

THE EFFECTS OF NINTH GRADE SMALL LEARNING COMMUNITIES ON
AT-RISK STUDENTS IN SCIENCE AND MATHEMATICS

by

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DEDICATION

This record of study is dedicated to all the strong women in my life. You gave me courage when I needed it, made me laugh when I wasn't sure whether to laugh or cry, and helped me see that the impossible is possible. Thank you for always being there when I needed you.

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ABSTRACT

The purpose of this research was to investigate the relationship of small learning communities with a ninth grade academy (SLCNGA) and student achievement of at-risk students over time on the science and mathematics Texas Assessment of Knowledge and Skills (TAKS) test in large suburban school districts. Research included data for school years 2003-2004 through 2009-2010 retrieved from the Texas Education Agency (TEA).

This study used a Hierarchical Linear Model along with a cross-validation analysis to investigate, analyze, and examine the TAKS data in science and mathematics.

Data from this study revealed an insignificant difference in science TAKS scores for students who attended an SLCNGA compared to those who did not attend a SLCNGA. However, it did find a statically significant difference in the covariates (sex, at-risk, and ethnicity) used in the study.

Data from this study also revealed a significant difference in mathematics TAKS scores for students who attended an SLCNGA compared to those who did not attend a SLCNGA. Furthermore, it did find a statically significant difference in the covariates (sex, at-risk, and ethnicity) used in the study.

Further investigation is needed to gain a better understanding of the relationship of SLCNGAs on additional covariates. Also, a mixed methods approach incorporating the implementation methods of SLCNGAs needs to be explored.

CHAPTER 1

INTRODUCTION TO THE STUDY

The headline on the June 21, 2006 edition of *The New York Times* was “A Third of U.S. Dropouts Never Reach 10th Grade.” The news writer, Diana Schemo, quoted Christopher Swanson’s research, *Diplomas Count: An Essential Guide to Graduation Rates and Policies* stating, “The report found that nationwide, only 69.6% of the students who enter ninth grade graduate in four years with a regular diploma (Schemo, 2006). The report goes on to specify...69.6% of an estimated four million students, meaning about 1.2 million students likely won’t graduate this year. That means about 7,000 students drop out per school day” (Toppo, 2006, p.1).

What the headline did not say was that a large percentage of the students who dropped out were considered at-risk students. According to Swanson (2010), “A majority of non-graduates are members of historically disadvantage minorities and other educationally underserved groups. They (high school dropouts) come disproportionately from communities challenged by severe poverty and economic hardship” (p.1). At-risk students are those who face challenges and situations which make them unable to participate fully in their studies. The educational system’s lack of response to student needs creates at-risk students (Fantini & Weinstein, 1968). The State of Texas defines an at-risk student as a student who is under 21 years of age and meets at least one of the following statutory criteria:

- was not advanced from one grade level to the next for one or more school years;
- is in grades 7 - 12 with an average below 70% in two or more subjects in the foundation curriculum, either during one semester in the preceding or current school year, or is not maintaining such an average in the current semester;
- did not perform satisfactorily on an assessment instrument administered to the student under TEC Subchapter B, Chapter 39, and who has not subsequently, in either the previous or current school year, performed at a level of at least 110% of the level considered to be satisfactory on the same instrument or another appropriate instrument
- is in prekindergarten, kindergarten or grades 1 - 3 and did not perform satisfactorily on a readiness test or assessment instrument administered during the current school year;
- is pregnant, or is a parent;
- has been placed in an alternative education program in accordance with §TEC 37.006 during the preceding or current school year;
- has been expelled in accordance with §TEC 37.007 during the preceding or current school year;
- is currently on parole, probation, deferred prosecution, or other conditional release;
- was previously reported through the PEIMS to have dropped out of school;
- is a student of limited English proficiency, as defined by §TEC 29.052; is in the custody or care of the Department of Protective and Regulatory Services or has, during the current school year, been referred to the department by a school official, officer of the juvenile court, or law enforcement official;

- is homeless, as defined by 42 U.S.C. Section 11302 and its subsequent amendments;
or
- resided in the preceding school year, or presently resides in a residential placement facility in the district, including a detention facility, substance abuse treatment facility, emergency shelter, psychiatric hospital, halfway house, or foster group home ((§TEC 29.081).).

The academic challenges confronting at-risk students are often exacerbated in core academic courses such as mathematics and science, which build on knowledge taught the previous academic year. According to Allensworth & Easton (2007), at-risk students are more likely to drop out of high school if they are unsuccessful or fall behind in core classes such as mathematics and/or science. This lack of success leads to poor school attendance, low performance, under-credited grades and, ultimately, low graduation rates and ultimately higher dropout rates than non-at-risk students.

Compounding the problems they already face, at-risk students are more likely to be enrolled in large schools with larger class sizes that subsequently give students less individualized instructional time and puts them at a higher risk of academic failure. In fact, traditional, large high schools provide anonymity for students to hide their frustrations and challenges (Jenkins & Daniel, 2000). Conversely, small schools can help each child in the learning process from ninth grade to graduation and beyond (Horwitz & Snipes, 2008).

Recent research studies suggest that students in small schools perform better academically, attend school on a regular basis, experience fewer disciplinary issues, feel safer and have a higher participation rate in extracurricular activities (Shakrani, 2008;

Eichestein, 1994; Kershaw and Blank, 1993). According to a study by New York University's Institute for Education and Social Policy (2007), small schools provide a positive social and academic environment for students as well as more effective interaction between students, teachers, and administrative staff, contributing to higher attendance and graduation rates (Jacobwitz & Weinstein).

In small learning communities, particularly ninth grade academies, students have been shown to become more productive and experience academic achievement due to the small class size. Small classes make it possible to decrease the achievement gap between at-risk students and those who are not at-risk (Bickel, Howley, & Strange, 2000). Further, while small learning communities provide a range of options and areas of interest beneficial to all students, they are especially effective both within the science or mathematics disciplines, and for at-risk students who often struggle in large classes. The student's progress becomes positive in spite of hardships such as poverty. It is noted that the larger the school, the more severe the effects of poverty on achievement (Battistich, Solomon, Kim, Watson, and Schaps, 1995). This suggests that establishing small learning communities and implementing smaller classes could help less affluent at-risk students.

Background to the Study

Our democracy depends on a well-educated citizenry. In the words of Thomas Jefferson, "If we're going to have a successful democratic society, we have to have a well educated and healthy citizenry." In 1776, democracy was inventive, challenging, and experimental. The fathers of democracy, George Washington, John Adams, Thomas Jefferson, Josiah Quincy, Alexander Hamilton, and Benjamin Franklin knew that in order to for this new republic to be successful a well educated citizenry would need to be

created (Barber 2002). This ideal of education for all led to the creation of the nation's first public schools in the second half of the 17th century.

As of 1870, there were still only 500 public high schools with 50,000 students (Boyer, 1983). Enrollment began to increase later in the 19th century because schools started enrolling young girls in order to support the need to develop future teachers. Simultaneously, in 1874 a Michigan Supreme Court ruled in a case that allowed communities to use local property tax dollars to support high schools (Charles E. Stuart et al. v. School District No. 1 of the Village of Kalamazoo, 1874). This ruling paved the way for states to support schools with tax dollars collected from their citizens. By the early 1900's society was changing from a rural, agrarian system to an urban, industrial system. This created a need for greater access to education.

As the Industrial Revolution began to flourish in the late 19th and early 20th centuries, commerce and trade thrived, aided by new forms of transportation and communication. Factories, railroads, and trading companies were becoming dependent on managers who could read and write (Partnership for 21st Century Skills, 2007). As a result, the working class youth entered high schools in order to learn a skilled trade. The industrial boom created a need for educated personnel. At the same time, United States State Supreme Courts' ruled that state taxes could be levied to support public schools. These two factors coupled together helped create the demand and funding source that helped the United States (U.S.) public educational system spread rapidly (Herbst, 1996).

Starting in the 1960's, the U.S. had a population boom resulting in an increase of students attending secondary schools. To accommodate this increase, not only were more schools built, but also larger schools were built. According to the United States Census

Bureau (2005), from 1940 to 1990 the U.S. population grew by 70%. In this same time period, enrollment in public elementary and secondary schools increased to 41.2 million students (NCES, 2008). Between 1997 and 2009, public high school enrollment increased by 12 % (NCES, 2009). The increase in student population also led to an increase in school buildings. In the last seven years, 144 billion dollars were spent on school construction, with \$87 billion (more than 60%) going to entirely new school buildings. In 2007, more than 63% of school constructions went into new buildings, the highest percentage since 1978 (Abramson, 2008). This is an increase of approximately 10,600 schools.

Shift to Large Schools

Beginning in the 1870s, the United States experienced rapid population growth, which continued through the turn of the 20th century. This created extreme pressure for the country to develop efficient ways to manage the needs of these new citizens (Tyack and Cuban, 1995). While the one room schoolhouse might have been practical in rural areas, immigrants who were settling in densely populated urban areas were driving the rapid increase in student population. These fast-growing, densely populated areas could not be efficiently served by small, one room school houses designed to fit an agrarian setting. According to Wagner (2002), “we needed something more than an unregulated system of one-room schoolhouses—we needed an assembly line form of education that would standardize the delivery of basic skills—the three Rs to large number of students” (p. 9).

Given the success of factories during the Industrial Revolution era, it is not surprising that many school officials looked to industry for efficient models of how to

educate growing numbers of students. Large schools are efficient because they work similar to a factory line (Darling-Hammond, 1997). According to Townsend (1997), students were grouped into classes, sent to schools where they were taught a sequential curriculum—from easy to more complex—and promoted within the school. The culmination of the process was graduation at Year 12 with a matriculation certificate. Elwood P. Cubberly, an influential educator, called for schools to be factories in which children are to be shaped and fashioned to meet the various demands of life (Tyack & Cuban, 1995). Thus began the movement from one room, small schoolhouses toward large, factory-style schools that were designed to serve as many students as possible in one building.

While large schools were gaining in popularity, studies of the cost efficiency for “producing” a given level of student achievement favored school consolidation and larger size (Kenny, 1982, Buzacott, 1982; Guthrie, 1979). School finance researchers advocate that larger schools are able to educate a greater number of students, and offer more resources at a lower cost to the school district (Conant, 1959; Mitchell, 2000). Research has suggested that the larger the size of the school the greater the economic efficiency and added educational benefits to students (Guthrie, 1979; Michelson, 1972). Large schools were seen as being able to offer more course selections, a wider range of extracurricular activities, and usually more experienced teachers (Guthrie, 1979).

As the U.S. transitioned from an industrial economy to a knowledge economy, the minimum education required for success in the workplace also increased. The result was higher expectations for schools and greater interest in how they performed or could be improved. The outcome is the accountability movement.

Statement of Problem

The shift from an industrial economy to a knowledge economy beginning in the mid-twentieth century led to the creation of the accountability movement. This nationwide movement sought to evaluate, improve, and determine best practices in order to deliver systemic quality education. While education has a long history of disjointed reform measures, it is only since the mid-1900s that reformers have been able to link measurable performance indicators determined by state and federal mandates on a national basis. A landmark event in the accountability movement was the 1966 report, *Equality of Educational Opportunity*. Better known as the Coleman Report, this report spurred interest in educational accountability nationwide. The Coleman report (and others) revealed that the U.S. was lagging behind other countries in terms of education achievement, particularly with certain groups of students. This lag was most pronounced in key subjects such as math and science. The report was the result of a study that compared the distribution of resources and opportunities among students of different races along with their achievement scores (Ravitch, 2002). The study consisted of test scores and questionnaire responses from students of different grade levels and questionnaire responses from teachers and principals. Data on students included age, sex, race and ethnic identity, socioeconomic background, attitudes toward learning, education and career goals, and racial attitudes. Scores on teacher-administered standardized academic tests were also included. These scores reflected performance on tests assessing ability and achievement in verbal skills, nonverbal associations, reading comprehension, and mathematics. Data on teachers and principals included academic discipline,

assessment of verbal facility, salary, education and teaching experience, and attitudes toward race (Coleman et al.1966).

