Mirando Hacia el Futuro: Using Multilevel Growth Models to Examine the Achievement Gap Between White and Hispanic Students

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Mirando Hacia el Futuro: Using Multilevel Growth Models to Examine the Achievement Gap Between White and Hispanic Students

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DISSERTATION

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DEDICATION

To my ancestors and family,

your hard labor has created the path for me to achieve my educational dreams.
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Mirando Hacia el Futuro: Using Multilevel Growth Models to Examine the Achievement Gap Between White and Hispanic Students

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ABSTRACT

Academic achievement gaps have been a topic of study for researchers within the United States of America for many decades because there has been a steady achievement disparity between White students and students of color. The mathematics achievement gap for the largest growing population, Hispanic students, has not changed when compared to White students over the last few decades (Dillen, 2009; Hemphill, Vanneman, & Rahman, 2011; Perie, Moran, & Lutkus, 2005). Utilizing mathematics achievement scores from students in 3rd-5th grades in a large Southwestern Urban School District, levels of math achievement between White and Hispanic students were compared to examine the achievement gap in elementary school. The objective of this research was to address two research questions, one, how does math achievement between White and Hispanic students vary over time, within and across schools and two, whether controlling for other student factors may partly or completely explain differences
in math achievement. A multilevel growth curve model was used to examine the initial levels of, and changes in, achievement for White and Hispanic students within schools and how this varies across schools. In addition, a series of growth models examined trajectories of math achievement and how student characteristics (e.g., Gender, eligibility for Free and Reduced Lunch, and English Language Learner status) may explain these disparities between White and Hispanic students above and beyond ethnicity and how this varies across schools. Results found evidence of a significant math achievement gap between Hispanic and White students even when controlling for additional student characteristics. The math achievement gap exists across schools, however the magnitude is different depending on the school context. Overall, more energy and resources need to be invested in understanding the achievement gap prior to developing holistic and contextual interventions.
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Achievement Gaps in Focus

Academic achievement gaps have been a topic of study for researchers within the United States of America for many decades because there has been a steady achievement disparity between White students and students of color. Specifically, the mathematics achievement gap between Hispanic students and White students has not changed since the 1990s (Dillon, 2009; Hemphill, Vanneman, & Rahman, 2011; Perie, Moran, & Lutkus, 2005). Prior to the 1990s, the achievement gap between Hispanic and White students closed slightly which was attributed to the emphasis of educational reform focusing on culturally relevant curriculum and more school days (Harris & Herrington, 2006). Besides ethnicity, socio-economic status (SES) and parental background variables explain a large percentage of the variance when comparing White and Hispanic students on math achievement scores (Duncan & Magnuson, 2005). In recent years, gender has become a focus in improving achievement. Men of color face unique challenges through the intersection of gender, familial, psychological, and economic factors compared to women of color in the educational pipeline (College Board Advocacy & Policy Center, 2010). Since Hispanic students are the fastest growing population in the United States, and a large percentage of English Language Learners (ELL) are from Hispanic backgrounds they experience challenges in math achievement as early as kindergarten as a large majority of English Language Learners speak Spanish (Kieffer, 2008). With the emphasis from President Obama to prepare students for the 21st century in Science,
Technology, Engineering & Mathematics (STEM) careers, mathematics is a key field in which education for Hispanic students is critical.

Hispanic and White students are making progress in mathematics. The gap, however, between these two groups has remained unchanged in National Assessment for Educational Progress (NAEP) scores since 1990 although some states have been able to impact the magnitude of this gap and narrow these vast differences such as Connecticut, District of Columbia, Massachusetts, New Jersey, New York, and Rhode Island (Hemphill et al., 2011). What is of prime importance within this research is to attempt to understand the magnitude of the achievement gap and how this varies in elementary school and if the gap is more prominent between Hispanic and White students at different schools when accounting for gender, SES, and English Language Learner status. This study compared math achievement between White and Hispanic students from 3rd-5th grade and examined the effects of gender, SES and ELL status and its relationship to achievement overtime. In order to examine math achievement between Hispanic and White students over time within and across schools, this study focused on using multilevel growth models. Multilevel growth models have not always been the standard when reporting and measuring achievement gaps.

**History of Measuring Achievement Gaps**

The United States of America was a nation born on the principle of democracy and with the belief that all Americans regardless of ethnic and socio-economic background could achieve prosperity and success with hard work, also known as, the American Dream. According to a recent meta-analysis of national achievement gains spanning the last four decades, students of color and low-income students have
performed below their White and Asian peers (Gamoran, 2007). When educational opportunities became a reality for historically low performing students from various ethnic and socio-economic backgrounds, problems and concerns began to arise about the equality of education in public schools. The history of studying achievement gaps between Hispanic and White students dates back to the initiation of the Civil Rights Act of 1964, in which the tenant of the legislation prevented the discrimination and denial of education based on race, color or national origin (Kentucky State Advisory Committee Report, 2006). Further research was motivated by the revelations of the disparity in equality in education as a result of the Coleman et. al. (1966) report that made salient the disparities in achievement between students of color and those from lower SES backgrounds compared to White and higher SES peers. This marked the beginning of research that began to focus on understanding the achievement disparities across ethnically diverse student populations, specifically Hispanic and White students.

The United States has fallen to a ranking of 25th in mathematics (Levels, Dronkers & Kraaykamp, 2008; The College Board Advocacy, 2008; U.S. Department of Education, 2008). Many educational researchers have concluded that this has negative ramifications for future educational quality and the global competitiveness of the economy of the United States and for Hispanic populations as the largest minority group (Kirsch, Braun & Yamamoto, 2007; Obama at The National Academy of Sciences, 2009; Perie et al., 2005). This has created a necessity for educational researchers and stakeholders to better understand achievement gaps between Hispanic and White students in order to address these issues and re-build the American reputation of having strong
mathematics performance (Kirsch et al., 2007). In order to move forward, more research in understanding math achievement disparities needs to occur.

**Educational Policies and Practices**

The term “Achievement Gap” entered the American lexicon when researchers began noting differences in educational outcomes between White and African-American students, but later included other students of color, specifically Hispanic students (Anderson, Medrich, & Fowler, 2007; Gwartney, 1970; Hauser, McMurrin, Nabrit, Nelson, & Odell, 1964; Roscigno, 2000; Venzant-Chambers, 2009). By drawing attention to the issue that students from diverse ethnic and socio-economic backgrounds were not performing at similar rates on academic tests, the federal government began to take action during President Johnson’s administration. Just one year after the enactment of the Civil Rights Act, the *Elementary and Secondary School Act* of 1965 immediately mandated federal dollars to be poured into schools in order to even the playing field for students from different backgrounds (Public Law 88-352, 1965). Remnants of the Kennedy administration led an effort to have a federal role in educational reform through national assessments and thus the development and creation of the *The National Assessment of Educational Progress* (NAEP) in 1964 (Vinovskis, 1998). Shy of ten years later, the increase in public schools receiving federal funds increased as a result of the *Equal Educational Opportunities Act* of 1974 (Public Law 93-380, 1974). The two above pieces of legislation provided funding to kindergarten through 12th grade public schools under Title I, which was the beginning of the largest federal fiscal support of public education in the United States’ history (Anderson et al., 2007). This increase in
federal dollars in public education and educational reform efforts emphasized culturally relevant curriculum and more time in school (Harris & Herrington, 2006).

During this time with the influx of federal funding into education, there was not a systematic process for reporting achievement gaps within public education to the federal government in order to measure any type of fiscal impact or return on investment. The status quo of the era for reporting achievement gaps typically compared the educational outcomes of students from different ethnic and socio-economic backgrounds on educational tests. Traditionally, educational outcomes within the highly publicized literature of this era focused on assessment scores and grades (Gamoran, 2007). Traditionally underperforming groups of students had lower academic gains compared to their higher performing peers. Students of color (African American, Hispanic, American Indian, Hawaiian and Pacific Islander), students from low-income families or those who qualified for Free or Reduced Lunch (FRL), and English Language Learners (ELL) students fell significantly below the standard when comparing educational outcomes such as assessment scores (Murphy, 2009).

In 1994 the Improving America’s Schools Act (IASA) (Public Law 103-382, 1994) provided a platform for determining school progress by measuring how each state was meeting its standards. This stimulated a new era of educational measurement that required analytic comparisons between states on student standardized assessment scores. Despite legislation efforts during this era, the educational progress of students of color in the late 20th century still was lagging behind White students and the gap on NAEP scores from cohort to cohort (Hemphill et al., 2011). The IASA was one of the first major strides in state accountability for student achievement. Until the early 21st century,
attempts to resolve and diminish academic achievement gaps through educational reform efforts were implemented throughout the country such as extended school days, curriculum changes, developing learning goals/outcomes and accountability based on state expectations (Adams Jr., 2010). However, nothing seemed to be the magic potion that would eliminate achievement gaps within the education system that educational policy makers, educators, parents and community stakeholders so desired. The National Assessment for Educational Progress (NAEP) provided evidence that there was a flat trend across cohorts of students in mathematics achievement for all students in the late 20th century despite these various school reform efforts (Kirsch et al., 2007).

In response to this trend, President George W. Bush in 2002 signed the No Child Left Behind Act (NCLB), which had the same purpose as the IASA, but was now dedicated to raising educational standards, holding states accountable fiscally for student achievement and quality of teaching (Adams Jr., 2010; Lee, 2006). It also included a stringent process in reporting achievement gaps by mandating states to using proficiency and single-time point methods in calculating student achievement and gains in standardized test scores compared to pre-specified standards (Blagg, 2011). This law provided Federal funding contingent on student achievement outcomes; increasing the proportion of students proficient in specific content areas, with mathematics as a major area of focus. This new focus on students within schools, districts and states did not allow much time to focus on helping individual students grow from “not proficient” to “proficient,” which severely limited educational measurement in annual reports (Anderson et al., 2007; Blagg, 2011). Stemming from the NCLB legislation, the current administration has focused on continuing educational reform. President Obama’s
educational reform provides states the ability to develop growth models to address the historic achievement gap (Trent, 2013). There have been many changes in legislation around school reform, but standards-based accountability and achievement have become the focus of federal and state funding.

**Standards-Based Accountability and Achievement**

The wealth of literature on achievement gaps is large; however the educational policies and practices have consistently changed through the tenure of many different political leadership teams. Since the 1970s, achievement gaps were measured using test scores as an outcome variable to compare students of color and their White peers (Dillon, 2009; Gamoran, 2007). Standards, levels of achievement that are pre-specified, and benchmarks, a level of a standard to be judged, in educational assessment became a trend in measuring achievement in the 1980s and continued to expand through the latter part of the 20th century (Lee, 2002). Since the 1980s, academic standards have been established in public schools across the country (Gamoran, 2007). The emergence of standardized assessments used to determine if students were meeting these standards became typical in educational measurement of achievement (Yaffe, 2012). Although it was a forward thinking concept at the time to develop standards and use these to measure achievement gaps, there was a lot of variation in how the fifty states measured standards. This issue of comparability and generalizability from state to state continues today. It is directly related to states and their autonomy in developing their own standards and thus may not be equally comparable across the United States (Betebenner & Linn, 2009; Lee, 2006). *The National Assessment of Educational Progress (NAEP)* was initially developed to establish federal standards to be measured across states and play an integral role in
educational reform and progress, but currently is a measure of national academic achievement as mandated by the government (Vinovskis, 1998). Measuring national academic progress through the NAEP and allowing states to independently measure standards as well as be held accountable for student achievement, the role of the *No Child Left Behind (NCLB)* legislation, was thus even more critical to maintaining a standards-based accountability in regards to student achievement.

This process of standards-based accountability as it was termed at the turn of the 20th century through the *NCLB* legislation provided a platform for educational researchers to further investigate achievement gaps and attempt to compare these standards across states. The fallacy in measuring achievement gaps through this method was that it was grounded within states, and due to the inconsistency in how states actually develop these standards, external validity issues existed (Ho, Furgol & National Opinion Research Center, 2011). For example, since the individual variation in developing standards is provided to states by the Federal government, all states’ standards are different and thus comparing states with one another remains difficult using state-standards-based assessments and this is why the NAEP is important (Vinovskis, 1998).

With the NCLB, more standardized and statistically grounded methodology has become part of the process in reporting academic achievement gaps. In 2002, the *No Child Left Behind Act (NCLB)* allowed the measurement and the reporting of student achievement to be more standardized, but allowed individual states to develop their own standardized assessments. States were mandated to develop standards-based assessments to measure achievement growth and make conclusions about how many students were meeting these pre-specified standards (Blagg, 2011). The tenet of this process was to
create a more streamlined and systematic process to measure, report and close the historic achievement gap between students of color, lower socio-economic students and those from English Language Learner backgrounds, however since states were allowed to develop standards-based assessments individually, this made it difficult to compare achievement across states (Shirvani, 2009). The last decade of educational measurement of the achievement gap has been dominated by the NCLB use of proficiency standards, single-time point methods to compare students below, nearing and above the standard threshold using scores on the standardized assessment scores (Lee, 2006).

