/Hispanic (Everyday Math)

Levene's Test of Equality of Error Variances[a,b]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
.702	1	88	.405

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Treatment = Alternative Treatment (Everyday Math)

b. Design: Intercept + Black/Hispanic

Table 53

Tests of Between-Subjects Effects of ANOVA – Black/Hispanic (Everyday Math)

Tests of Between-Subjects Effects[a]

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	10658.000[b]	1	10658.000	10.954	.001	.111	10.954	.905
Intercept	4402533.556	1	4402533.556	4524.912	.000	.981	4524.912	1.000
Black/Hispanic	10658.000	1	10658.000	10.954	.001	.111	10.954	.905
Error	85620.000	88	972.955					
Total	4505238.000	90						
Corrected Total	96278.000	89						

a. Treatment = Alternative Treatment (Everyday Math)

b. R Squared = .111 (Adjusted R Squared = .101)

c. Computed using alpha = .05

Null Hypothesis 4f

There is no significant difference in the overall 2012 NJ ASK5 performance of Black and Hispanic students in the Singapore Math Experimental Treatment.

An ANOVA was conducted comparing the 2012 NJ ASK5 mean scale scores of Black students in the Singapore Math Experimental Treatment and Hispanic students in the Singapore Math Experimental Treatment. The results are shown in Tables 54 through 58. Levene's Test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p<0.05$) caused the null hypothesis of equal variances to be rejected, and it is concluded that there are significant differences between the variances in the sample populations[17] (see Table 55). All other assumptions for ANOVA were met (see Appendix C).

Black students in the Singapore Math Experimental Treatment (N=51) had a mean scale score of 205.94 (*SD* = 29.69). Hispanic students in the Singapore Math Experimental Treatment (N=37) had a mean scale score of 225.92 (*SD* = 37.29). The independent variable Black/Hispanic was statistically significant; $p < 0.05$, indicating there was a significant difference between the performance of Black students in the Singapore Math Treatment and Hispanic students in the Singapore Math Treatment.

Table 54

Descriptive Statistics of ANOVA – Black/Hispanic (Singapore Math)

Descriptive Statistics[a]

Dependent Variable: MathScaleScore2012

Black/Hispanic	Mean	Std. Deviation	N
Black	205.94	29.690	51
Hispanic	225.92	37.287	37
Total	214.34	34.355	88

a. Treatment = Experimental Treatment (Singapore Math)

[17] An Independent Samples t-test was run in addition to this analysis to verify the ANOVA findings (See Tables 57 and 58.)

Table 55

Levene's Test of Equality of ANOVA – Black/Hispanic (Singapore Math)

Levene's Test of Equality of Error Variances[a,b]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
4.458	1	86	.038

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Treatment = Experimental Treatment (Singapore Math)

b. Design: Intercept + Black/Hispanic

Table 56

Tests of Between-Subjects Effects of ANOVA – Black/Hispanic (Singapore Math)

Tests of Between-Subjects Effects[a]

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	8558.192[b]	1	8558.192	7.819	.006	.083	7.819	.790
Intercept	3999220.783	1	3999220.783	3653.902	.000	.977	3653.902	1.000
Black/Hispanic	8558.192	1	8558.192	7.819	.006	.083	7.819	.790
Error	94127.580	86	1094.507					
Total	4145584.000	88						
Corrected Total	102685.773	87						

a. Treatment = Experimental Treatment (Singapore Math)

b. R Squared = .083 (Adjusted R Squared = .073)

c. Computed using alpha = .05

Table 57

Group Statistics of Independent Samples T-test – Black/Hispanic (Singapore Math)

Group Statistics[a]

	Race/Ethnicity	N	Mean	Std. Deviation	Std. Error Mean
MathScaleScore2012	Black	51	205.941	29.6900	4.1574
	Hispanic	37	225.919	37.2875	6.1300

a. Treatment = Singapore Math_Experimental Treatment

Table 58

Independent Samples T-test – Black/Hispanic (Singapore Math)

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
MathScaleScore2012	Equal variances assumed	4.458	.038	-2.796	86	.006	-19.9777	7.1444	-34.1803	-5.7752
	Equal variances not assumed			-2.697	66.590	.009	-19.9777	7.4068	-34.7635	-5.1919

a. Treatment = Singapore Math_Experimental Treatment

Subsidiary Question 5

How much variance in the 2012 NJ ASK5 mean scale score of Black students can be explained by the predictor variables treatment, attendance, gender, and SES?

Null Hypothesis 5

H0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, and SES account for no variation in the performance of Black students on the 2012 NJ ASK5.

A simultaneous regression analysis was conducted to determine the degree to which the predictor variables treatment, attendance, gender, and SES account for variation in the performance of Black students on the 2012 NJ ASK. Basic descriptive statistics, correlations, model summaries, ANOVA, and regression coefficients are shown in Tables 59 through 63. Collinearity statistics revealed VIFs less than 2.5, indicating that there was not a high correlation among the predictor variables (Allison, 1999). The Durbin-Watson statistic was applied as a measure of correlation between the residuals. In this analysis, the value of the Durbin-Watson statistic is 2.20, approximately equal to 2, indicating no serial correlation between the residuals (Durbin & Watson, 1950, 1951).

A total of 101 Black students (M=208.74, SD=29.475) were considered in this analysis. These students had a mean attendance of 354.51 (SD = 11.59). Model 1 did not explain a significant proportion of variance in 2012 NJ ASK5 Black performance. Overall results indicate that the predictor variables treatment, attendance, gender, and SES did not account for a significant proportion of variance in the mathematics performance of Black students.

Table 59

Descriptive Statistics of Simultaneous Regression Analysis (Black), Treatment, Attendance, Gender, and SES

Descriptive Statistics

	Mean	Std. Deviation	N
MathScaleScore2012	208.74	29.475	101
Treatment	.50	.502	101
Gender	.62	.487	101
SES	.84	.367	101
Attendance_2yr	354.5050	11.58997	101

Table 60

Model Summary of Simultaneous Regression Analysis (Black), Treatment, Attendance, Gender, and SES

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.201[a]	.041	.001	29.467	.041	1.013	4	96	.405	2.199

a. Predictors: (Constant), Attendance_2yr, SES , Treatment, Gender

b. Dependent Variable: MathScaleScore2012

Table 61

ANOVA of Simultaneous Regression Analysis (Black), Treatment, Attendance, Gender, and SES

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3519.395	4	879.849	1.013	.405[a]
	Residual	83357.912	96	868.312		
	Total	86877.307	100			

a. Predictors: (Constant), Attendance_2yr, SES , Treatment, Gender

b. Dependent Variable: MathScaleScore2012

Table 62

Coefficient Statistics of Simultaneous Regression Analysis (Black), Treatment, Attendance, Gender, and SES

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	135.099	91.997		1.469	.145					
	Treatment	-4.145	5.934	-.071	-.698	.487	-.096	-.071	-.070	.977	1.024
	Gender	-9.023	6.181	-.149	-1.460	.148	-.152	-.147	-.146	.959	1.043
	SES	4.860	8.164	.061	.595	.553	.037	.061	.060	.967	1.034
	Attendance_2yr	.218	.256	.086	.850	.397	.103	.086	.085	.983	1.017

a. Dependent Variable: MathScaleScore2012

Table 63

Residual Statistics of Simultaneous Regression Analysis (Black), Treatment, Attendance, Gender, and SES

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	195.89	220.39	208.74	5.932	101
Residual	-65.703	73.096	.000	28.872	101
Std. Predicted Value	-2.166	1.964	.000	1.000	101
Std. Residual	-2.230	2.481	.000	.980	101

a. Dependent Variable: MathScaleScore2012

Subsidiary Question 6

How much variance in the 2012 NJ ASK5 mean scale score of Hispanic students can be explained by the predictors treatment, attendance, gender, and SES?

Null Hypothesis 6

H_0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, and SES account for no variation in the performance of Hispanic students on the 2012 NJ ASK5.

A simultaneous regression analysis was conducted to determine the independent variable(s) best correlated with the performance of Hispanic students on the 2012 NJ ASK5. Basic descriptive statistics, model summaries, ANOVA, and regression coefficients are shown in Tables 64 through 67. Collinearity statistics revealed VIFs less than 2, indicating that there was not a high correlation among the predictor variables (Allison, 1999). The Durbin-Watson statistic was applied as a measure of correlation between the residuals. In this analysis, the value of the Durbin-Watson statistic is 1.483, approximately equal to 2, indicating no serial correlation between the residuals (Durbin & Watson, 1950, 1951).

A total of 77[18] Hispanic students (M=229.86, SD=35.315) were considered in this analysis. These students had a mean attendance of 349.07 (SD = 19.49). Model 1, which combined the predictor variables treatment, attendance, gender, and SES, explained a significant proportion of variance (21.8%) in 2012 NJ ASK5 performance; $F(4, 72) = 5.052$, $R = 0.467$, $R^2_{adj} = .175$, $p<0.05$.

Only two variables in the model accounted for a significant proportion of variation in the performance of Hispanic students on the 2012 NJ ASK5

- Attendance, β =0.462 (explaining 16.6% of variance), t(77) = 4.141, *p*=0.000
- SES, β =-0.226 (explaining 5% of variance), t(77) = -2.067, *p*=0.042

The variables treatment and gender were not significant predictors of performance in this analysis.

Table 64

Descriptive Statistics of Simultaneous Regression Analysis (Hispanic), Treatment, Attendance, Gender, and SES

Descriptive Statistics

	Mean	Std. Deviation	N
MathScaleScore2012	229.86	35.315	77
Treatment	.48	.503	77
Gender	.57	.498	77
SES	.91	.289	77
Attendance_2yr	349.0714	19.48763	77

[18]Sample size (N = 77) does not meet the criterion for sample size as defined by Field (2009) and Green (1991). Adequate sample size in this analysis would be 50 + 8k, where “k” equals the number of predictors, or 82.

Table 65

Model Summary of Simultaneous Regression Analysis (Hispanic), Treatment, Attendance, Gender, and SES

Model Summary[a,c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.467[b]	.218	.175	32.080	.218	5.025	4	72	.001	1.483

a. Black_Hispanic = Hispanic

b. Predictors: (Constant), Attendance_2yr, Gender, Treatment, SES

c. Dependent Variable: MathScaleScore2012

Table 66

ANOVA of Simultaneous Regression Analysis (Hispanic), Treatment, Attendance, Gender, and SES

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20684.652	4	5171.163	5.025	.001[c]
	Residual	74098.777	72	1029.150		
	Total	94783.429	76			

a. Black_Hispanic = Hispanic

b. Dependent Variable: MathScaleScore2012

c. Predictors: (Constant), Attendance_2yr, Gender, Treatment, SES

Table 67

Coefficient Statistics of Simultaneous Regression Analysis (Hispanic), Treatment, Attendance, Gender, and SES

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-36.309	70.173		-.517	.606
	Treatment	.233	7.600	.003	.031	.976
	SES	-27.618	13.359	-.226	-2.067	.042
	Gender	-2.191	7.537	-.031	-.291	.772
	Attendance_2yr	.838	.202	.462	4.141	.000

a. Black_Hispanic = Hispanic

b. Dependent Variable: MathScaleScore2012

Subsidiary Question 7

Is there a statistically significant difference in the 2012 NJ ASK5 performance of Hispanic students based on SES classification and treatment status when controlling for attendance; and is there significant interaction between treatment status and SES classification for Hispanic students when controlling for attendance?

Null Hypothesis 7a

There is no significant difference in the 2012 NJ ASK5 performance of Hispanic students based on SES classification and treatment status when controlling for attendance.

Null Hypothesis 7b

There is no significant interaction between treatment status and SES when controlling for attendance.

A factorial ANCOVA was conducted comparing the 2012 NJ ASK5 mean scale score of Hispanic students in the Everyday Math treatment to the 2012 NJ ASK5 mean scale score of Hispanic students in the Singapore Math Treatment, controlling for attendance. The results are shown in Tables 68 through 72. Levene's Test of Equality was applied to assess the homogeneity of variance. The resulting p-value ($p>0.05$) allowed the null hypothesis of equal variances to be accepted, and it is concluded that there are no differences between the variances in the sample populations. See Table 69. All other assumptions for ANCOVA were met (see Appendix C).

Low SES Hispanic students (N=70) had a mean scale score of 228.514 (SD = 35.58). Higher SES Hispanic students (N = 7)18[19] had a mean scale score of 243.29 (SD = 31.763). Low SES Hispanic students in the Everyday Math Alternative Treatment (N= 37) had a mean scale score of 233.00 (SD = 34.24). Low SES Hispanic students in the Singapore Math Experimental Treatment (N=33) had a mean scale score of 223.49 (SD = 36.89). Higher SES Hispanic students in the Everyday Math Alternative Treatment (N= 3)[20] had a mean scale score of 239.667 (SD = 25.38). Higher SES Hispanic students in the Singapore Math Experimental Treatment (N=4)[21] had a mean scale score of 246.00 (SD = 39.56). The independent variable *SES* was statistically significant with a p-value < 0.05; $F(1, 76) = 4.366$, $\eta_p^2 = 0.057$, $p = 0.040$ indicating that low SES Hispanic students' performance was significantly different than Higher SES Hispanic students and, in this case, worse. The covariate *attendance* was also statistically significant with a p-value <

[19] Small sample size (N = 7) could potentially reduce the statistical power of this analysis.

[20] Small sample size (N = 3) could potentially reduce the statistical power of this analysis.

[21] Small sample size (N = 4) could potentially reduce the statistical power of this analysis.

0.05; $F(1, 76) = 20.804$, $\eta_p^2 = 0.224$, $p = 0.000$. Adjusted means are displayed as Estimated Marginal Means in Tables 71 and 72. The independent variable treatment and the interaction of treatment and SES was not statistically significant with p-values > 0.05, indicating that there was no significant difference in treatment.

Table 68

Descriptive Statistics of Factorial ANCOVA (Hispanic), Treatment, Attendance, and SES

Descriptive Statistics

Dependent Variable: MathScaleScore2012

Treatment	SES	Mean	Std. Deviation	N
Everyday Math_Alternative Treatment	HigherSES	239.667	25.3837	3
	Low SES	233.000	34.2434	37
	Total	233.500	33.4457	40
Singapore Math_Experimental Treatment	HigherSES	246.000	39.5643	4
	Low SES	223.485	36.8901	33
	Total	225.919	37.2875	37
Total	HigherSES	243.286	31.7633	7
	Low SES	228.514	35.5783	70
	Total	229.857	35.3150	77

Table 69

Levene's Test of Equality of ANOVA (Hispanic), Treatment, Attendance, and SES

Levene's Test of Equality of Error Variances[a]

Dependent Variable: MathScaleScore2012

F	df1	df2	Sig.
.239	3	73	.869

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + SYs1011Attendance + Treatment + SES + Treatment * SES

Table 70

Test of Between-Subject Effects of ANOVA (Hispanic), Treatment, Attendance, and SES

Tests of Between-Subjects Effects

Dependent Variable: MathScaleScore2012

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	23603.310[a]	4	5900.827	5.969	.000	.249	23.875	.979
Intercept	1419.662	1	1419.662	1.436	.235	.020	1.436	.219
SYs1011Attendance	20566.790	1	20566.790	20.804	.000	.224	20.804	.994
Treatment	2139.270	1	2139.270	2.164	.146	.029	2.164	.306
SES	4316.524	1	4316.524	4.366	.040	.057	4.366	.541
Treatment * SES	3005.615	1	3005.615	3.040	.085	.041	3.040	.405
Error	71180.119	72	988.613					
Total	4163025.000	77						
Corrected Total	94783.429	76						

a. R Squared = .249 (Adjusted R Squared = .207)

b. Computed using alpha = .05

Table 71

Estimated Marginal Means (1) of ANOVA (Hispanic), Treatment, Attendance, and SES

Estimates

Dependent Variable: MathScaleScore2012

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Everyday Math_Alternative Treatment	230.633[a]	9.520	211.656	249.610
Singapore Math_Experimental Treatment	250.381[a]	9.002	232.436	268.326

a. Covariates appearing in the model are evaluated at the following values: SYs1011Attendance = 349.071.

Table 72

Estimated Marginal Means (2) of ANOVA (Hispanic), Treatment, Attendance, and SES

2. Treatment * SES

Dependent Variable: MathScaleScore2012

Treatment	SES	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Everyday Math_Alternative Treatment	Higher SES	232.752[a]	18.216	196.439	269.066
	Low SES	228.513[a]	5.262	218.024	239.003
Singapore Math_Experimental Treatment	Higher SES	275.153[a]	16.971	241.322	308.983
	Low SES	225.610[a]	5.493	214.660	236.561

a. Covariates appearing in the model are evaluated at the following values: SYs1011Attendance = 349.071.

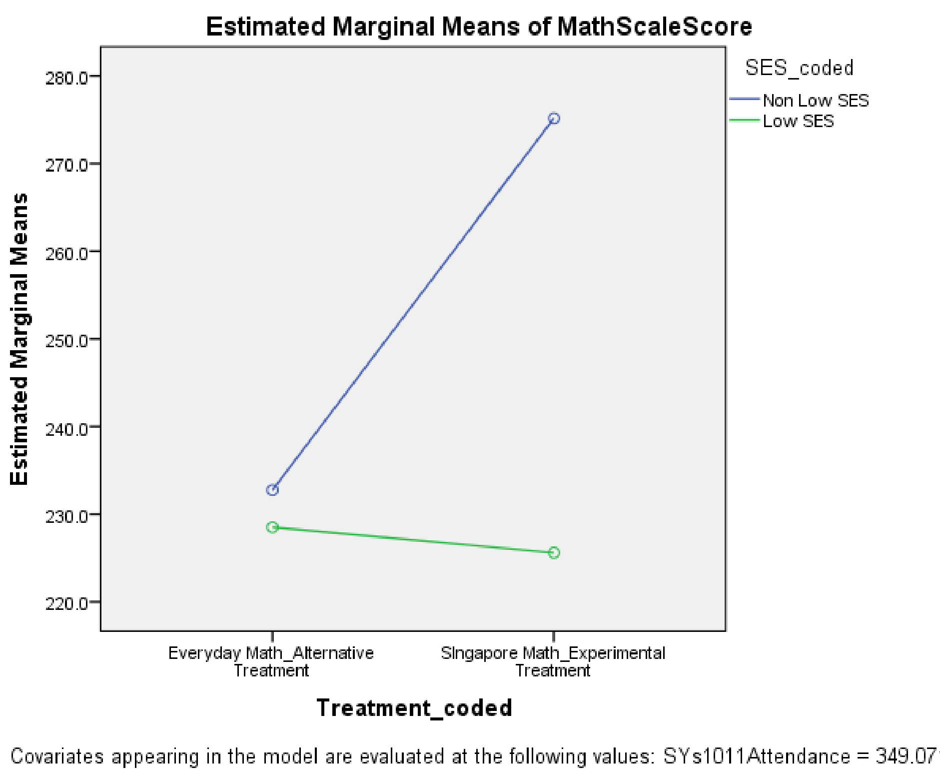


Figure 7. Estimated Marginal Means of MathScaleScore2012 - Hispanic, SES, Attendance

Review of the Findings

This chapter concludes with a brief discussion of the results and findings associated with each subsidiary question and the corresponding hypotheses. Also, see Table 73. A complete evaluation of each hypothesis, along with future recommendations, is included in Chapter 5.