The Coleman Report concluded that school funding had little effect on scholastic achievement of students. Variables such as a student's background and socioeconomic status, and school composition of the student body had a more significant impact on students' achievement than the expenditure per pupil (Coleman et al.1966).

The Coleman Report's conclusion became widely disputed and has been credited for the "effective schools" movement in the late 1970's. The effective schools movement sought to dispute Coleman's research by identifying school variables that were related to student learning (Teddle & Reynolds, 2000). Researchers such as Ronald Edmonds, Director of the Center for Urban Studies at Harvard University focused their attention on schools from the poorest neighborhoods producing high achieving students. Researchers found evidence nationwide where children from poverty were learning. These findings, which contradicted Coleman's report, were widely publicized and led to the development of models of school improvement as the means to achieving high and equitable levels of student learning.

Although the Coleman Report has been widely challenged by researchers, it provided the data necessary for stakeholders such as policy makers, community members, and public officials to identify and push for structural changes and market competition in schools (Ravitch, 2002). The push to promote higher academic/education attainment by the accountability movement gained additional momentum with the creation of the National Assessment of Educational Progress (NAEP) in 1970.

NAEP provided data that documented the educational achievement of U.S. students. Student data on achievement were also accumulated in international tests of mathematics and science. In comparing the NAEP with international test results, the trends began to indicate that U.S. students performed poorly and seldom above the international mean (Evers & Walberg, 2002). As achievement data became increasingly available, policymakers, such as governors, became more scrutinized by the public for the performance of their state's schools. Governors knew they had to do something about the increasing achievement gap between ethnic minorities groups and different socio-economic classes. According to Ravitch (2002), "They (Governors) concluded that what mattered most were results—that is, whether students were learning. They used test scores as the best measure of student learning, and they urged that schools should focus relentlessly on improving student achievement" (p.16).

In 1993, Texas became one of the first states to begin implementing a statewide accountability system. The Texas accountability system was created to accredit school districts and rate schools based on their testing results. Texas Education Agency staff, teachers, business leaders, community members and legislative representatives collaborated on the system design. According to the 2000 Accountability Manual the accountability system "integrates the statewide curriculum; the state criterion-referenced assessment system; district and campus ratings; district and campus recognition for high performance and significant increases in performance; sanctions for poor performance; and school, district, and state-level reports" (p. 1).

The first test used in the Texas accountability system was the Texas Assessment of Academic Skills (TAAS). The TAAS test was used from 1991 to 2002. In 1999, the

76th Session of the Texas Legislature enacted Senate Bill 103, mandating implementation of a new statewide testing program. In 2003, the test was changed to The Texas Assessment of Knowledge and Skills (TAKS), Texas' high stakes examination.

The new statewide testing program mandated that students in grades 3, 5, and 8 must take English Language Arts, Mathematics, Science and Social Studies test. Furthermore, students in grades 3, 5, or 8 who fail specific tests may not advance to next grade level unless placement is approved by a unanimous decision of a grade placement committee. At the high school level, the TAKS tests are taken in 9, 10, and Exit Level. In 9th grade students take English Language Arts, and Mathematics; students in 10th grade and Exit Level take English Language Arts, Science, Mathematics and Social Studies (Texas Education Code, 2007). Texas students have been required to pass mathematics and English language arts, state exit examination since 1987. Texas was one of the first states to begin testing students on science and social studies with the inception of the present assessment program in 2003. Thus, students had to pass each of the four exit tests in order to graduate.

Historically, the science and mathematics test have been the most difficult for Texas students to pass. According to Texas Education Agency (TEA) results from 2009 only 71% of Texas ninth grade students and 48% of at-risk students passed the mathematics test. On the science TAKS 67% of students, including 42% of at-risk students, passed the achievement test.

Schools are consistently under pressure to meet the state accountability standards. In 10th grade students must answer 32/56 questions correctly in mathematics and 35/55 questions correctly in science in order to pass the examinations. Overall, schools must

have a passing rate of 45% in mathematics and 40% in science in order to meet acceptable accountability ratings (TEA, 2000). The results of the TEA data reveal a persistent learning gap between at-risk and non at-risk students. As the gaps in education become more apparent so does the need for educational reform.

Small Learning Communities

Many approaches have been tried to address the educational gap between at-risk and non at-risk students. One approach is small learning communities. A significant amount of federal and private monies has been invested into small learning communities. The question is whether small learning communities are benefitting the needs of suburban at-risk students. A Small Learning Community (SLC) refers to a subdivision of larger school populations into smaller, autonomous groups of students and teachers. The smaller learning communities are usually organized around career, academic, and interest-based themes that enable students to develop learning alternatives, meaningful connections, and make better choices. The students are usually taught in separate academies centered on career themes. The students most at-risk have alternative classes and are placed in groups for targeted academic grade level teaching.

According to Blanchard and Harms (2006), “the goal of SLC’s is to make the learning environment more personal for all students, the instructional focus relevant and effective, and the degree of empowerment of students and teachers over the learning experience more significant” (p.3). The students can also have opportunities to work with related community, college, or business partners and experience electives within the context of their interests and academic goals. This makes it possible for 9th grade students

of science and mathematics who are at-risk to learn effectively, and thus increases the number of students graduating (Hull, 2005).

Dr. Diana Oxley, Project Director at Northwest Regional Educational Laboratory, with over 20 years experience of research on transforming high schools into small learning communities links SLC's to the following positive student outcomes:

- SLC enrolls no more than a few hundred students
- SLC encompasses at least a half-day block of students' instructional day.
- Interdisciplinary teams of teachers share students in common
- Team members instruct more than half their class load in the SLC
- The SLC team shares planning time in common
- SLC partner with parents and community stakeholders
- SLC has building space sufficient to create a base for collaboration
- SLC admission is driven by student and teacher choice
- SLC community offerings attract a diverse group of students

(Allen, 2001; Oxley, 2007; Oxley, 2004; Ready, Lee, & LoGerfo, 2000)

According to the studies on large school breakups, high schools have implemented a variety of different models to downsize into smaller learning communities, each typically serving 200 to 500 students (Gregory, 2001). One reportedly successful model is the ninth grade academy (Cotton, 2001).

Ninth grade academies are designed to provide a high level of instruction, make personal connections between teachers and students, give guidance for personal planning for high school and beyond, train teachers to provide instruction to different modes of

students learning, and distribute leadership between teachers, parents, students, and administration (Walker, 2006).

With the increasing pressures of state and federal accountability, the decrease of graduation rates and increase in dropout rates in suburban and urban schools it becomes necessary to study the effects on ninth grade academics on at-risk students. Although a substantial amount of research exists on the effects of ninth grade academics in large urban schools, little research has been conducted into the effects of ninth grade academics on at-risk students in suburban schools, especially in the areas of mathematics and science.

Purpose of the Study

The purpose of this quantitative post-positivistic study is twofold. First, it will assess how the implementation of a ninth grade academy affects the academic achievement of at-risk ninth grade students in a large suburban school, based on data from the Texas Achievement of Knowledge and Skills (TAKS) test in mathematics and science. Second, it will determine if there are differences between the rates of academic achievement based on TAKS for at-risk students in ninth grade academics and similar students in typical school settings.

Little research has been conducted on the effects of at-risk students in suburban schools. Suburban school districts usually have a lower at-risk population than urban schools. A lower at-risk population may provide the appearance of higher standard state test scores, smaller drop-out rates and lower attrition rates because the majority of students do not fall into the at-risk population. Therefore, the purpose of this study is to evaluate the effectiveness of the implementation of ninth grade academics in large

suburban central Texas high schools specific to the academic achievement of at-risk students in mathematics and science as measured by the Texas state administered TAKS test.

Research Questions

Two primary questions will guide this study: (1) How the outcome of student achievement in math and science changes over time for at-risk students in suburban area schools that participate in a ninth grade academy; (2) How the outcome of student achievement in math and science changes over time for at-risk students in suburban area schools that do not participate in a ninth grade academy.

Significance of the Study

The findings of this study will provide local, state, and national education policymakers with a greater understanding of the impact of ninth grade academies on academic achievement of at-risk students in suburban area schools. Evaluating achievement in mathematics and science in these settings is important because of the impact success or failure can have not only on the students' academic future, but the larger impacts on the global economy, accountability standards, and financial resources dedicated by the federal government and private entities. According to Cutshall (2003), Congress, through the Department of Education's Smaller Learning Communities program, set aside \$125 million in 2001 and \$142 million in 2002 for districts that wanted to create smaller schools. Due to the large amount of money provided by the federal government for this initiative, it is crucial to assess the effectiveness of small learning communities on at-risk students.

On the district level, this study will help to determine if ninth grade academies are an appropriate alternative for raising test scores in mathematics and science for Texas high schools with a history of substandard academic achievement for students who are at-risk. The study will inform the district as to the efficacy of delivering academic services to at-risk students through ninth grade academies.

Definitions of Terms

Throughout this study, several terms will be used that may have multiple definitions. For the purpose of this study, the following definitions will be used:

At-risk student according to the Texas State criteria now defined in Section 29.081 of the Texas Education Code, as follows: each student in grades 7 through 12 who is under 21 years of age is in an at-risk situation if the student meets one or more of the following criteria:

- was not advanced from one grade level to the next for two or more school years;
- has mathematics or reading skills that are two or more years below grade level;
- did not maintain an average equivalent to 70 on a scale of 100 in two or more courses during a semester, or is not maintaining such an average in two or more courses in the current semester, and is not expected to graduate within four years of the date the student begins ninth grade;
- did not perform satisfactorily on an assessment instrument administered under Subchapter B, Chapter 39; or e.) is pregnant or a parent.

Additionally, students in any grade are identified as being in at-risk situations if they are not disabled and reside in a residential placement facility in a district in which the student's parent or legal guardian does not reside. This includes a detention facility,

substance abuse treatment facility, emergency shelter, psychiatric hospital, halfway house, or foster family group home.

Dropout is a student who was enrolled in public school in grade 7-12 in the previous year has left the school district and was not expelled, cannot be accounted for as a transfer, non public school student, completed a GED, or graduate (TEA, 2010)

Annual Dropout Rate is the percent of students who do not complete graduation requirements. The Texas dropout rate is calculated by the number of students that drop out of high school during the school year divided by the total number of students enrolled during the same school year (TEA, 2008).

Major Suburban A suburban area is a residential community that lies immediately outside of a city. TEA defines Major Suburban as a district neighboring a major urban district, with an enrollment of at least 3% of the neighboring major urban district, or at least 4,500 students. A district is also major suburban when it does not meet the criteria for classification as major urban; yet, it is located in the same county as a major urban district, and its enrollment is at least 15% that of the nearest major urban district in the county or at least 4,500 students (2010).

Ninth grade academy is a school-within-a-school, uniquely designed to provide ninth graders with the challenge and support they need (Legters & Morrison, 1998). A freshman academy may include ninth-grade students exclusively, or it may be part of an SLC that combines a small number of ninth through twelfth-grade students for instruction by the same core group of academic teachers (Smaller Learning Communities Program, 2005).

Other Central City Suburban is a district with a county population of between 100,000 and 734,999 whose enrollment is at least 15% of the largest district enrollment in the county. A district is also defined as other central city suburban, if it adjoins another central city district, its enrollment is greater than 3% of that of the contiguous other central city district, and its enrollment exceeds the median district enrollment for the state of 735 students. For the purpose of this investigation, other central city suburban will be identified as reported by TEA (2008).