Proficiency standard methods of reporting achievement gaps only provide understanding of students’ performance at one single-time point and leave one desiring more information about achievement over time (Betebenner & Linn, 2009). The limited generalizability of these methods limits researchers’ ability to make conclusions about developmental formal schooling experiences over time due to the single-time point methods and the inability to understand student-level as well as school-level information interactions. This has led to the emergence of longitudinal designs to measure achievement over time. Utilizing standards-based assessment scores as a metric for the achievement gap, the nested structure of time, student and school-level characteristics as predictors has gained popularity and desirability as a method in reporting achievement over time (Bryk & Raudenbush, 1988).

Although, many exceptions exist, the main focus of achievement gap research can be summarized as follows: There has been a steady achievement gap (i.e., ethnicity, gender, SES, English Language Learner, etc.) in the United States for the last few decades and this gap has been more detrimental for students of color, especially Hispanic
students (Dillon, 2009; Duncan & Magnuson, 2005; Perie et al., 2005). U.S. students are not making adequate gains in mathematics, thus placing American children more at risk for not being prepared for 21st careers (Kirsch, Braun, Yamamoto & Sum, 2007). With Hispanics as one of the largest and fastest growing populations, this disparity is ever more prominent and must be addressed (Roscigno, 2000). Students of color tend to have lower initial levels of academic achievement scores compared to their White peers, thus even if they grow at the same rate or faster, it does not guarantee the gap will close (D'Agostino, Borman, Hedges & Wong, 1998). Besides, ethnicity alone, students in higher income schools grow at a slower rate over time compared to lower incomes schools, but initial level of achievement for students in the lower income schools is much lower, thus students less fortunate have more to grow over time (Alexander, Entwisle & Olson, 2001). Students for whom English is a second language in Kindergarten are already behind their English peers on initial achievement scores (Kieffer, 2008). Current No Child Left Behind Standards-Based Accountability only analyzes one time point and fails to look at individual students overtime and thus ignores academic growth (Blagg, 2011). The above achievement gaps are a crisis in America as in order to maintain the global competitiveness through economic development, these gaps need to be closed (Kirsch et al., 2007). The United States is currently ranked 25th in mathematics and hence the critical nature of having students be successful in school, specifically Hispanics students, in order to close the historic achievement gap and contribute to the 21st century workforce needs is of prime importance (The College Board Advocacy, 2008; U.S. Department of Education, 2008).
The past decade of educational research on achievement gaps has spent a lot of energy on refuting the current *No Child Left Behind Act (NCLB)*. The original intent of NCLB was to focus on the achievement of low-performing students and hold states, districts, and schools accountable for poor academic performance. The NCLB mandate includes criteria to assess accountability in the public education system in order to improve achievement and prevent low performing students from falling behind (Overview NCLB: Executive Summary, 2002). The tremendous number of published research articles and efforts resulting from this Act has left educational leaders, teachers, students, families, policy makers and other key stakeholders left to wonder why academic achievement gaps in the U.S. have not closed (Barone, 2009; Ho, Furgol & National Opinion Research Center, 2011; McCall, Hauser, Cronin, Kingsbury & Houser, 2006).

This study focused on the disparity in math achievement between White and Hispanic students and whether SES, gender and ELL status play a role in explaining the differences between students and their achievement over time within and across schools. A multilevel growth model was used to examine student-level characteristics that may possibly explain the mathematics achievement gap above and beyond ethnicity (e.g., gender, Free and Reduced Lunch, English Language Learner) from 3rd -5th grade. These disparities will be illustrated utilizing multilevel growth models.
Chapter Two

Literature Review

Introduction

This literature review summarizes how students from different ethnic, socio-economic, and language backgrounds develop knowledge and the history of achievement gaps in the United States of America and its major impact between Hispanic and White students. The rest of this chapter explains the educational thought and policy related implications on how academic achievement gaps between Hispanic and White students are studied, measured and reported, and, therefore, how educational policy/practices drive the methodology of studying the achievement gap. The literature review closes with an argument for the use of time focused models in measuring student academic achievement gaps and standardized test scores.

The Social Construction of Knowledge

The social construction of knowledge is unique to each individual and their academic trajectories vary overtime. Students in early childhood develop mathematics knowledge from the social context of the family and in everyday life prior to formal schooling (Brenner, 1998). Through social interaction, learning and cultural knowledge are exchanged. Active learners internalize the cultural knowledge through this exchange. Novices in these social contexts are able, through scaffolding by an expert, to achieve more in this context than independently. This is defined as ‘situated learning’ (Collins, Seely Brown & Holum, 1991; Bruning, Schraw, Norby & Ronning, 2004; Langford, 2005). Situated learning occurs when the learner, through selective help from an expert, is able to make gains through scaffolding and cues. This is termed, the zone of proximal
development (Langford, 2005). Building foundations for learning using these cultural knowledge exchanges is central to social constructivist theory.

Mathematics knowledge becomes apparent through formal schooling and is evident on standardized testing, with students from various ethnic and socio-economic backgrounds typically having lower scores (Perie et al., 2005). This begins the deficit model of achievement, but when focusing on the social construction of knowledge, students are active participants in learning and through guided-social interaction, the transmission of knowledge is developed and thus impacts achievement for specific student populations (Bruning et al., 2004; Rogoff, 1990).

In Hispanic communities in which students are from lower socio-economic and more diverse language backgrounds, mathematics interventions focusing on the student white utilizing cultural resources through social constructivist theory to help build a math frame of mind are more effective educational practices (González, Andrade, Civil & Moll, 2001). Effective educational practices need to be developed in order to help students construct knowledge, work with and support the families and larger communities. Hispanic, low socio-economic status, and language diverse students from communities in which parents are integrated and play a central role in mathematics education make larger gains than similar communities that did not use this model (Moll & Ruiz, 2002). In sum, the holistic construction of knowledge is critical in impacting achievement gaps and may help guide appropriate methodology when attempting to understand achievement gaps between Hispanic and White students prior to developing interventions.
Critical Focus on ‘Time & Growth’

‘Time as he grows old teaches many lessons’ ~*Aeschylus*. In a time when the U.S. has a 50% high school graduation rate, a 70% rate of matriculation to college and a 7.8% unemployment rate, educational researchers must continue to understand academic achievement gaps in order to make better policy related decisions (Bureau of Labor Statistics, 2012; National Center for Education Statistics, 2011). A focus on time and growth is a critical factor in understanding achievement gaps overtime between White and Hispanic students. The emphasis and importance of methods used to understand the historic achievement gap play an integral role in monitoring progress and what may and may not work in closing the gap. However, the intent of this literature review is not to spend time explaining reasons why historic achievement gaps in the U.S. have not closed, but rather provide insight on methodology that measures academic achievement growth that provides more depth and information about the gap than previous methodology to compare White and Hispanic students and take into account gender, SES (e.g., Free and Reduced Lunch status) and English Language Learner status. This research lends itself to using longitudinal growth models as the intent of this study is to understand student achievement over time within schools and how that varies across schools.

**U.S. Mathematics Achievement Gap: White and Hispanic Students**

Hispanics are the largest and fastest growing minority group in the United States and 78.3% are concentrated in 10 states, California, Arizona, New Mexico, Colorado, Texas, Illinois, Florida, New York, New Jersey, and Georgia (Census.gov, 2010; The College Board Advocacy; 2008). The mathematics achievement gap between Hispanic and White students remains consistent since the 1990s (Dillon, 2009; Hemphill et al.,
The United States of America was once the leader in education, but since the 1970s, achievement gaps between White and minority students, specifically Hispanic students have been noted. The magnitude of the gap decreased slightly prior to the 1990s and has remained constant since that time (Gamoran, 2007). During the 1970s and 1980s, perhaps due to the Federal policies allocating funds to schools to close the achievement gap, there was a slight closing of the gap between Hispanic and White students. This slight closure may be explained by the emphasis and implementation of culturally relevant curriculum and adding more school days, which has shown to be critical for students of color, however, there is insufficient empirical evidence to support this claim (Harris & Herrington, 2006).

Ethnic differences in school performance are center stage within the academic achievement literature. Historically, the achievement gap has been empirically supported through comparing assessment scores between White students and students of color. Although, students of color, specifically Hispanic students are making academic progress over time during formal schooling, the initial level of achievement for these students is much lower than White students, thus closing this historic gap since the 1990s has not become a reality (Gamoran, 2007; Hanushek & Rivkin, 2009). Teachers that are role models within the school context critically impact Hispanic student achievement. For example, Hispanic students’ achievement scores are better when they are encouraged to be socially active within their communities and their teachers are from similar ethnic backgrounds as this appears to increase their academic self-efficacy and internalization of content (Goldsmith, 2004). Although an encouraging finding, achievement gaps may continue to be perpetuated by the intersection of multiple student background variables.
Consistently, Hispanic students who are from lower income backgrounds are not meeting academic standards (D'Agostino et al., 1998; Dillon, 2009). When analyzing the achievement gap by ethnicity, Hispanic students make gains, but not enough to close the gaps and are dramatically below their White peers when performing on standardized tests (Dillon, 2009).

Although, there have been multiple reasons for the continued achievement gap in the United States between Hispanic and White students, many educational researchers conclude that achievement gaps present themselves long before formal schooling begins and only become evident on standardized tests in early elementary school. Besides ethnicity, these gaps have been associated with socio-economic status, gender, cultural, and language backgrounds and are compounded by critical formal school transitions, such as that from elementary to middle school and from middle school to high school (Goldstein, 1997). The central focus of this review is to understand over and above ethnicity, which student characteristics relate to the achievement gap and the overall construction of mathematics knowledge.

**Early Elementary School Achievement**

Students in the United States from diverse cultural and socio-economic backgrounds are brought together for formal schooling in kindergarten and teachers begin noting academic outcomes differences between students. The differences typically show White and higher-income students outperforming low-income students and students of color, especially Hispanic students (Haycock, 1998). The initial level of academic achievement for students is critical in impacting future academic growth and the overall achievement gap. Research using the Early Childhood Longitudinal Study (ECLS) demonstrates the
evidence of achievement disparities at an early age between White and Hispanic students (Bodovski & Farkas, 2007; Easton-Brooks & Davis, 2009).

Students with a lower level of mathematics readiness showed less growth from kindergarten to 3rd grade than students with a higher initial level of mathematics readiness (Bodovski & Farkas, 2007). Prior skill level in math before elementary school impacts growth in achievement over time. Children with low level math skills eventually grow at the same rate as their peers with average or high math skills, but a disparity remains through 5th grade due to a low initial level of achievement and growth in early elementary school (Bodovski & Farkas, 2007; Crosnoe et al., 2010). What can be extracted from these findings is that students who come from households that have more financial resources possess a higher level of mathematical and school readiness (Duncan & Magnuson, 2005). Early elementary school is a critical point in cognitive development that appears to be a first formal indicator of long-term academic success and gains in mathematics through the tenure of formal schooling. Thus, when attempting to understand academic achievement gaps between White and Hispanic students, early elementary is an important time frame to observe.

Financial Disparities

As soon as disparities in academic achievement become apparent during formal schooling, most educational research not only indicates ethnicity as a possible variable in explaining these differences, but also socio-economic status (SES) as a viable characteristic in understanding these achievement disparities. Socio-economic status explains a large percentage of the relationship between why White students outperform Hispanic students at the beginning of formal schooling as more Hispanic students are also
lower income compared to their White peers (Duncan & Magnuson, 2005). Samples of school children in highly populated urban locales have been analyzed and the results are consistently similar. Both higher and lower socio-economic status (SES) children make adequate achievement gains during the school year and thus grow at the same rate, but initial level of achievement for lower SES children is dramatically lower and these groups of students do not tend to grow over the summer months (Alexander et al., 2001; D’Agostino et al., 1998). This provides an added hardship for lower SES students as the achievement gap continues to persist because these students are not growing at a fast enough level to make gains in order to close any observed achievement gaps over the formal schooling period.