Table 73

Treatment Level Comparisons of Mean Scale Scores on the 2012 NJ ASK5

	Everyday Math	**Singapore Math**	**Significance** $p<0.05$	**Effect Size**
Total	225.45*	220.88	No	N/A
Males	227.18	229.64*	No	N/A
Females	224.20*	215.28	No	N/A
Black&Hispanic	222.05*	214.34	No	N/A
White	247.50	268.83*	No	N/A
Black	211.60*	205.94	No	N/A
Hispanic	233.50*	225.92	No	N/A
Low SES	224.73*	220.99	No	N/A
HigherSES	230.14*	220.27	No	N/A
Advanced Proficient	273.17*	269.50	No	N/A
Proficient	220.52	221.36*	No	N/A
Partially Proficient	174.27	176.55*	No	N/A
Total Proficient (AP + P)	233.98*	238.99	No	N/A

= Higher mean scale score

* Higher initial mean scale score as measured by the 2010NJ ASK3; 'Yes' – Mean difference is statistically significant at the confidence level of ≥95% ; 'No' – Mean difference is not statistically significant at the confidence level of ≥95%

Subsidiary Question 1

How much variance in the 2012 NJ ASK5 mean scale score can be explained by the predictors treatment, attendance, gender, race/ethnicity, and SES?

Null Hypothesis 1

H_0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, Black&Hispanic/White and SES account for no variation in student performance on the 2012 NJ ASK5. The null hypothesis was rejected.

Exploratory regressions analyses revealed that the variables *treatment*, attendance, gender, race/ethnicity (Black&Hispanic/White), and SES, combined, accounted for 21.8% of the variance in student performance as measured by the 2012 NJ ASK5. However, only two variables, Black&Hispanic/White and attendance, were statistically significant predictors of variance in student performance. Treatment, gender, and SES were not significant predictors of performance in this analysis.

While treatment was not found to be a significant predictor variable in the exploratory regression analyses, subsequent analyses incorporated treatment as a fixed or grouping variable and were conducted to either validate initial findings or to make comparisons between the treatment groups around significant predictors.

Subsidiary Question 2

Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment when controlling for attendance?

Null Hypothesis 2

There is no significant difference in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5 when controlling for attendance. The null hypothesis was accepted.

An ANCOVA was conducted to determine whether there were statistically significant differences in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5 when controlling for attendance. The mean scale score of the Everyday Math Alternative Treatment (N = 105) was 225.45 (SD = 33.43); the mean scale score of the Singapore Math Experimental Treatment (N = 100) was 220.88 (SD = 37.75). Results showed that the covariate *attendance* was statistically significant with a p-value < 0.05; $F(1, 76) = 9.343$, $\eta_\rho^2 = 0.044$, $p = 0.003$. Results showed that the effect of treatment was not statistically significant.

Subsidiary Question 3

To what extent do differences in performance exist when data are analyzed according to 2012 NJASK5 performance levels (Partially Proficient, Proficient, and Advanced Proficient) and treatment status, and is there significant interaction between the performance levels and treatment?

Multiple analyses were conducted to examine the 2012 NJ ASK performance of each treatment group at the three NJ ASK performance levels: Partially Proficient, Proficient, and Advanced Proficient (t-tests, ANCOVA, and factorial ANCOVA). Performance levels were described in Chapter 3, Table 5.

Null Hypothesis 3a

There is no significant difference between the Everyday Math Alternative Treatment's 2010 NJ ASK3 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient) and the Everyday Math Alternative Treatment's 2012 NJ ASK5 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient). The null hypothesis was rejected.

Null Hypothesis 3b

There is no significant difference between the Singapore Math Experimental Treatment's 2010 NJ ASK3 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient) and the Singapore Math Experimental Treatment's 2012 NJ ASK5 mean scale score at each performance level (Partially Proficient, Proficient, and Advanced Proficient). The null hypothesis was rejected.

For both treatment groups, an Independent Samples t-test was conducted, comparing 2010 NJ ASK3 performance at each performance level (Partially Proficient, Proficient, and Advanced Proficient) prior to treatment and the performance of the same cohort (scoring Partially Proficient, Proficient, or Advanced Proficient on the 2010 NJ ASK3) after treatment. For both treatment groups, there was a statistically significant difference between the mean scale score of students scoring Partially Proficient on the 2010 NJ ASK3 and the 2012 NJ ASK5 mean scale score of the same cohort of students. In both treatment groups, the 2012 NJ ASK5 mean scale score was significantly higher, suggesting that each treatment had a favorable impact on advancing the performance of Partially Proficient students.

Everyday Math Alternative Treatment

- Partially Proficient (N=27); $t(27) = -4.018$, $p < 0.05$, $d = 0.897$
- 2010 NJ ASK3 (M=172.15, SD=19.13); 2012 NJ ASK5 (M=192.56, SD=25.861)

Singapore Math Experimental Treatment

- Partially Proficient (N=34); $t(34) = -5.753$, $p = < 0.05$, $d = 0.992$
- 2010 NJ ASK3 (M=169.91, SD=18.99); 2012 NJ ASK5 (M=189.85, SD=23.96)

For both treatment groups, there was a statistically significant difference between the mean scale score of students scoring Advanced Proficient on the 2010 NJ ASK3 and the mean scale score of the same cohort of students on the 2012 NJ ASK5. In both treatment groups, the 2012 NJ ASK5 mean scale score was significantly lower, suggesting that neither treatment had a favorable impact on advancing the performance of Advanced Proficient students.

Everyday Math Alternative Treatment

- Advanced Proficient (N=26); $t(26) = 4.377$, $p < 0.05$, $d = 0.545$
- 2010 NJ ASK3 (M=275.19, SD=19.57); 2012 NJ ASK5 (M=262.69, SD=25.884)

Singapore Math Experimental Treatment

- Advanced Proficient (N=28); $t(28) = 4.377$, $p = < 0.05$, $d = 0.774$
- 2010 NJ ASK3 (M=277.68, SD=19.50); 2012 NJ ASK5 (M=261.21, SD=22.94)

For both treatment groups, there was no statistically significant difference between the mean scale score of students scoring Proficient on the 2010 NJ ASK3 and the mean scale score of the same cohort of students on the 2012 NJ ASK5.

Everyday Math Alternative Treatment

- Proficient (N=52); $t(52)= .495$, $p = 0.319$
- 2010 NJ ASK3 (M=221.19, SD=11.312); 2012 NJ ASK5 (M=223.90, SD=18.085)

Singapore Math Experimental Treatment

- Proficient (N=38); $t(38)= .495$, $p = 0.624$.on the

- 2010 NJ ASK3 (M=220.84, SD=14.689); 2012 NJ ASK5 (M=218.92, SD=28.237)

Null Hypothesis 3c

There is no significant interaction between the independent variables treatment and performancelevel2012 (the categorical variable representing the 2012 NJ ASK5 proficiency levels: Advanced Proficient, Proficient, and Partially Proficient). The null hypothesis was accepted.

A factorial ANOVA was conducted incorporating the independent variables treatment and performancelevel2012 (the categorical variable representing the 2012 NJ ASK5 proficiency levels: Advanced Proficient, Proficient, and Partially Proficient). The mean scale score of Everyday Math students scoring Advanced Proficient (N=23) was 273.17 (SD = 16.30); scoring Proficient (N= 67) was 220.52 (SD = 13.92) and scoring Partially Proficient (N= 15) was 174.27 (SD = 17.49). The mean scale score of Singapore Math students scoring Advanced Proficient (N=26) was 269.50 (SD = 15.58), scoring Proficient (N= 45) was 221.36 (SD = 15.47), and scoring Partially Proficient (N=29) was 176.55 (SD = 14.68). The interaction of treatment and performancelevel2012 was not statistically significant at the $p<0.05$ level.

Null Hypothesis 3d

There is no significant difference between the mean scale scores of those students scoring Proficient on the 2012 NJ ASK5 (scoring 200 and above) in the Everyday Math Alternative Treatment and the mean scale score of those students scoring Proficient on the 2012 NJ ASK5 (scoring 200 and above) in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5. The null hypothesis was accepted.

An ANOVA was conducted comparing the scale scores of those students in each *treatment* scoring 200 and above on the 2012 NJ ASK5. The total number of Everyday Math Treatment students meeting the criteria for proficiency by scoring Proficient or Advanced Proficient on the Grade 5 NJ ASK was 90 (M= 233.98, SD = 27.25). The total number of Singapore Math Treatment students meeting the criteria for proficiency by scoring Proficient or Advanced Proficient on the Grade 5 NJ ASK was 71 (M=238.99, SD = 27.98). Results showed that the effect of treatment was not statistically significant at the $p<0.05$ level.

Null Hypothesis 3e

There is no significant difference between the mean scale scores of those students scoring not proficient on the 2012 NJ ASK5 (scoring below 200) in the Everyday Math Alternative Treatment and the mean scale score of those students scoring not proficient on the 2012 NJ ASK5 (scoring below 200) in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5. The null hypothesis was accepted.

An ANOVA was conducted comparing the scale scores of those students in each *treatment* scoring below 200 on the 2012 NJ ASK5. The total number of Everyday Math Treatment students not meeting the criteria for proficiency (scoring less than 200) on the

Grade 5 NJ ASK was 15 (M= 174.27, SD = 17.487). The total number of Singapore Math students not meeting the criteria for proficiency (scoring less than 200) on the Grade 5 NJ ASK was 29 (M=176.55, SD = 14.681). Results showed that the effect of treatment was not statistically significant at the $p<0.05$ level.

Subsidiary Question 4

Is there a statistically significant difference in the 2012 NJ ASK5 performance level of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic), and is there significant interaction between treatment status and race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic)?

Null Hypothesis 4a

There is no significant interaction between treatment status and Black&Hispanic/White performance as measured by the 2012 NJ ASK5. The null hypothesis was accepted.

A factorial ANOVA was conducted incorporating the independent variables treatment and Black&Hispanic/White (the dichotomous variable representing the race/ethnicity status, Black and Hispanic or White).

Black and Hispanic students in the Everyday Math Alternative Treatment (N= 90) had a mean scale score of 221.33 (*SD* = 32.890). White students in the Everyday Math Alternative Treatment (N= 15) had a mean scale score of 250.13 (*SD* = 25.743). Black and Hispanic students in the Singapore Math Experimental Treatment (N=88) had a mean scale score of 214.34 (*SD* = 34.355). White students in the Singapore Math Experimental Treatment (N=12) had a mean scale score of 268.83 (*SD* = 25.316). The interaction of treatment and race/ethnicity (Black&Hispanic/White) was not statistically significant suggesting that there was no significant interaction between *race/ethnicity* (Black&Hispanic/White) and treatment with student performance on the 2012 NJ ASK5. The independent variable Black&Hispanic/White was statistically significant; p-value < 0.05, $F(1, 204) = 37.554$ and $\eta_p^2 = 0.157$, indicating that the performance level of Black and Hispanic students was significantly different, and in this case, significantly worse than White students. Based on the results, two additional analyses were run to determine whether significant differences in the performance level of the subset of Black and Hispanic students and the subset of White students occurred across both treatments. (see Null Hypotheses 4a and 4b).

Null Hypothesis 4b

There is no significant difference between the overall performance of the subset of Black and Hispanic students in the Everyday Math Alternative Treatment and the subset of Black and Hispanic students in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5. The null hypothesis was accepted.

An ANOVA was conducted comparing the 2012 NJ ASK5 mean scale score of the subset of Black and Hispanic students in the Everyday Math treatment to the 2012 NJ ASK5 mean scale score of the subset of Black and Hispanic students in the Singapore Math treatment. Black and Hispanic students in the Everyday Math Alternative Treatment (N= 90) had a mean scale score of 221.33 (*SD* = 32.89). Black and Hispanic students in the Singapore Math Experimental Treatment (N=88) had a mean scale score of 214.34 (*SD* = 34.36). The independent variable treatment was not statistically significant with a p-value > 0.05, indicating that there was no significant difference in the performance of the subset of Black and Hispanic students in the Everyday Math treatment and the subset of Black and Hispanic students in the Singapore Math Treatment.

Null Hypothesis 4c

There is no significant difference between the overall performance of White students in the Everyday Math Alternative Treatment and White students in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5. The null hypothesis was accepted.

An ANOVA was conducted comparing the 2012 NJ ASK5 mean scale score of the subset of White students in the Everyday Math treatment to the 2012 NJ ASK5 mean scale score of the subset of White students in the Singapore Math Treatment.

White students in the Everyday Math Alternative Treatment (N= 15) had a mean scale score of 250.13 (*SD* = 25.74). White students in the Singapore Math Experimental Treatment (N=12) had a mean scale score of 268.83 (*SD* = 25.32). The independent variable treatment was not statistically significant with p-values > 0.05, indicating that there was no significant difference in the performance levels of White students in the Everyday Math treatment and White students in the Singapore Math Treatment.

Null Hypothesis 4d

There is no significant interaction between *treatment* status and Black/Hispanic performance as measured by the 2012 NJ ASK5. The null hypothesis was accepted.

A factorial ANOVA was conducted incorporating the independent variables treatment and Black or Hispanic. Black students in the Everyday Math Alternative Treatment (N= 50) had a mean scale score of 211.60 (*SD* = 29.27). Hispanic students in the Everyday Math Alternative Treatment (N= 40) had a mean scale score of 233.50 (*SD* = 33.45). Black students in the Singapore Math Experimental Treatment (N=51) had a mean scale score of 205.94 (*SD* = 29.69). Hispanic students in the Singapore Math Experimental Treatment (N=37) had a mean scale score of 225.92 (*SD* = 37.29). The interaction of treatment and Black/Hispanic was not statistically significant. The independent variable Black/Hispanic was statistically significant; p-value < 0.05, $F(1, 177) = 18.526$; and $\eta_p^2 = 0.096$. Based on the results, two additional analyses were run to determine whether significant difference in the performance of Black and Hispanic students occurred across both treatments (see Null Hypotheses 4e and 4f).

Null Hypothesis 4e

There is no significant difference in the overall 2012 NJ ASK5 performance of Black and Hispanic students in the Everyday Math Alternative Treatment. The null hypothesis was rejected.

An ANOVA was conducted comparing the 2012 NJ ASK5 mean scale scores of Black students in the Everyday Math Alternative Treatment and Hispanic students in the Everyday Math Alternative Treatment. Black students in the Everyday Math Alternative Treatment (N= 50) had a mean scale score of 211.60 (*SD* = 29.27). Hispanic students in the Everyday Math Alternative Treatment (N= 40) had a mean scale score of 233.50 (*SD* = 33.45). The independent variable Black/Hispanic was statistically significant; $F(1, 90) = 10.954$, $p < 0.05$, and $\eta_p^2 = 0.111$, indicating that the performance of Black students was significantly different, and in this case, significantly worse than Hispanic students.

Null Hypothesis 4f

There is no significant difference in the overall 2012 NJ ASK5 performance of Black and Hispanic students in the Singapore Math Experimental Treatment. The null hypothesis was rejected.

An ANOVA was conducted comparing the 2012 NJ ASK5 mean scale scores of Black students in the Singapore Math Experimental Treatment and Hispanic students in the Singapore Math Experimental Treatment. Black students in the Singapore Math Experimental Treatment (N=51) had a mean scale score of 205.94 (*SD* = 29.69). Hispanic students in the Singapore Math Experimental Treatment (N=37) had a mean scale score of 225.92 (*SD* = 37.29). The independent variable Black/Hispanic was statistically significant; F(1, 90) = 7.819, $p < 0.05$, and $\eta_p^2 = 0.006$, indicating that the performance of Black students was significantly different, and in this case, significantly worse than Hispanic students.

Subsidiary Question 5

How much variance in the 2012 NJ ASK5 mean scale score of Black students can be explained by the predictor variables treatment, attendance, gender, and SES?

Null Hypothesis 5

H_0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, and SES account for no variation in the performance of Black students on the 2012 NJ ASK5. The null hypothesis was accepted.

A simultaneous regression analysis was conducted to determine the degree to which the predictor variables treatment, attendance, gender, and SES account for variation in the performance of Black students on the 2012 NJ ASK.

A total of 101 Black students (M=208.74, SD=29.475) were considered in this analysis. These students had a mean attendance of 354.51 (SD = 11.59). Overall results indicate that the predictor variables treatment, attendance, gender, and SES did not account for a significant proportion of variance in the mathematics performance of Black students.

Subsidiary Question 6

How much variance in the 2012 NJ ASK5 mean scale score of Hispanic students can be explained by the predictor variables treatment, attendance, gender, and SES?

Null Hypothesis 6

H_0: $\beta_0 = 0$; the predictor variables treatment, attendance, gender, and SES account for no variation in the performance of Hispanic students on the 2012 NJ ASK5. The null hypothesis was rejected.

A simultaneous regression analysis was conducted to determine the independent variable(s) best correlated with the performance of Hispanic students on the 2012 NJ ASK5. A total of 77 Hispanic students (M=229.86, SD=35.315) were considered in this analysis. These students had a mean attendance of 349.07 (SD = 19.49). Model 1, which combined with the predictor variables treatment, attendance, gender, and SES, was significant; $F(4, 72) = 5.052$, $R = 0.467$, $R^2_{adj} = .175$, $p<0.05$. Only two variables in the model accounted for a significant proportion of variation in the performance of Hispanic students on the 2012 NJ ASK5:

- Attendance, $\beta = 0.462$, $t(77) = 4.141$, $p=0.000$
- SES, $\beta = -0.226$, $t(77) = -2.067$, $p=0.042$

The variables treatment and gender were not significant predictors of performance in this analysis.

Subsidiary Question 7

Is there a statistically significant difference in the 2012 NJ ASK5 performance of Hispanic students based on SES classification and treatment status when controlling for attendance; and is there significant interaction between treatment status and SES classification for Hispanic students when controlling for attendance?

Null Hypothesis 7a

There is no significant difference in the 2012 NJ ASK5 performance of Hispanic students based on SES classification and treatment status when controlling for attendance. The null hypothesis was accepted.

Null Hypothesis 7b

There is no significant interaction between treatment status and SES when controlling for attendance. The null hypothesis was accepted.

A factorial ANCOVA was conducted comparing the 2012 NJ ASK5 mean scale score of Hispanic students in the Everyday Math treatment to the 2012 NJ ASK5 mean scale score of Hispanic students in the Singapore Math Treatment, controlling for attendance. Low SES Hispanic students (N=70) had a mean scale score of 228.514 (SD = 35.58). Higher SES Hispanic students (N = 7) had a mean scale score of 243.29 (SD = 31.763).

Low SES Hispanic students in the Everyday Math Alternative Treatment (N= 37) had a mean scale score of 233.00 (SD = 34.24). Low SES Hispanic students in the

Singapore Math Experimental Treatment (N=33) had a mean scale score of 223.49 (SD = 36.89).

Higher SES Hispanic students in the Everyday Math Alternative Treatment (N= 3) had a mean scale score of 239.667 (SD = 25.38). Higher SES Hispanic students in the Singapore Math Experimental Treatment (N=4) had a mean scale score of 246.00 (SD = 39.56).

The independent variable SES was statistically significant with a p-value < 0.05; $F(1, 76) = 4.366$, $\eta_p^2 = 0.057$, $p = 0.040$, indicating that the performance of low SES Hispanic students was significantly different, and in this case, worse, than higher SES Hispanic students. The covariate attendance was also statistically significant with a p-value < 0.05; $F(1, 76) = 20.804$, $\eta_p^2 = 0.224$, $p = 0.000$. The independent variables treatment and the interaction of treatment and SES were not statistically significant with p-values > 0.05, indicating that there was no significant difference in treatment.