Small learning community (SLC) is identified by district characteristics that contribute to its effectiveness. According to Seitsinger et al. (2008), a primary trait is a team structure that includes a group of teachers who work with a specific group of students.

Student achievement is generally understood as the ability of students to comprehend and attain educational success. In this study, student achievement will be defined as passing the statewide accountability assessment program of Texas. Specifically, student achievement will be defined as passing the *exit* level of the TAKS in the eleventh grade in the following reported areas: English Language Arts, Math, Science, and Social Studies (TEA, 2009).

Texas Assessment of Knowledge and Skills (TAKS) is a criterion-referenced assessment measuring student performance in the state curriculum, the Texas Essential Knowledge and Skills (TEKS). The TAKS is administered during the spring of each school year to Texas students enrolled in grades three through eleven.

Assumptions and Limitations of the Study

Certain assumptions will be made in the course of the study. The researcher will assume that each ninth grade academy is implemented within the guidelines and best practices set forth in ninth grade implementation research. The researcher also assumes that the students classified as at-risk in each school population were properly identified by each school district.

Because this study includes only schools in the central Texas region, some findings may be specific to this context and may not be applicable to other contexts. Additionally the use of TAKS scores as the sole measure of student achievement could limit the perceived success of the academies

CHAPTER 2

LITERATURE REVIEW

The literature reviewed in this chapter is pertinent to high school reform efforts in United States public schools leading to the inception of ninth grade academies in suburban schools, and higher levels of achievement for at-risk student populations in mathematics and science. The literature review is organized into six major sections indicative of education reform efforts prompted by identified instructional needs for at-risk students: (a) history of public education reform in the United States; (b) defining at-risk students in United States public education; (c) reform efforts related to optimal school size; (d) ninth grade academies as a school-size reform; (e) characteristics of ninth grade and; (f) challenge to educate at-risk students in suburban schools. As interest in the ninth grade academy concept grows in suburban area schools, increased understanding of its relationship to at-risk student achievement in mathematics and science is critical to make effective decisions related to high school reform.

History of Public Education Reform

Improving public schools is a response to the evolving economy and the increased role formal education plays in securing personal and professional success (Conkin & Curran, 2005). Until the 1840's, education was localized and only attainable for the wealthy. Reformers of education, Horace Mann and Henry Barnard, started the publication of the Common School Journal, which brought educational issues to the public conscience. School reformers argued that educated citizens could create a united society with good citizenry, and lower the crime rate among those in poverty (Mondale & Patton, 2001). As a result of their efforts, free public education at the elementary level

was available for all United States (U.S.) children by the end of the 19th century (Mondale & Patton, 2001).

Pre-1900, many students transitioned from elementary schools to secondary schools with little academic direction (Thurlow, Sinclair & Johnson, 2002). In addition, teachers were not well trained to handle the demands of the incoming population. The requirements to become a teacher were negligible. Usually the teacher had to persuade the local school board of their high moral character and in some districts take a general knowledge test (Ravitch, 2003). All of this, together, produced a large population of students not completing secondary schools.

At the same time, immigrants were pouring into this country, and the one-room schoolhouse became impractical. According to Wagner (2002), “we needed something more than an unregulated system of one-room schoolhouses—we needed an assembly line form of education that would standardize the delivery of basic skills—the three Rs to large numbers of students” (p. 9).

Public schools had to make room for the influx of students coming into the new system. In response, public schools became sorting machines, placing students on an academic track based on their perceived ability (Wheelock, 1992). Potential college students were on one track, general high school completers on another track, and lastly, vocational students on another track. Students with high abilities and skills were given intense, rigorous academic training while students with lower abilities were given vocational education (Wheelock, 1992). According to Cooper (1996), tracking was supported by a philosophy of the time that “high achievement was more the product of

innate ability and intellect and less the produce of an individual's work ethic or determination" (p.192).

During this same time period, the early 1900's, 96% of individuals 18 years and older did not complete high school (Thurlow, Sinclair, & Johnson, 2002). On top of this staggering statistic Doyle (1989) also reported that about 20% of the students in U.S. public schools were retained each year. City leaders realized that they needed to develop a new strategy to retain students. In response, many cities began experimenting with junior high schools that were composed of seventh through ninth grade students (Clark & Clark, 1994). Ninth grade was included in junior high because educators believed that if the students would finish ninth grade they would finish high school (Clark & Clark, 1994).

By the 1950s, the number of junior high schools jumped in the United States from 2,268 in 1925 to 10,322 by 1947 (Clark, 2000). During this era, political concerns began to rise surrounding (a) the Cold War; (b) the Russian launch of Sputnik in 1957 and; (c) a documented U.S. student achievement gap in mathematics and science compared to other countries. The U.S. public's growing awareness of their country's deficiencies in public education made educational restructuring a necessity (Hartman, 2008).

In 1983, a publication titled, *A Nation At-risk*, made its way to the front pages of the United States media. The publication of *A Nation At-Risk* became the watershed moment in modern educational reform in the U.S. According to the authors, the National Commission on Excellence in Education, the educational foundation of our society was seen as "being eroded by a rising tide of mediocrity that threatens our very future"

(National Commission of Excellence in Education [NCEE], 1983, p. 5). The opening paragraphs of the report set the tone:

Our nation is at-risk. Our once unchallenged preeminence in commerce, industry, science and technological innovation is being overtaken by competitors throughout the world...The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a nation and as a people...If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war...We have, in effect, been committing an act of unthinking, unilateral educational disarmament (1983, p. 5).

In short, the U.S. educational system was graduating students that were not as sufficiently prepared as their Russian, Japanese, and Korean counterparts (Hartman, 2008). Whether the report, *A Nation At-Risk*, was seen as a reality or a manufactured crisis of its times, it paved the way to blame the decline of the nation's economy and a decrease in U.S. global competitive advantage on the public education system. The push for school improvement quickly became an overwhelming public outcry for better schools which continues to this day.

Soon after the release of the *A Nation At-Risk* report, the National Commission on Excellence in Education put together recommendations for school reform. The commission's landmark recommendations include the following:

- Content—high school graduation requirements would become strengthened.

All students seeking a high school diploma would be required to pass four

years of English; three years of mathematics; three years of science; three years of social studies; and one-half year of a foreign language.

- Standards—universities, colleges and schools were to adopt measurable and rigorous standards. Teachers were to present challenging material to students and support an environment that fostered authentic learning.
- Time—more time was to be given for learning, including a longer school day.
- Teaching—teachers should be required to meet high educational standards to demonstrate an aptitude for teaching.
- Leadership—educators and elected officials would be held accountable for providing the leadership necessary to achieve the educational reform.

The report recognized the federal government has primary responsibility to provide the funding necessary to protect and promote the interest of education (*A Nation at Risk*, 1983).

Seven years later, Alsalam and Ogle (1990) authors of the report, *The Condition of Education*, cited that the United States Department of Education report stated “stagnation at relatively low levels appears to describe the level performance of American students”. Scholars have debated various reasons such as inadequate financial resources, lack of leadership, the changes were vast, and local educators who did not have any ownership in the reform recommendations, for the overall failure of the reform (Sarason, 1991). The demise of the Excellence Movement prompted a new movement by President George H. W. Bush, the Restructuring Movement.

The Restructuring Movement formed from the result of the identification of ‘Goals 2000’—eight national goals for education to be achieved by 2000:

1. All children in America will start school ready to learn;

2. The high school graduation rate will increase to at least 90%;
3. U.S. students will leave grades four, eight, and twelve having demonstrated competency in English, mathematics, science, history, and geography...;
4. U.S. students will be first in the world in mathematics and science achievement.
5. Every adult in the U.S. will be literate and will possess the knowledge and skills necessary to compete in a global economy...;
6. Every school in the U.S. will be free of drugs and violence and will offer a disciplined environment that is conducive to learning.
7. The nation's public education teaching force will have access to programs for the continued development of their professional skills.
8. Every school will promote partnerships that will increase parental involvement and participation in promoting social, emotional, and academic growth (Goals 2000: Educate America Act, Title III, Sec.302).

Along with national goals a new emphasis on site-based reform was a major factor of this reform movement. Educators believed they would have greater control creating and implementing reforms in their own schools in order to meet the national goals. Local administrators and teachers could be creative, use their own pedagogy and resources could be used more effectively and efficiently to support collaboration (DuFour and Eaker, 1998). Despite the high hopes and ideals of the Goals 2000 reform, studies indicated that only marginal improvements were accomplished. In 1992, Perkins wrote that a review of the research on school innovation led to “the profoundly discouraging conclusion that “almost all educational innovations fail in the long term” (p. 205).

According to DuFour and Eaker, (1998) “Past efforts to improve schools have not had the anticipated results for a number of reasons: the complexity of the task, misplaced focus, and ineffective strategies, lack of understanding of the change process” (p. 17).

After Goals 2000 reform efforts continue to be implemented to improve the education of all students. One priority area for educational reformers is to improve the academic achievement rate of the at-risk student population. According to Donnelly, (1987) “the identification of at-risk students and the development of programs to prevent their failure are necessary components of educational reform (p.1).”

Defining At-Risk Students

Researchers define at-risk students in different ways. The term generally refers to students who are at-risk of failure to complete school (Slavin & Madden, 1989). Analysis of large scale data collections have found that dropout rates and lower achievement are associated with characteristics such as low socio-economic status (SES), racial or ethnic background, single-parent family, mother with low education, and limited proficiency in English (Miller, 1993).

From a federal perspective, in the *No Child Left Behind Act*, the term at-risk, means a school-aged individual who is at-risk of academic failure, has a drug or alcohol problem, is pregnant or is a parent, has experience with the juvenile justice system, is at least 1 year behind the expected grade level for his/her age, has limited English proficiency, is a gang member, has been a past school drop-out, or has a high absentee rate at school (No Child Left Behind Act, 2002). However, the federal definition differs from individual states' criteria which often differ from one state to another.

The Texas criteria used to identify at-risk students are specified in Section 29.081 of the Texas Education Code, as follows:

each student in grades seven through twelve who is under twenty-one years of the age is in an at-risk situation if the student meets one or more of the following criteria: a.) was not advanced from one grade level to the next for two or more school years; b.) has mathematics or reading skills that are two or more years below grade level; c.) did not maintain an average equivalent to seventy on a scale of one-hundred in two or more courses during a semester, or is not maintaining such an average in two or more courses in the current semester, and is not expected to graduate within four years of the date the student begins 9th grade; d.) did not perform satisfactorily on an assessment instrument administered under Subchapter B, Chapter 39; or e.) is pregnant or a parent. (Texas Education Code, 2005)

Having defined at-risk students from a general, federal and State of Texas viewpoint, it is important to look at their traditional performance in public schools.

Dropout of At-Risk Students

In a recent interview Arne Duncan, the United States Secretary of Education made the following statement after a report by the National Center for Education Statistics entitled, Public School Graduates and Dropouts from the Common Core of Data: School Year 2007-08 was published. Mr. Duncan was quoted saying, “Today’s report confirms that our nation faces a dropout crisis. When 25% of our students – and almost 40% of our black and Hispanic students – fail to graduate high school on time, we know that too many of our schools are failing to offer their students a world-class education (Downey, 2010). According to the Texas Education Agency’s (TEA) Division

of Accountability and Research (2009) out of 2,016,470 students who attended grades 7-12 in Texas public schools during the 2005-2006 school year, 51,841 students were reported to have dropped out of all grades. A total of 48,803 students dropped out of grades 9th – 12th. An equally important factor in dropout statistics is the number and dropout rate specific to at-risk students.

In 2005-2006, there were 613,589 at-risk students enrolled in grades 9-12, approximately 46.6% of the Texas student population. In this same year, it was reported to TEA that 57.9% of students classified as at-risk dropped out of high school in Texas (TEA, 2007). This challenge is not unique to Texas public schools.