The 21st century achievement gap has widened between higher and lower income families by 30-40% compared to the late 20th century, with this having the strongest effect on Hispanic students (Reardon, 2011). Parental educational background and other neighborhood characteristics, play a significant role in explaining the achievement gap and the differences in SES between Hispanic and White students. The educational status of parents is related to achievement; making income a strong indication and prediction of long-term academic success (Dronkers & Robert, 2008). However, this is a domino effect of inequality in that, higher income families invest more in their children in terms of educational opportunities, which severely impact lower income students who do not have this type of exposure, thus putting lower SES Hispanic students farther behind (Reardon, 2011). Through the research in achievement gaps over the last three decades, it is clear that students from lower SES backgrounds are at a severe disadvantage at the beginning of formal schooling.
Gender Disparities

With the dwindling number of males who graduate from K-12 education and matriculate to higher education, gender is an area of critical focus in academic achievement, especially for males of color. Hispanic males tend to have lower mathematics, reading, and writing achievement than their Hispanic female peers by 3rd grade and are twice as likely as their female peers to be held back one year (Sáenz & Ponjuan, 2011). In addition to being more likely to be held back, Hispanic males are overrepresented in special education and are more likely to be in the discipline system inside and outside school (Dunn, 2012). Gender and academic achievement are strongly related. For example, males of color are more at risk for dropping out of school and being less likely to be college ready compared to their female peers of color and White males (Conley, 2007; Sáenz & Ponjuan, 2011). Gender plays an important role in academic achievement overtime and compounded with ethnicity is an area for educators to work with the student and help the student develop skills to be successful in education such a help-seeking and self-management (Dunn, 2012). Gender is a critical factor in understanding academic achievement and its interaction with ethnicity to observe its relationship with mathematics.

English Language Learner Disparities

Recently, with the influx in immigration and with 5.3 million English Language Learners or 10.7% nationally in the public schools (Migration Policy Institute, 2010), academic disparities have been noted as being related to language differences. Of the English Language Learners in the United States, 79% come from Spanish speaking backgrounds (Payán & Nettles, 2008). Students who are English Language Learners
(ELL) lag behind their English peers in formal schooling on assessments as their academic gains are smaller annually and initial level of achievement much lower in mathematics and reading (Kieffer, 2008). Students from lower socio-economic backgrounds are performing at lower levels than their White peers, thus students who have this added characteristic as an ELL are even further behind the curve on all content areas in formal schooling. Students arrive in formal schooling with these unique needs that sometimes go unaddressed. It has been concluded that English Language Learner students can dramatically improve their academic progress in mathematics through a focus on improving self-concept and their English skills (Marsh, Hau & Kong, 2002). English is the primary language for learning in the classroom and even if ELLs are provided a waiver to take assessments in their native language, their progress in the mathematics content or any other subject is inhibited due to the language of instruction (Payán & Nettles, 2008). This population of students comprises a large percentage of public school attendees and historically have underperformed compared to their non-English Language Learner peers, thus attention to this subgroup is of prime importance when investigating academic achievement gaps.

The School Context

There are contexts in elementary school that for some time have been regarded as important in understanding achievement gaps. The general consensus is that elementary school is an important time in which observed disparities in academic achievement are magnified between various sub groups of students (Balfanz & Byrnes, 2006; Goldstein, 1997). It has often been difficult for educational researchers to gauge this academic achievement gap during these formal school experiences as the common standard of
measurement is a single time point analysis and thus does not allow for a longitudinal experiences to be observed over time (Ho, Furgol & National Opinion Research Center, 2011). Achievement gaps vary at different schools for White and Hispanic students and school context plays a unique relationship and has been shown to decrease the gap when cultural curriculum is incorporated throughout the academic school year (Goldsmith, 2004). More startling is the type of school context and its relationship with achievement. Students in urban schools grew at higher rates than their rural counterparts (D'Agostino, Borman et al., 1998). In comparing private schools with public schools, private school students made larger gains over time (Lubienski & Lubienski, 2006). School context seems to be related to better achievement over time. Conclusions for the explanation of academic gains are strongly related to instruction within the classroom; however, most of the variance in initial formal school achievement is explained by socio-economic variables (Dronkers & Robert, 2008; Hoffer, Greeley & Coleman, 1985). The disparities are more salient in mathematics achievement as seen as early as kindergarten through number sense assessments and the gap seen between White students and students of color (Jordan, Kaplan, Oláh & Locuniak, 2006).

**Progression from Proficiency Standards**

Proficiency standards are one dominant method in reporting achievement in States’ achievement standards and these assessments provide a cross-sectional analysis of student achievement in different subjects (Dahlin & Cronin, 2010). The purpose of this methodology is to compare a student’s score on a standardized assessment with a pre-specified standard and categorize it into a category of proficiency. The analyses of compartmentalizing these students’ scores into specific criteria is reported under the
Annual Yearly Progress report, an annual report based on the state’s standardized assessment scores (Gamoran, 2007). For example, the common categories are Beginning Step, Nearing Proficiency, Proficient and Advanced (Barone, 2009). Proficiency models must use well-defined vertically scaled assessments, which are forms of a standardized-assessment that measure developmentally appropriate content over specified grade levels, but are statistically equated in order to make comparisons between each form across grades and overall student achievement (MacCallum, Zhang, Preacher & Rucker, 2002; Wisconsin Department of Public Instruction, 2009). Vertically-scaled assessments have a continuous variable to measure achievement over time (e.g., state-SBA scores), but proficiency models then utilize the continuous variable to categorize into dichotomous areas of proficiency (i.e., meets proficiency vs. does not meet proficiency) (Wisconsin Department of Public Instruction, 2009). This severely impacts the validity because the categories established may not be qualitatively similar within each determined category, thus making sweeping generalizations and severely impacting the external validity of scores and achievement gaps (MacCallum et al., 2002). For example, a student within a multilevel growth model would be classified as “approaching an average growth” and this same student would be classified as “not meeting proficiency” within a proficiency model framework.

In addition to the problems associated with the dichotomization of quantitative variables such as achievement test scores, there exists criticism of vertically scaled tests. Proficiency models require vertical and well-defined scales to determine what percentages of students that meet or exceed a specified cut score and category; not focusing on the individual growth of students within each category, only on which
students meet or do not meet that specification (Wisconsin Department of Public Instruction, 2009). Vertical scales measure specific content areas at varying educational levels along the same scale (Jorgensen, 2004; Tong & Kolen, 2008). Due to the inability of proficiency models to provide a more holistic measure of academic growth, these models do allow researchers to understand intraindividual change in achievement. For example, proficiency models may indicate only if students meet the proficiency standard or not. Therefore, the students will be marked as not meeting proficiency, but may still grow within a specified time frame (e.g., year), making sufficient achievement gains (Cody, Farland, Moore & Preston, 2010). Unfortunately, proficiency models are unable to measure and represent the level in academic growth of students over a period of time, groups and/or schools and only provides a snapshot of student achievement at one time point. Proficiency models are able to measure different groups of students within a given year, but not the same students over time. Individual growth models are superior because they can be used to measure individual change throughout grade levels (Barone, 2009). Proficiency models are limited as static models and when attempting to understand student growth and change, more inclusive and time-sensitive models should be used.

Part of the problem in understanding the achievement gap overtime resides in the lack of variety of educational analyses utilized to understand the achievement gap and the other is the lack of comparable assessment scores over the formal schooling period. A second part of the problem is the educational policies that govern key stakeholders and decision makers of curriculum, direction, etc. of formal schooling. In order to address the achievement gap between White and Hispanics for the future, the precision in understanding these disparities needs to be made salient over time and the attempt to
understand how knowledge is constructed over time. In order to discuss achievement over
time, the current standard of reporting achievement is through the current educational
policies and practices; standards-based assessment and accountability laws. A majority
of student achievement studies lack longitudinal designs and fail to track individual level
information and rather focus on group information. By utilizing a multiple time point
model and reviewing mathematics and critical thinking achievement over time by
examining within classroom indicators such as student characteristics have concluded
that initial level of achievement in early elementary school has an impact on later
achievement (Bryk & Raudenbush, 1988; Zvoch & Stevens, 2006).

**Multilevel Growth Models**

Traditional statistical and predictive models have continually focused on single-
time point analyses that require a certain set of assumptions specifically in regression and
the assumption of independence of observations (Hox, 2002; Goldstein et al., 2004). For
example, single-level regression-based models lack the complexity to account for nested
structures of observed data, such as students within classrooms in order to understand and
control for the levels of nesting (Goldstein, Browne & Rasbash, 2001). Proficiency
models currently utilize a single-time point analysis to make inferences about
achievement over time and thus are unable statistically to measure growth in achievement
within the methodology alone (Dahlin & Cronin, 2010). This limitation has led to the
ever growing popularity of multilevel and growth curve models. The increasing pressure
of the Federal government on states to close the historic achievement gap has increased
the interest in growth models to understand these academic disparities (Blagg, 2011).
Recently, President Obama has allowed for a sample of states to be freed of using
proficiency models and develop growth models to report progress annually (Hefling & Feller, 2012).

Currently, the standard for reporting academic achievement disparities allows researchers only to understand a single time point analysis. Growth models, in contrast, allow one to control for the student and school level characteristics. Longitudinal growth models have recently taken center stage as an alternative to measure academic achievement gaps over time in many states (Ho, Furgol & National Opinion Research Center, 2009). Longitudinal growth models allow for change in academic disparities and growth to be analyzed and explored at different time points in a student’s educational journey. And while growth models still meet the goal of NCLB to provide a systematic model of school accountability on academic achievement by understanding how students perform according to certain pre-specified standards, it allows for more depth by observing change over time and unique contextual factors that may impact achievement as well as demographic variables (e.g., low-income, English language learners, and ethnicity/race; Blagg, 2011).

Growth models allow for individual change in achievement to be measured across time and more states are opting to pilot these measurement tools as they provide more insightful information about the achievement gap and student growth over time (Cody et al., 2010). These models allow for different characteristics at each level (i.e., students, classrooms, schools) to be controlled for and understand each unique relationship with achievement on the specified outcome variable (Hedeker, 2004, Hox, 2002; Wisconsin Department of Public Instruction, 2009). However, because of the novel nature of growth models in this educational context of understanding achievement gaps, there
exists considerable variance in the types of growth models used within academic research and what researchers consider to be a ‘growth model’. Some researchers use two time points to generalize and discuss student growth, however growth trends in statistics are recommended to have at least three time points to infer any conclusions (Hox, 2002, MacCallum, Zhang, Preacher & Rucker, 2002).

This study utilized conditional models of growth using standards-based assessment (SBA) math scores. Growth models allow for nested structure effects (test scores nested within students nested within schools) to have its own distribution (intercepts, slopes), which is detailed by its parameters in the model (i.e., means, variances, etc.) allowing for researchers to be able to understand these multiple relationships across time and at each level (Hox, 2002). Growth models allow for intraindividual change or the change in an individual’s measured variable or construct within the study.

**Methodological Review**

A methodological review of research on the achievement gap in the past 15 years was conducted to understand the varying types of methods used. Due to the variance in achievement gap research over time and how educational researchers use growth models, a review of the methods literature in academic achievement was conducted to provide strong support for the use of explaining and illustrating growth modeling within this study. All non-empirical studies, those not using data were excluded in the final review. Articles based on achievement gaps were classified into three major categories: cross-sectional, single-time point, and longitudinal. For each of the three categories, the dependent and independent variables were coded into the following areas, either a
scaled/continuous variable or a categorical variable. For each longitudinal study, the number of time points utilized was classified and the type of methodology was indicated.

A sample of achievement gap articles were reviewed that focused on group membership and comparing some academic achievement outcome. Articles that were not empirical studies were excluded. For this initial review, only 30 research articles were included. Each article was classified as cross-sectional, single-time point, and longitudinal. Cross-sectional articles were those that discuss multiple developmental years using different students during a given time frame. For example, if 3rd-5th graders were analyzed on math test scores during the 2005 school year, this would be classified as a cross-sectional article. Single-time point articles are those that use one time frame analyzing the students on some type of educational outcome variable. Longitudinal articles are classified as those that use more than one time point analyzing the same students over time.

Methodologies within each major area were then coded into a specific statistical design category: descriptive/qualitative, correlational, general-linear modeling, regression, growth model and structural equation models. These categories are not mutually exclusive and there could be overlap in methodologies, but the following operational definitions were utilized during coding. Descriptive/qualitative studies are those that did not have any manipulation of variables, but summarized outcome measures into frequencies, averages, percentages, etc. Correlational studies are those that did not have inferential statistics, but observe and analyze relationships between a set of variables. General-linear modeling are those studies that compared group means on the dependent variable and interactions between independent variables and their impact on
the dependent variable. Regression studies are classified as those with a predictive modeling component (i.e., intercept, slope) and growth models as utilizing multiple time points with the same students over time to examine growth trajectories. Structural equation models focus on utilizing latent variables and examining these multiple relationships.