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

The primary purpose of this study was to provide performance data to show how two elementary school mathematics curricula, aligned to two different sets of standards, impacted student performance on New Jersey State standardized tests. The study provides data to assist stakeholders in better understanding the role that standards-aligned curricular materials play in the development of students' skills in elementary mathematics by examining significant differences between the achievement effects of one proposed Common Core State Standards-aligned mathematics program, *Math in Focus: Singapore Math* (published by Houghton Mifflin Harcourt, 2010), and one NCTM-aligned mathematics program, *Everyday Mathematics* (currently published by the Wright Group/McGraw-Hill, 2007). The study takes place within the Large Northeastern Urban Public School District – a district categorized within District Factor Group A, the lowest grouping, indicative of the district's relative socioeconomic status. The participants were identified as the 2011-2012 cohort of fifth grade students within the Large Northeastern Urban Public School District in the eight schools identified as either Singapore Math Experimental Treatment or Everyday Math Alternative Treatment sites. The qualifying Grade 5 sample was a representation of (a) general education students from one of the four Large Northeastern Urban Public School District regions who (b) remained within their respective schools sites for their third, fourth, and fifth grade years and (c) used *Everyday Mathematics* as their core program in their third grade year. The *experimental treatment* sample, 100 Grade 5 students, reflected the qualifying subset of students from the four schools piloting the *Math in Focus: Singapore Math* (Houghton Mifflin Harcourt, 2010). This group used the Singapore Math program as their core instructional mathematics program in their fourth and fifth grade years.

Four additional schools with similar past performance trends, demographic compositions, and within-school factors as compared to the piloting sites were selected and paired with each of the experimental treatment sites. The *alternative treatment* sample, 105 Grade 5 students, reflected the qualifying subset of students from the four schools that continued to use the district-adopted program, *Everyday Mathematics*, 3rd Edition (McGraw-Hill Education, 2007) in their fourth and fifth grade years.

This study employed an explanatory non-experimental research design, using post hoc pre- and post-test data from 2010 and 2012 administrations of the New Jersey Assessment of Skills and Knowledge (NJ ASK). Multiple analyses were employed in the study, first to establish the comparability of the groups and control for initial differences, then to determine if the implementation of a K-5 CCSSM-aligned mathematics program, Singapore Math, is related to differences in performance on New Jersey Assessment of Skills and Knowledge (NJ ASK) for Grade 5 general education students in comparison to students using a NCTM-aligned elementary mathematics program, Everyday Mathematics.

This research was guided by one overarching research question with seven subsidiary questions. All primary analysis findings are reported in aggregate at the *treatment* level. Findings, conclusions, and the potential implications for theory, knowledge, practice, policy, and future research are discussed in this chapter.

Summary of Findings

This study examined the primary research question "What is the impact of implementing a proposed CCSSM-aligned mathematics program, Singapore Math, on the mathematics achievement of Grade 5 general education students as measured by the 2012 Grade 5 NJ ASK (NJ ASK5) in comparison to the mathematics achievement of Grade 5 general education students using a NCTM-aligned elementary mathematics program, Everyday Mathematics, in the Large Northeastern Urban Public School District?"

Via research methods designed to test the null hypotheses, the following subsidiary questions and their corresponding analyses and results are discussed.

Subsidiary Question 1

How much variance in the 2012 NJ ASK5 mean scale score can be explained by the predictor variables treatment, attendance, gender, race/ethnicity, and SES?

Findings for Subsidiary Question 1. 18.5% of the variance in student performance can be explained by the predictor variables treatment, attendance, gender, race/ethnicity, and SES, whereas the significant proportions can be explained by attendance (3.8%) and race/ethnicity (12.5%).

Exploratory regressions analyses revealed that the variables *treatment*, attendance, gender, race/ethnicity, and SES, combined, accounted for a significant proportion of variance in student performance (18.5%) as measured by the in 2012 NJ ASK5. However, only two variables, Black&Hispanic/White (the dichotomous variable representing race/ethnicity status, Black/Hispanic or White/Other) and attendance, were statistically significant predictors of variance in student performance. The variable attendance explained 3.8% of the variance in performance. The variable

Black&Hispanic/White explained 12.5% of the variance in performance. Treatment, gender, and SES were not significant predictors of performance in this analysis. While *treatment* was not found to be a significant predictor variable in the exploratory regression analyses, subsequent analyses incorporated *treatment* as a fixed or grouping variable and were conducted to either validate the initial findings or to make comparisons between the treatment groups around the significant predictor variables: race/ethnicity and attendance.

Subsidiary Question 2

Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment when controlling for attendance?

Findings for Subsidiary Question 2. There is no significant difference in the overall performance of students in the Everyday Math Alternative Treatment and students in the Singapore Math Experimental Treatment as measured by the 2012 NJ ASK5.

An ANCOVA was conducted to determine whether differences existed between the Singapore Math Experimental Treatment and the Everyday Math Alternative Treatment on overall performance as measured by the 2012 NJ ASK5, when controlling for *attendance*. While the mean scale score of the Everyday Math Alternative Treatment (225.45) was higher than the mean scale score of the Singapore Math Experimental Treatment (220.88), the means did not differ significantly based upon *treatment* status. The covariate attendance was statistically significant with a p-value = 0.003 and η_ρ^2 = 0.044.

Subsidiary Question 3

To what extent do differences in performance exist when data are analyzed according to 2012 NJ ASK5 performance levels (Partially Proficient, Proficient, and Advanced Proficient) and treatment status, and is there significant interaction between the performance levels and treatment?

Findings for Subsidiary Question 3. There were no significant differences in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on performance level:

- For both treatment groups, the 2012 NJ ASK5 mean scale score of the cohort of students initially scoring Partially Proficient on the 2010 NJ ASK3 was significantly higher than their 2010 NJ ASK3 mean scale score, with both treatments having fairly large effect sizes
- For both treatment groups, the 2012 NJ ASK5 mean scale score of the cohort of students initially scoring Advanced Proficient on the 2010 NJ ASK3 was significantly lower than their 2010 NJ ASK3 mean scale score, with both treatments having medium effect sizes
- There was no significant interaction between the performance levels and *treatment.*

Multiple analyses were conducted (t-tests, ANOVA, and factorial ANOVA) to examine the 2012 NJ ASK5 performance of each treatment group at the three NJ ASK performance levels: Partially Proficient, Proficient, and Advanced Proficient.

For both treatments, an Independent Samples t-test was conducted comparing the 2010 NJ ASK3 performance at each performance level (Partially Proficient, Proficient, and

Advanced Proficient) prior to treatment and the performance of the same cohort (scoring Partially Proficient, Proficient, or Advanced Proficient) on the 2010 NJ ASK3 after treatment. For both treatment groups, (1) the 2012 NJ ASK5 mean scale score of the cohort of students initially scoring Partially Proficient on the 2010 NJ ASK3 was significantly different and, in this case, significantly higher than their 2010 NJ ASK3 mean scale score; (2) the 2012 NJ ASK5 mean scale score of the cohort of students initially scoring Advanced Proficient on the 2010 NJ ASK3 was significantly different, and in this case, significantly lower than their 2010 NJ ASK3 mean scale score; and (3) the 2012 NJ ASK5 mean scale score of the cohort of students initially scoring Proficient on the 2010 NJ ASK3 was not significantly different than their 2010 NJ ASK3 mean scale score.

A factorial ANOVA was conducted incorporating the independent variables treatment and performancelevel2012 (the categorical variable representing the 2012 NJ ASK5 proficiency levels: Advanced Proficient, Proficient, and Partially Proficient). The interaction of treatment and mathproficiecylevel2012 was not statistically significant, suggesting that there was no significant difference in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on performance level. The variable performancelevel2012 was the only statistically significant variable in this analysis with p values < 0.05.

An ANOVA was conducted comparing the mean scale scores of those students in each treatment meeting the criteria for “passing” by scoring Proficient or Advanced Proficient on the 2012 NJ ASK5. While the mean scale score of Everyday Math Treatment students “passing” the 2012 NJ ASK5 (233.98) was lower than the mean scale score of Singapore Math Treatment students "passing" the 2012 NJ ASK5 (238.99), the means do not differ significantly.

An ANOVA was conducted to compare the mean scale scores of those students in each treatment "failing" the NJ ASK5 (scoring below 200). While the mean scale score of Everyday Math Treatment students "failing" the 2012 NJ ASK5 (174.27) was lower than the mean scale score of Singapore Math students "failing" the 2012 NJ ASK5 (176.55), the means do not differ significantly.

Subsidiary Question 4

Is there a statistically significant difference in the 2012 NJ ASK5 performance of students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic), and is there significant interaction between treatment status and race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic)?

Findings for Subsidiary Question 4. There were no significant differences in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity (Black, Hispanic, White, subset of Black and Hispanic):

- Despite treatment, White students performed significantly better than the subset of Black and Hispanic students on the 2012 NJASK5
- Despite treatment, Hispanic students performed significantly better than Black students on the 2012 NJASK5
- There was no significant interaction between race/ethnicity (Black&Hispanic/White) and treatment

- There was no significant interaction between race/ethnicity (Black/Hispanic) and treatment.

Multiple analyses were conducted (e.g., ANOVA and factorial ANOVA) to examine the 2012 NJ ASK performance of each treatment group based on race/ethnicity (Black, Hispanic, White, subset of Black/Hispanic).

A factorial ANOVA was conducted incorporating the independent variables treatment and Black&Hispanic/White (the dichotomous variable representing the race/ethnicity status, Black and Hispanic or White). The interaction of treatment and Black&Hispanic/White was not statistically significant, suggesting that there was no significant difference in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity. The variable Black&Hispanic/White was the only statistically significant variable in this analysis with p values < 0.05. Based on the results, two additional analyses were run to determine whether significant differences in the performance of the subset of Black and Hispanic students and the subset of White students occurred across both treatments.

An ANOVA, conducted to compare the 2012 NJ ASK mean scale scores of the cohort of Black and Hispanic students in the Everyday Math Treatment (221.33) and the cohort of Black and Hispanic students in the Singapore Math Experimental Treatment (214.34), revealed that treatment was not statistically significant, indicating that there was no significant difference in the 2012 NJ ASK performance of the cohort of Black and Hispanic in the Everyday Math Treatment and the cohort of Black and Hispanic students in the Singapore Math Treatment.

An ANOVA, conducted to compare the 2012 NJ ASK mean scale scores of the subset of White students in the Everyday Math treatment[22] (250.13) and White students in the Singapore Math Experimental Treatment[23] (268.83) revealed that treatment was not statistically significant, indicating that there was no significant difference in the 2012 NJ ASK performance of White in the Everyday Math treatment and White students in the Singapore Math Treatment.

A factorial ANOVA was conducted incorporating the independent variables treatment and Black/Hispanic (the dichotomous variable representing the race/ethnicity status, Black or Hispanic). The interaction of treatment and Black&Hispanic was not statistically significant, suggesting that there was no significant difference in the overall performance of the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on race/ethnicity. The variable Black&Hispanic was the only statistically significant variable in this analysis with p values < 0.05. Based on the results, two additional analyses were run to determine whether significant difference in the performance of Black and Hispanic students occurred across both treatments.

A comparison between the 2012 NJ ASK5 mean scale scores of Black students in the Everyday Math Alternative Treatment (211.60) and Hispanic students in the Everyday Math Alternative Treatment (233.5) revealed the independent variable Black/Hispanic was statistically significant; p-value < 0.05, $\eta_p^2 = 0.111$, indicating the performance of Black and Hispanic students, regardless of treatment, was significantly different.

A comparison between the 2012 NJ ASK5 mean scale scores of Black students in the Singapore Math Experimental Treatment (205.94) and Hispanic students in the

[22] Small sample size (N = 15) could potentially reduce the statistical power of this analysis.
[23] Small sample size (N = 12) could potentially reduce the statistical power of this analysis.

Singapore Math Experimental Treatment (225.92) revealed that the independent variable Black/Hispanic was statistically significant; p-value < 0.05, $\eta p^2 = 0.006$, indicating that performance of Black and Hispanic students, regardless of treatment, was significantly different.

Subsidiary Question 5

How much variance in the 2012 NJ ASK5 mean scale score of Black students can be explained by the predictors treatment, attendance, gender, and SES?

Findings for Subsidiary Question 5. There is no significant variance in the 2012 NJ ASK5 mean scale score of Black students that can be explained by the predictors treatment, attendance, gender, and SES.

A simultaneous regression analysis was conducted to determine the degree to which the predictor variables treatment, attendance, gender, and SES account for variation in the performance of Black students on the 2012 NJ ASK. A total of 101 Black students (M = 208.74, SD = 29.33) were considered in this analysis. Overall results indicate that the predictor variables treatment, attendance, gender, and SES did not account for a significant proportion of variance in the mathematics performance of Black students.

Subsidiary Question 6

How much variance in the 2012 NJ ASK5 mean scale score of Hispanic students can be explained by the predictors treatment, attendance, gender, and SES?

Findings for Subsidiary Question 6. 21.8%, of the variance in the 2012 NJ ASK5 mean scale score of Hispanic students can be explained by the predictors treatment, attendance, gender, race/ethnicity and SES, whereas the significant proportions can be explained by attendance (16.6%) and *SES* (5.1%).

A simultaneous regression analysis was conducted to determine the independent variable(s) best correlated with the performance of Hispanic students on the 2012 NJ ASK5. A total of 77[24] Hispanic students (M=229.86, SD=35.315) were considered in this analysis. The combination of the predictor variables treatment, attendance, gender, and SES was significant; $p<0.05$, explained 21.8% of the variance in 2012 NJ ASK5 performance; however, only two variables in the model, attendance (explaining 16.6% of variance), and SES (explaining 5.1% of variance), accounted for a significant proportion of variation in the performance of Hispanic students on the 2012 NJ ASK5. The variables treatment and gender were not significant predictors of performance in this analysis.

---

[24] Sample size (N = 77) does not meet the criterion for sample size as defined by Field (2009) and Green (1991). Adequate sample size in this ion analysis would be 50 + 8k, where 'k' equals the number of predictors, or 82.

Subsidiary Question 7

Is there a statistically significant difference in the 2012 NJ ASK5 performance of Hispanic students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on SES when controlling for attendance; and is there significant interaction between treatment status and SES when controlling for attendance?

Findings for Subsidiary Question 7.

- There is no statistically significant difference in the 2012 NJ ASK5 performance of Hispanic students in the Everyday Math Alternative Treatment and the Singapore Math Experimental Treatment based on SES when controlling for attendance.
- There is no significant interaction between treatment status and SES when controlling for attendance.

A factorial ANCOVA was conducted comparing the 2012 NJ ASK5 mean scale score of low SES Hispanic students (228.51) to higher SES Hispanic students (243.29) based on treatment status while controlling for attendance. The independent variable *SES* was statistically significant with a p-value < 0.05; $F(1, 76) = 4.366$, $\eta_p^2 = 0.057$, indicating that the performance of low SES Hispanic students was significantly different, and in this case, worse, than higher SES Hispanic students. The covariate attendance was also statistically significant with a p-value < 0.05; $F(1, 76) = 20.804$, $\eta_p^2 = 0.224$. The independent variable treatment and the interaction of treatment and SES were not statistically significant, indicating that there was no significant difference in the effect of treatment when controlling for attendance.

Discussion and Conclusions

Preliminary analyses designed to establish the homogeneity of the treatment groups provided sufficient evidence to conclude that there were no statistically significant differences between the Singapore Math Experimental Treatment sample and Everyday Math Alternative Treatment sample based on the primary distributions of race/ethnicity (White, Black, Hispanic, Other), gender (male, female), SES (students receiving free or reduced lunch, students not receiving free or reduced lunch), and pre-test performance (Proficient, Partially Proficient), providing well-matched, homogeneous comparison groups. The subcategories Black or Hispanic, female, low SES, and Proficient maintained the highest distributions between the Alternative Treatment and Experimental Treatment samples. Overall, 75.6% of the entire sample can be characterized as low SES, Black or Hispanic fifth grade general education students; 75% of the Singapore Math sample and 76% of the Everyday Math sample fit this description.

Curriculum Findings

These data and statistical analyses indicate fairly consistent results regarding differences between students' performance on the 2012 NJ ASK5 in schools implementing the Singapore Math program and in schools implementing Everyday Mathematics. Generally, across all analyses, there were no substantial differences in performance based upon treatment status. Overall, treatment was found to be the weakest predictor of student performance. Similarly, there were no patterns of differential treatment effects across the dimensions of race/ethnicity, gender, and SES.

While the mean scale score for Everyday Math's females[25] was higher than that of Singapore Math's females[25], differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Everyday Math's Black and Hispanic subgroup was higher than that of Singapore Math's Black and Hispanic subgroup, differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Everyday Math's Hispanic students was higher than that of Singapore Math's Hispanic students, differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Everyday Math's low SES students was higher than that of Singapore Math's low SES students, differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Everyday Math's higher SES students was higher than that of Singapore Math's higher SES students, differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Everyday Math's Advanced Proficient students was higher than that of Singapore Math's Advanced Proficient students, differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Singapore Math's males[26] was higher than that of Everyday Math's males[26], differences were not statistically significant. Pretest differences were comparable.

[25] See Appendix D for t-test analysis (females).
[26] See Appendix D for t-test analysis (males).

While the mean scale score for Singapore Math's White students was higher than that of Everyday Math's White students, differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Singapore Math's Proficient students was higher than that of Everyday Math's Proficient students, differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Singapore Math's Partially Proficient students was higher than that of Everyday Math Partially Proficient students, differences were not statistically significant. Pretest differences were comparable.

While the mean scale score for Singapore Math's "passing" (Proficient and Advanced Proficient) students was higher than that of Everyday Math's "passing" (Proficient and Advanced Proficient) students, differences were not statistically significant. The Everyday Math sample had an initial pretest higher "passing" (Proficient and Advanced Proficient) mean scale score.

Summary of curriculum findings. The data and statistical analyses from this study indicated there were no statistically significant differences based upon the students' exposure to the Everyday Mathematics program or the Singapore Math program as measured by fifth grade performance on the 2012 NJ ASK. It is important to note that students in the Singapore Math Experimental Treatment faired equally as well as the students in the Everyday Math Alternative Treatment on an NJ ASK-aligned assessment measure that presumably gave advantage to the Everyday Math Alternative Treatment. However, the extent of the advantage (if any) cannot be substantiated by the analytics used in this study.

Overall research on elementary mathematics programs, when textbooks were compared, has shown modest differences on standardized assessment measures with small to moderate effect size suggesting that curriculum differences appear to be less consequential than instructional differences (Hiebert & Grouws, 2007; Sconiers et al., 2003; Slavin et al., 2007; NRC, 2004). While a key consideration for analyzing relative curriculum effect is the environment and approach to its implementation, Hiebert et al. (2007) explain that variables such as curriculum and their effects typically depend on the system in which they function. Anthony and Walshaw (2009) contend that mathematics pedagogy is not an isolated event but one that should be interpreted as a "complex web of factors that can affect student learning" (p. 148). Based on collective reviews of international studies and extending the work of Hiebert and Grouws (2007), the researchers identified ten principles of effective mathematics pedagogy that extend well beyond curriculum, incorporating practices relating to classroom community, classroom discourse, teacher knowledge, and "worthwhile mathematical tasks" (p. 155):

- An ethic of care
- Arranging for learning
- Building on students' thinking
- Worthwhile mathematical tasks
- Making connections
- Assessment for learning
- Mathematical communication
- Mathematical language
- Tools and representations

- Teacher knowledge

These principles reinforce that view of teaching practice as residing within a "nested system" (p. 149) within the larger classroom learning community. Given the findings noted within this study, recommendations for policy, practice, and future study and concluding statements include variables relating specifically to teacher practice and are framed within contexts supported by research that underscores the interrelation between specific teaching behaviors and student learning (Stylianides & Ball, 2004; Hiebert & Grouws, 2007; Anthony & Walshaw, 2009).