The National Center for Educational Statistics (NCES) estimated graduation rates for the 2006-2007 school year in the United States as 73.9%. NCES reached 73.9% by calculating the average freshman graduation rate (AFGR). According to The National Center of Educational Statistics, the AFGR provides an estimate of the percentage of high school students who graduate within four years. The rate uses aggregate student enrollment data to estimate the size of an incoming freshman class and counts of the number of diplomas awarded four years later. The incoming freshman class size is estimated by summing the enrollment in eighth grade in the first year, ninth grade for the next year, and tenth grade for the year after, and then dividing by three. The averaging is intended to account for prior year retentions in the ninth grade. Based on a technical review and analysis, the AFGR was selected from a number of alternative estimates that can be calculated using available cross-sectional data (Seastrom et al. 2006a, 2006b). Depending on the data source, methods used, and specific graduation definition the statistic can vary from 50% to 85%. However, one thing is for certain, in 2006-2007

Texas had the second largest student population and had the second largest dropout rate in the United States at 50,824 students, only second to California (NCES, 2009).

According to research, there are a disproportionate number of ninth grade students who are held back, while others drop out (Kennelly & Monrad, 2007). The promotion from 9th grade to 10th grade is relatively lower than promotion between other grades. Students who drop out of high school before tenth grade are exposed to more risks and challenges than those who graduate from high school (Kennelly & Morad, 2007). Students who drop out of public high school without a diploma reduce their lifetime earnings and decrease their employability. Diminished earnings potential and decreased employability have a negative effect on the society in terms of reduced revenue, higher crime rates, and greater public assistance (Dianda, 2008; Psacharopoulos, 1972). Ninth grade dropouts and attrition are far more pronounced in urban, high poverty schools, low-income high schools and low poverty districts (EPE Research Center, 2006).

Academic failure is cited as one of the key factors determining which students drop out in public schools. (Ekstrom, Goetz, Pollack, & Rock, 1986; Goldschmidt & Wang, 1999; Kemp, 2006; Rumberger, 1995; Rumberger & Larson, 1998; Swanson & Schneider, 1999). One researcher found that the probability of dropping out of school was between 40% and 50% if a student failed one grade, and it increased the risk to 90% if the student failed two grades (Roderick, 1994). In public high schools, ninth graders that had to repeat their freshman year had a 90% probability of dropping out of high school prior to earning a diploma (Balfanz & Letgers, 2006). Identifying structural interventions that can be implemented by public schools is necessary to provide an educational environment where at-risk students can succeed academically.

Reform Efforts Related to Optimal School/Class Size

A major consideration in school success or failure is school class size. The debate over school size proliferated in that late 1950's. One popular viewpoint during the 1950's is by James B. Conant, author of *American High Schools Today* (1959), who states

The enrollment of many American public high schools is too small to allow a diversified curriculum except at exorbitant expense. The prevalence of such high schools—those with graduating classes of less than one hundred students—constitutes one of the serious obstacles to good secondary education throughout most of the United States. (p. 77)

Although Conant's theory was popular other theorists, such asSizer, challenged him.

Since the early 1980's, TheodoreSizer has been one of the most vocal advocates of school reform to address the anonymity students experience in large high schools, students' lack of engagement in learning, and lack of meaningful learning (Sizer, 1984; 1992; 1996; 1999). Practitioners have been influenced by Sizer's work with the Coalition of Essential Schools, a group of schools working together to increase personalization in schools, committed to "paying attention to the character, needs, and potential of each student" aimed at fostering "thoughtfulness—clear, informed thinking and decent behavior" in the school community (Sizer, 1996, p.40). Sizer believed that smaller school environments were more personal.

Small school advocates, practitioners and researchers point out that most high schools have become too large to provide the critical personal connection between teacher and students that is often the mechanism for preventing dropout, reducing school violence, and improving academic performance (Cotton, 1996; Folwer & Walberg, 1991; Bickel,

Howley, & Strange, 2000; Lee & Smith, 1997). Between 1952 and 1998, the percentage of U.S. high schools enrolling 1,000 or more students rose from 7% to 25% (Mitchell, 2000). As a result, by 1998, 59% of the country's high school students attended schools of 1,000 or more students (Mitchell, 2000). In 2004, numbers increased to 70% of U.S. students who attend high schools with 900 or more students and hundreds of schools have enrollments in excess of 2,500 students (Education Week, 2004).

A good deal of research has dealt with potential of small schools to lower the challenges faced from the feeling of anonymity in large high schools. One of the earlier reviews on school size and student performance was conducted by Cotton (1996) who found mixed results. However, she noted "...we may safely say that students achievement in small schools is at least equal—and often superior—to student achievement of larger schools" (p.1). Fowler and Walberg (1991) found evidence to suggest that both smaller schools and smaller districts, regardless of SES and grade level may be more efficient at enhancing educational outcomes. In another study by Bickel, Howley, et al. (2001) using 1,100 Texas schools found that as school size increases achievement decreases for economically disadvantaged students (Bickel, Howley, et al., 2001). The findings that large schools have stronger negative effects for lower SES students have been widely corroborated (Howley, 1995; Bickel, Howley, & Strange, 2000; Lee & Smith 1995, 1997).

Small schools have been linked to a decrease in the high school dropout rate. Pittman and Haughwout (1987) estimated that every 400-student increase in enrollment is associated with a 1% rise in the dropout rate at a particular school. According to Gladden (1998), "students attending smaller high schools are more likely to pass their courses, accumulate credits...and attain a higher level of education than students who attend larger

schools (p. 127). Other empirical studies have confirmed that smaller schools have lower dropout rates, higher graduation rates and better attendance rates than larger schools (Lindsay, 1982; Wasley et al., 2000).

Lindsay (1982) found that students in small schools experienced greater satisfaction than students in medium or large schools and Wasley et al. (2000) had similar findings—namely that “students’ attachment, persistence, and performance are all stronger in the small schools as compared to the system at large” (p. 20). According to the Architecture Research Institute (1999) school size research consistently finds stronger feeling of belonging on the part of small-school students than large-school students. Teachers and students often feel connected and in the process a caring environment is established. The Architecture Research Institute researchers (1999) write that, “the extra attention that students get from the staff affords them greater educational, psycho-emotional, and social services, and also makes them feel part of a community” (Ayers, Bracey & Smith, 2000; Cotton, 1996; Fine & Sommerville, 1998, Gladden, 1998, p. 3).

One reform strategy that aligns with the smaller school reform movement is the development of ninth grade academies in smaller learning communities (SLCNGA). The small learning communities for ninth grade students are often organized as ninth grade academies. The SLCNGA’s academies provide a small class size and a wide range of options that the students can employ in their learning process depending on their individual needs. These options include extended leaning time, accelerated

learning options, environments for personalized learning, dropout prevention and recovery programs, and literacy instruction programs (Chait, Muller, Goldware, Housman, 2007).

Ninth Grade Academy

Ninth grade has become a focal point for school reform efforts because the transition from middle to high school has been identified as a critical juncture in a student's academic success or failure. Many students need interventions during the pivotal year in order to minimize dropout rates, increase standardized test scores, and improve graduation rates. The importance of this transition necessitates collaboration and support from teachers, counselors, parents and administration at both educational levels (Hertzog & Morgan, 1998; National Center for Education Statistics (NCES), 2002; Roderick & Camburn, 1999). The Small Learning Community fosters an environment where at-risk students realize their relationship with school can improve with: teachers, students, family, and other collaborators, which make communication easier. This improves relationships between students and teachers (Coffee & Pestrige, 2001).

Ninth grade academies are a reform effort designed to improve the transition from middle school to high school through the more personalized learning environment that the small schools movement seeks for students at all skill levels (Burrill, 1998). However, at-risk students, in particular, can benefit from the extra support (ie, smaller class size, academic team setting, academic rigor) that the ninth grade academies provide during this stage because it eases their transition into high school and helps them in their career exploration (McDonough, 2004). This addresses the increased challenges at-risk students

face inside and outside of school that negatively impact their likelihood for academic success as defined by academic achievement and graduation rates.

At-risk students in mathematics and science are particularly vulnerable in the ninth grade due to academic gaps that have formed prior to ninth grade. The academic gap in mathematics and science can have profound consequences on at-risk students' futures in the increasingly knowledge oriented U.S. economy (Duderstadt, 2005).

Nationally, the large achievement gap separating at-risk students has been the focus of discussion, research and controversy for over 20 years. Many students end middle school ill prepared to succeed in a rigorous sequence of college-preparatory mathematics courses in high school (Balfanz, McPartland & Shaw, 2002). Creating strong instructional programs, better supported, trained, and more knowledgeable math and science teachers will improve learning climates of at-risk students (Lee, 2002). Small Learning Communities' operate with team teaching in core areas, mentoring, as well as extra support services provided for students. This academic structure is researched to help at-risk students achieve success in academic and social aspects of life (Oxley, 2004).

As ninth grade students are introduced into ninth grade academies, teachers can easily identify at-risk students and guide instruction based on data gathered from previous years state academic testing and report card grades. Integrating data on students gives insight to the teachers and can help in supporting at-risk students (Horwitz & Snipes, 2008). The early dropout warning signs are revealed in the data collected and provide crucial information about at-risk students. Teachers will also look at the patterns of student failure in science and mathematics in the ninth grade to make decisions about instruction (SREB, 2000). The academic performance and behaviors of at-risk students in

mathematics or science can be used to develop academic rescue initiatives specific to those students who are struggling. These academies or communities have effective instructional practices for high school students in a number of ways (Spake, 2010). Common instructional practices within a ninth grade academy include: career pathways, teaming and class size, making connections, mentoring, and problem based learning.

Career Pathway

A common component of ninth grade academies in a career-focused curriculum, called a career pathway/cluster, which begins early in the ninth grade (Stern, Raby & Dayton, 1992). A career pathway/cluster is any separately defined, individualized learning unit within a larger school setting. Students and teachers are scheduled together and frequently have a common area of the school in which to hold most or all their classes (Shannon & Bylsma, 2003). The organization of these learning communities around career, academic and other interest based themes enable students to develop learning alternatives and choices. According the U.S. Department of Education SLC program, academy models organize their curricula around one or major themes, usually careers or occupations (Coffee & Pestridge, 2001).

Students in ninth grade academics that have a career cluster model are able to select specialized classes depending on their personal interests. For example, the science and mathematics project themes given per learning community enable the students to explore the theme and focus in great depth which increases the students' achievement and reduces the feeling of isolation as sometimes experienced in large schools (Wasley et al., 2000). This helps the science and mathematics students, including those at-risk, to mirror their best interests or future career goals. The students can have opportunities to work

with related community, college or business partners and experience electives within the context of their interests and academic goals (Allen, 2001). The student is more apt to view schoolwork as more relevant and focused to their futures. The learning needs of each student are fostered by providing individual teaching and opportunities for learning based on their needs and strengths (Klem & Connell, 2004).

Academic Teaming and Small Class Size

Small learning communities incorporate academic teaming into their instructional practices. Interdisciplinary academic teams consist of four or five core teachers that are assigned approximately 100 to 125 students. The schools form academic teams to facilitate the development and alignment of curricula, inform instruction and further the development of professional learning communities (Cotton, 2000). This can help the teachers to develop a more coherent and deeper academic curriculum that integrates lessons across subject areas, and puts more focus on thematic units. There is curricular flexibility that benefits students because educators can adjust the flexible curriculum depending on individual needs of a student (Legters, 2002).

The development of teams in small classes takes consideration of interests, personality, ability and other factors that are essential for academic success. The at-risk students benefit from a more personalized school due to small class sizes (Nye, Hedges & Konstantopoulos, 2000). These students are less able to be idle and their participation in the learning environment increases. They are able to feel a sense of belonging and are able to work in a group in a more cohesive manner (Blum and Rinehart, 1997).