*Figure 1. Academic Achievement Gap Research Review*

Results of this quick methodological review were limited as only 30 research articles were included in the final review, but of the articles included, 90% utilized a growth and multilevel methodology when understanding academic achievement gaps over time. This further supports the rise and popularity in using growth models when understanding achievement gaps.
Research Questions

The goal of the current research was to better understand the mathematics achievement gap between Hispanic and White students in 3rd-5th grades. A multilevel growth model was used to model trajectories of math achievement for these two groups. Student level characteristics (SES represented by Free and Reduced Lunch status, gender, English Language Learner status) were also used as controls to better understand differences in achievement for these two groups. The specific research questions were:

1) How does math achievement from 3rd-5th grade differ between Hispanic and White students?
   a. How do the intercepts and slopes (rates of change) in math achievement vary between Hispanic and White students?
   b. Does this difference in intercepts/slopes between Hispanic and White students vary from school to school?

2) How does math achievement from 3rd-5th grade differ between Hispanic and White students when accounting for gender, Free & Reduced Lunch (FRL) and English Language Learner (ELL) status?
   a. How do the intercepts and slopes (rates of change) in math achievement vary between Hispanic and White students, while controlling for gender, FRL and ELL status?
   b. Does this difference in intercepts/slopes between Hispanic and White students, while controlling for gender, FRL and ELL status vary from school to school?
Chapter Three

Methodology

Introduction

Within this research study, secondary data analyses came from a large Southwestern Urban School District. The data consisted of Standards-Based Assessment (SBA) mathematics scores. A series of multilevel growth curve models were used to model change in math achievement over time and to control for student-level characteristics that can possibly explain the achievement gap above and beyond ethnicity (e.g., Free and Reduced Lunch, gender, English Language Learner). Free and Reduced Lunch status was used as a proxy for socio-economic status due to only having this variable available. Some schools within the school district with a population of 80% or higher of Free and Reduced Lunch status students classified all students as meeting this designation. Throughout the rest of this study, socio-economic status will be represented as Free and Reduced Lunch status.

This chapter will synthesize the methodological framework, support and evidence for utilizing the proposed models, process, data management and multilevel model construction and articulation. The chapter will go in depth about using growth models to understand and explain math achievement through using a 3-wave longitudinal dataset.

Mirando Hacia el Futuro

This study explored a series growth models utilizing standards-based assessment scores in mathematics from 3rd -5th grades (3-wave) in a large Southwestern urban school district in order to address the two research questions. By using a growth model, the graphs estimating achievement provide a visual representation of the academic
achievement gap between Hispanic and White students early in the educational pathway. Through these analyses, the results provided data-driven evidence how to better understand the achievement gap. These models when used in achievement gap research and understanding student growth provide a model to help understand the achievement gap’s complexities in a holistic way by using time-based achievement scores. Utilizing growth models to explore the achievement gap between Hispanic and White students can provide a better understanding of initial levels of achievement in early childhood. This provides support into why early childhood intervention into the achievement gap is important especially for Hispanic students. This will provide more information about student growth to educational researchers when analyzing achievement gaps in lieu of the proficiency, single-time point models currently being used. Before achievement gaps can truly be addressed, it will be important for researchers to better understand the importance of achievement in early childhood, over time and how that varies by ethnicity, gender, SES and ELL status. The results from this study may guide readers on how growth can be understood over time.

Growth Model Conceptual Framework

Growth models provide information about how the individual varies in reference to his/her environment and a rich context for interpretation, thus making these attractive for longitudinal designs (Boyle & Willms, 2001; Hox & Maas, 2002). In addition to intraindividual change, multilevel models allow researchers to investigate both the average intercept or initial level of the dependent variable, in this case SBA scores, and the average rate of change over time and how individual students may differ from the average intercept and slope (Hox, 2002; Kreft & de Leeuw, 1998; Little, Schnabel &
Missing data on the dependent variable(s) does not pose as large a problem for the model parameters (i.e., intercept, slope, etc.) as with other statistical models. This is because maximum likelihood (ML) is used as a model estimator for multilevel models. Its estimates values of the model parameters that maximizes the greatest probability of the observed data, thus when missing a few data points, it will make the best estimate with the actual observed information (Collins & Sayer, 2001; Hox, 2002; Little et al., 2000; Raudenbush, 2001). Cases missing explanatory variables, or level-2 predictors and/or covariates, should be excluded. Including such cases could create interpretability and generalizability issues (Hox, 2002).

In sum, growth models allow for the flexibility of real-world data to be analyzed. Growth models do not necessarily need to meet all the assumptions that other statistical models require such as single-level regression or general-linear modeling (GLM). Traditional statistical models rely on independent observations and due to the nesting of growth models, this assumption is violated (Goldstein, 1997). Multilevel models are robust against violations of normality that other regression models need in order to run due to the levels of nesting and the dependencies within the observed data across levels of nesting (Gibbons et al., 1993). In addition, regression models indicate that $y_i$ given $x_i$ are independently distributed, which does not take into account the complexity of student achievement overtime and the specific data nesting (i.e., students within classrooms nested within schools, etc.; Goldstein et al., 2004). More importantly when analyzing change over time, multilevel models do not require that every individual is measured at each occasion or that the intervals between assessments are equal, making them far more attractive to researchers (Bryk & Raudenbush, 1988). Hence, this study
utilizing a large-scale dataset will be ideal for using such complex methods to illustrate the achievement gap between Hispanic and White student and how this varies across schools; providing meaningful evidence in understanding math achievement.

**Measurement**

The state Standards-Based Assessment (state-SBA) is used as a measure of academic achievement within this study. The SBA is a criterion referenced assessment development by Harcourt Assessment Inc., as a result of the No Child Left Behind (NCLB) legislation in 2003 in the Southwest state (Harcourt Assessment Inc., 2005). This assessment was developed to measure 3rd-8th grade mathematics, reading, and science achievement standards in the state in order to report annual yearly progress. SBA scores in mathematics were available from 2008-2010, with first wave measuring the spring during 3rd grade. Test developers provided evidence for the reliability of test scores utilizing coefficient alphas for inter-item reliability measures in the state-SBAs, Mathematics (.91-.92), which show credible evidence for test score reliability (Harcourt Assessment Inc., 2005).

**Participants**

The large-scale database is from a large Southwestern Urban School District containing de-identified student-level SBA scores from 3rd-5th grade on mathematics. Demographic variables such as race/ethnicity, if the student qualifies for Free and Reduced Lunch (FRL), gender, and English Language Learner (ELL) are coded for each student at each test occasion. Test occasions in 3rd grade include a level of SBA measurement in the spring of that academic year. Also, included within the database are de-identified school-level information for each student at each test occasion. There are
5,849 students beginning 3rd grade in the 2008-2009 academic year that were included in the study analyses. The following table shows the students within this district who progressed from 3rd to 5th grade and completed a Spring administration of the state Standards-Based Assessments (state-SBA) in the years 2008 through 2010 in mathematics.

Table 1
<table>
<thead>
<tr>
<th>Mathematics State-SBA Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd</td>
</tr>
<tr>
<td>N= 5,849</td>
</tr>
<tr>
<td>4th</td>
</tr>
<tr>
<td>5th</td>
</tr>
<tr>
<td>5,260</td>
</tr>
<tr>
<td>5,130</td>
</tr>
</tbody>
</table>

Since the span of the data ranges from 3rd-5th grade, each student has mathematics scores for elementary school (3rd-5th grade) that were included in the analyses. Table 2 indicates the means and standard deviations at each grade level for mathematics standards-based assessment scores:

Table 2
<table>
<thead>
<tr>
<th>State-SBA Mathematics Scores by Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
</tr>
<tr>
<td>3rd</td>
</tr>
<tr>
<td>M 605.36</td>
</tr>
<tr>
<td>SD 36.25</td>
</tr>
<tr>
<td>4th</td>
</tr>
<tr>
<td>M 632.98</td>
</tr>
<tr>
<td>SD 34.52</td>
</tr>
<tr>
<td>5th</td>
</tr>
<tr>
<td>M 657.69</td>
</tr>
<tr>
<td>SD 35.81</td>
</tr>
</tbody>
</table>

Data Management & Dealing with Missing Data

The data that were analyzed from 2008 containing three waves of SBA math scores along with student-level demographics. However, missing data from the district was common within this dataset. Missing data within this analysis were taken into consideration, because multilevel analysis uses the maximum likelihood estimator, it did not pose a great threat. For example, the maximum likelihood estimator used for multilevel analyses is based on a normal distribution that maximizes the greatest
probability of the observed data and makes the best estimate with the actual observed information within the model (Hox, 2002). However, when explanatory variables or level-2 variables are missing, such as ethnicity, it is advised to exclude this case entirely from the data. The main focus of this study was on ethnic group membership, and if this variable appeared to be missing, it would be difficult to understand the nature of achievement gaps without this critical variable by impacting the estimation of intercepts and slopes, thus impacting the interpretation of results (Hox, 2002; Raudenbush & Bryk, 2002).

**Adding a 3rd Level**

Linear growth models have been utilized for understanding the complexity of nesting especially in regards to student-level and school-level variables. When attempting to understand academic performance, Bryk and Raudenbush (1988) note that school-level variable estimates from the aggregate of individual-level variable estimates may be a stronger indicator of academic achievement outcomes than the relationship purely between the individual level and the observed outcome. When specifying a model, it is critical to ensure all observed levels of nesting are included as when ignoring a nesting level occurs, regression coefficients and variances may be biased (Moerbeek, 2004; Opdenakker & Van Damme, 2000; Van Landeghem, De Fraine & Van Damme, 2005). Including a third level of nesting can create a complex model due to the fact that the number of parameters estimated increases substantially from a level-2 model and a large sample size at level-3 units is necessary (Hox, 2002). The flexibility of level-3 models compared to level-2 models allows for effects to vary across level-2 units, level-3 units, or both and the inclusion of predictors at any level (Hox, 2002, Lubienski &
Lubienski, 2006; Muthén & Curran, 1997). This flexibility to add complexity to the model provides researchers the ability to estimate random intercepts/slopes and parameter estimates at level-2 and/or level-3 predictors, level-2 random intercepts/ slopes predicted by level-3 predictors, and interaction effects within any level (level-1, 2 and/or 3) and the interaction between levels (Hox, 2002).

Figure 2. Three-Level Model

Model 1: Ethnicity & Math Achievement

When analyzing linear change over time, longitudinal growth models not only can examine change over time, but understand these trends at different levels of maturation over time (Cudeck & Klebe, 2002; Hox, 2002; Hox & Stoel, 2005). Model 1 focused on the relationship between ethnicity and academic achievement. A three-level linear growth model estimated mathematics scores of individual students and to investigate the initial achievement score and average rate of change in math scores between Hispanic and White students from 3rd to 5th grade. Equation 1 represents the level-1 model,
\[ Math_{tij} = \pi_{0ij} + \pi_{1ij} Time + e_{tij} \]

\[ Math_{tij} \] represents the academic achievement (i.e., Mathematics scores) state-SBA scores of students at each test occasion or time, \( t \); \( \pi_{0ij} \) represents initial academic achievement for each student when time is equal to zero or in the 3\(^{rd}\) grade, time will be coded as \( (3^{rd} = 0, 4^{th} = 1, 5^{th} = 2) \); \( \pi_{1ij} \) is the average rate of change or slope when there is one unit of change in time or from one grade to the next. \( e_{tij} \) is the level-1 residual representing what remains of the math score after accounting for change over time. The intercept and slope coefficients from the above equations can vary from student to student.

**Ethnicity & Math Achievement**

\[ \pi_{0ij} = \beta_{00j} + \beta_{01j} Hispanic_{1ij} + u_{0ij} \]

\[ \pi_{1ij} = \beta_{10j} + \beta_{11j} Hispanic_{1ij} + u_{1ij} \]

In an effort to understand math achievement from 3\(^{rd}\)-5\(^{th}\) grade and how it may vary as a function of ethnicity, the level-2 part of the model is represented in the equations above. This model represents the initial level of math achievement, \( \beta_{00j} \) for White students and the linear increase in intercept as a function of ethnicity, \( \beta_{01j} Hispanic_{1ij} \). The equation also represents the change in math achievement, \( \beta_{10j} \) for White students and the linear change as a function of ethnicity, \( \beta_{11j} Hispanic_{1ij} \). Ethnicity is a categorical variable in which White students will be the comparison group (coded 0) comparing to Hispanic students (coded 1). Ethnicity is inputted as a level-2 predictor that is accounted for within the model to describe how initial level of achievement and change in achievement vary between Hispanic and White students. The
ethnicity variable is included as a predictor for both the \( \pi_{0ij} \) intercept for academic achievement for student \( i \), when time is equal to zero at school \( j \), and \( \pi_{1ij} \) which is the change in achievement that is conditional on ethnicity at school \( j \).