Performance-Level Findings

Although the data and statistical analyses indicate consistent results rejecting the existence of a relationship between the implementation of the Everyday Mathematics program and the Singapore Math program and student achievement on the NJ ASK, several points merit further exploration. Of the analyses conducted, four resulted in statistically significant differences with effect sizes large enough to be useful to educators with regard to performance level comparisons and demographic comparisons.

Performance-level comparisons. For both treatment groups, the 2012 NJ ASK5 mean scale score of the cohort of students initially scoring Partially Proficient on the 2010 NJ ASK3 was significantly higher than their 2010 NJ ASK3 mean scale score, with both treatments having fairly large effect sizes. For both treatment groups, the 2012 NJ ASK5 mean scale score of the cohort of students initially scoring Advanced Proficient on the 2010 NJ ASK3 was significantly lower than their 2010 NJ ASK3 mean scale score, with both treatments having medium effect sizes.

Summary of performance-level findings. These findings prompted further inquiry around (a) NJ ASK cut score reliability, (b) differences in difficulty on the 2010 NJ ASK3 and the 2012 NJ ASK5, and (c) differences in NJ ASK cut scores calculations given the incongruousness of these differences occurring between higher performing and lower performing groups across both treatments. NJ ASK scale scores have a range of 100 to 300. A student is classified as Partially Proficient if his or her scale score is lower than 200. A student is classified as Advanced Proficient if his or her scale score is 250 or higher. All other students are classified as Proficient.

Cut score reliability. Significant differences in performance levels could have resulted from unreliable cut score calculations. The cut score is the point on a score scale that separates one performance standard from another, thereby defining levels of performance (Horn, Ramos, Blumer, & Madaus, 2000). The *2010 NJ ASK Grades 3-8 Technical Report* calculates and reports cut score reliability as a measure of conditional standard error, a reliability index (Kappa), and as a classification consistency index. These statistics are estimates indicating how reliably the test classifies students into the performance categories Partially Proficient, Proficient, and Advanced Proficient. The 2010 Grade 3 NJ ASK measure of standard error was 3.12. The consistency index, 75%, indicated hypothetically that 75% percent of the examinees would be assigned to the same achievement level if the same test was administered a second time or an equivalent test was administered under the same conditions (NJDOE, 2011).

The *2012 NJ ASK Grades 3-8 Technical Report* calculated and reported cut score reliability as a measure of conditional standard error, whereas the 2012 NJ ASK5 ranges fell between 2.83 and 3.22 (NJDOE, 2013). Both reports indicate fairly reliable cut score classifications, suggesting that differences in the performance of the Partially Proficient cohort and the Advanced Proficient cohort did not result from unreliable cut score calculations.

Differences in difficulty. Significant differences in performance levels could have resulted from differing degrees of item difficulty between the NJ ASK3 and the NJ ASK5. For each NJ ASK administration, statistics are calculated that provide key information about the "quality of each item from an empirical perspective" (NJDOE, 2011, p. 31). Item difficulty, expressed as a *p-value,* indicates the percentage of examinees in the sample that answered the item correctly and generally falls within the range of 0.20 to 0.90. A second calculation, the Item Discrimination Mean (measured as an *r-biserial statistic)*, reflects the correlation between the item score and the test criterion score. Ultimately, it is an indication of the differences in the performance of competent and less competent examinees. The 2010 and 2012 NJ ASK Technical Reports reflect a similar degree of item difficulty, reporting an overall p-value of 0.67 (SD = 0.09) and a discrimination mean of 0.41 for the 2010 NJ ASK3 and an overall p-value of 0.68 (SD = 0.13) and a discrimination mean of 0.42 for the 2012 NJ ASK5.

The reported statistics indicate a fairly similar degree of item difficulty on the 2010 NJ ASK3 and the 2012 NJ ASK5, suggesting that differences in the performance of the Partially Proficient cohort and the Advanced Proficient cohort did not result from differences in item difficulty.

Differences in the calculation of cut scores. Significant differences in performance levels could have resulted from differences in the calculation of cut scores on the NJ ASK3 as compared to the NJ ASK5. Each year, the cut score in raw points that defines the performance levels on the NJ ASK may vary. Therefore, when comparing scores across the years, it is important to determine whether any differences in performance are large enough to suggest a difference in the standard reached (MacCann & Stanley, 2004). To produce the scale score ranges, linear transformations were applied to theta estimates and scale scores. Linear transformations can be used to transform raw scores to scale scores. The NJDOE's approach was adapted from Kolen and Brennan (2004), in which raw scores are converted to scale scores by first specifying the scale score equivalents of two raw score points, which, in turn, defines a linear raw-to-scale score equivalent.

$$sc(y) = \left[\frac{sc(y_2) - sc(y_1)}{\theta_2 - \theta_1}\right] y + \left\{ (sc(y_1) - \left[\frac{sc(y_2) - sc(y_1)}{\theta_2 - \theta_1}\right] \theta_1 \right\}$$

Equation 1: Linear Transformation Formula (NJDOE, 2011, 2013)

The formula presented in Equation 1 was used to obtain the slopes and intercepts for the transformation functions, where θ_2 and θ_1 are person parameter estimates that correspond to the cut score points[27], and $sc(y^1)$ and $sc(y^2)$ are scale score points. *The 2010 NJ ASK Grades 3-8 Technical Report* reported the Grade 3 Proficient Cut Theta as 0.1712, whereas the 2012 Grade 5 Proficient Cut Theta was 0.07726 (difference = 0.09). The 2010 Grade 3 Advanced Proficient Cut Theta was 1.47, whereas the 2012 Grade 5 Proficient Cut Theta was 1.6988 (difference = 0.22). See Table 74.

A smaller 2012 Grade 5 Proficient Cut Theta could explain the increase in Partial Proficient means across both treatments. A larger 2012 Grade 5 Advanced Proficient Cut Theta could explain the significant decrease in Advanced Proficient means across both treatments. Had the cut score thetas been the same or comparable, significant differences may not have resulted for the Partially Proficient and Advanced Proficient cohorts.

---

[27] *sc(y1)* is 200 and *sc(y2)* is 250

Table 74

Slope and Intercept of Theta to Scale Score Transformation

Grade	Proficient			Advanced Proficient			Slope	Intercept
	Raw Score	Theta	Scale Score	Raw Score	Theta	Scale Score		
3	24	0.1731	200	39	1.4775	250	38.76	192.26
5	22	0.0773	200	38	1.6988	250	32.12	195.32

Demographic Findings

Race/ethnicity, addressed through multiple analyses, explained a significant percentage (12.5%) of performance on the 2012 NJ ASK5. White students (M = 258.64) performed significantly better than Black[28] and Hispanic[29] students combined (M = 217.88). Hispanic students (M = 229.86) performed significantly better than Black students (M = 208.74). Attendance (16.6%) and SES (5.1%) explained a significant percentage of the variance in the performance of Hispanic students on the 2012 NJ ASK5.

Summary of demographic findings. Additional calculations showed the 2012 NJ ASK mean scale score of Black students to be close to two standard deviations below that of White students. The 2012 NJ ASK mean scale score of Hispanic students was one standard deviation below White students. These findings are consistent with the volumes

---

[28] White students (M = 258.64) performed significantly better than Black students (M = 208.78).

[29] White students (M = 258.64) performed significantly better than Hispanic students (M = 229.86).

of research documenting the achievement gap in education (Brooks-Gunn et al., 1993; Coleman et al., 1966; Gamoran, 1987; Gottfried et al., 2003; Jencks et al., 1972, 1979; Lee, Bryk, & Smith, 1993; Smith, et al., 1997). The achievement gap in education refers to the disparity in academic performance between groups of students (generally using measures of standardized-test scores, course selection, dropout rates, and college-completion rates, among other success measures) and is often used to describe performance gaps between African-American and Hispanic students and their White counterparts. Achievement gaps between students of different racial/ethnic backgrounds remain large, with White and Asian/Pacific Islander students typically performing significantly better than their Black, Hispanic, or American Indian/Alaska Native counterparts. Studies have found that, on average, Black students score one standard deviation below White students on standardized tests (NCES, 2009, 2011).

As most research supports that socioeconomic status (SES), closely associated with race/ethnicity, is one of the strongest predictors of academic achievement (Atweh, Meaney, McMurchy-Pilkington, Neyland, & Trinick, 2004), these findings are also fairly consistent with studies examining academic disparities between students from low income families and those from higher income families. This study revealed that SES and attendance, more so than any other racial/ethnic subgroup, was a significant predictor of Hispanic performance.

In one of the earlier and seminal curriculum effectiveness studies, Waite (2001) found significant achievement differences on the Texas Assessment of Academic Skills in mathematics for all student subcategories with the exception of Hispanic students, attributing language barriers to slow student progress in achievement when Everyday

Mathematics was used. Difficulties in reading are much more likely to occur among poor children, non-White children, and non-native speakers of English (Snow, Burns, & Griffin, 1998). As the ability to understand written text is of paramount importance in solving math word problems since it requires constructing meaning from text, children have to have general language comprehension skills and the ability to accurately and fluently identify written words (Snow, Burns, & Griffin, 1998). The language proficiencies needed for problem solving may contribute to and possibly compound differences in the performance of Hispanic students from low-income families compared to those who are better off. Abedi, Lord, and Hofstetter (1998), in their study of LEP and non-LEP math performance on a linguistically-modified NAEP assessment, found that language-related background variables were strong predictors of eighth-grade performance in math, whereas the length of time residing in the United States was the strongest predictor of students' math performance. Students familiar with two languages may find problem-solving tasks more difficult when administered in the less familiar language as compared with students who are routinely exposed to standard academic English and students from homes where English is the only or primary language.

Attendance was also found to be a significant predictor of Hispanic performance as measured on the 2012 NJ ASK5, explaining a statistically significant proportion of variance (16.6%). Attendance was documented for all participants for school years 2010-2011 and 2011-2012 (the two successive years reflected within this study) and reported as the total possible number of days (370). Further analyses of the variable attendance revealed that of all subgroups[11] (Black, White, and Hispanic), Hispanic students had the following attributes:

- greatest range in attendance, 118 days
- lowest mean attendance, 349 days
- greatest standard deviation for attendance, 19.49
- lowest minimum attendance, 251 days

A correlation analysis also revealed a statistically significant correlation between Hispanic attendance and the Hispanic 2012 NJ ASK mean scale score. The effect size, r = 0.408, indicates a moderately strong and positive linear relationship (see Appendix E).

The Hispanic population is currently the largest race or ethnic minority group in the United States (U.S. Department of the Census, 2012), representing 16.7% of the total U.S. population and 33.8% of the city of housing the Large Northeastern Urban Public School District. Researchers who study Hispanic families have suggested that the role of the family is significant in influencing the school performance of children (Collins, Maccoby, Steinberg, Hetherrington, & Bornstein, 2000; Trice, Hughes, Odom, Woods, & McClellan, 1995). Family support also strongly influences the academic achievement and attendance of Hispanic students (Zoppi, 2006). Given the findings noted within this study, recommendations for policy, practice, and future study along the lines of developing a strong collaborative relationship between the Hispanic families and schools

---

[11] Attendance Statistics (Note: Race/ethnicity status Other (N=2) is not reflected in the statistics below).

Black, Range = 53; White, Range = 33
Black, Mean = 354; White, Mean = 356
Black, Standard Deviation = 11.59; White, Standard Deviation = 9.56
Black, Minimum = 317; White, Minimum = 336

supported by relevant research (Chrispeels & Rivero, 2002; Delgado-Gaitan, 2004; Quezada, Diaz & Sanchez, 2003) are discussed in this chapter.

Recommendations for Policy and Practice

As there were no conclusive findings favoring one program over the other, this study reaffirms that curricular effectiveness, as it is an "integrated judgment based upon a number of scientifically valid evaluations that combine social values, empirical evidence, and theoretical rationales" (NRC, 2004, p. 4), cannot be established by a single scientifically valid study. Instead, a corpus of research-based studies is needed (NRC, 2004) to provide educators with valid, informative, and credible data on curricular effectiveness. As such, this study along with existing research should serve as a guide in the selection, development, and refinement of instructional programs (Hiebert, 1999).

Incidental findings such as the significance and effect size of *race/ethnicity* and *SES* and other compelling variables should influence future direction with regard to implications for education policy and practice. Although this study suggests that curriculum has small effects on student performance, research supports the correlation between school-related factors and student achievement and success.

This study found conclusively that background factors relating to a student's race/ethnicity and SES were significantly tied to academic achievement. The concern over achievement gaps in education has been addressed within recent NCLB legislation calling for the prioritization of funding around state efforts addressing the achievement gaps between high- and low-performing students, minority and nonminority students, and disadvantaged students and their more advantaged peers. However, large-scale school turnaround, takeover, and corporate education reform efforts, also licensed through

NCLB's call to "states and districts willing to take on ambitious, comprehensive reforms" and characterized by narrowed and test-driven curricula, school closings, competition, and free-market strategies, rapid charter school expansion, and test-based evaluation of teachers and school leaders are typically unfounded.

National Level Recommendations

Efforts and initiatives substantially founded on Essentialist perspectives that do not take into account student background factors will not produce significant or sustained results. Given the complexity of the variables relating to student background, (including those variables not explored within this study such as language) national, state, and district leaders must explore avenues that work toward the goal of mitigating those socio-economic factors (family income level, parent education level) that research has to tied long-lasting disparities in student achievement (Brooks-Gunn et al., 1993; Gamoran, 1987; Gottfried et al., 2003; Jencks et al., 1972, 1979; Lee, Bryk, & Smith, 1993; Smith, et al., 1997). This includes measures impacting poverty (providing equal access to quality education and healthcare, safe and affordable housing, adequate income supports)

State/District Level Recommendations

At the state and district levels, leadership should develop a local strategy to bring additional resources into the schools, allowing schools to be more responsive to the needs of students and families (G.E.D. classes, job training, university partnerships, etc.) Further, there should be increased efforts to expand universal access to early math start programs which should include early screening that is inarguably diagnostic in nature and developmentally appropriate. Early screening can help to identify children in need of concentrated educational supports or intervention "before failure occurs" (Jordan et al., 2007, p. 36). In almost every state and school district, “children are screened for potential reading difficulties in the primary grades” (Gersten & Jordan, 2005 as cited by Jordan et al., 2007, p. 36). However, screening for potential math difficulties is in its infancy (Gersten, Jordan, & Flojo, 2005). As a result, math difficulties, in a child’s formative years, are likely to go unnoticed. Studies have tracked the relationship between early mathematics achievement and later achievement. An understanding of *number* and *quantity* as specific competencies has been found to have a sustained impact on mathematical understandings beyond the early grades (Duncan et al., 2007; Jordan et al., 2009; Sarama et al., 2009); therefore, one goal of states and districts should be to improve the mathematics trajectory of all students.

Additionally, greater investments at the state level need to be made in teacher education, specifically at the graduate level. High-achieving countries such as Sweden and Finland invest heavily in graduate level teacher preparation programs aimed at helping teachers teach “diverse learners – including special education students – for deep understanding with a strong focus on how to use formative assessments in the service of student learning” (Darling et al., 2008, p. 6).

School Level Recommendations

Since being introduced by Gene V. Glass in 1976 and spurred by the recent policy movement toward the process of using scientifically or evidence-based research in education since the NCLB Act of 2001 (USDOE, 2002), schools are more engaged in data-driven practices. At the school level, leaders should disaggregate student achievement data in broader and more meaningful ways, noting patterns in student attendance, retention, and attrition rates and factoring in variables such as the length of time students have been in the United States and how students are progressing toward the development of cognitive/academic language proficiency.

As states move toward new standards, curricular materials, and professional development models, students and classroom teachers should be fully supported. School leaders should consider "pushing" supports into the classrooms (content coaches, media specialists, school counselors, special education and English Language Learner supports). School leaders should also establish and sustain strong and collaborative professional development partnerships to increase the time in which low-performing, minority, and disadvantaged students are in front of high quality and competent teachers while engaging in rigorous and meaningful mathematics.

Recommendations for Future Study

The recommendations for future research are based on the theory that multiple studies, set in multiple environments, will result in patterns that allow us to determine which curricula are most effective in varied circumstances (Bhatt et al., 2012; Hiebert, 1999; NRC, 2004; Slavin et al., 2008). Many of the recommendations below suggest revisiting this study once New Jersey's statewide assessment measure, the New Jersey Assessment of Knowledge and Skills, is replaced in 2014-2015 by the Common Core State Standards aligned Partnership for Assessment of Readiness for College and Careers (PARCC) assessment. The recommendations for future research follow:

Recommendation 1

Present sixth, seventh, and eighth grade (middle school) students within the Large Northeastern Urban Public School District were third, fourth, and fifth grade students, respectively, at the inception of the Singapore Math pilot. Over time, each piloting site extended the Singapore Math program into its middle school classrooms while each non-piloting site transitioned to the Connected Mathematics Project, another of the NSF-endorsed curriculum projects. Standardized assessment data for Grades 3-8, in addition to other meaningful indicators of performance, can be used to make longitudinal comparisons to determine the differential effects of treatment over multiple years. Future research could replicate the current study to measure student mathematics achievement on a longitudinal basis.

Recommendation 2

This study used NJ ASK performance data to show how two elementary school mathematics curricula impacted student performance. The PARCC assessments, which will be ready for states to administer during the 2014-15 school year, will replace state tests currently used to meet the requirements of the federal Elementary and Secondary Education Act. The PARCC assessments are intended to be an improved measure of students' problem solving, communication, and reasoning skills. Using the 2014-2015 PARCC assessment as the dependent measure, future research could extend the current study, using the same intact groups to measure mathematics performance.

Recommendation 3

As District Factor Groupings are closely tied to socioeconomic status (a variable typically found to be a significant predictor of student performance), future research could expand the current study to include other schools/districts in the same district factor groupings that are using the programs explored in this study. This would increase the sample size, thereby achieving greater degrees of statistical power (Cohen, 1988).

Recommendation 4

This study did not include the analyses of individual clusters in the research design due to reported 2012 NJ ASK5 reliability coefficient alphas with ranges from .41 - .78 per cluster (NJDOE, 2013). Future research could expand the current study, using reliable standardized assessment measures as well as additional assessment measures (performance-based assessments) to conduct statistical analyses based on CCSS domain performance[12].

Recommendation 5

At the time of this study, the NJ ASK tests were aligned to New Jersey State's Core Curriculum Content Standards (NJCCCS). Since the NJCCCS for mathematics were philosophically aligned with the NCTM standards (1989, 2000), as is the Everyday Mathematics program, the Everyday Math Alternative Treatment group had a presumed degree of advantage over the Singapore Math Experimental Treatment group. Therefore, this study could be refocused to determine if either program was more closely aligned to the NJ ASK, using a content analysis procedure (such as the Surveys of Enacted Curriculum), which compares the alignment or misalignment of "any two documents of content standards, assessments, curriculum materials, and instructional practices" (Martone & Sireci, 2009 as cited by Porter et al., 2011, p. 104), "defining content at the intersections of topics and cognitive demands" (p. 104).

Recommendation 6

This study delimited the population to general education students who, at the time of the administration of the NJ ASK3 and NJ ASK5, were not identified as special

[12] The NJDOE adjusted the 3-5 NJASK in 2012-2013 and the 6-8 NJASK in 2013-2014 to align to the Common Core State Standards; no longer reporting cluster data. Data are reported in 'domains' reflective of the Common Core State Standards for Mathematics.

education classified or Limited English Proficient classified. After establishing adequate comparability of the treatment groups, future research could replicate the current study to include special classifications of students initially excluded from this study.