Heterogeneous grouping that comprises teachers from specified subject areas and students from diverse backgrounds can benefit those students who are at-risk of academic

failure (Oxley, 2001). In the group work environment, teachers know and identify the students based on their ability and challenges. The teacher can group the students by avoiding placing students who need extra help together. Learning groups offer opportunities for focusing attention on individual learners, and the general characteristics of the individual (Gladden, 1998; Wasley & Lear, 2001; Legters, 1999; Mohr, 2000; NASSP, 1996; Oxley, 2001; Raywid, 1996). It is imperative to note that learning styles affect the quality of learning and academic achievement. Science and mathematics are subjects that are technology-based or project oriented. Cooperative learning strategies are useful especially when handling practical lessons when data is obtained, shared or group analyzed (Johnson & Johnson, 1994). The learning community can adopt strategic grouping of students to enhance sharing opportunities. Such groups, when developed in the ninth grade, can also assist students to develop skills in high-level discussion and experimentation (Cuseo, 1992). Sharing of knowledge also teaches the students to avoid selfishness in academic success and base their actions on cooperation (Jackson & Kassam, 1998).

In such small or group learning, ninth grade at-risk students will benefit from evaluation and engaging them in cooperative learning (Zakaria & Iksan, 2007). The teachers and students can collaborate and cooperate. When teachers assist students in mediated learning environments, like the small leaning communities, the students learn to solve conflicts and can overcome challenges that put him or her amenable to risk. Students also employ more helping behaviors with their peers since the feelings of neglect are not there. Their peers shield the at-risk student since there is environment of connection and feelings of community in the class.

When the classes are departmentalized, the teachers are able to know the subject areas and specialize. This will make the teachers to deliver high level instruction that will influence present and future academic standards of the student (Reigeluth, 1999). The small science and mathematics classes help the students to benefit from subject-area specialization and eliminate potentially alienating factors since the teachers will act as team leaders and support interaction among students and staff and among students themselves. Alienation and feelings of neglect, or academic loneliness that may be developed by the student is overcome through group work initiatives (Ayers, Bracey, & Smith, 2000; Cotton, 1996; Gladden, 1998; Klonsky & Klonsky, 1999; Raywid, 1996; and Wasley, et al., 2000). The teachers are provided with a more integrated view of the progress of students. The students can also feel that they are supported and this may help them overcome their fear, or express their challenges to those they trust-the teachers, parents, mentors or school administration (Legters & Toch, 2007).

Submitting science and mathematics students in the ninth grade to small classes helps them to adjust to the learning environment in colleges and other post-secondary educational institutions. Students in the ninth grade negotiate and form new relationships, new physical space, and more challenging academic demands (Letgers, 1999). Most students experience the risks of transition during this stage rather than later in their high school life. Thus, they need much more bonding and close monitoring by an interested party to prevent them from deviating and subsequently becoming effected in their academic life (Conchas & Clark 2002).

The small classes and academic teaming enable students to develop subject area knowledge in the ninth grade, which they will apply in the investigations by embedding

the skills they learned. Through such initiatives, at-risk students are helped to grasp the basic knowledge through support, concern and active participation. When students pass through the small classes early in life, they are subjected to higher order thinking skills so that they become prepared for serious academic thinking by the time they pass ninth grade (Haller, Monk, & Tien, 1993).

Making Connections

Making connections with peers, teachers, counselors, and the overall learning environment is important to student success (James & Jurich 1999, p. xvi). At-risk students often do have the confidence to approach their teachers or colleagues during class time. The students may not find adequate time to consult with their teachers on academic and other social issues that may be affecting them. At-risk students, therefore, need adequate time and well structured programs that exist in small learning communities (Davis, 1984).

According to Raywid (1994) she emphasizes the importance of teachers having close relationships with at-risk students so teachers can understand them better and provide enough support for their development is critical. Teachers who create a caring, structures, and fair classroom with high expectations have students with higher levels of school engagement and achievement (Klem & Connell, 2004). Students attach considerable social importance to their teachers, especially on discovering that the teachers care (Brewster & Bowen, 2004). In the small learning communities, the students adjust to the academic conditions and the schools adjust to the needs of the students.

The social connections between teacher and students and the peer culture of student achievement make at-risk students of science and mathematics feel the need to

achieve and demonstrate academic competence. A network of caring adults has shown to have a high impact on school success, reducing the likelihood of at-risk students dropping out by 50% (Croninger & Lee, 2001). The students can identify the mutual relationship between themselves and their teachers. The educators are responsible for assisting students to overcome the barriers to social bonding and membership. Qualitative studies dating back 30 years, have described the importance that caring relationships with teachers have for at-risk students (Comer 1980, Rutter, 1979).

The students, through small learning communities, form partnerships that permit them to extend their learning outside the normal classroom environment. At-risk students are able to connect with community organizations and thus, they can explore their potential careers through job shadowing, internships and work-based learning. The students' assets and needs are identified, and mathematics or science programs are developed that are tailored to their needs.

Mentoring and Caring Adult In Schools

At-risk students need caring, knowledgeable adults in the forms of mentors, teachers, parents, community members and counselors. These adults give at-risk students a much-needed feeling of belonging within their educational community (James and Jurich 1999, p. X). This sense of belonging increases lines of communication and trust between the at-risk students and adult mentors. As the lines of communication become more open, the at-risk students develop feelings that they are comfortable with the education environment (Berends, 1995). With a growing comfort in their education environment, at-risk students are more likely to reach out for help, which makes them

more open to learning. At-risk students are also more likely to attend school more frequently when their teachers become a significant source of their social capital.

In Small Learning Communities, at-risk students are able to connect to adults in the school or learning community through opportunities for formal mentoring, as well as counseling by other students and teachers (Rockwell, 1997). The at-risk students are able to continue with their education because teachers build positive relationships that create powerful incentives despite the challenging academic work the at-risk student may be experiencing (Lieberman, Darling-Hammond & Zuckerman, 1991). The science and mathematics students who are at-risk are frequently monitored through pull-out or one-on-one counseling sessions (Gladden, 1998; Klonsky & Klonsky, 1999; and Duke & Trautvetter, 2001). These students are identified and assisted to define his or her personal and academic goals and the steps involved to achieve these goals. This makes them prepare for academic and social challenges and obtain support from mentors and other students. The result is higher quality peer-to-peer relationships and student-teacher relationships. These relationships increase academic skills that form the foundation to build into future skills. This is why caring adults tend to focus on assets, and small learning communities reflect caring for youth (Mosteller, 1995).

Project Based Learning In Science and Mathematics

Science and mathematics courses benefit from practical applications and projects that complement theory. This helps students appreciate that science is much more than memorizing parts, formulas and bodies. John Dewey stated “for learning to be effective it should shift from the memorization of a body of knowledge to a process of inquisition, knowing, and understanding” (Dewey, 1960, p. 157). Learning and activities need to be

aligned to a problem or task (Savery & Duffy, 1996). Project based learning can be achieved better in small learning communities than traditional school settings, because small learning communities naturally lead students to work in a collaborative manner, and adopt group work to solve problems (Letgers, 1999). This fits the learning process in science where practice is part of the curriculum. This is well suited for an interactive small learning community where student participation levels are higher. Learning in smaller communities also allows students to work together to reconstruct knowledge progressively from immature experiences to the learning experiences based on meaning and systematic organization (Dewey, 1960).

When these small learning communities are fully developed in ninth grade, students can relate the projects to the real world. This offers opportunities for at-risk students to test ideas against their alternative views. These classroom experiences assist students in reflecting on the content learned and processes followed (SREB, 2000). Students, who have difficulty following the scientific process, and those with language difficulties, can be introduced into the process in the ninth grade. This can maximize their ability to understand the concepts developed and benefit even more from this learning for the remainder of high school.

The development of projects allows students to be involved in design, investigation, research, solving problems, making decisions, and then culminate presentations (Thomas, 2000). These processes are learned in stages from ninth grade through to the future academic and career work (Twig, 2004). Both teachers and students in small learning communities are continuously engaged in experimental or project learning that is part of scientific or mathematical studies.

The implementation of project based learning in the ninth grade can help at-risk students grasp a basic knowledge of the scientific process and mathematics. Project based learning accomplishes this by creating a collaborative environment that encourages active participation and provides opportunities to test concepts conclusively, and provides supplementary support when concepts prove to be challenging.

The Challenge to Educate At-Risk Students In Suburban Area Schools

The challenges to educate at-risk students have been increasing over time particularly in the schools that are located in the suburban areas. The highest challenge rates are found among the minority and/ or poor students that live in the suburban areas. Students are considered at-risk when their communities, families and the institutions they are in fail to help them to achieve their academic desires (Hood, 2008). Several studies have acknowledged that most school programs pay no attention to the impacts of family and society context in the children's academic growth. Research also confirms that there has never been programmatic policies that provide at-risk students with adequate attention throughout their schooling period. Statistics show that minority and poor students are suspiciously placed at-risk for low achievements, continual discrimination, dropout and exposure to less competent teachers (Sanders, 2000). Sanders also address some strategies and practices that can be used to make a difference in the challenges posed by the outcomes and instructive opportunities. He goes on to examine both past and current approaches that are used in educating at-risk students (Sanders, 2000).

Navok (1994) argues that visions of at-risk students are slowly stifled by both the education systems and social pressure from the society. Stringfield and Land (2002) have given attention to the background factors that put students at-risk. They identify

particular strategies that are helpful in extenuating the academic risks of such students. Studies have also shown that difficulties faced by at-risk students can be attributed to their low self-esteem. However, if this is enhanced through incorporating personal interests between teachers and students, and introducing special care and love into the school programs then this challenge is likely to decrease. McBeath, Reyes and Ehrlander (2008), suggest the performance of at-risk students can be improved by increasing the time on learning so as to recompense for many of the disadvantages that these students experience.

Other researchers have studied the extent of resiliency that is exhibited by at-risk students and how it can be reduced by applying appropriate interventions (Stringfield & Land, 2002). According to McBeath, Reyes & Ehrlander (2008), the biggest challenge that most governments face in addressing the issue of education improvement for at-risk students is that schools in such areas lack efficiently developed administrators and teachers who can effectively address the needs of these students. Thus, the challenge is not only the students, but the lack of experience and proficiency, as well. Like many other researchers, Navok (1994) supports the idea that at-risk students usually have difficulties in adapting to school life due to the difficult life experiences. Therefore, he suggests teachers and administrators be oriented on how to understand and address the needs of students considered to be at-risk.

Navok also demonstrates that teachers in at-risk schools face the challenge of developing strategies that can successfully help students to establish close relationships with their teachers and peers thus aiding their adaptation to school life (Navok, 1994). Despite the fact that math and science are fundamental in most professional fields, most

students in suburban areas perform very poorly in these subjects. Research also shows that most of these students are blacks and their poor performance is attributed to poverty and exposure to racism (Henig et al, 2001). Various studies have reported on some of the efforts that governments are implementing to ensure that no child is left behind in math and science. Some of the efforts include educating teachers and school administrators on how well they should handle students from suburban areas, rewarding students who perform well in these subjects as well as funding projects that focus on testing modeling science and math activities (Henig et al, 2001).