Growth models allow the advantage of taking into account the nested structure and thus the dependencies within the variables observed (Goldstein, 1997). The above level-1 part of the model allows the individual variation within students across time, 3rd-5th grade to be modeled. The level-2 part of the models allows this individual variation and change over time to be compared between students accounting for ethnicity. Thus, the level-3 part of the model, shown in the equations below, will examine the variation between Hispanic and White students and how this varies between schools. With \( \gamma_{000} \) as the average math achievement in 3rd grade across schools, \( \gamma_{100} \) represents the average change in achievement across schools.

**Ethnicity & Math Achievement**

\[
\beta_{0ij} = \gamma_{000} + \tau_{00j} \]

\[
\beta_{10j} = \gamma_{100} + \tau_{10j} \]

**The Variance Model**

*Figure 3. Three-Level Variances*
Three-level models add complexity when attempting to interpret the variance terms. Random effects or residuals in growth models allow these to vary across the levels of nesting within the data (Goldstein, Browne & Rasbash, 2004). For example, the level-1 residual, $e_{tij}$ is the differences between a student’s math score and her model predicted score. The variance of the level-1 residuals represent the unexplained variance after accounting for the effect of time. The level-2 variances represent the unexplained differences in the residual terms for the initial level, $u_{0ij}$ and rate of change, $u_{1ij}$ in math achievement between students after accounting for ethnicity (i.e., Hispanic) within the same school. The level-3 variance is the unexplained differences corresponding to the level-3 residuals for the initial level of, $\tau_{00j}$ and change, $\tau_{10j}$ in math achievement between schools. The level-1 variance is the grade-to-grade variability within students, the level-2 variance is the student-to-student variance, and the level-3 variance is school-to-school variance in math scores unexplained when taking into account ethnicity.

**Model 2: Gender, Free & Reduced Lunch, ELL Status & Student Achievement**

It has been noted that academic achievement is strongly related to student characteristics such as financial, gender, language and these specific characteristics can help explain achievement disparities beyond ethnicity alone (Duncan & Magnuson, 2005). Model 2 focused on the second research question within this study regarding the relationship between student achievement over and above ethnicity by taking into account student gender, Free and Reduced Lunch and English Language Learner status. A three-level linear growth model was used to understand mathematics scores of individual students through the estimation of initial achievement scores and average rate
of change in math scores between Hispanic and White students while accounting for 
other student-level variables (e.g. gender, FRL, ELL) from 3rd to 5th grade.

\[ Math_{tij} = \pi_{0ij} + \pi_{1ij}Time + e_{tij} \]

Similar to Model 1, the above model equations for Model 2 are identical at level-
1, however, since this analyses focused on understanding the effects of other student 
characteristics besides ethnicity and how these are related to math achievement in 3rd 
grade and growth over time, gender, FRL and ELL status were incorporated, which are 
all categorical variables gender (Female =1), non-FRL (coded=0); FRL (coded=1), non-
ELL (coded=0) and ELL (coded=1) as level-2 predictors. The level-3 equation is similar 
to Model 1 except that student-level predictors and their interaction with time and at 
different schools were accounted for within Model 2, thus a cross-level interaction of 
these effects.

*Ethnicity, Gender, FRL, ELL Status & Math Achievement*

\[ \pi_{0ij} = \beta_{00j} + \beta_{01j}Hispanic_{1ij} + \beta_{02j}Gender_{2ij} + \beta_{03j}FRL_{3ij} + \beta_{04j}ELL_{4ij} + u_{0ij} \]

\[ \pi_{1ij} = \beta_{10j} + \beta_{11j}Hispanic_{1ij} + \beta_{12j}Gender_{2ij} + +\beta_{13j}FRL_{3ij} + \beta_{14j}ELL_{4ij} + u_{1ij} \]

More information on subscripts can be found in Appendix A.
Chapter Four

Results

Overview of Analyses

In order to understand and address the primary research questions regarding the mathematics achievement gap between Hispanic and White students, while considering other student-level factors (i.e., FRL, gender and ELL), a series of growth models were developed using 3-waves of SBA math scores as the dependent variable. Time was centered at 3rd grade (time = 0, 3rd grade). Preliminary analyses focused on understanding the mean math achievement by each student-level factor and the change in achievement annually. When taking into account additional student-level factors and their relationship in understanding math achievement from 3rd-5th grade, a correlation analysis was conducted with ethnicity, gender, Free and Reduced lunch status, ELL, and math achievement.

Model 1: Ethnicity & Math Achievement

In order to examine the ethnicity achievement gap over time from 3rd-5th grade, a 3-level multilevel growth model utilizing the nested structure of time (level-1) nested within students (level-2) nested within schools (level-3) was estimated conditioned on ethnicity. The magnitude of the achievement gap was examined by estimating the group differences in the initial level of achievement (intercepts) and group differences in the average change in achievement (slopes) in mathematics for Hispanic and White students across schools with a 3-level growth model (time nested within students nested within schools) and how this varied across elementary schools. This proposed model would have allowed the intercepts (initial level of achievement in 3rd grade) and slopes (average
change in SBA math scores) to vary across students, then allow the average intercepts, slopes differences in intercepts between Hispanic and White students, and the average differences in slopes between Hispanic and White student to vary across schools. Each of these 3-level models either failed to converge or produced out of bounds parameter estimates. Thus, a 2-level model was employed focusing on time nested within students estimating intercepts and slopes for Hispanic and White students as well as average slopes over time and how this looked at different elementary schools.

**Model 2: Controlling for Gender, Free & Reduced Lunch, ELL Status**

In an effort to understand if the student-level factors, gender, Free and Reduced Lunch eligibility, and English Language Learner status play a role in explaining the ethnicity achievement gap from 3rd-5th grade, a 3-level multilevel growth model utilizing the nested structure of time nested within students nested within schools was compared conditioned on ethnicity and the above student-level factors. Similar to the first model, the intercepts and slopes were allowed to vary across elementary schools using a 3-level growth model in order to understand the magnitude of the mathematics achievement gap while controlling for other student-level factors and whether the ethnicity gap still exists at different schools. Unfortunately, due to the same estimation issues from the first model, model convergence was not achieved, thus a 2-level model was conducted estimating the above student-level parameters and the interaction of time on the average mathematics score.

**Preliminary Analyses**

The large Southwestern Urban School district sample from 3rd-5th grade, is diverse with regard to student ethnicity. There are five ethnicity/racial groups that are
identified within this dataset, White, Black, Hispanic, Native American, and Asian. For the purpose of this study and analysis, only Hispanic and White students will be included as participants. Of the included participants, English Language Learners make up 17.9% of the total sample with 63% of the total sample qualifying for Free and Reduced Lunch. According to the most recent 2010 report from the large Southwestern Urban School district Research, Deployment and Accountability Office demographic report, this is a representative sample (RDA 2009-2010 Demographics). Below are the demographic summary for all 3rd graders in 2008.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Descriptive State-Standards-Based Assessment Scores in 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>M</td>
</tr>
<tr>
<td>Math SBA Scores</td>
<td>605.36</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>27.2</td>
</tr>
<tr>
<td>Black</td>
<td>2.8</td>
</tr>
<tr>
<td>Hispanic</td>
<td>62.7</td>
</tr>
<tr>
<td>Native</td>
<td>4.4</td>
</tr>
<tr>
<td>Asian</td>
<td>2.9</td>
</tr>
<tr>
<td>FRL</td>
<td>69.8</td>
</tr>
<tr>
<td>Non-FRL</td>
<td>30.2</td>
</tr>
<tr>
<td>ELL</td>
<td>23.9</td>
</tr>
<tr>
<td>Non-ELL</td>
<td>76.1</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>49.6</td>
</tr>
<tr>
<td>Males</td>
<td>50.4</td>
</tr>
</tbody>
</table>

Table 4 shows the means and standard deviations in mathematics by ethnicity, gender, Free and Reduced Lunch status, and English Language Learner status. Pearson correlations were used to examine whether there was a relationship among the student-level variables and between the student-level variables and math achievement. The results revealed that there was a significant relationship between FRL and Ethnicity; these two variables were strongly correlated, $r(5847) = .454, p < .001$, revealing that a statistically
significant larger proportion of Hispanic students qualify for Free and Reduced Lunch (81%) compared to White students (19%). ELL status was highly correlated with all student-level variables. Specifically, ELL status and identifying as part of a Hispanic group were significantly correlated, \( r(5847) = .36 \ p < .001 \), with more Hispanics being classified as English Language Learners (97%) compared to White students. A Pearson’s \( r \) correlation between ELL and Mathematics scores indicates that ELL students score significantly lower than their non-ELL peers, \( r(5847) = -.202, \ p < .001 \). FRL was also significantly correlated with ELL status, \( r(5847) = .339, \ p < .001 \), showing that students eligible for FRL were more likely to be classified as ELL.

Table 4
Correlations, means and standard deviations of model variables

<table>
<thead>
<tr>
<th>Measure</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Math SBA</td>
<td>5,847</td>
<td>605.36</td>
<td>36.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td>-.280**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1,401</td>
<td>648.82</td>
<td>41.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>3,728</td>
<td>625.24</td>
<td>39.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Gender</td>
<td></td>
<td>.007</td>
<td>.005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>2,555</td>
<td>633.19</td>
<td>41.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>2,574</td>
<td>630.93</td>
<td>41.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. FRL</td>
<td></td>
<td>-.347**</td>
<td>.454**</td>
<td>.009</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-FRL</td>
<td>1,812</td>
<td>652.06</td>
<td>40.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRL</td>
<td>3,317</td>
<td>623.42</td>
<td>38.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. ELL</td>
<td></td>
<td>-.202**</td>
<td>.355**</td>
<td>-.014</td>
<td>.339**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-ELL</td>
<td>4,472</td>
<td>635.89</td>
<td>41.47</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELL</td>
<td>657</td>
<td>619.90</td>
<td>39.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note *\( p < .05, **p < .01 \)

Model 1: Ethnicity

Initial attempts to estimate the full 3-level model with math scores nested within students, and students nested within schools were not successful. These models were run both in SPSS and R data analyses software. The models failed to converge and if they
did, the estimates were out of bounds and thus producing problematic results. Instead, a 2-level model eliminating the school-level nesting and focusing solely on the time nested within students resulted in no estimation errors. The limitation of the 2-level model is that it doesn’t examine school-to-school differences in the math achievement gap, thus separate 2-level models were run for all 90 elementary schools.

An two-level growth model was used to understand mathematics trajectories for individual students and to investigate initial achievement score and average rate of change in achievement between Hispanic and White students. Equation 1 represents the level-1 model,

\[ Math_{ti} = \pi_0i + \pi_1i Time_{ti} + e_{ti} \]

\( Math_{ti} \) represents the academic achievement (i.e., mathematics) based on the state-SBA scores of students at each test occasion or time, \( t \); \( \pi_0i \) represents initial academic achievement when time is equal to zero or in the 3rd grade. Time was coded as (3rd = 0, 4th = 1, 5th = 2). \( \pi_1i \) is the average rate of change or slope when there is one unit of change in time or from one grade to the next. \( e_{ti} \) is the residual for each student at each test occasion.

The level-2 model includes the average initial level of achievement and the mean growth across grades and includes the variable Hispanic as a predictor of the intercept and slope. The level-2 model represents the academic achievement growth in mathematics and how the factor of ethnicity may impact the initial level and change in achievement.

\[ Math \text{ Achievement} \]

\[ \pi_{0i} = \beta_{00} + \beta_{01} Hispanic_{i} + u_{0i} \]
\[ \pi_{1i} = \beta_{10} + \beta_{11}Hispanic_{1i} + u_{1i} \]

Reduced Form:
\[ Math = \beta_{00} + \beta_{01}Hispanic_{1i} + \beta_{10}Grade_{ti} + \beta_{11}Hispanic_{1i}Grade_{ti} + u_{1i}Grade_{ti} + u_{0i} + e_{ti} \]

\( \beta_{00} \) represents the initial average academic achievement state-SBA scores (i.e., mathematics) of 3rd graders who are White (2008); \( \beta_{10} \) represents the expected academic achievement growth from 3rd-5th grade for the White students; \( \beta_{01} \), represent the difference between the Hispanic and White groups on initial level of 3rd grade mathematics achievement. \( \beta_{11} \) represents the difference in slopes between the Hispanic and White groups.