Recommendation 7

While reading level may contribute to variances observed in mathematics performance (Sconiers et al., 2002), this study did not control for reading level. Using the same intact groups, future research could replicate the current study to examine the influence of reading level on student mathematics achievement, using NJ ASK 3 and 5 Language Arts Literacy scores as additional independent variables.

Recommendation 8

Whereas language-related background variables such as the length of time in which LEP and non LEP students reside in the United States was found to be a strong predictor of student mathematics performance (Abedi et al., 1998), future research could replicate the current study to examine the mathematics achievement differences between foreign-born and native-born Hispanic students after establishing adequate comparability of the treatment groups.

Recommendation 9

This study defined a student's socioeconomic status (SES) based upon New Jersey Department of Education guidelines which use the status attributed to a student qualifying for free or reduced-price lunch. This measure is based upon family income level, parents' educational attainment, and parents' occupation as defined by the U.S. government under the National School Lunch Program (NLSP). While SES typically serves as a proxy for a composite of factors ultimately denoting parent income level, additional family background characteristics are worthy of consideration (language, culture, parenting styles, and parents' involvement in child's education). Future research could incorporate a qualitative design that explores family background characteristics and mathematics achievement in schools using a CCSSM-aligned mathematics program as compared to schools using a NCTM-aligned elementary mathematics program.

Recommendation 10

Whereas this study incorporated a quantitative methodology, future research could incorporate a descriptive-qualitative design that explores the influence of teacher variables (teacher affect, degree of mathematics professional development, mathematics content knowledge) on student perceptions in schools using a CCSSM-aligned mathematics program as compared to schools using a NCTM-aligned elementary mathematics program. Such methods may prove to benefit the body of research around curriculum effectiveness.

Recommendation 11

Whereas this study incorporated a non-experimental design, this study could be redesigned to incorporate a more purposeful experimental or quasi-experimental design that increases the number of students assigned to each treatment; one group using the Singapore Math Experimental Treatment, the other using the widely established program, Everyday Mathematics. The redesigned study should employ a combination of methodologies such as those recommended by the NRC (2004) (embedding a content analysis, documenting the extent of coverage or opportunity to learn, delineating alignment to assessed skills, including multiple forms of student outcomes and indicators sensitive to curricular effects).

Recommendation 12

This study could be redesigned to incorporate a hierarchical linear modeling (HLM) statistical design analysis methodology in order to examine differences in achievement at the student and classroom levels. While ANOVA is appropriate to a "tremendous variety of designs" (Raudenbush, 1993, p. 459), its methods "are not widely applicable in larger-scale experiments when the data are unbalanced with some predictors that are continuous" (p. 460). While regression allows for a mix of discrete and continuous predictors, its benefits "are only available in fixed-effects models" (p. 461). HLM duplicates the results of standard ANOVA but "extends the study of fixed and random effects to include unbalanced data, predictors that are either continuous or discrete, and random effects that co-vary" (p. 459). Applying a general two-level HLM would allow the exploration of achievement at the student level, using level one factors such as prior achievement, SES, gender, race/ethnicity, and attendance and at the classroom-level, using level two factors such as extent of implementation, teacher content knowledge (addressed via proxies such as degree attainment), and hours of content-specific professional development.

Summary

Chapter I of this research study provided background information detailing the current U.S. reform policies and efforts designed to encourage states to address gaps in achievement specific to the STEM-related fields believed to influence economic growth. As states begin the work of selecting new standards-aligned materials, this study uses research-based methodology to provide timely and credible data on curricular effectiveness, specifically data on the effectiveness of the two elementary school mathematics curricula presented in this study. Chapter I included the purpose of the study, statement of the problem, research questions, research hypotheses, significance of the study, research design, limitations and delimitations of the study, and definitions of relevant terms.

Chapter II provided a review of the relevant literature, depicting historical factors relating to mathematics reform, research about mathematics learning, and concluding with current findings relating to seminal studies in the field of curriculum effectiveness, their documented impact on student achievement, and current studies relating to the programs explored in this study.

Chapter III presented the setting for the study, treatment, participants, subsidiary research questions and their accompanying null hypotheses, research design, data collection, instrumentation, instrument reliability and validity, procedures, and methods of data analysis.

Chapter IV presented the results and findings of this study. Multiple data analyses were conducted and the results were reported and summarized to answer the seven research questions and test the accompanying hypotheses, reporting the magnitude, statistical significance, and validation of results.

Chapter V presented the findings and conclusions, providing potential implications for theory, knowledge, practice, policy, and future research.

Final Thoughts

In the final analysis, broader questions arise. Do mathematics curricula matter, and can schools use school-level resources to mitigate the negative effects of disadvantage? While more research on the performance of disadvantaged students in mathematics education is needed, it is important to note that disadvantage is not an inherent construct of a student's background as much as it is "relational and depend[s] on the norms and practices within which students from diverse backgrounds have to integrate" (Willis, 1998, as cited by Atweh et al., 2004, p. 8). If schools are to mitigate the negative effects of disadvantage using school-level resources, namely curriculum in its broader sense (the total learning experiences of the individual), then educational structures must present a balance between delivering knowledge and the experiences of the student (Dewey, 1902).

It is then the job of school leaders to cultivate a system of more progressive practices where the student is not only factored into the equation, but is at its center. This thinking encourages schools to establish a paradigm that emphasizes Tyler's (1949) educational imperatives whereby the structure of the school curriculum is responsive to three central factors: (1) the nature of the learner (developmental factors, learner interests and needs, life experiences, (2) the values and aims of society (democratizing principles, values, and attitudes), and (3) knowledge of subject matter (what is believed to be worthy and usable knowledge). This paradigm requires comprehensive and accurate methods for determining progress (and failure) in learning, assessing the appropriateness of the curriculum, and detecting the root causes of the observed effects. While this paradigm does not necessarily eliminate the debate, it "mediates the hard edges of Essentialism" (Christopher Tienken, personal communication, July14, 2010) by providing a basis for more evolved and systemic approaches, at the school level, for assessing progress. Assessment then becomes a learning-based measure that assesses both student performance and the instructional model itself. Growth is sampled over time. Myopic measures that assess only cognitive ability levels are deemphasized; and large-scale multiple indexes such as student perception, engagement, and other “messy” variables are considered. As second-order change is a gradual process, it is understood that “quick fix” remedies are unlikely to make a long-term impact on the beliefs and practices so firmly embedded in the traditional practices of mathematics classrooms. Rather, sustainable and scalable approaches occurring at the school and governing levels, closest to the students, are needed. These approaches should promote creativity, diversity, and equity.

Therefore, it is this researcher’s final recommendation that schools (1) promote a shared commitment for curricular improvement and responsiveness, and (2) provide all stakeholders with the time, resources, technical assistance, and expertise needed for engaging in systemic efforts toward providing all students with the “knowledge and experiences that enable them to grow in exercising intelligent control of subsequent knowledge and experience” (Tanner & Tanner, 2007, p. 191). This and future curriculum studies should serve to support schools in meeting these goals.

REFERENCES

Abedi, J., Lord, C., & Hofstetter, C. (1998). *Impact of selected background variables on students' NAEP math performance*. Los Angeles, CA: UCLA Center for the Study of Evaluation/National Center for Research on Evaluation, Standards, and Student Testing.

Achieve, (2008). The building blocks of success: Higher level math for all students. Retrieved from www.achieve.org/files/BuildingBlocksofSuccess.pdf

Agodini, A., & Harris, B. (2011). Curriculum matters: Evidence from a randomized control trial of four elementary schools. *SREE Fall 2011 Conference Abstract* (pp. 1-4). Retrieved from www.sree.org/conferences/2011f/program/downloads/abstracts/247.pdf

Agodini, R., Harris, B., Atkins-Burnett, S., Heaviside, S., Novak, T., & Murphy, R. (2009). *Achievement effects of four early elementary school math curricula: Findings from first graders in 39 schools* (NCEE 2009-4052). Washington, DC: U.S. Department of Education, National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences (NCEE 2009-4052).

Ai, X., & Rivera, N. (2003). *Linking ideas to practice: Effectiveness of coaching upon teacher practice.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL

American Institutes for Research. (2005). What the United States can learn from Singapore's world-class mathematics (and what Singapore can learn from the United States): An exploratory study. Washington, DC: Author. Retrieved from www.air.org/news/documents/Singapore%20Report%20(Bookmark%20Version).pdf

Amrein, A. L., & Berliner, D. C. (2002). High-stakes testing, uncertainty, and student learning. *Educational Policy Analysis Archives*, *10*(18). Retrieved from http://epaa.asu.edu

Anthony, G., & Walshaw, M. (2009). Characteristics of effective teaching of mathematics: A view from the west. *Journal of Mathematics Education*, *2*(2), 147-164.

Atweh, B., Meaney, T., McMurchy, C., Neyland, J., & Trinick, T. (2004). Social justice and sociocultural perspectives. In B. Perry, G. Anthony, & C. Diezmann (Eds.), *Research in mathematics education in Australasia 2000-2003* (pp. 29-52). Brisbane, Australia: Post Pressed.

Balfanz, R. & Byrnes, V. (2012). *Chronic absenteeism: Summarizing what we know from nationally available data*. Baltimore, MD: Johns Hopkins University Center for Social Organization of Schools.

Ball, D. L., & Bass, H. (2003). Toward a practice-based theory of mathematical knowledge for teaching. In B. Davis & E. Simmt (Eds.), *Proceedings of the 2002 annual meeting of the Canadian Mathematics Education Study Group* (pp. 3-14). Edmonton, AB: CMESG/GDEDM.

Ball, D. L., Hill, H. H., & Bass, H. (2005, Fall). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator*, 14-46.

Baxter, J. A., Woodward, J., & Olson, D. (2001). Effects of reform-based mathematics instruction on low achievers in five third-grade classrooms. *Elementary School Journal*, *101*(5), 529-547.

Berends, M., Lucas, S. R., Sullivan, T. & Briggs, R. J. (2005). *Examining gaps in mathematics achievement among racial-ethnic groups, 1972-1992*. Santa Monica, CA: RAND Corporation. Retrieved from http://www.rand.org/pubs/monographs/MG255 (Also available in print form).

Bhatt, R., & Koedel, C. (2012). Large-scale evaluations of curricular effectiveness: The case of elementary mathematics in Indiana. *Educational Evaluation and Policy Analysis*, *34*(4), 391-412.

Bloom, H. S., Black, A. R., Hill, C. J., & Lipsey, M. W. (2008). Empirical benchmarks for interpreting effect sizes in research. *Child Development Perspectives*, *2*(3),172-177.

Bohon, S. A., Johnson, M. K., & Gorman, B K. (2006). College aspirations and expectations among Latino adolescents in the United States. *Social Problems*, *53*(2), 207–225.

Booth, J. L., & Siegler, R. S. (2006). Developmental and individual differences in pure numerical estimation. *Developmental Psychology*, *41*, 189–201.

Bozick, R., Ingels, S. J., & Owings, J. A. (2008). *Mathematics coursetaking and achievement at the end of high school: Evidence from the education longitudinal study of 2002* (Statistical Analysis Report). Washington, DC: U.S. Department of Education, National Center for Education Statistics. Retrieved from nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2008319

Braams, B. (2003). Spiraling through UCSMP everyday mathematics. Retrieved from http://www.math.nyu.edu/mfdd/braams/links/emspiral.html [8/27/03]

Braun M. T. (2011, June). Exploratory regression analysis: A tool for selecting models and determining predictor importance. *Behavior Research Methods, 43*(2), 331-339. doi: 10.3758/s13428-010-0046-8

Brooks-Gunn, J., Guo, G., & Furstenberg, F. (1993). Who drops out of and who continues beyond high school? Journal of Research on Adolescence, 3, 271–294.

Brooks-Gunn, J., Duncan, G. J., Klebanov, P. K., & Sealand, N. (1993). Do neighborhoods influence child and adolescent development? American Journal of Sociology, 99(2), 353-395.

Brooks-Gunn, J., Klebanov, P. K., & Duncan, G. J. (1996). Ethnic differences in children's intelligence test scores: Role of economic deprivation, home environment, and maternal characteristics. *Child Development*, *67*, 396–408.

Bull, R., Espy, K., & Wiebe, S. A. (2008). Short-term memory, working memory, and executive functioning in preschoolers: Longitudinal predictors of mathematical achievement at age 7 years. *Developmental Neuropsychology*, *33*(3), 205-228. doi 10.1080/87565640 801982312

Carnevale, A. P., & Desrochers, D. M. (n. d.). *The democratization of mathematics.* Paper prepared for the National Forum on Quantitative Literacy. Retrieved from www.maa.org/ql/pgs21_31.pdf

Carnevale, A. P., & Desrochers, D. M. (2003). *Standards for what? The economic roots of K-16 reform.* Princeton, NJ: Educational Testing Service. Retrieved from www.learndoearn.org/For-Educators/Standards-for-What.pdf

Carroll, W. M. (2001). Students in a standards-based mathematics curriculum: Performance on the 1999 Illinois State Achievement Test. *Illinois Mathematics Teacher*, *52*(1), 3-7.

CCSSO/NGA. (2010). *Common core state standards for mathematics.* Washington, DC: Council of Chief State School Officers and the National Governors Association Center for Best Practices. Retrieved from http://corestandards.org/

Chingos, M. M., & Whitehurst, G. J. R. (2012). *Choosing blindly: Instructional materials, teacher effectiveness, and the common core.* Washington, DC: Brown Center on Education Policy at Brookings Institute. Retrieved from http://www.brookings.edu/~/media/research/files/reports/2012/4/10%20curriculum%20chingos%20whitehurst/0410_curriculum_chingos_whitehurst.pdf

Chrispeels, J. H., & Rivero, E. (2001). Engaging Latino families for student success: How parent education can reshape parents' sense of place in the education of their children. *Peabody Journal of Education*, *76(*2), 1-29.

Clements, D. H., & Sarama, J. (2004). Learning trajectories in mathematics education [Special issue]. *Mathematical Thinking and Learning*, *6*(2).

Clements, D. H., & Sarama, J. (2009). *Learning and teaching early math: The learning trajectories approach*. New York, NY: Routledge.

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Alexander M. Mood, A. M., Weinfeld, F. D., & York, R. L. (1966). *Equality of Educational Opportunity*. Washington, DC: U.S. Department of Health, Education, and Welfare, Office of Education.

Common Core Standards Writing Team. (2011). Progressions for the Common Core State Standards in Mathematics: K–5, Number and Operations in Base Ten. Retrieved from http://commoncoretools.files.wordpress.com/2011/04/ccss_progression_nbt_2011_04_073.pdf

Confrey, J., & Kazak, S. (2006). A 30-year reflection on constructivism. In A. Gutierrez & P. Boero (Eds.), *Handbook of research on the psychology of mathematics education: Past, present and future* (pp. 305-346). Rotterdam, The Netherlands: Sense.

Conley, D. T. (2003). Understanding university success. A Report from Standards for Success, a project of the Association of American Universities and the Pew Charitable Trusts. Retrieved from www.s4s.org/UUS_Complete.pdf

Conley, D. T. (2003, January*). Standards for success: What it takes to succeed in entry-level university courses*. Paper presented at the annual meeting of the American Association of Colleges and Universities, Seattle, WA.

Conley, D. T. (2007). Redefining college readiness. Eugene, OR: Educational Policy Improvement Center.

Cooper, H. M. and Lindsay, J. J. (1998). Research synthesis and meta-analysis. L. Bickman, & D. J. Rog (Eds.), *Handbook of applied social research methods* (pp. 3-16). Thousand Oaks, CA: Sage.

Corcoran, T., Mosher, F. A., & Rogat, A. (2011). *Learning progressions in mathematics: A foundation for standards, curriculum, instruction, and assessment* (Research Report #RR-63). Philadelphia, PA: Consortium for Policy Research in Education.

Cuoco, A. A. (n.d.). *Beyond problem solving: Mathematics as a way of thinking* *about things*. Paper prepared for the Education Development Center, New York.

Cuoco, A. A., Goldenberg, E. P., & Mark, J. (1997). Habits of mind: An organizing principle for mathematics curriculum. *Journal of Mathematical Behavior*, *15*(4), 375-402.

Darling-Hammond, L., & McCloskey, L. (2008). Assessment for learning around the world: What would it mean to be internationally competitive? *Phi Delta Kappan*, *90*, (4), 263-272.

Daro, P., McCallum, B., & Zimba J. (2012). The *K–8 publishers' criteria for the Common Core State Standards for Mathematic*s. Retrieved from http://www.corestandards.org/assets/Math_Publishers_Criteria_K-8_Summer%202012_FINAL.pdf

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

Deary, I. J., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence*, *35*, 13–21.

Delgado-Gaitán, C. (1991). *Involving parents in the schools: A process of empowerment*. *American Journal of Education, 100*(1), 20-46.

Delgado-Gaitán, C. (2004). Involving Latino families in schools: Raising student achievement through home-school partnerships. Thousand Oaks, CA: Corwin Press, SAGE.

Dewey, J. (1902). *The child and the curriculum.* Chicago, IL: University of Chicago Press.

Dindyal, J. (2006, July). The Singaporean mathematics curriculum: Connections to TIMSS. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *Proceedings of the 29th annual conference of the mathematics education Research group of Australasia, 1*, 179-186.

Dorn, S. (2003). High-stakes testing and the history of graduation. *Education Policy Analysis Archives*, *11*(1), 1-29.

Duncan, G. J., & Brooks-Gunn, J. (1997). Income effects across the life-span: Integration and interpretation. In G. J. Duncan & J. Brooks-Gunn (Eds.), *Consequences of growing up poor*. New York, NY: Russell Sage Foundation.

Duncan, G. J., Chantelle J., Dowsett, A., Claessens, K. M., Aletha C. Huston,A. C., Pamela Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology, 43*,(6), 1428, Retrieved from http://dx.doi.org/10.1037/0012-1649.43.6.1428.supp

Durbin, J., & Watson, G. S. (1950). Testing for serial correlation in least squares regression, I. *Biometrika*, *37*(3–4), 409–428. JSTOR 2332391

Durbin, J., & Watson, G. S. (1951). Testing for serial correlation in least squares regression, II. *Biometrika*, *38*(1–2), 159–179. JSTOR 2332325

Dynarski, M., Clarke, L., Cobb, B., Finn, J., Rumberger, R., & Smink, J. (2008). *Dropout prevention: A practice guide* (NCEE 2008–4025). Washington, DC: U.S. Department of Education. National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences. Retrieved from http://ies.ed.gov/ncee/wwc.

Editorial Projects in Education (2011). Diplomas count: Beyond high school, before baccalaureate. *Education Week*, *30*(34). Retrieved from http://www.edweek.org/go/dc11

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics achievement, attitudes, & affect: A meta-analysis. *Psychological Bulletin*, *136*, 103-127.

Embretson, S. E. (1995). The role of working memory capacity and general control processes in intelligence. *Intelligence,* 20(2), 169-189.

Epstein, J. L., & MacIver, D. J. (1992). *Opportunities to learn: Effects on eighth graders of curriculum offerings and instructional approaches*. Baltimore, MD: The Johns Hopkins University, Center for Research on Effective Schooling for Disadvantaged Students.

Fordham, S., & Ogbu, J. U. (1986). Black students' school success: Coping with the burden of ''acting White.'' *The Urban Review*, *18*, 176–206.