Hood (2004) has defined at-risk students as those who are likely to fail in academics because of social circumstances that are beyond their control. She also emphasizes the importance of teachers having close relationships with them so that they can understand them better, and provide sufficient support for their development. Some of the challenges that she identifies include lack of eagerness and incentive to learn, achievement gaps among students as well as social diversity. According to Hood (2004), the rates of push-outs and dropouts are higher in schools with greater numbers of at-risk students compared to schools that have low numbers of such students. In most cases, these students are either poor, come from single parented families, broken homes, abused or are drug addicts. Administrators and tutors thus face the challenge of dealing with students who have already given up in life and try to put some sense and hope in them. Some of the students are considered burdens because they pull down the performance of the schools especially in the most sensitive subjects such as math and science. Research has proved that if these barriers and other pressing circumstances are identified and

removed, then at-risk students are more likely to improve and succeed in such subjects (Krovetz, 1999).

Mendrinós (1997) suggests that teachers should use advanced technology in education so as to improve the attainment of students considered at-risk. She goes on to identify the appropriate programs which teachers teaching at-risk students can use successfully to enhance learning. Some of the proposed programs include CD-ROM, Internet and videodiscs among other technology. Research suggests that schools that have integrated these programs perform better than those schools that have not. According to Mendrinós (1997), most teachers fail to embrace academic technology because of the challenge of integrating these programs into math and science. She thus calls for teachers to improve their teaching strategies and expand their knowledge of technology.

Several studies have shown that schools that have embraced programs that include technology have shown great improvement in math and science. Students who were once classified as at-risk showed great improvement and were no longer considered as at-risk students (Sagor & Cox, 2004). Teachers have also reported augmented eagerness in teaching math after the introduction of these programs. Sagor & Cox (2004) have identified the psychosomatic needs exhibited by at-risk students. Such needs include the lack of the sense of belonging, effectiveness and competence among others and assert that these challenges can only be reduced if teachers and school administrators work hard towards meeting these needs. Several tips and strategies have been suggested so as to help teachers become effective in helping students to become successful in math and science. Sagor & Cox (2004) also supports the idea that when such students are

motivated and assisted in coping with the hard life circumstances they face in the home settings then teachers will not face challenges teaching them.

Research indicates that between 1972 and 1996, the rate of school dropouts for students coming from low-income families was higher than that of their counterparts who come from well off families (Sanders, 2000). Furthermore, the test scores of minority and poor students in mathematics and science are very low compared to the other students.

Research reveals that often such students are taught by tutors who have no professional qualifications to teach these subjects (Sanders, 2000). Several researchers have proved that students who come from suburban areas are likely to achieve poor grades, especially in math and science, thus posing a bigger challenge to their teachers. According to Sagor & Cox (2004), this may be attributed to factors such as poverty, language background, and the composition of their families as well as the education level of their mothers.

Conclusion

The U.S. has a history of implementing various school reform measures in order to increase academic standards and achievement. In recent years, school reform efforts are increasingly a priority as the public becomes aware of the academic achievement gap of U.S. students compared to the students of other countries, especially in the areas of mathematics and science. Among the recent reform efforts, the small school movement has gained prominence.

Within school reform, educating at-risk students is a priority because at-risk students face a myriad of additional challenges compared to their non-at-risk peers. The result is at-risk students who are statistically less likely to succeed compared to their non-at-risk peers. A particular area of focus for serving at-risk students is ninth grade, because

there is a strong correlation between overall success in high school and student performance in ninth grade. One primary reform effort is the Smaller Learning Communities Ninth Grade Academies.

SLCNGA's have been implemented in urban, rural, and suburban schools. At-risk ninth grade students in suburban area schools are particularly vulnerable in mathematics and science because they comprise a smaller overall percentage of the student enrollment compared to urban and rural schools, even when included in ninth grade academies. As a smaller percentage of the student body, at-risk students may or may not receive the extra attention they need in order to be academically successful. Within the ninth grade curriculum, extra emphasis is placed on mathematics and science. These areas are emphasized because success or failure in these core subjects impacts secondary achievement and graduation rates as well as post-secondary and career options. The reason: you can't graduate from high school without passing mathematics and science.

Exploring the successful impacts of ninth grade academies provides critical information to stakeholders searching for a way to improve achievement levels for at-risk students. As they evaluate this particular school reform model, and its unique focus on serving at-risk students in mathematics and science in suburban schools, they will be better equipped to decide if ninth grade academies are the right approach for their particular situation.

CHAPTER 3

RESEARCH DESIGN

This chapter provides a description and explanation of the design and analysis components of this study. Chapter three is organized into six sections: (a) overview of the analytic method, (b) key terminology, (c) population and sample, (d) variables, (e) data screening, and, (f) data analysis.

Overview of Analytic Method

“As interest in hierarchical models has grown, the pace of methodological innovation has accelerated, with many creative applications in social science and medicine” (Raudenbush & Bryk, 2002, p10).

The purpose of this study is to examine the effect of participation in SLCNGAs academies on achievement in science and mathematics for at-risk students in ninth grade. To examine the effect of participation in an SLCNGA's over time, a random coefficients hierarchical linear growth model was used to determine if significant growth occurred in science and mathematics for at-risk students in ninth grade academies. Specifically, the study was designed to answer the following research questions: (1) How does student achievement in math and science change over time for at-risk students in suburban area schools that participate in a ninth grade academy? (2) How does student achievement in math and science change over time for at-risk students in suburban area schools that do not participate in ninth grade academies? According to Singer & Willett (2003) three important features of longitudinal growth studies are:

1. “Three or more waves of data”. The data used for this study will contain three years of assessment results (8th grade, 9th grade, and, 10th grade)
2. “Time is the fundamental predictor in every study of change”. The metric for time in this study of change in achievement growth in math and science will be grade and year.
3. “An outcome whose values change systematically over time” (p.8). The outcome that will be changing are the scores in the state-wide standardized tests in mathematics and science each year.

At the first level of a hierarchical linear model (HLM or random coefficients regression model, RCRM), student-level scores (level-1) occurring at specific points in time are viewed as observations nested within an individual (level-2). The intercepts (i.e. means) and slopes (i.e. rate of change) in math and science scores are allowed to vary randomly over time. In the HLM/RCRM approach, student scores may occur at equal or unequally-spaced time increments. This allows flexibility in the acquisition of data with regard to different schedules for different individuals. Data structures within HLM can be unbalanced or balanced. In the unbalanced case, there exists different numbers of observations (i.e. TAKS scores) for each individual. The third level of a repeated measures HLM/RCRM, is the cluster level or the level at which the classrooms and students are nested. In this study, the classroom (i.e. teacher), school, or district serves as the level-3 cluster in the HLM/RCRM. However, the results of a three-level HLM/RCRM analysis revealed a small intra-class correlation (i.e. $ICC < .01$) providing evidence that using a three-level model was unnecessary to answer the research questions posed in this study.

A particular strength of HLM is that it provides a statistical framework for examining person-specific growth trajectories. The data used in this study consists of TAKS scores in mathematics and science. The mathematics data used in this study will be collected in April of their 8th, 9th, and 10th grade year. Data may be unbalanced in that not all students will have data in all three grade levels. The science data to be used in this study will be collected in April of their 8th and 10th grade year. Data will need to be collected in both years in order for the HLM model to estimate the variation in the growth pattern. This type of modeling allows one to estimate the variation (i.e. rate of change) in growth patterns within and individual and between individuals while simultaneously controlling for covariates such as sex, ethnicity, and at-risk classification (Raudenbush & Bryk, 2002).

HLM allows the researcher to incorporate time-invariant covariates at level 2 to account for variation in growth parameters across individuals. This study will examine three time-invariant covariates: attended/not attended ninth grade academy, ethnicity and sex.

Using a hierarchical linear growth model will provide a method for the analysis of students' initial mathematics status at 8th grade, their individual change in scores (i.e. growth) over time and the acceleration and deceleration (i.e. change in slopes of the regression coefficients) of that growth over time. The hierarchical linear model (HLM/RCRM) will provide an analysis of the rates of change across time within (individual) students. Additionally, a between groups comparison of ninth grade academy vs. non academy students will be conducted at each of three time points in mathematics and two time points in science. A repeated measure HLM/RCRM is the method of choice

for the present study due to (a) the nested structure of the data, and (b) because the data are time unstructured and unbalanced.

Hierarchical Linear Modeling is an ideal model for research in educational settings. According to Arnold (1992), “Hierarchical linear modeling (HLM) estimates linear equations that explain outcomes for members of groups as a function of the characteristics of the groups as well as the characteristics of the members” (p.58). Critical problems in education often focus on the relationships between student outcomes and the characteristics of these groups. According to Arnold (1992), “student growth occurs within students within classrooms within school within districts. Identifying the predictors of student growth and achievement in schools is thus, a multilevel problem” (p.58).

A multilevel modeling approach such as HLM provides the correct analytic technique for situations where nested data structures naturally exist. Nesting occurs when units at one level are nested within or sub-grouped at a second or higher level. Nesting can occur as children nested with classrooms and classrooms nested with schools. Nested structures exist in educational settings and persist over time yielding repeated observations on the same individuals over time. Using standard general linear modeling (GLM) techniques such as multiple linear regression or analysis of variance (ANOVA) causes (a) model misspecification, (b) incorrect statistical tests of significance (i.e. inflated Type I error rate), and (c) a missed opportunity to examine potentially interesting contextual questions. HLM’s can have up to three levels in an analytic hierarchy depending on the data structure and research questions posed. Estimation of model parameters (e.g., regression coefficients/beta weights and standard errors) is

accomplished using the method of restricted maximum likelihood (REML) instead of ordinary least squares (OLS).

HLM has three advantages in investigating research questions in large scale educational research. First, HLM affords a rigorous way to explain student growth in achievement at the individual student level in classrooms or schools by modeling the amount of the variance within and between students. Second, HLM provides a framework for modeling the effect of demographic factors or characteristics such as sex, race, or social-economic status on classroom or school achievement. Ultimately, incorporating demographic factors into HLM analyses allows a researcher to provide a more detailed explanation regarding the differences between schools and within classrooms. “Lastly, it can produce better estimates of predictors of student outcomes within classrooms borrowing information about these relationships from other schools and classrooms” (Arnold, 1992, p.58).

Key Terminology

The following is a list of concepts and terms related to the methods employed in this study.

Between-cluster variance. In a growth modeling framework, this is the variance in the outcome between students or the student-level variance (Raudenbush & Bryk, 2002).

Centering. The time variable must be deviated from a particular measurement point to interpret the growth parameters of the model. Time can be centered at the midpoint or at the endpoint of the data collection period depending on the time period of interest (Raudenbush & Bryk, 2002).

Growth modeling. A statistical procedure to analyze the evidence of change and the variables that influence growth as they relate to academic achievement (Raudenbush & Bryk, 2002).

Hierarchical linear modeling (HLM). A regression-based statistical method that deals with multi-level data including repeated measures of student performance such as repeated scores nested within individual students.

Interperson variability. Referred to as inter-individual differences in change or what predicts differences among people in their changes (Singer & Willet, 2003).

Intraperson variability. Referred to as within individual change and examines how each person changes over time (Singer & Willet, 2003).

Level-1 equations. These equations reflect the growth trajectories of individuals (Holt, 2008)

Level 2-equations. These equations describe the between-person variability in the growth parameters (Holt, 2008).

Nesting. The cluster units into a hierarchy.

Random Coefficients Regression Model. A multi-level regression model where the regression coefficients (the intercepts and predictor slopes) may vary across groups (higher-level units), which are considered to be randomly sampled from a population of groups (Tabachnick & Fidell, 2012).

Small learning community. Any separately defined, individualized learning unit within a larger school setting. Students and teachers are scheduled together and frequently have a common area of the school in which to hold most of their classes (Wasley et al. 2000).

Texas Assessment of Knowledge and Skills. State achievement tests based on the academic standards of each grade level.

Time-varying. These types of covariates are ones that change over time (Raudensbush & Bryk, 2002).

Time-unstructured data. The spacing of these data points across repeated measures may vary across person (Raudensbush & Bryk, 2002).