Table 5 includes the fixed and random effects of the 2-level model using ethnicity (Hispanic vs White) and grade as predictors of mathematics achievement. The intercept and the slope for grade were allowed to vary across students. This means that initial levels of math achievement and the rate of increase in math achievement over time could differ across students. The first part of the table includes the fixed effects for the model. The first value shows the intercept, or the average 3rd grade level of mathematics achievement for 3rd graders in 2008 that are White. The second value in the fixed effects is the difference between White students’ initial level of math achievement and that for Hispanic students. On average, Hispanic 3rd graders in 2008 scored nearly half a standard deviation (14.83 points) below White students \( (p < .001) \). The level of change in achievement was 26.92 points per grade for White students from 3rd-5th grade. The statistically significant interaction between ethnicity and grade shows that Hispanic
students had a statistically slower growth rate compared to White students with an average of 25.74 points gained annually in math achievement scores ($p < .001$).

The intercept and slope variances are displayed in the bottom of Table 5, the variance of the initial level of, $\tau_{00}$, and the variance of the slopes, $\tau_{10}$, for math achievement were statistically significant ($p < .001$). In addition, when controlling for ethnicity, $\sigma^2_e$, is the level-1 residual variance in mathematics achievement from 3rd-5th grade. Together these represent the residual variance or unexplained variation in the initial level of and change in mathematics state-SBA math scores when controlling for ethnicity and grade. The level-1 residual variance, $\sigma^2_e$, in mathematics achievement by time is 518.41 and is statistically significant ($p < .001$).

Table 5

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept (White)</td>
<td>616.74</td>
<td>.85</td>
<td>728.1</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Hispanic</td>
<td>-14.84</td>
<td>1.03</td>
<td>-14.4</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Slope (White)</td>
<td>26.92</td>
<td>.43</td>
<td>62.9</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Time × Hispanic</td>
<td>-1.18</td>
<td>.52</td>
<td>-2.3</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma^2_e$</td>
<td>518.41</td>
<td>22.77</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>$\tau_{00}$ (intercept)</td>
<td>1269.03</td>
<td>35.63</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>$\tau_{10}$ (slope)</td>
<td>43.08</td>
<td>6.564</td>
<td>&lt; .001</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Linear time centered at 0, grade 3 = 0; $B =$ regression coefficient; $SE =$ standard error of regression coefficient; $t =$ t statistic.

Figure 4 below represents the mathematics achievement gap between Hispanic and White students, with Hispanic students having a lower level of achievement than White students beginning in 3rd grade. Hispanic students are making significantly slower gains in mathematics from year to year averaging an annual increase of 25.74 points compared to the annual increase for White of 26.92 points. This compounds the lower initial level of
achieved for Hispanic students, the gap is actually increasing instead of closing. Hispanic students are at a large disadvantage as their initial rate of math achievement is 14.84 points below White students. At the current rate of growth, it will take Hispanic students 15 years to catch up if they can grow one point more per year, but currently the gap closing does not look promising.

Figure 4. Math Achievement of 3rd Graders 2008-2010 Conditioned on Ethnicity

![Mathematics Achievement Gap](image)

To explore initial levels and change in math achievement and ethnicity between Hispanic and White students across schools, separate 2-level growth models were estimated for each of the 90 schools. The parameters from the 90 schools were compiled and descriptive analyses were run in order to examine the school-to-school differences. In order to determine the magnitude of the achievement gap between Hispanic and White students and how this varied across the different elementary school the intercepts and
slopes for Hispanic and White students were estimated at each school. The following model was used to estimate parameters for each of the 90 elementary schools.

Reduced Form:

\[
Math = \beta_{00} + \beta_{01} \text{Hispanic}_{1i} + \beta_{10} \text{Grade}_{ti} + \beta_{11} \text{Hispanic}_{1i} \text{Grade}_{ti} + u_{1i} \text{Grade}_{ti} + u_{0i} + e_{ti}
\]

The average intercepts and slopes in mathematics between Hispanic and White students were estimated across schools using the above model. Of the 90 elementary schools, Hispanics on average scored 7 points lower on the SBA math assessment and have a slightly slower growth rate over time. School context seems to play a role in the magnitude of the mathematics achievement gap. Table 7 notes the average achievement gap as a factor of ethnicity.

Table 6
School-to-School Math Achievement Gap

<table>
<thead>
<tr>
<th>School</th>
<th>Average Intercept (White)</th>
<th>Average Slope (White)</th>
<th>Average Gap Hispanic</th>
<th>Average Slope Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 90</td>
<td>609.75</td>
<td>26.70</td>
<td>602.36</td>
<td>25.97</td>
</tr>
</tbody>
</table>

In order to investigate the school-to-school differences further, a random sample of 4 of the 90 schools were analyzed on the magnitude of the gap. Sources for school level demographics for these 4 schools can be found in Appendix B. The parameter estimates from the 2-level models run for these 4 schools were used to compute the different levels of achievement from 3rd-5th grade in math achievement.

Table 7
School-to-School Differences in Math Achievement

<table>
<thead>
<tr>
<th>School</th>
<th>Intercept (White)</th>
<th>Slope (White)</th>
<th>Hispanic</th>
<th>Wave × Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>601.62</td>
<td>28.11</td>
<td>-12.77</td>
<td>2.15</td>
</tr>
<tr>
<td>2</td>
<td>608.88</td>
<td>31.84</td>
<td>-18.36</td>
<td>-0.79</td>
</tr>
<tr>
<td>3</td>
<td>571.64</td>
<td>31.30</td>
<td>-24.39</td>
<td>4.92</td>
</tr>
<tr>
<td>4</td>
<td>605.90</td>
<td>14.89</td>
<td>10.00</td>
<td>-4.18</td>
</tr>
</tbody>
</table>
Figure 5 indicates that the mathematics achievement gap can remain constant from 3rd-5th grade, decrease, or increase depending on the school. The y-axis below is the difference between Hispanic and White students on mathematics assessment scores.

*Figure 5. Magnitude of Mathematics Achievement Gap by Ethnicity*

[Graph showing mathematics achievement gap by grade and school for 3-5 grades.]

Mathematics achievement between Hispanic and White students can vary at different schools. The magnitude of the math achievement gap varies across schools, with Hispanic students typically scoring below White students. In some schools, the ethnicity gap closes, but in others it may remain consistent across time. The following figures indicated the Ethnicity gap at the 4 of the 90 elementary schools analyzed.
Figure 6. Mathematics Achievement Gaps By School 1

Sch_1 School-To-School Math Achievement
Hispanic and White Students

Figure 7. Mathematics Achievement Gaps By School 2

Sch_2 School-To-School Math Achievement
Hispanic and White Students
Figure 8. Mathematics Achievement Gaps By School 3

Figure 9. Mathematics Achievement Gaps By School 4
Figure 6 indicates a consistent math achievement gap from 3rd-5th grade with Hispanic students scoring 13 points below White students, but with Hispanic students growing slightly faster every year with a 2 point advantage in annual growth showing promise in closing the gap at School 1. Figure 7 illustrates a widening of the math achievement gap from 3rd-5th grade with Hispanic students scoring 18 points below White students beginning in 3rd grade and Hispanic students growing slightly slower than White students at School 2. Figure 8 shows an achievement gap in which Hispanic students are scoring 20 points below White students in 3rd grade on math scores, but with Hispanic students growing slightly faster at School 3. Although, Hispanic students are growing faster from 3rd-5th grade, it does not appear that they catch up to their White peers by 5th grade and thus the achievement gap does not close at this school. Figure 9 again illustrates a scenario where Hispanic students are scoring 10 points higher on SBA math scores than White students, but with a slower growth rate over time at School 4. What is noted from this school is that White students are able to catch up to their Hispanic peers by 5th grade because there are growing by 4 more points per year.

Model 2: Ethnicity, Gender, FRL & ELL

Similar to Model 1, there were convergence issues with the proposed 3-level model as out of bound parameter estimates occurred. The third level of nesting was therefore excluded from this model and only time nested within students was included. An two-level growth model was used to understand mathematics trajectories for individual students and to investigate initial achievement scores and average rate of change in achievement between Hispanic and White students. Equation 1 represents the level-1 model,
Math\textsubscript{ti} = \pi_{0i} + \pi_{1i} Time\textsubscript{ti} + e_{ti}

Math\textsubscript{ti} represents the academic achievement (i.e., mathematics) of the state-SBA scores of students at each test occasion or time, \( t \). \( \pi_{0i} \) represents initial academic achievement when time is equal to zero or in the 3\textsuperscript{rd} grade, time will be coded as (3\textsuperscript{rd} = 0, 4\textsuperscript{th} = 1, 5\textsuperscript{th} = 2). \( \pi_{1i} \) is the average rate of change or slope when there is one unit of change in time or from one grade to the next. \( e_{ti} \) is the residual term for each student at each test occasion.

The level-2 model represents the average growth in mathematics based off initial level of achievement and the mean growth across and how this may change when students identify in a Hispanic group. The level-2 model represents the academic achievement growth in mathematics and how the factor of ethnicity may impact the initial level and change in achievement.

**Math Achievement**

\[
\begin{align*}
\pi_{0i} &= \beta_{00} + \beta_{01} Hispanic_{1i} + \beta_{02} FRL_{2i} + \beta_{03} ELL_{3i} + \beta_{04} Gender_{4i} + u_{0i} \\
\pi_{1i} &= \beta_{10} + \beta_{11} Hispanic_{1i} + \beta_{12} FRL_{2i} + \beta_{13} ELL_{3i} + \beta_{14} Gender_{4i} + u_{1i}
\end{align*}
\]

Reduced Form:

Math\textsubscript{ti}

\[
= \beta_{00} + \beta_{01} Hispanic_{1i} + \beta_{02} FRL_{2i} + \beta_{03} ELL_{3i} + \beta_{04} Gender_{4i} \\
+ \beta_{10} Grade_{ti} + \beta_{11} Hispanic_{1i} Grade_{ti} + \beta_{12} FRL_{2i} Grade_{ti} + \beta_{13} ELL_{3i} Grade_{ti} \\
+ \beta_{14} Gender_{4i} Grade_{ti} + u_{1i} Grade_{ti} + u_{0i} + e_{ti}
\]

\( \beta_{00} \) represents the initial average academic achievement state-SBA scores (i.e., mathematics) of 3\textsuperscript{rd} graders who are White (2008); \( \beta_{10} \) represents the expected academic achievement growth from 3\textsuperscript{rd}-5\textsuperscript{th} grade for the White students; \( \beta_{01}, \beta_{02}, \beta_{03}, \beta_{04} \) represent the initial level of 3\textsuperscript{rd} grade mathematics achievement as a factor of identifying in a
Hispanic group, gender, Free and Reduced Lunch and English Language Learner status compared to students not in those groups, $\beta_{11}, \beta_{12}, \beta_{13}, \beta_{14}$ represents the expected change in mean academic achievement growth across time by as a factor of being in a Hispanic group gender, Free and Reduced Lunch and English Language Learner status compared to students not in those groups. In comparing math achievement between Hispanic and White students using the estimated parameters in reference to the mean and standard deviation, ($M = 605.36$, $SD = 36.25$), Hispanic students’ initial level of achievement in 3rd grade is below the mean. When controlling for gender, eligibility for Free and Reduced Lunch, and English Language Learner status, the initial difference in achievement between Hispanic and White students decreased from a 14.84 points to 9.94 points differential in mathematics in 3rd grade. The initial level of achievement differential between Hispanic and White students is still statistically significant even when controlling for the other student factors, ($p < .001$).

Table 8 includes the fixed and random effects of the 2-level model controlling for gender, FRL and ELL as predictors of mathematics achievement above and beyond ethnicity. The intercept represents the expected level of 3rd grade math achievement for a student who is White, male, and not eligible for Free or Reduced Lunch or English Language Learner status. The slope parameter estimate describes the expected yearly change in math achievement for this student, which is 26.73 points per year. Gender describes how females will score differently than males in 3rd grade, this difference is not statistically significant. Females, however, grow slightly faster than males averaging 1.55 points per year ($p < .001$). Free and Reduced Lunch (FRL) describes average math achievement for students enrolled in FRL will differ from non-FRL students in the 3rd
grade, showing that these students on average begin 11.91 points below their non-FRL peers and growing slower at 24.65 per year ($p < .001$). English Language Learner (ELL) describes how average math achievement for students receiving ELL services differs from that for non-ELL students in 3rd grade scoring 6.61 points below their non-ELL peers and growing at 24.03 point per year, which is 2.70 points less ($p < .001$). When controlling for gender, FRL and ELL, the time by Hispanic interaction describes how the rate of change in math achievement will differ between White and Hispanic students, with Hispanic students growing at the same rate at White students.