Fuson, K. C., Carroll, W. M., & Drueck, J. V. (2000). Achievement results for second and third graders using the standards-based curriculum Everyday Mathematics. *Journal for Research in Mathematics Education*, *31*(3), 277-295.

Gamoran, A. (1987). The stratification of high school learning opportunities. *Sociology of Education*, *60*, 135-155.

Gamoran, A, & Hannigan, E. (2000). Algebra for everyone? Benefits of college-preparatory mathematics for students with diverse abilities in early secondary school. *EPAA*, *22*(3), 241-254.

Gaumer-Erickson, A. S., Kleinhammer-Tramill, J., & Thurlow, M. L. (2007). An analysis of the relationship between high school exit exams and diploma options and the impact on students with disabilities, *Journal of Disability Policy Studies*, *18*, (1), 117-128. Retrieved from http://www.redorbit.com/news/education/1086577/an_analysis_of_the_relationship_between_high_school_exit_exams/

Geary, D. C. (2011). Cognitive predictors of achievement growth in mathematics: A 5-year longitudinal study. *Developmental Psychology, 47*(6), 1539-1552. doi:10.1037/a0025510

Geary, D. C., Bow-Thomas, C. C., & Yao, Y. (1992). Counting knowledge and skill in cognitive addition: A comparison of normal and mathematically disabled children. *Journal of Experimental Child Psychology*, *54*, 372-391.

Gersten, R., Jordan, N. C., & Flojo, J. R. (2005). Early identification and interventions for students with mathematics difficulties. *Journal of Learning Disabilities*, *38*, 293-304.

Ginsburg, A., Leinwand, S., Anstrom, T. & Pollock, E. (2005). *What the United States can learn from Singapore's world-class mathematics system*. Washington, DC: American Institutes for Research.

Ginsburg, P. H., & Baroody, A. J. (2003). *Test of early mathematics ability examiner's manual*. Austin, TX: Pro-ed.

Goldman, M., Retakh, V., Rubin, R., & Munnigh, H. (2009). *The effect of Singapore mathematics on student proficiency in a Massachusetts school district: A longitudinal statistical examination*. Bryn Mawr, PA: The Gabriella and Paul

Rosenbaum Foundation. Retrieved from http://www.utahsmathfuture.com/SM_NMRSD_Report.pdf

Gottfried, A. W., Gottfried, A. E., Bathurst, K., Guerin, D. W., & Parramore, M. M. (2003). Socioeconomic status in children's development and family environment: Infancy through adolescence. In M. H. Bornstein & R. H. Bradley (Eds.), *Socioeconomic status, parenting and child development* (pp. 189–207). Mahwah, NJ: Lawrence Erlbaum Associates.

Gottfried, M. A. (2009). Excused versus unexcused: How student absences in elementary school affect academic achievement. *Educational Evaluation and Policy Analysis*, *31*(4), 392–415.

Great Source. (2009). Math in focus: The Singapore approved research base. Boston, MA: Houghton Mifflin Harcourt Publishing Company.

Halle, T., Kurtz-Costes, B., & Mahoney, J. (1997). Family influences on school achievement in low-income, African American children. *Journal of Educational Psychology*, *89*, 527–537.

Hiebert, J., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 371-404). Charlotte, NC: Information Age Publishers.

Hill, H. C., & Ball, D. L. (2004). Learning mathematics for teaching: Results from California's Mathematics Professional Development Institutes. *Journal of Research in Mathematics Education, 35*, 330-351.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406.

Hoven, J., & Garelick, B. (2007). Singapore math: Simple or complex? *Educational Leadership*, *65*(3), 28-36.

Hwang, J., McMaken, J., Porter, A., and Yang, R. (2011). Common Core Standards: The new U.S. intended curriculum. *Educational Researcher, 40*, (3), 103-116.

Hyde, J. S., Fennema, E., & Lamon, S. (1990). Gender differences in mathematics performance: A meta-analysis. *Psychological Bulletin, 107*, 139–155.

Isaacs, A. C., Carroll, W., & Bell, M. (2001). *A research-based curriculum: The research basis of the UCSMP Everyday Mathematics curriculum*. Chicago, IL: University of Chicago School Mathematics Project Elementary Component.

Jencks, C. (1979). *Who gets ahead? The determinants of economic success in America*. New York, NY: Basic Books.

Jencks, C., & Phillips, M., Eds. (1998). *The black-white test score gap*. Washington DC.: Brookings Institution Press.

Jensen A. R. (1998). *The g factor: The science of mental ability*. Westport, CT: Praeger.

Jordan, N. C., Kaplan, D., Ramineni, C., & Locuniak, M. N. (2009). Early math matters: Kindergarten number competence and later mathematics outcomes. *Developmental Psychology*, *45*(3), 850-867.

Kamii, C., & Dominick, A. (1998). The harmful effects of algorithms in grades 1-4. In L.J. Morrow & M. J. Kenney (Eds.), *The teaching and learning of algorithms in* *school mathematics* (pp. 130-140). Reston, VA: National Council of Teachers of Mathematics.

Kamii, C., & Joseph, L. L. (1989). *Young children continue to reinvent arithmetic: 2nd grade: Implications of Piaget's theory*. New York, NY: Teachers College Press.

Klein, D. (2000*). Weaknesses of everyday mathematics K-3*. (Unpublished manuscript). Retrieved from http://www.math.nyu.edu/mfdd/braams/nychold/report-klein-em-00.html

Kober, N., & Rentner, D. (2011). *Common Core State Standards: Progress and challenges in school districts' implementation*. Center on Education Policy. Retrieved from http://www.cep-dc.org/displayDocument.cfm?DocumentID=374

Koedel, C., & Bhatt, R. (2013, April 4). Which materials? Evaluating curricular effectiveness [Web log comment]. Retrieved from http://www.edpolicyinca.org/blog/which-materials-evaluating-curricular-effectiveness

Kolen, M. J., & Brennan, R. L. (2004). *Test equating, scaling, and linking: Methods and practices* (2nd ed.). New York, NY: Springer-Verlag

Kovas, Y., Haworth, C. M. A., Harlaar, N., Petrill, S. A., Dale, P. S., & Plomin, R. (2007). Overlap and specificity of genetic and environmental influences on mathematics and reading disability in 10-year-old twins. *Journal of Child Psychology and Psychiatry*, *48*, 914-922.

Krajewski, K., & Schneider, W. (2009). Early development of quantity to number-word linkage as a precursor of mathematical school achievement and mathematical difficulties: Findings from a four-year longitudinal study. *Learning and Instruction*, *9*, 513–526. doi: 10.1016/j.learninstruc.2008.10.002

LaMarca, P. M, Redfield, D., Winter, P. C., Bailey, A. & Despriet, L. H. (2000). *State standards and state assessment systems: A guide to alignment.* Washington, DC: Council of Chief State School Officers. Retrieved from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/1a/33/5d.pdf

Leder, G. (1992). Mathematics and gender: Changing perspectives. In D. A. Grouws, (Ed.), *Handbook of Research on Teaching and Learning Mathematics* (pp.597-622*)*. New York, NY: Macmillan.

Lee, V. E., & Bukam, D. T. (2003). Dropping out of high school: The role of school organization and structure. *American Educational Research Journal*, *40*(2), 353-393.

Lee, V. E., Bryk, A., & Smith, J. (1993). The organization of effective secondary schools. *Review of Research in Education*, *19*, 171.

Leung, Shing On (2003). A practical use of vertical equating by combining IRT equating and linear equating. *Practical Assessment, Research & Evaluation*, *8*(23). Retrieved from http://PAREonline.net/getvn.asp?v=8&n=23.

Libertus, M. E., Feigenson, L., & Halberda, J. (2011). Preschool acuity of the approximate number system correlates with school math ability. *Developmental Science*, *14*(6), 1292-1300. doi: 10.1111/j.1467-7687.2011.01080.x

Locuniak, M. N., & Jordan, N. C. (2008). Using kindergarten number sense to predict calculation fluency in second grade. *Journal of Learning Disabilities*, *41*(5), 451-459.

MacCann, R. G., & Stanley, G. (2004). Estimating the standard error of the judging in a modified-angoff standards setting procedure. *Practical Assessment, Research & Evaluation*, *9*(5). Retrieved from http://PAREonline.net/getvn.asp?v=9&n=5

Madison, B., & Steen, L. (2003). *Quantitative literacy*: *Why numeracy matters for schools and colleges*. Princeton, NJ: National Council on Education and the Disciplines.

Marshall Cavendish Education. (2010a). *Grade 3 math in focus: Singapore math 3A* [Teacher's edition]. Boston, MA: Houghton Mifflin Harcourt Publishing.

Marshall Cavendish Education. (2010b). *Grade 3 math in focus: Singapore math 3B* [Teacher's edition] Boston, MA: Houghton Mifflin Harcourt .Company.

Marshall Cavendish Education. (2010c). *Grade 4 math in focus: Singapore math 4A* [teacher's edition]. Boston, MA: Houghton Mifflin Harcourt Publishing.

Marshall Cavendish Education. (2010d). *Grade 4 math in focus: Singapore math 4B* [Teacher's edition]. Boston, MA: Houghton Mifflin Harcourt Publishing.

Marshall Cavendish Education. (2010e). *Grade 5 math in focus: Singapore math 5A* [Teacher's edition]. Boston, MA: Houghton Mifflin Harcourt Publishing.

Marshall Cavendish Education. (2010f). *Grade 5 math in focus: Singapore math 5B* [Teacher's edition]. Boston, MA: Houghton Mifflin Harcourt Publishing.

Marshall Cavendish Education. (2010g). *Math in focus: The Singapore approach research base*. Boston, MA: Houghton Mifflin Harcourt Publishing. Retrieved from www.barrington220.org/site/handlers/filedownload.ashx?...pdf

McKnight, C. C., Crosswhite, F. J., Dossey, J. A., Kifer, E., Swafford, J. O., Travers, K. J., & Cooney, T. J. (1987*). The underachieving curriculum: Assessing U.S. school mathematics from an international perspective*. Champaign, IL: Stipes.

Mullis, I. V. S., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMSS 2011 international results in mathematics*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

National Center for Education Statistics (2007*). The condition of education special analysis: High school coursetaking*. Retrieved from nces.ed.gov/programs/coe/2007/analysis/2007065.pdf

National Center for Education Statistics (2009). *The nation's report card: Mathematics 2009* (NCES 2010–451). Washington, DC: U.S. Department of Education, Institute of Education Sciences.

National Center for Education Statistics (2011). *The nation's report card: Mathematics 2011* (NCES 2012–458). Washington, DC: U.S. Department of Education, Institute of Education Sciences.

National Commission on Excellence in Education. (1983). *A Nation at Risk: The Imperative for Educational Reform*. Washington, DC: National Commission on Excellence in Education.

National Council of Teachers of Mathematics. (1980*). An agenda for action: Directions for school mathematics for the 1980s*. Reston, VA: Author.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (1995). *Assessment standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2006). *Curriculum focal points for prekindergarten through grade 8 mathematics*: *A quest for coherence*. Reston, VA: Author. Retrieved from www.nctmmedia.org/cfp/full_document.pdf

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for English language arts and literacy in history/social studies, science, and technical subjects*. Washington, DC: Author.

National Mathematics Advisory Panel. (2008*). Foundations for success: The final report of the National Mathematics Advisory Panel*. Washington, DC: U.S. Department of Education. Retrieved from www.ed.gov/about/bdscomm/list/mathpanel/ report/final-report.pdf

National Research Council. (1998). *Everybody counts: A report to the nation on the future of mathematics education*. Washington, DC: National Academy Press. Retrieved from www.nap.edu/openbook.php?isbn=0309039770

National Research Council. (2001). *Adding it up: Helping children learn mathematics*. Washington DC: National Academy Press.
Retrieved from www.nap.edu/openbook.php?isbn=0309069955

National Research Council. (2004). *On evaluating curricular effectiveness: Judging the quality of K-12 mathematics evaluations*. Washington, DC: The National Academies Press. Mathematical Sciences Education Board, Center for Education, Division of Behavioral and Social Sciences and Education.

National Research Council. (2005). *How students learn: Mathematics in the classroom.* Washington DC: National Academy Press. Retrieved from www.nap.edu/openbook.php?isbn=0309089492

National Research Council. (2007). *Rising above the gathering storm*. Washington, DC: National Academy Press. Retrieved from http://www.books.nap.edu/openbook.php?isbn=0309100399

National Research Council. (2011). *Report to Congress*. Washington, DC: The National Academies Press. Retrieved from http://www.nationalacademies.org/annualreport/Report_to_Congress_2011.pdf

National Science Board. (2010), *Globalization of science and engineering research: A companion to science and engineering indicators 2010*. Arlington, VA: National Science Foundation.

National Science Board. (2012). *Science and Indicators.* Arlington, VA: National Science Foundation.

The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology. (1983). *Educating Americans for the 21st century: A report to the American people and the national science board*. Washington, DC: National Science Foundation.

Neufeld, B., & Roper, D. (2003). Coaching: A strategy for developing instructional capacity, promises and practicalities. Washington, DC: The Aspen Institute. Retrieved from http://www.annenberginstitute.org/publications/reports.html

New Jersey Department of Education (1996). *The New Jersey mathematics curriculum framework*. Trenton, NJ: New Jersey Department of Education. Retrieved from http://dimacs.rutgers.edu/nj_math_coalition/framework.html

New Jersey State Department of Education. (2004a). *District Factor Groups (DFG) for school districts*. Trenton, NJ: Author. Retrieved from http://www.state.nj.us/education/finance/rda/dfg.pdf

New Jersey Department of Education. (2004b). *New Jersey Core Curriculum Content Standards for mathematics*. Trenton, NJ: New Jersey Department of Education. Retrieved from http://www.nj.gov/education/cccs/2004/s4_math.pdf

New Jersey Department of Education. (2008). *New Jersey Core Curriculum Content Standards for mathematics*. Trenton, NJ: New Jersey Department of Education. Retrieved from http://www.nj.gov/education/cccs/2004/s4_math_sands.doc

New Jersey Department of Education. (2010). *2009-2010 school report card*. Trenton, NJ: New Jersey Department of Education. Retrieved from http://education.state.nj.us/rc/rc10/nav.php?c=13;d=3570

New Jersey Department of Education. (2011a). *2010-2011 school report card*. Trenton, NJ: New Jersey Department of Education. Retrieved from http://education.state.nj.us/rc/rc11/nav.php?c=13;d=3570

New Jersey Department of Education. (2011b). *New Jersey assessment of skills and knowledge, 2010 technical report, grades 3-8*. Trenton, NJ: New Jersey

Department of Education. Retrieved from http://www.nj.gov/education/assessment/es/njask_tech_report10.pdf

New Jersey Department of Education. (2013). *New Jersey assessment of skills and knowledge, 2012 technical report, grades 3-8*. Trenton, NJ: New Jersey Department of Education. Retrieved from http://www.nj.gov/education/assessment/es/njask_tech_report12.pdf

No Child Left Behind (NCLB) Act of 2001, Pub. L. No. 107-110, § 115, Stat. 1425 (2002).

North Central Regional Educational Laboratory. (2003*). enGauge: 21st century skills for 21st century learners.* Naperville, IL: Author.

Packer, A. (n.d.). *What mathematics should "everyone" know and be able to do?* Paper prepared for the National Forum on Quantitative Literacy. Retrieved from www.maa.org/ql/pgs33_42.pdf

Passolunghi, M. C., Vercelloni, B., & Schadee, H. (2007). The precursors of mathematics learning: Working memory, phonological ability, and numerical competence. *Cognitive Development*, *22*, 165-184.

Pinar W. F., Reynolds, W. M., Slattery, P., & Taubman, P. M. (1995). *Understanding curriculum: An introduction to the study of historical and contemporary curriculum discourses*. New York, NY: Peter Lang.

Pinker, S. (1997) *How the mind works*. New York, NY: W.W. Norton & Company.

Poglinco, S., Bach, A., Hovde, K., Rosenblum, S., Saunders, M., & Supovitz, J. (2003). *The heart of the matter: The coaching model in America's Choice schools*.

Philadelphia, PA: Consortium for Policy Research in Education, University of Pennsylvania. Retrieved from http://www.cpre.org/Publications/ Publications_Research.htm

Raudenbush, S.W. (1993). Hierarchical linear models as generalizations of certain common experimental design models. In L.Edwards (Ed.). *Applied analysis of variance in behavioral science* (pp. 459-496). New York, NY: Marcell Decker.

Resnick, R. M., Sanislo, G., & Oda., S. (2010). *The complete K–12 report: Market facts and segment analyses.* Rockaway Park, NY: Education Market Research.

Richardson, K. (2012). *How children learn number concepts: A guide to the critical learning phases.* Bellingham, WA: Math Perspectives Teacher Development Center.

Ridley, D. (2008), *The literature review: A step-by-step guide for students*. London: SAGE.

Riordan, J. E., & Noyce, P. E. (2001). Impact of two standards-based mathematics curricula on student achievement in Massachusetts. *Journal for Research in Mathematics Education*, *32*(4), 368-398.

Roby, D. E. (2004). Research on school attendance and student achievement: A study of Ohio schools. *Educational Research Quarterly*, *28*, 3-14.

Rose, H., & Betts, J. R. (2001). *Math matters: The links between high school curriculum, college graduation, and earnings*. San Francisco, CA: Public Policy Institute of California. Retrieved from www.ppic.org/content/pubs/report/R_701JBR.pdf

Schmidt, W. H., Wang, H. C., & McKnight, C. C. (2005). Curriculum coherence: An examination of U.S. mathematics and science content standards from an international perspective. *Journal of Curriculum Studies*, *37*(5), 525-559.

Schmidt, W. H., McKnight, C., Valverde, G. A., Houang, R. T., & Wiley, D. E. (1997). *Many visions, many aims*: *Volume I. A cross-national investigation of curricular intentions in school mathematics*. Dordrecht/Boston/London: Kluwer.

Schmidt, W. H., McKnight, C. C., Houang, R. T., Wang, H., Wiley, D. E., Cogan, L. S., & Wolfe, R. G. (2001). *Why schools matter: A cross-national comparison of curriculum and learning.* San Francisco, CA: Jossey-Bass.

Schoenfeld, A. H. (2002). Making mathematics work for all children: Issues of standards, testing, and equity. *Education Researcher*, *31*(1), 13-25. www.noycefdn.org/documents/Making_Math_Work-Schoenfeld.pdf

Sconiers, S., Isaacs, A., Higgins, T., McBride, J., & Kelso, C. (2003). The Arc Center tri-state student achievement study. Lexington, MA: COMAP.

Sconiers, S., Isaacs, A., Higgins, T., McBride, J., & Kelso, C. (2003). *Three-state student achievement study project report: A report by the ARC Center at the Consortium for Mathematics and Its Applications* (Unpublished Manuscript). Boston, MA. Retrieved from www.comap.com/elementary/projects/are

Secretary's Commission on Achieving Necessary Skills. (1991). *What work requires of schools*. Springfield, VA: National Technical Information Service (NTIS PB92-1467111NZ)

Slavin, R. E. (1986). Best-evidence synthesis: An alternative to meta-analytic and traditional reviews. *Educational Researcher*, *15*, (9), 5-11. Reprinted in W. R.

Shadish and C. S. Reichardt (Eds.), *Evaluation Studies Review Annual* (Vol. 12). Newbury Park, CA: Sage.

Slavin, R. E. (2007). *Educational research in the age of accountability.* Boston, MA: Allyn & Bacon.

Slavin, R. E. (2008). What works? Issues in synthesizing educational program evaluations. *Educational Researcher*, *37*(1), 5-14.