Unbalanced data. These types of data do not require the same number of observation per person (Raudensbush & Bryk, 2002).

Unconditional linear model. The level-1 equation describes a person's initial status in terms of their growth, the rate of change, and other fluctuations in their growth pattern. The level-2 equation describes between-person variability in the growth parameters; namely the intercept and linear slope (Holt, 2008).

Unconditional quadratic model. This type of model can be used to describe curvilinear trends by including squared terms in the level-1 model. Variation in the trends can be explicitly modeled in the level-2 models (Holt, 2006).

Population and Sample

The data that will be used in this dissertation were drawn from two groups of students. One group of students included at-risk suburban students in Texas who completed their 8th, 9th, and 10th grade year in the same school district, attended a ninth grade academy in their district and completed an eighth grade and tenth grade TAKS test in science, and their TAKS test in mathematics. The second group of students included at-risk 8th, 9th, and 10th grade suburban students in comparable Texas schools, who completed their 8th, 9th, and 10th grade year in the same school district, did not attend a

ninth grade academy in their district, and completed an eighth grade and tenth grade TAKS test in science, and their eighth, ninth, and tenth grade TAKS test in mathematics. Data consist of TAKS scores of science from the same cohort of students in 2006 and 2008; 2007 and 2009; 2008 and 2010. Data will be used from the TAKS scores of mathematics consist of the same cohort of students in 2004, 2005, and 2006; 2005, 2006, and 2007; 2006, 2007, and 2008; 2007, 2008, and 2009; 2008, 2009, and 2010. The suburban schools that were selected to participate in the study are based on the information on location type taken from the National Center of Education Statistics (NCES), Common Core of Data (CCD). The location type is a descriptive term used by the U.S. Department of Education Center of Education Statistics (NCES), to indicate a district's urban, suburban, or rural status, based on locale codes of the schools in the district. According to the CCD, "if 60% of students were enrolled in schools with a rural - distant locale code, and 40% were enrolled in schools with a "town – small" locale code, the district would be assigned a "rural – distant" locale code. If no single locale code accounts for 50% of the students, then the major category (city, suburb, town, or rural) with the greatest percent of students determines the locale; the locale code assigned is the smallest or most remote subcategory for that category" (NCES, 2000). In 2000, NCES has developed twelve new locale type designations, which have been broken down as follows:

1. City: Large, Midsize, Small
2. Suburban: Large, Midsize, Small
3. Town: Fringe, Distant, Remote
4. Rural: Fringe, Distant, Remote

For the purposes of this study all student data were acquired from large suburban school districts. The CCD defines a large suburban school district as, “territory outside a principal city and inside an urbanized area with a population of 250,000 or more”.

The data from students in suburban schools and in ninth grade academies will be based on the award grantees of the Smaller Learning Communities grant by the U.S. Department of Education. According to the details of their narrative submitted to the U.S. Department of Education each of the four schools developed a Freshman Academy in order to bridge the transition between 8th grade and high school.

Students

Hierarchical linear modeling (HLM) can reveal complex relationships between longitudinal outcome measures and their covariates under proper consideration of potentially unequal error variances. For this study, three individual student difference variables (i.e. covariates) are used for each student: sex, ethnicity, at-risk. Including these covariates in the analyses provides a mechanism for examining the moderating effect for the outcome of interest (i.e. on educational achievement as measured by TAKS).

Sample Size Justification

This study will utilize a three-level Hierarchical Linear Model approach, with testing occasions nested within students and nested within classrooms/schools. The level-1 or general model includes (a) occasions of testing, (b) n students, and (c) number of classrooms/schools. The level-2 model includes (a) the random effect for students within specific classrooms/schools, and (c) the between-person variance of change. The level-3 part of the model is cluster specific and includes (a) the grand mean for polynomial change, (b) the main effect of treatment or intervention, (c) a random effect associated

with each cluster, and (d) a between-cluster variance component of change. As such, it is necessary to determine how many subjects are needed in both the groups either attending or not attending the 9th grade academy. This is a nested design, and as such, we will utilize an apriori mathematical model for establishing power and sample size based on a Repeated Measures Hierarchical General Linear Model with between and within group main effects and interactions. Power and sample size analysis will be conducted using the Optimal Design 3.5 software (Raudenbush & Liu, 2000). The parameters included in the power analysis include: (1) Effect size (d), (2) Type-1 error rate or α (a), (3) Statistical power (1- β), (4) Number of independent groups, and (5) Number of occasions of testing and how many times a student was tested on each occasion. The effect size ranges included for sample size planning were: .02, .35, and .50 providing for an adequate level of sensitivity for testing the hypotheses. The alpha error probability rate (a) is modeled at 5%, which tells us that one has a 5% chance of committing a Type I error and erroneously rejecting the null hypothesis. The statistical power is set at 80%, which means that one would have an 80% chance of detecting a significant difference in (a) random intercepts between groups and (b) random slopes within and between students, if one truly exists. The number of independent groups, 2, represents the groups that either will attend or not attend the 9th grade academy. The correlation represents the degree of relationship in scores across years. This study is longitudinal with math having, three time points corresponding with the three respective years of data collection and two time points with the two respective years for science. Table 1 below lists the number of subjects needed in each group to determine a significant difference in math and/or

science scores between groups, across time, at varying levels of effect size and correlation.

Table 1
Power and Sample Size

| Effect Size d | Alpha Type-1 Error | Power | Number of Groups* | Number of Clusters per Study Group | Repetitions (Years) | # of measurements in each year | n (per group) |
|-----------------|--------------------|-------|-------------------|------------------------------------|---------------------|--------------------------------|---------------|
| 0.20 | 0.05 | 0.8 | 2 | 80 | 3 | 1 | 1600 |
| 0.35 | 0.05 | 0.8 | 2 | 30 | 3 | 1 | 600 |
| 0.50 | 0.05 | 0.8 | 2 | 23 | 3 | 1 | 460 |

*Number of groups refers to 9th grade academy and non-ninth grade academy

*Number of students within classrooms is estimated at $n = 20$.

**Effect size is Cohen's d (.2 = sm, .5= med., .8= lg) or the standardized difference between treatment effects *page 16 of the Optimal Design Manual – pdf file.

Based on these calculations 400 subjects in each group would optimize the model with an effect size of .5, an error rate of 5%, .80 level of power and a correlation of .5 between scores across time. However, other combinations are provided and included in Table 1. This is most likely an *oversample*, as a true HLM model is robust and has much less variability and error associated with observations at each respective level, compared with other GLM techniques that employ non-hierarchically structured between and within group effects.

Variables

For the research questions-is there a relationship between TAKS mathematics achievement scores or TAKS science achievement scores of suburban at-risk students and the completion of attending a ninth grade academy we apply a three-level conditional HLM model. Interest centers on achievement growth parameters, the growth intercept and the growth rate.

Attention is restricted to two student-level variables: (a) the outcome, Y_{ij} , a standardized measure of science achievement and/or mathematics achievement and (b) one predictor (AR)_{ij}, at-risk student population in ninth grade academy. School-level variables include (SECTOR), an indicator variable taking on a value of one for ninth grade academies and zero for non-ninth grade academies, and (MEAN, AR) the average of the student AR values within schools that have ninth grade academies and those that do not have ninth grade academies.

Instrumentation

TAKS was established in 2003 as the statewide assessment test. TAKS testing system was designed to measure students' basic academic knowledge and skills in the areas of mathematics, science, social studies, and language arts. Texas state law requires that students in grades three to eleven complete a yearly reading and math assessment. Writing assessments are completed by fourth and seventh graders; science is required for the fifth, eighth, tenth, and eleventh grades. Social studies tests are implemented in the eighth, tenth and eleventh grades. TAKS is designed to see how well a student is able to acquire, learn, and use the specific skills and goals outlined in an instructional unit or a year-long curriculum that is taught according to state educational standards. In each cohort there will be three measurement points of study for mathematics. The first measurement point will be the students' eighth grade TAKS mathematics composite scale score collected in April, the second measurement will be their ninth grade TAKS mathematics composite scale score collected in April, and a final measurement will be their TAKS mathematics composite scale score collected in April of their tenth grade year.

In each cohort there will be two measurements points of study for science. The first measurement point will be students' eighth grade TAKS science composite scale score collected in April and the second measurement will be their tenth grade TAKS science score collected in April of their tenth grade year.

Validity

A framework for evaluating the validity of the mathematics and science TAKS assessment is a multiple step process set up by the Texas Education Agency (TEA) and Pearson Testing Center. According to the TEA Framework field test questions are analyzed for reliability, validity, and possible bias (TEA, 2007). Various statistical analysis including Rasch's model –based analyses (i.e., 1-Parameter item response theory - IRT) measurement are used to evaluate the field-test data for reliability, validity, And item and/or test bias (a.k.a. differential item functioning). “Pearson provides an array of statistical analysis useful in understanding the psychometric properties of the tests, the performance of individual test items, distributions of test scores at the student, school, district, and state levels” (TEA, 2007). Three types of differential item functioning data are presented during committee review: separately calibrated Rasch difficulty comparisons, Mantel-Haenszel Alpha and associated chi-square significance, and response distributions for each analysis group (TEA, 2007).

The differential Rasch comparisons provide item difficulty estimates for each analysis group. The Mantel-Haenszel Alpha is a log/odds probability indicating when it is more likely for one demographic group to answer a particular item correctly than another group. Response distributions for each analysis group indicate whether members of a group were drawn to one or more answer choices for the item. TEA and Pearson use the

item statistics during the test construction process to calculate and adjust for difficulty and content coverage (TEA, 2007).

Data Screening

This study of student growth involved a doubly nested structure of repeated observations (mathematics and science scores through academic years) within individual students, who were nested within organizational settings (schools and districts). Data screening was conducted using SPSS version 21.0. Tabachnick and Fidell (2012) recommend a checklist for screening data. The process of data screening involved resolving issues of accuracy of data that were entered into the data file, dealing with missing data, transforming variables to bring them into compliance with the requirements of analysis, and dealing with outliers (Tabachnick & Fidell, 2012).

The scale scores for science TAKS tests were obtained from the Texas Education Agency for the same cohort of students. Analysis of science results used TAKS data for the same cohort of students in 2006 and 2008; 2007 and 2009; 2008 and 2010 were used. Analysis of mathematics results used TAKS data from the same cohort of students in 2004, 2005, and 2006; 2005, 2006, and 2007; 2006, 2007, and 2008; 2007, 2008, and 2009; 2008, 2009, and 2010. The outcome variable in this study was mathematics and science achievement as measured by TAKS scale scores. The time invariant covariates, at level 2, included students enrolled in a ninth grade academy and those not enrolled in a ninth grade academy. Sex was coded as: 0=female and 1=male. Ethnicity was coded as 2=Asian, 3=African Americans, 4=Hispanic, and 5=White.

An HLM model is based on a number of assumptions. These assumptions need to be satisfied by the researcher in order for estimating and testing coefficients to be valid.

According to Snijders and Bosker (1999) the assumptions are: the linear dependence of the dependent variable Y, on the explanatory variables and, the random effects; the independence of the residuals at level one as well as the higher level or levels; the specification of the variables having random slopes (which implies a certain variance and correlation structure for the observations); and the normal distributions for the residuals.

Analytic Samples

Using population data provided by the Texas Education Agency specific to 2004-2010 student level data of at-risk suburban students in 8th, 9th, and 10th grade. Each student was registered in his or her home district all three years. The population data consisted of their science and mathematics scale score in each testing year, grade, ethnicity, sex, at-risk status, disadvantaged status, TAKS met expectations, TAKS commended performance, district name and campus name. Four random samples were constructed by proportionally stratifying on cohort, ethnicity and sex for use in the analyses. The four random samples included (a) a validation sample for the math analysis, (b) a cross-validation sample for the math analysis, (c) a validation sample for the science analysis, and d) a cross-validation sample the science analysis.