The level-2 variances are displayed in the bottom of Table 5 similar to Model 1, which are the unexplained variance after controlling for the above student-level factors. The intercept variance, $\tau_{00}$, represents residual variation in initial levels of math achievement after controlling for gender, FRL, and ELL. The slope variance, $\tau_{10}$, represents residual variance in individuals’ rates of change in math achievement after controlling for the effects of gender, FRL, and ELL. The level-1 residual variance, $\sigma_e^2$ represents variation in math scores not accounted for by grade, gender, FRL, or ELL.
Table 8  
*Controlling for Gender, FRL, ELL-Model 2 for state-SBA Math Scores*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept (White)</td>
<td>622.50</td>
<td>1.05</td>
<td>593.4</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Hispanic</td>
<td>-9.94</td>
<td>1.15</td>
<td>-8.7</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Gender (Female)</td>
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<td>1.05</td>
<td>0.0</td>
<td>n.s.</td>
</tr>
<tr>
<td>FRL</td>
<td>-11.91</td>
<td>1.06</td>
<td>-11.3</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>ELL</td>
<td>-6.61</td>
<td>1.20</td>
<td>-5.5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Slope (White)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time × Hispanic</td>
<td>26.73</td>
<td>.52</td>
<td>51.7</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Time × Gender</td>
<td>-0.04</td>
<td>.60</td>
<td>-0.1</td>
<td>n.s.</td>
</tr>
<tr>
<td>Time × FRL</td>
<td>1.55</td>
<td>.48</td>
<td>3.2</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Time × ELL</td>
<td>-2.08</td>
<td>.58</td>
<td>-3.6</td>
<td>&lt; .001</td>
</tr>
<tr>
<td></td>
<td>-2.70</td>
<td>.71</td>
<td>-3.8</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

|                  | Estimate | SE  | p     |
| **Random Effects**|          |     |       |
| $\sigma_{e}^2$   | 528.60   | 22.99 | < .001 |
| $\tau_{00}$ (intercept) | 1189.34 | 34.49 | < .001 |
| $\tau_{10}$ (slope)    | 41.69   | 6.46  | < .001 |

*Note.* Linear time centered at 0, grade 3 = 0; B = regression coefficient; SE = standard error of regression coefficient; t = t statistic, z = Wald, z statistic; 95% CI = 95% confidence interval.

*Figure 10.* Math Achievement of 3rd Graders 2008-2010 Other Student-Level Factors
Figure 10 shows that the mathematics achievement gap from 2008-2010 between Hispanic and White. When controlling for the above student-level factors, Hispanic students make similar gains in mathematics from year to year, however the lower initial level of achievement for Hispanic students means that these students will not close the achievement gap. While controlling for all other student-level factors, it is noted that qualifying for Free and Reduced Lunch and English Language Learner status negatively impacts mathematics growth for both White and Hispanic students. Because the effects are additive, these are added to the negative impact of identifying as a Hispanic student. Overall, the ethnic achievement gap lessens when controlling for gender, FRL and ELL status, but still exists in mathematics beginning in 3rd grade.

The average intercepts and slopes in mathematics between Hispanic and White students while taking into account gender, FRL and ELL are listed below. Of the 90 elementary schools, Hispanics on average scored 6.22 points lower in math and had similar growth rates overtime. The gender gap indicates that females tend to grow at a slightly faster rate than males in elementary school. Students who qualify for FRL score an average of 6.92 points less than non-FRL students in the 3rd grade. With ELL students scoring an average of 4 points less than non-ELL students in 3rd grade across schools. Table 9 notes the average achievement gap as a factor of ethnicity, gender, FRL, and ELL status.
Table 9

*School-to-School Math Achievement Gap-Other Student Factors*

<table>
<thead>
<tr>
<th>School Average</th>
<th>N = 90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept (White)</td>
<td>616.72</td>
</tr>
<tr>
<td>Slope (White)</td>
<td>25.13</td>
</tr>
<tr>
<td>Hispanic Gap</td>
<td>610.50</td>
</tr>
<tr>
<td>Hispanic Slope</td>
<td>25.47</td>
</tr>
<tr>
<td>Gender Gap</td>
<td>615.77</td>
</tr>
<tr>
<td>Gender Slope</td>
<td>27.46</td>
</tr>
<tr>
<td>FRL Gap</td>
<td>609.78</td>
</tr>
<tr>
<td>FRL Slope</td>
<td>24.27</td>
</tr>
<tr>
<td>ELL Gap</td>
<td>612.71</td>
</tr>
<tr>
<td>ELL Slope</td>
<td>23.26</td>
</tr>
</tbody>
</table>

In order to investigate the school-to-school differences further, a sample of 4 of the 90 schools were analyzed on the magnitude of the gap. The parameter estimates from the 2-level models run for these 4 schools were used to compute the different levels of achievement from 3rd-5th grade in math achievement and Table 10 lists the parameter estimates for Hispanic and White students controlling for gender, FRL and ELL. After controlling for these student-level factors, there is still a large ethnicity gap between Hispanic and White students across elementary schools.

Table 10

*School-to-School Differences in Math Achievement-Other Student Factors*

<table>
<thead>
<tr>
<th>School Average N = 90</th>
<th>School 1</th>
<th>School 2</th>
<th>School 3</th>
<th>School 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept (White)</td>
<td>605.33</td>
<td>613.37</td>
<td>636.91</td>
<td>582.78</td>
</tr>
<tr>
<td>Slope (White)</td>
<td>30.87</td>
<td>31.33</td>
<td>20.75</td>
<td>20.07</td>
</tr>
<tr>
<td>Hispanic Gap</td>
<td>-14.29</td>
<td>-14.84</td>
<td>-5.78</td>
<td>17.65</td>
</tr>
<tr>
<td>Hispanic Slope</td>
<td>3.53</td>
<td>-0.60</td>
<td>2.95</td>
<td>-2.77</td>
</tr>
<tr>
<td>Gender Gap</td>
<td>-1.47</td>
<td>-1.21</td>
<td>-4.35</td>
<td>1.47</td>
</tr>
<tr>
<td>Gender Slope</td>
<td>-2.61</td>
<td>2.16</td>
<td>1.74</td>
<td>6.27</td>
</tr>
<tr>
<td>FRL Gap</td>
<td>-1.64</td>
<td>-10.76</td>
<td>-16.84</td>
<td>18.84</td>
</tr>
<tr>
<td>FRL Slope</td>
<td>-3.04</td>
<td>-2.20</td>
<td>-2.39</td>
<td>-11.81</td>
</tr>
<tr>
<td>ELL Gap</td>
<td>-9.76</td>
<td>-7.28</td>
<td>-14.01</td>
<td>-0.78</td>
</tr>
<tr>
<td>ELL Slope</td>
<td>1.61</td>
<td>7.64</td>
<td>2.86</td>
<td>-4.42</td>
</tr>
</tbody>
</table>
Figure 11 indicates that the mathematics achievement gap across schools when controlling for gender, FRL and ELL. The y-axis below is the difference between Hispanic and White students on mathematics assessment scores after controlling for these student-level factors. The magnitude of the achievement gap between Hispanic and White students varies across schools even when taking into account additional student-level factors that could help explain the variance in mathematics scores.

*Figure 11. Magnitude of Mathematics Achievement Gap by Other Student Factors*

The magnitude of the achievement gap between Hispanic and White students varies at different schools, with some schools doing better than others in closing the historic achievement gap. The following figures illustrate the Ethnicity gap while controlling for gender, FRL and ELL at 4 of the 90 elementary schools analyzed.
Figure 12. Mathematics Achievement Gaps By School 1

![Figure 12. Mathematics Achievement Gaps By School 1](image1.png)

Figure 13. Mathematics Achievement Gaps By School 2

![Figure 13. Mathematics Achievement Gaps By School 2](image2.png)
Figure 14. Mathematics Achievement Gaps By School 3

Figure 15. Mathematics Achievement Gaps By School 4
Figure 12 indicates a math achievement gap from 3rd-5th grade with Hispanic students scoring 14 points below White students and Hispanic students in 3rd grade and growing slightly faster every year with a 4 point advantage in annual growth showing promise in closing the gap at school 1. Figure 13 displays a consistent math achievement gap that is slightly increasing between Hispanic and White students as Hispanic students are making slower gains. Figure 14 shows a school in which the ethnic gap is small and actually closes by 5th grade due to the faster gains that Hispanic students are making in math. The math achievement gap at School 4 illustrated by Figure 15 shows an ethnic gap in which White students are scoring lower on mathematics than Hispanic students. Although the initial level of achievement is lower for White students, they are growing at a slightly faster rate from 3rd-5th grade.
Chapter Five

Discussion

Study Overview

The main goal of this study was to understand the mathematics achievement gap between Hispanic and White students over time by taking into account multiple years of observed data. In addition, since other student-level factors such as gender, Free and Reduced Lunch, and English Language Learner status have been found to be highly correlated with ethnicity, these were taken into account at the student level and controlled for in order to understand any observed differences overtime (D'Agostino et al., 1998; Dillon, 2009). A series of growth curve models was used to address the research questions and examine the initial level of, and change in, math achievement between White and Hispanic students within schools and across schools, while taking into account other student level factors to discover if an ethnicity gap still exists.

Achievement Gap

The first research question addressed the ethnicity gap between Hispanic and White students on math scores within and across schools. This question was addressed using a series of growth models to understand math achievement by estimating initial level of and change in achievement of White students and then estimating how these can change as a factor of ethnicity. Results of this study found support that an ethnicity gap in mathematics standards-based assessment scores in 3rd grade exists with White students scoring 14.84 points above Hispanic students. Further results indicated that Hispanic students actually grow at a slower rate in mathematics from 3rd-5th grade. Currently, at this initial rate of mathematics achievement and the slower growth rate, Hispanic students
will not catch up to their White peers and the gap is widening instead of closing over

time. When examining the initial level and change in achievement between Hispanic and
White students across schools, results showed that the gap is not the same across schools.
In some cases the gap between Hispanic and White students actually closed and in other
schools it remained consistent or widened.

The second research question was concerned with understanding if the
achievement gap between Hispanic and White students changed as a result of taking into
account other student-level factors such as gender, Free and Reduced Lunch, and English
Language Learner status and how this gap varied across different elementary schools.
Results found that when accounting for gender, Free and Reduced Lunch, and English
Language Learner status, these characteristics partially explained the math achievement
disparities between Hispanic and White students, however an ethnicity gap still exists
even when controlling for these student-level factors. The ethnic differences in math
achievement between Hispanic and White students varied across different schools and
similar to the ethnicity only model, these gaps were of different magnitudes across
schools.

These results are consistent with research that has found that Hispanic students’
initial level of achievement is far behind that of their White peers (Zurawsky, 2004). to
the results also support the idea that it would be impossible for Hispanic students to catch
up to their White peers unless they grow at faster rate in math scores per year. Students
who qualify for Free and Reduced Lunch and as English Language Learners had an
added negative deficit as their math scores are far below their non-Free and Reduced
Lunch and non-English Language Learner peers. In addition to ethnicity, these student-
level characteristics may pose an extra hardship for both Hispanic and White students in regards to math achievement. The above results supported the use of growth models in understanding math achievement across time and by student-level factors overtime. In addition, growth models are robust enough to allow the examination of the achievement gap across 90 of the elementary schools within the study. These results provide information about math achievement overtime as well as how school context and student-level factors can help explain ethnic achievement gaps. Further expanding on Dillon (2009), the emphasis of new educational policy needs to be written with a focus to first understand achievement gaps with more precision through attempting to understand the achievement gap before identifying ways to address the issues is critical. It is important to understand initial math achievement and how this changes overtime before successful interventions can be implemented.

**Implications for Education**

This methodological exploration of utilizing individual growth models to analyze achievement disparities can provide summative information to researchers and policy makers to better understand achievement gaps and allow current research to provide evidence about student-level math achievement and how this can vary across time and schools accounting for the complexities of data nesting structure (Hox, 2002). With the current state of the high-stakes accountability movement and the inconsistency in how individual states report AYP and achievement data, it makes it difficult to find solutions to address the historic mathematics achievement gap if researchers do not understand the gap overtime. The initial charge of the NCLB legislation was to close the achievement gap especially for disadvantaged students (Overview NCLB: Executive Summary, 2002).
Due to the inconsistencies and variation in measuring achievement in the K-12 school system, it often becomes difficult for educational policy makers to address the achievement gap (Dillon, 2009). Although, still an empirical question, the results from the current study provide evidence that the historic math achievement gap has not closed for Hispanic students and those who qualify for Free and Reduced Lunch and English Language Learner status. In proficiency models, growth and initial levels of achievement are unable to be captured and thus cannot provide educational policy makers with an accurate picture of the achievement gap, however growth models used within this analysis allow for researchers to account for multiple student and school-level predictors across time (Ho, Furgol & National Opinion Research Center, 2011).