Slavin, R. E., & Lake, C. (2007*). Effective programs in elementary mathematics: A best-evidence synthesis.* Baltimore, MD: Johns Hopkins University School of Education's Center for Data-Driven Reform in Education (CDDRE). Retrieved from http://www.bestevidence.org/word/elem_math_feb_9_2007.pdf

Slavin, R. E., & Lake, C. (2008). Effective programs in elementary mathematics: A best-evidence synthesis. *Review of Educational Research*, *78* (3), 427-515.

Slavin, R.E., Lake, C., & Groff, C. (2009). Effective programs in middle and high school mathematics: A best-evidence synthesis. *Review of Educational Research*, *79* (2), 839-911.

Smith, J. R., Brooks-Gunn, J., & Klebanov, P. K. (1997). The consequences of living in poverty for young children's cognitive and verbal ability and early school achievement. In G. J. Duncan & J. Brooks-Gunn (Eds.), *Consequences of growing up poor* (pp. 132-189). New York: Russell Sage Foundation.

Snow, C., Burns, S., & Griffin, P. (Eds.). (1998). Preventing reading difficulties in young children. Washington, DC: National Academy Press (NAP).

SRA/McGraw-Hill. (2003). *Everyday mathematics student achievement studies* (Volume 4). Chicago, IL: SRA/McGraw-Hill.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, *52*, 613–629.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African-Americans. *Journal of Personality and Social Psychology*, *68*, 797–811.

Steele, C. M., Spencer, S. J., Hummel, M., Carter, K., Harber, K., Schoem, D., & Nisbett, R. (in press). African-American college achievement: A "wise" intervention. *Harvard Educational Review*.

Steen, L. A. (1999). Algebra for all in eighth grade: What's the rush? Middle matters. (1991). *National Association of Elementary School Principals*, *8*,(1), 6-7. Retrieved from www.stolaf.edu/people/steen/Papers/algebra.html

Steen, L. A. (2003). *Quantitative literacy: Why numeracy matters for schools and colleges*. Princeton, NJ: National Council on Education and the Disciplines.

Steffe, L. P., & Cobb, P. (1988). *Construction of arithmetical meanings and strategies.* New York, NY: Springer-Verlag.

Steffe, L. P., & Gale, J. (Eds.). (1995). *Constructivism in education*. Hillsdale, NJ: Erlbaum.

Stevenson H. W., Parker T., Wilkinson A., Hegion A., & Fish E. (1976). Longitudinal study of individual differences in cognitive development and scholastic achievement. *Journal of Educational Psychology*, *68*, 377–400.

Stylianides, A. J., & Ball, D. L. (2004). *A framework for studying the mathematical knowledge needed for teaching: Knowledge of reasoning and proof.* Paper presented at the annual meeting of the American Educational Research Association, San Diego, CA.

Tanner, D., & Tanner, L. (2007). *Curriculum development: Theory into practice*. Upper Saddle River, NJ: Pearson Education.

Taub, G., Floyd, R. G., Keith, T. Z., & McGrew, K. S. (2008). Effects of general and broad cognitive abilities on mathematics achievement from kindergarten through high school. *School Psychology Quarterly*, *23*(2), 187–198.

Thurlow, M., & Esler, A. (2000). *Appeals processes for students who fail graduation exams: How do they apply to students with disabilities?* (Synthesis Report No. 36). Minneapolis, MN: University of Minnesota, National Center on Education Outcomes. Retrieved from http://education.umn.edu/NCEO/OnlinePubs/Synthesis36.html

Tyler, R. W. (1949). *Basic principles of curriculum and instruction*. Chicago, IL: The University of Chicago Press.

U.S. Census Bureau. (2010a). *American community survey*. Washington, DC: Government Printing Office.

U.S. Census Bureau. (2010b). *ACS 5-year detailed tables.* Retrieved from https://www.census.gov/acs/www/data_documentation/2010_release/

U.S. Department of Education. (2009a). American Recovery and Reinvestment Act. Washington, DC: U.S. Department of Education. Retrieved http://www2.ed.gov/programs/racetothetop/executive-summary.pdf

U.S. Department of Education. (2009b). *Race to the Top Program: Executive summary.* Washington, DC: Author. Retrieved from http://www2.ed.gov/programs/ racetothetop/executive-summary.pdf.

University of Chicago School Mathematics Project. (2005). *Everyday mathematics research summary*. Retrieved from http://everydaymath.uchicago.edu/educators/ references/shtml

University of Chicago School Mathematics Project. (2007a). *Fifth grade everyday mathematics teacher's lesson guide* (Vol. 1). Chicago, IL: SRA/McGraw-Hill.

University of Chicago School Mathematics Project. (2007b). *Fifth grade everyday mathematics teacher's lesson guide* (Vol. 2). Chicago, IL: SRA/McGraw-Hill.

University of Chicago School Mathematics Project. (2007c). *Fourth grade everyday mathematics teacher's lesson guide* (Vol. 1). Chicago, IL: SRA/McGraw-Hill.

University of Chicago School Mathematics Project. (2007d). *Fourth grade everyday mathematics teacher's lesson guide* (Vol. 2). Chicago, IL: SRA/McGraw-Hill.

University of Chicago School Mathematics Project. (2007e). *Third grade everyday mathematics teacher's lesson guide* (Vol. 1). Chicago, IL: SRA/McGraw-Hill

University of Chicago School Mathematics Project. (2007f). *Third grade everyday mathematics teacher's lesson guide* (Vol. 2). Chicago, IL: SRA/McGraw-Hill.

Walberg, H. J. (1984). Families as partners in educational productivity. *Phi Delta Kappan*, *65*(6), 397-400.

Waite, R. D. (2000). A study of the effects of *Everyday Mathematics* on student achievement of third-, fourth-, and fifth-grade students in a large north Texas urban school district. *Dissertation Abstracts International*, *61*(10), 3933A. (UMI No. 9992659).

Wang, T. & Birdwell J. D. (2001) *A Review of Everyday Math*. Retrieved from http://www.lit.net/orschools/A_Review_of_Everyday_Math.pdf

Webb, N. L. (1997). Criteria for alignment of expectations and assessments in mathematics and science education (NISE Research Monograph No. 6). Madison, WI: University of Wisconsin–Madison, National Institute for Science Education.

Webb, N. L. (1999). *Alignment of science and mathematics standards and assessment in four states* (NISE Research Monograph No.18). Madison, WI: University of Wisconsin–Madison, National Institute for Science Education.

What Works Clearinghouse (2006). *Elementary school math.* Washington, DC: U.S. Department of Education. Retrieved from http://w-w-c.org

What Works Clearinghouse (2010). *Everyday Mathematics.* Washington, DC: U.S. Department of Education. Retrieved from http://w-w-c.org

Zhao, Y. (2012). *World class learners. Educating creative and entrepreneurial students*. New York, NY: Corwin Press.

Zhao, Y. (2012, December 11). Numbers can lie: What PISA and TIMSS truly tell us, if anything? Retrieved from http://zhaolearning.com/2012/12/11/numbers-can-lie-what-timss-and-pisa- truly-tell-us-if-anything/

APPENDIX A

NPS IRB Letter of Approval

THE NEWARK PUBLIC SCHOOLS

Institutional Review Board (IRB)
2 Cedar Street, Room 909
Newark, New Jersey 07102

Cami Anderson
State District Superintendent

Christopher Cerf
COMMISSIONER OF EDUCATION

IRB Panel

Rochanda C. Jackson, Ed. M., M.P.A.
Marguerite Leuze, DMH
Elaine Walker, PhD
Yolanda Mendez
Darleen Gearhart, MA, MS
Stephanie Moore
Eusebia Tejada
Maria Ruela

April 5, 2013

Tina Powell
Director
Mathematics Office
Newark Public Schools
2 Cedar Street
Newark, NJ 07102

Re: NPS IRB Review

Dear Ms. Powell:

I am pleased to inform you that the research proposal entitled "Evaluating the Effects of the Singapore Math Curriculum on Fifth Grade Achievement in a Large Northeastern Urban School District" has been approved for research through the NPS IRB Administrative Review process. Approval is based upon the following conditions:

1. The attached letter assuring confidentiality of the student data you acquire is signed and returned.
2. You comply with NPS policies and federal guidelines regarding parental consent for student participation in research.
3. The NPS IRB is notified as soon as possible of any significant changes in your research or unanticipated problems that occur subsequent to the approval date.
4. Additional research surveys and protocols that were not included with your original proposal are forwarded for NPS IRB review. Please be advised that if there are significant changes, further IRB review and approval may be required.
5. One year from the approval date, you will need to submit a summary of the first year's research activities and study status. As this is a multiyear study, you will be required to resubmit for review and approval a research continuation plan.

Please contact me at (973) 733-8773 if you have questions.

Sincerely,

Rochanda Jackson
Supervisor
Office of Policy, Planning, Research and Assessment

Changing Hearts and Minds to Value Education

APPENDIX B

Chi Square Preliminary Analyses

Null Hypothesis 1. There is no difference between the distribution of White, Black, Hispanic, and Other students in each of the four Experimental Treatment sites and the distribution of White, Black, Hispanic, and other students within each of the four respective paired Alternative Treatment sites. To answer the null hypothesis, the observed and expected frequencies of race/ethnicity for each Experimental Treatment site and Alternative Treatment site were computed. These data were used for the chi-square analysis.

Race/Ethnicity: Experimental Treatment Site 1 and Alternative Treatment Site 1

The result of the non-parametric chi-square test for Hypothesis 1 is shown in Tables 1a - c. It can be seen that $\chi(3) = 371.423$, $p = 3.42E\text{-}80$. This indicates that there is sufficient evidence to reject the null hypothesis and conclude that there is a statistically significant difference between the distribution of race/ethnicity between Experimental Treatment Site 1 and Alternative Treatment Site 1. The majority of the participants from Experimental Treatment Site 1 was Black (539). The majority of the participants from Alternative Treatment Site 1 was Hispanic (291).

Table 1a

Observed Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Site 1	2	539	12	2	555
Alternative Treatment Site 1	2	240	291	2	535
Total	4	779	303	4	1090

Table 1b

Expected Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Site 1	2.04	396.65	154.28	2.04	555
Alternative Treatment Site 1	1.96	382.35	148.72	1.96	535
Total	4	779	303	4	1090

Table 1c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	371.423	3	3.42E-80
N of Valid Cases	8		

Race/Ethnicity: Experimental Treatment Site 2 and Alternative Treatment Site 2

The result of the non-parametric chi-square test for Hypothesis 1 is shown in Tables 2a-c. It can be seen that $\chi(3) = 616.408$, p = 2.7941E-133. This indicates that there is sufficient evidence to reject the null hypothesis and conclude that there is a statistically significant difference between the distribution of race/ethnicity between Experimental Treatment Site 2 and Alternative Treatment Site 2. The majority of the participants from Experimental Treatment Site 2 was Hispanic (616). The majority of the participants from Alternative Treatment Site 2 was Black (402).

Table 2a

Observed Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Site 2	7	197	616	11	831
Alternative Treatment Site 2	0	402	5	0	407
Total	7	599	621	11	1238

Table 2b

Expected Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Site 2	4.70	402.08	416.84	7.38	831
Alternative Treatment Site 2	2.30	196.92	204.16	3.62	407
Total	7	599	621	11	1238

Table 2c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	616.408	3	2.7941E-133
N of Valid Cases	8		

Race: Experimental Treatment Site 3 and Alternative Treatment Site 3

The result of the non-parametric chi-square test for Hypothesis 1 is shown in Tables 3a-c. It can be seen that $\chi(3) = 64.988$, p =5.0465E-14. This indicates that there is sufficient evidence to reject the null hypothesis and conclude that there is a statistically significant difference between the distribution of race/ethnicity between Experimental Treatment Site 3 and Alternative Treatment Site 3. The majority of the participants from Experimental Treatment Site 3 was Hispanic (447). The majority of the participants from Alternative Treatment Site 2 was Hispanic (644).

Table 3a

Observed Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Site 3	321	79	447	6	853
Alternative Treatment Site 3	287	22	644	3	956
Total	608	101	1091	9	1809

Table 3b

Expected Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Site 3	286.69	47.62	514.44	4.24	853.00
Alternative Treatment Site 3	321.31	53.38	576.56	4.76	956.00
Total	608.00	101.00	1091.00	9.00	1809.00

Table 3c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	64.988	3	5.0465E-14
N of Valid Cases	8		

Race: Experimental Treatment Site 4 and Alternative Treatment Site 4

The result of the non-parametric chi-square test for Hypothesis 1 is shown in Tables 4a-c. It can be seen that $\chi(3) = 3.159518$, $p = 0.368$.

This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference between the distribution of race/ethnicity between Experimental Treatment Site 4 and Alternative Treatment Site 4.

Table 4a

Observed Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Site 4	2	433	16	2	453
Alternative Treatment Site 4	0	541	18	1	560
Total	2	974	34	3	1013

Table 4b

Expected Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Site 4	0.89	435.56	15.20	1.34	453
Alternative Treatment Site 4	1.11	538.44	18.80	1.66	560
Total	2	974	34	3	1013

Table 4c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.159518	3	0.368
N of Valid Cases	8		

Summary for Hypothesis 1

The series of chi-square tests done for all four paired schools along the distribution of race/ethnicity revealed that only Experimental Treatment Site 3 and Alternative Treatment Site 3 have similar distribution of race/ethnicity, which resulted in the acceptance of the null hypothesis. Moreover, both Black students and Hispanic students equally maintained the highest distributions across four schools. A majority of Black students was seen from Experimental Treatment Site 1, Alternative Treatment Site 2, Experimental Treatment Site 4, and Alternative Treatment Site 4, whereas a majority of Hispanic students was seen from Alternative Treatment Site 1, Experimental Treatment Site 2, Experimental Treatment Site 3 and Alternative Treatment Site 3.

Null Hypothesis 2. There is no difference between the distribution of White, Black, Hispanic, and Other students in the Experimental Treatment sample (*n=100*) and the distribution of White, Black, Hispanic, and Other students within the Alternative Treatment sample (*n=105*). To answer the null hypothesis, the observed and expected frequencies of race for the Experimental Treatment sample and the Alternative Treatment sample were computed. These data were used for the chi-square analysis.

Race: Experimental Treatment Sample and Alternative Treatment Sample

The result of the non-parametric chi-square test for Hypothesis 2 is shown in Tables 5a-c. It can be seen that $\chi(3) = 0.365$, $p = 0.947363825$. This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference in the distribution of *race* between Experimental Treatment sample and Alternative Treatment sample.

Table 5a

Observed Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Sample	11	51	37	1	100
Alternative Treatment Sample	14	50	40	1	105
Total	25	101	77	2	205

Table 5b

Expected Frequencies (Race/Ethnicity)

	White	Black	Hispanic	Other	Total
Experimental Treatment Sample	12.20	49.27	37.56	0.98	100
Alternative Treatment Sample	12.80	51.73	39.44	1.02	105
Total	25	101	77	2	205

Table 5c

Chi-Square Tests (Race/Ethnicity)

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.365	3	0.947363825
N of Valid Cases	8		

Summary for Hypothesis 2

The series of chi-square tests done for both the Alternative Treatment sample and the Experimental Treatment sample along the distribution of race revealed a similar distribution of race, which resulted in the acceptance of the null hypothesis. Moreover, both Black students and Hispanic students maintained the highest distributions between the Alternative Treatment and Experimental Treatment samples.

Null Hypothesis 3. There is no difference between the distribution of male students and female students in each of the four Experimental Treatment sites and the distribution of male students and female students within each of the four respective paired Alternative Treatment sites. To answer the null hypothesis, the observed and expected frequencies of gender for each Experimental Treatment site and Alternative Treatment site were computed. These data were used for the chi-square analysis.

Gender: Experimental Treatment Site 1 and Alternative Treatment Site 1

The result of the non-parametric chi-square test for Hypothesis 3 is shown in Tables 6a-c. It can be seen that $\chi(1) = 0.093$, $p = 0.760238393$. This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference in the distribution of gender between Experimental Treatment Site 1 and Alternative Treatment Site 1.

Table 6a

Observed Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Site 1	276	279	555
Alternative Treatment Site 1	271	264	535
Total	547	543	1090

Table 6b

Expected Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Site 1	278.518	276.482	555
Alternative Treatment Site 1	268.482	266.518	535
Total	547	543	1090

Table 6c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.093	1	0.760238393
N of Valid Cases	4		

Gender: Experimental Treatment Site 2 and Alternative Treatment Site 2

The result of the non-parametric chi-square test for Hypothesis 3 is shown in Tables 7a-c. It can be seen that $\chi(1) = 0.018$, $p = 0.892534474$. This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference between the distribution of gender between Experimental Treatment Site 2 and Alternative Treatment Site 2.

Table 7a

Observed Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Site 2	424	407	831
Alternative Treatment Site 2	206	201	407
Total	630	608	1238

Table 7b

Expected Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Site 2	422.884	408.116	831
Alternative Treatment Site 2	207.116	199.884	407
Total	630	608	1238

Table 7c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.018	1	0.892534474
N of Valid Cases	4		

Gender: Experimental Treatment Site 3 and Alternative Treatment Site 3

The result of the non-parametric chi-square test for Hypothesis 3 is shown in Tables 8a-c. It can be seen that $\chi(3) = 3.091$, p =0.078706538. This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference between the distribution of gender between Experimental Treatment Site 3 and Alternative Treatment Site 3.

Table 8a

Observed Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Site 3	452	401	853
Alternative Treatment Site 3	467	489	956
Total	919	890	1809

Table 8b

Expected Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Site 3	433.337	419.663	853
Alternative Treatment Site 3	485.663	470.337	956
Total	919	890	1809

Table 8c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.091	1	0.078706538
N of Valid Cases	4		

Gender: Experimental Treatment Site 4 and Alternative Treatment Site 4

The result of the non-parametric chi-square test for Hypothesis 3 is shown in Tables 9a-c. It can be seen that $\chi(1) = 8.389$, $p = 0.004$.

This indicates that there is a sufficient evidence to reject the null hypothesis and conclude that there is a statistically significant difference in the distribution of gender between Experimental Treatment Site 4 and Alternative Treatment Site 4. The majority of the participants from Experimental Treatment Site 4 was Male (255). The majority of the participants from Alternative Treatment Site 2 was Female (296).

Table 9a

Observed Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Site 4	255	198	453
Alternative Treatment Site 4	264	296	560
Total	519	494	1013

Table 9b

Expected Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Site 4	232.090	220.910	453
Alternative Treatment Site 4	286.910	273.090	560
Total	519	494	1013

Table 9c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.389	1	0.004
N of Valid Cases	4		

Summary for Hypothesis 3

The series of chi-square tests done for all four paired schools along the distribution of gender revealed that Experimental Treatment Site 1 and Alternative Treatment Site 1, Experimental Treatment Site 2 and Alternative Treatment Site 2, and Experimental Treatment Site 3 and Alternative Treatment Site 3 have similar distributions of gender which resulted in the acceptance of the null hypothesis. Experimental Treatment Site 4 and Alternative Treatment Site 4 have significant differences in the distribution of gender.

Null Hypothesis 4. There is no difference between the distribution of male and female students in the Experimental Treatment sample (*n=100*) and the distribution of male and female students in the Alternative Treatment sample (*n=105*). To answer the null hypothesis, the observed and expected frequencies of gender for the Experimental Treatment sample and the Alternative Treatment sample were computed. These data were used for the chi-square analysis.

Gender: Experimental Treatment Sample and Alternative Treatment Sample

The result of the non-parametric chi-square test for Hypothesis 4 is shown in Tables 10a-c. It can be seen that $\chi(1) = 0.179$, $p = 0.671923567$.

This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference in the distribution of gender between Experimental Treatment sample and Alternative Treatment sample.

Table 10a

Observed Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Sample	39	61	100
Alternative Treatment Sample	44	61	105
Total	83	122	205

Table 10b

Expected Frequencies (Gender)

	Males	Females	Total
Experimental Treatment Sample	40.488	59.512	100
Alternative Treatment Sample	42.512	62.488	105
Total	83	122	205

Table 10c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.179	1	0.671923567
N of Valid Cases	4		

Summary for Hypothesis 4

The series of chi-square tests done for both the Alternative Treatment sample and the Experimental Treatment sample along the distribution of gender revealed a similar distribution of males and females, which resulted in the acceptance of the null hypothesis. Moreover, females maintained the highest distributions between the Alternative Treatment and Experimental Treatment samples.

Null Hypothesis 5. There is no difference between the distribution of low-income students and non-low-income students in each of the four Experimental Treatment sites and the distribution of low-income students and non low-income students within each of the four respective paired Alternative Treatment sites. To answer the null hypothesis, the observed and expected frequencies of Socioeconomic Status (SES) for each of the four Experimental Treatment sites and each of the four respective paired Alternative Treatment sites were computed. These data were used for the chi-square analysis.

SES: Experimental Treatment Site 1 and Alternative Treatment Site 1

The result of the non-parametric chi-square test for Hypothesis 5 is shown in Tables 11a-c. It can be seen that $\chi(1) = 95.489$, $p = 1.48724E-22$. This indicates that there is sufficient evidence to reject the null hypothesis and conclude that there is a statistically significant difference between the distribution of SES between Experimental Treatment Site 1 and Alternative Treatment Site 1. The proportions of low-income students and non low-income students within the Experimental Treatment and Alternative Treatment sites were also computed and are shown in Table 11. The majority of the participants from Experimental Treatment Site 1 was low income (392). The majority of the participants from Alternative Treatment Site 1 was low income (500).

Table 11a

Observed Frequencies (SES)

	Low Income	Non Low Income	Total
Experimental Treatment Site 1	392	163	555
Alternative Treatment Site 1	500	35	535
Total	892	198	1090

Table 11b

Expected Frequencies (SES)

	Low Income	Non Low Income	Total
Experimental Treatment Site 1	454.183	100.817	555
Alternative Treatment Site 1	437.817	97.183	535
Total	892	198	1090

Table 11c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	95.489	1	$1.48724E^{-22}$
N of Valid Cases	4		

SES: Experimental Treatment Site 2 and Alternative Treatment Site 2

The result of the non-parametric chi-square test for Hypothesis 5 is shown in Tables 12a-c. It can be seen that $\chi(1) = 0.137$, $p = 0.7114023$. This indicates that there is a sufficient evidence to accept the null hypothesis and conclude that there is not a statistically significant difference between the distribution of *SES* between Experimental Treatment Site 2 and Alternative Treatment Site 2.

Table 12a

Observed Frequencies (SES)

	Low Income	Non Low Income	Total
Experimental Treatment Site 2	691	140	831
Alternative Treatment Site 2	335	72	407
Total	1026	212	1238

Table 12b

Expected Frequencies (SES)

	Low Income	Non Low Income	Total
Experimental Treatment Site 2	688.696	142.304	831
Alternative Treatment Site 2	337.304	69.696	407
Total	1026	212	1238

Table 12c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.137	1	0.7114023
N of Valid Cases	4		

SES: Experimental Treatment Site 3 and Alternative Treatment Site 3

The result of the non-parametric chi-square test for Hypothesis 5 is shown in Tables 13a-c. It can be seen that $\chi(1) = 23.845$, p =1.04388E^{-}6. This indicates that there is a sufficient evidence to reject the null hypothesis and conclude that there is a statistically significant difference between the distribution of SES between Experimental Treatment Site 3 and Alternative Treatment Site 3. The majority of the participants from Experimental Treatment Site 3 was low-income (748). The majority of the participants from Alternative Treatment Site 3 was low-income (756).

Table 13a

Observed Frequencies (SES)

	Low Income	Non Low Income	Total
Experimental Treatment Site 3	748	105	853
Alternative Treatment Site 3	756	200	956
Total	1504	305	1809

Table 13b

Expected Frequencies (SES)

	Low Income	Non Low Income	Total
Experimental Treatment Site 3	709.183	143.817	853
Alternative Treatment Site 3	794.817	161.183	956
Total	1504	305	1809

Table 13c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.845	1	1.04388E^{-06}
N of Valid Cases	4		

SES: Experimental Treatment Site 4 and Alternative Treatment Site 4

The result of the non-parametric chi-square test for Hypothesis 5 is shown in Tables 14a-c. It can be seen that $\chi(1) = 0.431$, $p = 0.511468$.

This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference between the distribution of SES between Experimental Treatment Site 4 and Alternative Treatment Site 4.

Table 14a

Observed Frequencies (SES)

	Low Income	Non Low Income	Total
Experimental Treatment Site 4	404	49	453
Alternative Treatment Site 4	492	68	560
Total	896	117	1013

Table 14b

Expected Frequencies (SES)

	Low Income	Non Low Income	Total
Experimental Treatment Site 4	400.679	52.321	453
Alternative Treatment Site 4	495.321	64.679	560
Total	896	117	1013

Table 14c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.431	1	0.511468
N of Valid Cases	4		

Summary for Hypothesis 5

The series of chi-square tests done for all four paired schools along the distribution of SES revealed that Experimental Treatment Site 2 and Alternative Treatment Site 2 and Experimental Treatment Site 3 and Alternative Treatment Site 3 have a similar distribution of SES, which resulted in the acceptance of the null hypothesis. Moreover, low-income students maintained the highest distributions across all 8 schools.

Null Hypothesis 6. There is no difference between the distribution of low SES and higher SES students in the Experimental Treatment sample (*n=100*) and the distribution of low SES and higher SES students in the Alternative Treatment sample (*n=105*). To answer the null hypothesis, the observed and expected frequencies of SES for the Experimental Treatment sample and the Alternative Treatment sample were computed. These data were used for the chi-square analysis.

SES: Experimental Treatment Sample and Alternative Treatment Sample

The result of the non-parametric chi-square test for Hypothesis 6 is shown in Tables 15a-c. It can be seen that $\chi(1) = 0.117$, $p = 0.732149986$.

This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference in the distribution of SES between Experimental Treatment sample and Alternative Treatment sample.

Table 15a

Observed Frequencies (SES)

	Low SES	Higher SES	Total
Experimental Treatment Sample	85	15	100
Alternative Treatment Sample	91	14	105
Total	176	29	205

Table 15b

Expected Frequencies (SES)

	Low SES	Higher SES	Total
Experimental Treatment Sample	85.854	14.146	100
Alternative Treatment Sample	90.146	14.854	105
Total	176	29	205

Table 15c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.117	1	0.732149986
N of Valid Cases	4		

Summary for Hypothesis 6

The series of chi-square tests done for both the Alternative Treatment sample and the Experimental Treatment sample along the distribution of SES revealed a similar distribution of low SES and higher SES students which resulted in the acceptance of the null hypothesis. Moreover, low SES students maintained the highest distributions between the Alternative Treatment and Experimental Treatment samples.

Null Hypothesis 7. There is no difference between the distribution of Proficient students (scoring 200 and above on the 2010 NJ ASK3) and Partially Proficient students (scoring below 200 on the 2010 NJ ASK3) in the Experimental Treatment sample (*n=100*) and Proficient students and Partially Proficient students in the Alternative Treatment sample (*n=105*). To answer the null hypothesis, the observed and expected frequencies of performance for the entire Experimental Treatment sample and the entire Alternative Treatment sample were computed. These data were used for the chi-square analysis.

Table 16

Descriptive Statistics: 2010 NJASK3 Math Scale Score

Alternative Treatment Sample		*Experimental Treatment Sample*	
Count	105	Count	100
Mean	221.952381	Mean	219.44
Standard Error	3.902506496	Standard Error	4.590247017
Median	221	Median	216
Mode	227	Mode	300
Standard Deviation	39.98879193	Standard Deviation	45.90247017
Sample Variance	1599.10348	Sample Variance	2107.036768
Range	172	Range	172
Minimum	128	Minimum	128
Maximum	300	Maximum	300
Sum	23305	Sum	21944

Performance: Experimental Treatment Sample and Alternative Treatment Sample

The result of the non-parametric chi-square test for Hypothesis 7 is shown in Tables 16a-c. It can be seen that $\chi(1) = 1.682$, $p = 0.19462$.

This indicates that there is sufficient evidence to accept the null hypothesis and conclude that there is no statistically significant difference in the distribution of performance between Experimental Treatment sample and Alternative Treatment sample.

Table 16a

Observed Frequencies (Performance)

	Proficient	Partially Proficient	Total
Experimental Treatment Sample	66	34	100
Alternative Treatment Sample	78	27	105
Total	144	61	205

Table 16b

Expected Frequencies (Performance)

	Proficient	Partially Proficient	Total
Experimental Treatment Sample	70.244	29.756	100
Alternative Treatment Sample	73.756	31.244	105
Total	144	61	205

Table 16c

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.682	1	0.19462
N of Valid Cases	4		

Summary for Hypothesis 7

The series of chi-square tests done for both the Alternative Treatment sample and the Experimental Treatment sample along the distribution of performance revealed a similar distribution of Proficient and Partially Proficient, which resulted in the acceptance of the null hypothesis. Moreover, Proficient maintained the highest distributions between the Alternative Treatment and Experimental Treatment samples.

APPENDIX C

Tests for Normality

Table 1a: Descriptive Statistics - Everyday Math (2010 NJ ASK 3and 2012 NJ ASK5 Data)

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
MathScaleScore2010	105	128	300	221.95	3.903	39.989
MathScaleScore2012	105	140	300	225.45	3.262	33.429
Attendance_2yr	105	313.00	370.00	354.9000	1.08887	11.15761
Valid N (listwise)	105					

Table 1b: Skewness - Everyday Math (2010 NJ ASK 3and 2012 NJ ASK5 Data)

	Skewness	
	Statistic	Std. Error
MathScaleScore2010	.091	.236
MathScaleScore2012	.125	.236
Valid N (listwise)		

a. Treatment = Alternative Treatment (Everyday Math)

Table 1c: Descriptive Statistics - Singapore Math (2010 NJ ASK 3and 2012 NJ ASK5 Data)

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
MathScaleScore2010	100	128	300	219.44	4.590	45.902
MathScaleScore2012	100	146	300	220.88	3.775	37.752
Valid N (listwise)	100					

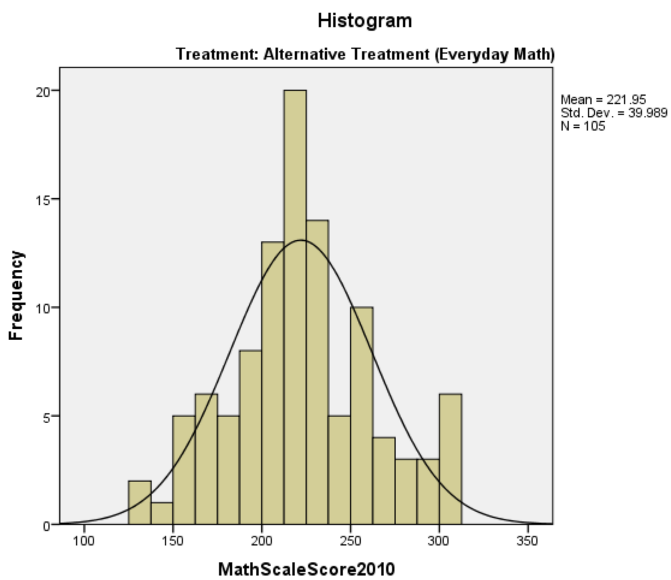
Table 1d: Skewness_ Singapore Math (2010 NJ ASK 3and 2012 NJ ASK5 Data)

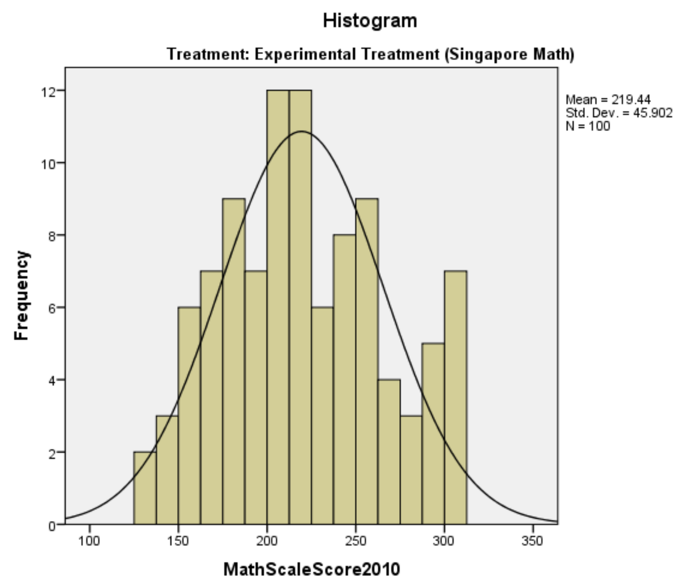
	Skewness	
	Statistic	Std. Error
MathScaleScore2010	.144	.241
MathScaleScore2012	.117	.241
Valid N (listwise)		

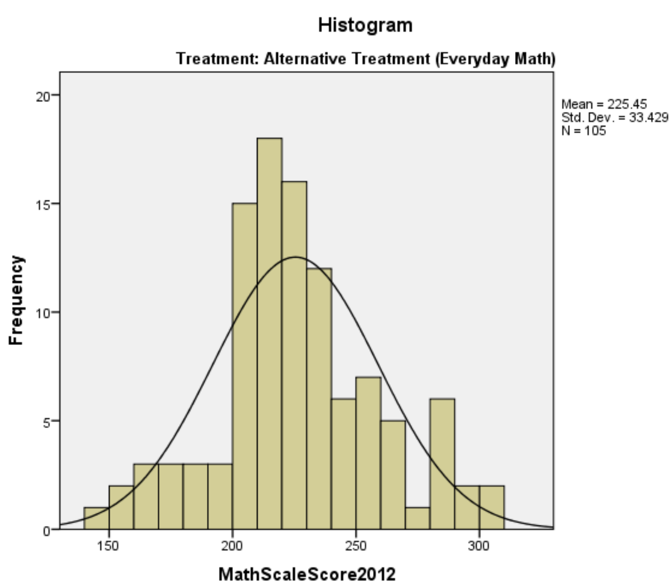
Table 1e: Tests for Normality, Both Treatments (2010 NJ ASK 3and 2012 NJ ASK5 Data)

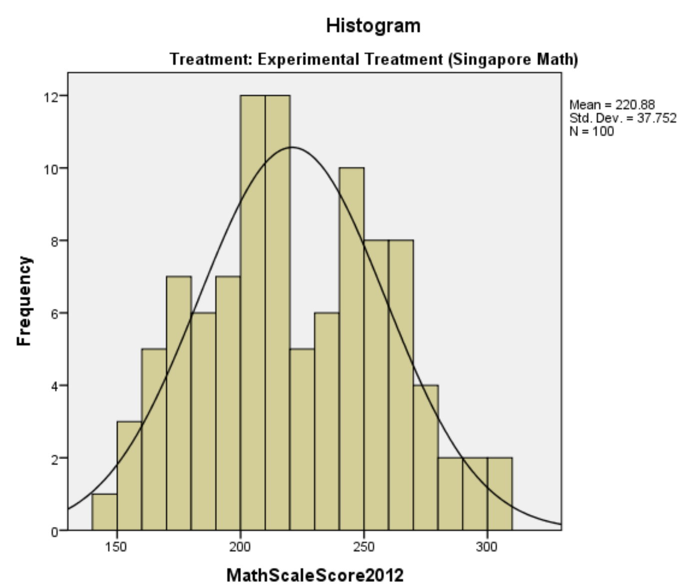
Tests for Normality

	Treatment	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
MathScaleScore2010	Alternative Treatment (Everyday Math)	.086	105	.052
	Experimental Treatment (Singapore Math)	.070	100	.200[*]
MathScaleScore2012	Alternative Treatment (Everyday Math)	.083	105	.073
	Experimental Treatment (Singapore Math)	.073	100	.200[*]









Race/Ethnicity - Black

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MathScaleScore2010	101	128	300	206.98	33.827	-.163	.240	.252	.476
MathScaleScore2012	101	140	287	208.74	29.475	.196	.240	.134	.476
Valid N (listwise)	101								

Race/Ethnicity - Hispanic

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MathScaleScore2010	77	134	300	225.38	46.950	-.012	.274	-1.086	.541
MathScaleScore2012	77	146	300	229.86	35.315	-.178	.274	-.220	.541
Valid N (listwise)	77								

Race/Ethnicity – Black & Hispanic Subgroup, White

Tests of Normality

	Race/ethnicity	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
MathScaleScore2010	Black&Hispanic	.053	178	.200*	.984	178	.037
	White	.214	27	.003	.879	27	.005
MathScaleScore2012	Black&Hispanic	.052	178	.200*	.990	178	.279
	White	.116	27	.200*	.950	27	.213

SES

Tests of Normality[a]

	SES	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.

MathScaleScore2010	Not Low	.152	16	.200*	.955	16	.567
	Low SES	.101	85	.031	.968	85	.032
MathScaleScore2012	Not Low	.096	16	.200*	.983	16	.984
	Low SES	.074	85	.200*	.986	85	.461

Gender

Tests of Normality[a]

	Gender	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
MathScaleScore2010	Males	.114	38	.200*	.971	38	.409
	Females	.091	63	.200*	.976	63	.257
MathScaleScore2012	Males	.149	38	.032	.969	38	.353
	Females	.073	63	.200*	.987	63	.760

APPENDIX D

Independent Samples t-test (Gender)

Independent Samples t-test – Comparison of Males

Group Statistics[a]

	Treatment	N	Mean	Std. Deviation	Std. Error Mean
MathScaleScore2012	Alternative Treatment (Everyday Math)	44	227.18	36.437	5.493
	Experimental Treatment (Singapore Math)	39	229.64	36.904	5.909

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
MathScaleScore2012	Equal variances assumed	.266	.608	-.305	81	.761	-2.459	8.062	-18.500	13.582
	Equal variances not assumed			-.305	79.552	.761	-2.459	8.068	-18.517	13.598

Independent Samples t-test – Comparison of Females

Group Statistics[a]

	Treatment	N	Mean	Std. Deviation	Std. Error Mean
MathScaleScore2012	Alternative Treatment (Everyday Math)	61	224.20	31.332	4.012
	Experimental Treatment (Singapore Math)	61	215.28	37.513	4.803

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
MathScaleScore2012	Equal variances assumed	4.879	.029	1.425	120	.157	8.918	6.258	-3.472	21.308
	Equal variances not assumed			1.425	116.310	.157	8.918	6.258	-3.476	21.312

APPENDIX E

Correlation Analysis (Hispanic)

Descriptive Statistics

	Mean	Std. Deviation	N
SYs1011Attendance	349.071	19.4876	77
MathScaleScore2012	229.857	35.3150	77

Correlation Analysis (Hispanic) – Attendance and 2012 NJ ASK5 Performance

Correlations

		SYs1011Attendance	MathScaleScore2012
SYs1011Attendance	Pearson Correlation	1	.408**
	Sig. (2-tailed)		.000
	N	77	77
MathScaleScore2012	Pearson Correlation	.408**	1
	Sig. (2-tailed)	.000	
	N	77	77

**. Correlation is significant at the 0.01 level (2-tailed).