**Limitations**

The standardized test scores utilized within this study are the only unit of measurement and proxy for math achievement. Using multilevel growth models when understanding achievement gaps may only explain some of the variance in achievement, and much more research is needed in this area. However, this is a first step in utilizing such data and hopefully future research can utilize similar models to understand the academic achievement gap issues taking into account time and individual student data.

This study used de-identified data from the large Southwestern Urban School District to mask any school or student identifying information. The main goal of this research was to seek understanding of the achievement gap between Hispanic and White students, and thus identifying student and school information was not relevant. It is highly recommended that when using these type of growth models for educational interventions, researchers should use identifying information to address any policy
implications. This study was intended to provide an illustration of utilizing such models and the value of understanding mathematics achievement overtime.

Due to the convergence issues of the 3-level model, a 2-level modeled was employed to answer and address the two primary study research questions. School-level variables have been found in prior research to be stronger indicators of achievement, thus making school contextual factors critical (Bryk and Raudenbush, 1988). However, because of the complexities of the number of parameters to be estimated when including the level-3, the level-2 parameters were only estimated in order to achieve model convergence. When not including a nesting level, regression coefficients and variances may be biased, thus leading to incorrect research conclusions, which is a major limitation of not including the school-level nesting within this research study (Moerbeek, 2004; Van Landeghem, De Fraine & Van Damme, 2005; Opdenakker & Van Damme, 2000).

When using vertical scales such as the SBA to understand academic achievement over time, caution should be used in determining if results from one year to the next are comparable since each state-SBA is vertically scaled over multiple developmental time frames and although mathematics in 3rd grade is linked to 5th grade, the content in each of these grades is not always comparable (Martineau, 2006). Results from these scales make it hard to extract meaningful results, however they allow researchers to look at achievement trends overtime using one continuous variable. Such vertical scales also work off the premise that there exists universality of developmental traits from one grade level to the next (Schafer, 2006).
Implications for Future Research

An important issue when understanding student growth overtime is to focus on longer periods of time to be included within growth models to understand if change is linear or non-linear. Another non-linear issue arises when students transition from one school to another; key transition points in a student’s educational journey. Students throughout formal schooling within the United States vary in their path not only through elementary school, but the transition through middle school. Students may attend a neighborhood school and then go to the feeder middle school or others may be bussed or transferred to a higher performing school if the students’ home school is not performing at the state’s adequate level. Regardless of the individual educational path, these are critical points in cognitive development and the necessity of appropriate curriculum to allow students to grow academically especially low-income and students of color is important to understand (Zurawsky, 2004). The paths of transition and transfer contextually impact and may tell a story about student achievement over time.

Modeling this contextual impact is of prime importance when attempting to understand these transition points. The above study only examined math achievement from 3rd-5th grade and did not tackle this phenomena. However, growth models may be sensitive to academic student growth over time, but unless certain parameters are set within the model to account for the variation at different school level variables within the same student, this can create noise within the model (Goldstein, 1997; Ma, 2005). When studying transitions from elementary to middle school, growth curve models allow for models of change in academic and cognitive growth through accounting for contextual changes. In typical growth models, test scores are associated with one school or context
and the movement and mobility of that student’s path in achievement is restricted to one context and thus the effects of different schools and its impact on test scores is ignored (Goldstein, Burgess & McConnell, 2007; Ma, 2005). By taking into account this shift in schools and not restricting test scores to a single context through the use of cross-classified modeling, researchers may be able to draw valid conclusions about the effects of school and contextual factors (Ai, 2002; Boyle & Willms, 2001). These critical time points in cognitive development and a student’s academic achievement journey can be modeled through the specification of the growth model. Further research on mathematics achievement gaps could utilize such modeling to understand this progression of students over time as well as across multiple school contexts.

Growth models not only allow the advantage of researchers to be able to model change over time and the change from one context to the next (e.g., level-3 variables), but a parameter can be set within the model that allows for a specific period of time to be modeled and visualized using a spline model (Pan & Goldstein, 1998). The beauty of growth models is the level of sophistication that can be used to model real-world phenomena. A cross-classified model allows researchers to model the change in the school level variable over time (i.e., elementary through middle school) and understand these unique relationships. A spline model allows one to understand how the achievement gap functions from 3rd-5th grade or in elementary school and how this compares to the gap from 6th-5th grade or in middle school. The gap from 5th-6th grade can be included to observe how this disparity may be different at varying schools and for different types of students. These unique transitions can be useful in understanding specific time points that may impact achievement and observing achievement gaps over
time is feasible using growth models that specify cross-classification and a spline model (Goldstein, Browne & Rasbash, 2004; Pan & Goldstein, 1998). Achievement gap research using growth models can understand these unique transition and critical points in the educational pathway for students.

Linear growth models have been utilized for understanding the complexity of nesting especially in regards to student-level and school-level variables, while non-linear growth models such as spline models provide a context for illustrating curvilinear growth over time in academic achievement (Shin, 2012). When discussing and understanding academic achievement gaps and the developmental growth in standards-based assessment scores, not all real world data is linear and may in fact have a non-linear trajectory. Although polynomial trends in growth can model the non-linearity of growth over time from 3rd-5th grade, they are unable to look at the quadratic trends from specific time points within these developmental years unless analyzed separately (Snijders & Bosker, 2011), thus spline models allow researchers to create nodes, taking a specific time point within the analysis and observing unique growth trends and changes in slope. Spline growth models have a non-linear function of time, which allows for modeling quadratic trends from 3rd-5th grade and from 6th-5th grade, creating a parameter for the transition from elementary to middle school (Golstein, 1997; Sniders & Bosker, 2011) in order to understand and illustrate the trends in academic achievement at critical developmental time points.

**Conclusion: Mirando Hacia el Futuro**

Evidence from this research indicates the importance of context and its relationship with the achievement gap. Current evidence points to the difference in math
achievement between Hispanic and White students and how this varies at different schools. There is something taking place within the school context that is impacting the math achievement gap between Hispanic and White students. In select schools, the achievement gap widens, in other schools it narrows, or it may not exist to the extent that is seen at the district and aggregate level. Social constructivist theory would indicate that the math achievement gap is different across schools because students internalize knowledge based on their specific learning contexts, thus making the school context a critical factor for student learning (González et. al., 2001). The schools in which Hispanic students are doing just as well or better than their White peers indicates something may be taking place at these specific schools to address and impact historic math achievement gaps. An in depth analysis of these specific school contexts regarding educational practices and curriculum would be beneficial to better understand these as best practices for impacting math achievement for Hispanic students at other elementary schools. Unfortunately, since the schools within this student are de-identified it is not possible to identify these schools for further investigation.

Educational practices that address the achievement gap should be developed that focus on the support to Hispanic families and communities instead of just on the students themselves due to the critical influence of school context on learning. When families and communities are involved in the education of their youth, Hispanic and low-income students fare better (Moll & Ruiz, 2002) over time on achievement gains. Currently, Hispanic, low-income, and ELL students score far below their peers on mathematics standards-based assessments in 3rd grade. However, as seen within this study, in some schools Hispanic students do better than their White peers or the achievement gap from
3rd-5th grade is closed. It may be the case that these schools have developed effective practices for addressing the achievement gap at the school and community level. A lot of pressure is placed on students to make mathematics gains during elementary school, but in order for students to construct mathematics knowledge, the context is of critical importance during development and formal schooling.

Not all students prior to, or during, formal schooling have exposure to equitable contexts that foster mathematics knowledge. In order to ensure that all students are provided equitable opportunities, the investment in early childhood education prior to formal schooling for at risk youth has noted positive outcomes with a reduction in the achievement gap (Heckman, 2011). Thus, schools, educational stakeholders, parents and community need to work collaboratively to develop interventions that are more holistic to address the achievement gap at schools where the historic achievement gap between Hispanic and White students exists. There are many factors not accounted for within this study that may affect math achievement, such as parental education and cultural resources, but these may play an integral role in understanding and addressing achievement gaps. More cultural resources could be integrated into the curriculum early in education to provide the tools and resources to Hispanic students in order to ensure they are constructing mathematics knowledge early in their educational journey (González, Andrade, Civil & Moll, 2001). Future research should focus on cultural capital and parental education as possible factors that may impact math achievement. The dataset for this study did not include these specific variables.

With the changing educational policy in how to measure standards-based assessment scores and accountability, more time and energy needs to be spent on
understanding the way students are learning before interventions that can appropriately address the achievement gap can be successfully implemented (Swenson, 2013; Trent, 2013). Innovation needs to be used when understanding achievement gaps between Hispanic and White students. This study was designed to examine the math achievement gap between Hispanic and White students to understand if ethnicity is a critical factor in explaining the variance in the observed differences in standards-based assessment scores from 3rd-5th grade while controlling for other student-level factors. It was found that even after controlling for gender, eligibility for Free and Reduced Lunch, and English Language Learner status, there was still a gap between Hispanic and White students in mathematics in 3rd grade, with Hispanic students scoring lower than their White peers on test scores. However, the annual mathematics gains were similar for Hispanic and White students, thus the gap in mathematics remains the same through 5th grade. This study found that the math achievement gap between Hispanic and White students looked different across elementary schools indicating the possible importance of school context influencing the gap. This study has important educational implications in why utilizing student information over multiple periods of time is critical in determining how to ‘mirando hacia el futuro’ in understanding and measuring the achievement gap. Future research needs to understand the achievement gap with more precision through more complex statistical growth models overtime as a primary step before culturally and evidence-based interventions can be applied to addressing the achievement gap.
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### Appendix A: Multilevel Equation Subscript Definitions

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<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y(\text{achievement})_{tij}$</td>
<td>Observed dependent variable for time (level-1) $t$, measured for student (level-2) $i$, at each school (level-3) $j$, time is defined as: (3rd = time 0, 4th = time 1, 5th = time 2, 6th = time 3, etc.)</td>
</tr>
<tr>
<td>$\pi_{0ij}$</td>
<td>Intercept; initial level of achievement of SBA score at the first wave or initial level of measurement, time = 0 or 3rd grade, for student $i$, at school $j$.</td>
</tr>
<tr>
<td>$\pi_{1ij}$</td>
<td>Slope; the average change for each student from time = 0 to time =1, etc., $i$, at school $j$.</td>
</tr>
<tr>
<td>$e_{tij}$</td>
<td>Individual level variance among students $i$ at school $j$.</td>
</tr>
<tr>
<td>$\beta_{00j}$</td>
<td>Intercept for academic achievement for student $i$, at school $j$.</td>
</tr>
<tr>
<td>$\beta_{01X1j}$</td>
<td>Value of the intercept conditioned on the predictor for level-2 unit, student $i$, at school $j$.</td>
</tr>
<tr>
<td>$\beta_{10j}$</td>
<td>Slope for academic achievement for student $i$, at school $j$.</td>
</tr>
<tr>
<td>$\beta_{11X1j}$</td>
<td>Slope; change in achievement that is conditional on predictor for level-2 unit, student $i$, at school $j$.</td>
</tr>
<tr>
<td>$u_{0ij}$</td>
<td>Variation in initial math achievement status among students at school $j$</td>
</tr>
<tr>
<td>$u_{1ij}$</td>
<td>Variation in change in math achievement status among students at school $j$</td>
</tr>
<tr>
<td>$\gamma_{000j}$</td>
<td>Grand mean for initial academic achievement status at schools</td>
</tr>
<tr>
<td>$\gamma_{100j}$</td>
<td>Grand mean for academic achievement growth rate at schools</td>
</tr>
<tr>
<td>$\tau_{00j}$</td>
<td>Variation in initial math achievement status across schools</td>
</tr>
<tr>
<td>$\tau_{10j}$</td>
<td>Variation in change in math achievement status across schools</td>
</tr>
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</table>
Appendix B: School Level Demographics

<table>
<thead>
<tr>
<th>School Level Demographics</th>
<th>School 1</th>
<th>School 2</th>
<th>School 3</th>
<th>School 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>24.4</td>
<td>52.5</td>
<td>3.7</td>
<td>6.1</td>
</tr>
<tr>
<td>Hispanic</td>
<td>75.6</td>
<td>47.5</td>
<td>96.3</td>
<td>93.9</td>
</tr>
<tr>
<td>Non FRL</td>
<td>24.4</td>
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