Data Analysis

The software used to conduct all analyses was SPSS version 21.0. The SPSS Mixed-Model algorithm was used to fit four random coefficients regression (hierarchical liner model) models to the math (validation and cross-validation analyses) and science (validation and cross-validation analyses) data.

The software used for sample size planning and evaluating statistical power was the Optimal Design for Multi-level and Longitudinal Research. This software was created by Raudenbush, Stephen, and Liu Xiaofeng in 2001.

Cross-Validation. Cross-validation is a model evaluation method that focuses on the number of available observations, n , split into two groups. One group is the number of observations used for model construction, and the other is the number of observations used from model validation or calculation of prediction residuals (Kozak and Kozak, 2003). Cross-validation with a second sample is highly recommended for statistical regression (Tabachnick & Fidell, 2012). Cross-validation is useful in overcoming bias by over-fitting. Over-fitting is the problem of capitalizing on the idiosyncratic characteristics of the sample (Babyak, 2013). Over-fitting will provide overly optimistic findings that appear in the model but don't really exist in the population, and are therefore not replicable. To avoid over-fitting in this study the use of the additional technique, cross validation, was used for the analysis of the mathematics and science data.

Summary

The federal mandate, *No Child Left Behind Act*, and the Texas State Accountability system have increased pressures of school districts to demonstrate results of learning with all students. Texas has implemented many programs and initiatives aimed at improving the graduation rate of students. Despite overall gains, there are still certain student groups, such as at-risk students, that continue to struggle especially in the areas of mathematics and science. One of the largest educational initiatives to transpire in Texas is the reform movement, High School Redesign. Historically, this movement was focused on the needs of students in urban school districts. Recently, the redesign model is

being implemented in suburban area school districts across the state of Texas. Suburban area districts are trying to create similar results with their at-risk population that some urban school districts have been able to demonstrate with their high population of at-risk students. This study will examine the relationship of academic progress of at-risk suburban students that attend a ninth grade academy compared to those that do not.

In an effort to address issues within the current structure of the American high school, the ninth grade academy as a smaller learning community has become a popular reform model (Cotton, 2001). Ninth grade academy provides a framework that focuses on both the affective and cognitive needs of high school freshman by attempting to place freshman in an appropriately-sized learning environment that offers support from a team of teachers. In Texas, there are four large-suburban districts that received grants from the United States Department of Education to implement a ninth grade academy.

Research on the impact of ninth grade academy on student achievement is limited. Researchers such as Dewees (1999) and Ready, Lee and Welner (2004) support the conclusion that studies are either nonexistent or limited as to the effectiveness of this reform. Because districts are spending time and financial resources in creating and implementing ninth grade academies without a significant amount of empirical research regarding academic progress, there is a need for this research between ninth grade academy and academic achievement.

The purpose of this study is to investigate whether the academic achievement of at-risk tenth grade suburban students improves in mathematics and science according to data on the Texas Achievement of Knowledge and Skills (TAKS), after completing their

ninth grade academic year in a ninth grade academy compared to those at-risk tenth grade suburban students who do not attend a ninth grade academy.

The TAKS mathematics and science tests were selected because they are state legislated accountability tests that the majority of Texas high school students must complete in their 8th grade year and in their 10th grade year. Additionally, in 8th grade students have multiple opportunities to pass both portions of the test, the passing rate on the first attempt for each test will be used for the purpose of this study. Both measures of achievement were developed for Texas based on academic standards, Texas Essential Knowledge and Skills, in mathematics and science, and are both used for state accountability purposes. Both tests are criterion references tests that have undergone a lengthy validation process to get approved.

This study will explore whether a statistical difference exists between students participating in a ninth grade academy as compared students in non-academy settings as measured by 8th and 10th TAKS assessments in mathematics and science. This study addresses the following questions:

- 1 Is there a difference between students participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy students related to academic achievement on the TAKS mathematics examination when the data are controlled for the same cohort?
- 2 Is there a difference between students participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy students related to academic achievement on the TAKS science examination when the data are controlled for the same cohort?

In summary, this study will focus on the academic achievement of tenth grade suburban area at-risk students in mathematics and science who attended a ninth grade academy and those who did not attend a ninth grade academy, as well as assessing if achievement rates increase with the duration of time passed after implementing a ninth grade academy.

CHAPTER 4

RESULTS

Chapter four provides the results of this study which analyzed change in student achievement in science and mathematics over time for at-risk students in suburban area schools regarding their participation in a ninth grade academy. Small learning community status (i.e. participation or no participation) served as the between groups (i.e. fixed effects) variable. Student level covariates included in the analyses hypothesized to account for substantial variability in TAKS performance included (a) at-risk status, (b) sex, and (c) ethnicity. A cross-validation strategy was used to provide further evidence to support or refute the results obtained from the science and mathematics validation samples. Therefore, four analyses were conducted overall. This chapter is organized into four divisions, each focused on one analysis including: (a) science random coefficients multilevel regression, (b) science cross-validation random coefficients multilevel regression, (c) mathematics random coefficients multilevel regression, and (d) mathematics cross-validation random coefficients multilevel regression. Each analysis is further organized into (a) a demographic description of sample, (b) procedures, (c) findings, and (d) statistical and practical evaluation of research questions.

Science Validation Sample

The science validation sample consisted of science TAKS test scores from 2006, 2007, 2008, 2009, and 2010 and was developed using a randomly selected sample stratified on cohort and grade of N=21,432 from an available population of N=27,547. The data were provided by the Texas Education Agency. The discrepancy existing in the

number of students comprising the total sample and the sample used for the analysis resulted from incomplete student-level data. This science validation sample consisted of student science TAKS data from four large suburban area Texas school districts, which included Clear Creek ISD, Irving ISD, Leander ISD, and Pflugerville ISD. A minimum of one school in each district housed a 9th grade academy (SLC). Each data set included a unique student-level science TAKS scale score in 8th grade and 10th grade. Each student's 10th grade science TAKS test was taken in the same district as his or her 8th grade science TAKS test.

Table 2 provides a summary of the sample characteristics for the validation sample (N=21,432). Demographic information is reflected by frequency counts for grade, SLC status, at-risk status, sex, and ethnicity. All students in this study completed both an 8th grade and a 10th grade science TAKS test in the same district.

Table 2
Demographic Characteristics Science

| Characteristic | N | Percentage (%) |
|------------------------|--------|----------------|
| Grade | | |
| 8 | 10,717 | 50.0 |
| 10 | 10,715 | 50.0 |
| Middle School Baseline | 10,717 | 50.0 |
| SLCNGA | | |
| Yes | 5,592 | 26.1 |
| No | 5,123 | 23.9 |
| At-Risk Status | | |
| Yes | 7,032 | 32.8 |
| No | 14,400 | 67.2 |

Table 2
Demographic Characteristics (continued)

| Characteristic | N | Percentage (%) |
|------------------|---------|----------------|
| Sex | | |
| Male | 10,866 | 50.7 |
| Female | 10,566 | 49.3 |
| Ethnicity | | |
| White | 112,976 | 60.5 |
| Hispanic | 6,114 | 28.5 |
| African American | 1,448 | 6.8 |
| Asian | 8,94 | 4.2 |

Note. N = number of participants

The variable *grade* (also serving as the repeated measure over time) was equally represented at the two points of measurement. In other words, 50% of the TAKS scores occurred at grade 8 and 50% at grade 10. Each student was recorded taking the science TAKS test once in 8th grade and once in 10th grade.

Examining the data relative to SLC status, this data set contained an almost equal split of the student population who attended their 9th grade in an SLCNGA and those who did not attend an SLCNGA.

The next section in Table 2 highlights the number of not at-risk students compared to at-risk students. There is approximately a 2:1 ratio of not at-risk (14,400) students to at-risk (7,032) students in this sample. Examining the data relative to sex, there is close to a 50/50 split between males and females.

The final category in Table 2 compares frequencies for ethnicities. The four districts that were used in this study had a large White population of 60.5%. Comparatively, there was 28.5% Hispanics, 6.8% African Americans, and 4.2% Asians.

Analytic Procedure and Results

Two random coefficients multilevel regression analyses were conducted using the SPSS v.21 Mixed-Model procedure to answer the science research questions posed in this study. TAKS science scores at two time points (time 1: N=10,716; time 2: N=10,716) served as the outcome variables for the analyses at grade 8 (N=10,716) and grade 10 (N=10,716). Additionally, the validation sample was randomly selected by stratifying on three cohorts (C3 – C5) of students (C3: N=7,137; C4: N=7,374; C5: N=6,920) staggered by academic year. Students served as the level-2 units, and scores at time points one and two, nested within students, served as the level-1 units of analysis. Participation in a small learning community (SLCNGA) served as the between groups (students) variable. Student level covariates in the model included (a) sex (0=female; 1=male), (b) at-risk (0=not at-risk; 1=at-risk), and (c) ethnicity (0=White; 1=Hispanic; 2=African American). The method of restricted maximum likelihood (REML) was used to estimate the model parameters. Because the variance of scores for students at time points one and two was substantially different, the within-subjects variance components were modeled using a heterogeneous autoregressive-1 structure (i.e. allowing different levels of variance at each time point to be captured). Results of the model for the science analyses revealed (a) significant random intercepts (i.e. means) and (b) significant random slopes (i.e. a rate of change over time being significantly different within students from grade 8 to grade 10).

A comparison of the unconditional random coefficients multilevel regression model with the conditional random coefficients multilevel regression yielded an intraclass correlation coefficient (ICC) of .50 at time 1 and .21 at time 2 verifying the need for a multilevel modeling analytic strategy. Students included in the sample were in

grades 8 (N=10,717) and 10 (N=10,715). Additionally, Table 3 provides the three cohorts of students (N=7,137; N=7,374; N=6,920) staggered by academic year that were included in the analyses.

Table 3
Student Cohort by Year Tested

| Cohort | Years Tested | N |
|--------|--------------|-------|
| 3 | 2006 | 7,137 |
| | 2007 | |
| | 2008 | |
| 4 | 2007 | 7,374 |
| | 2008 | |
| | 2009 | |
| 5 | 2008 | 6,920 |
| | 2009 | |
| | 2010 | |

Note. N = number of participants.

Science scores were not significantly different between cohorts over time; however the random variance within cohorts was included in the model in order to account for individual variability in change or growth over time. The method of restricted maximum likelihood (REML) was used to estimate parameters in all models. Because the variance at time points one and two were substantially different (e.g., for the validation group, at time 1 the variance was 59,128.98 within students and at time 2 the variance was 25,718.27 within students), the within-subjects variance components were modeled using a heterogeneous autoregressive-1 (ARH1) structure (i.e. allowing different levels of variance at each time point to be modeled for subjects over time). The models were also fit using only the autoregressive-1 covariance structure. The -2 log-likelihood is the global measure of fit for evaluating statistical models using maximum likelihood or restricted maximum likelihood estimation. The -2 log-likelihood values for competing models can be compared as a means of selecting the model with the best fit to the data.

The -2 log-likelihood were compared using a chi-square difference test and the ARH1 model proved statistically more accurate (and a smaller -2log-likelihood); and therefore was the analytic choice for all analyses.

The findings address the following research questions in each of the two analyses:

1. How does student achievement in science change over time for at-risk students in suburban area schools that participate in a ninth grade academy?
2. How does student achievement in science change over time for at-risk students in suburban area schools that do not participate in ninth grade academies?
3. Is there a difference between females participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy females related to academic achievement on the TAKS science examination when the data are controlled for the same cohort?
4. Is there a difference between males participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy males related to academic achievement on the TAKS science examination when the data are controlled for the same cohort?
5. Is there a difference between White students participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy White related to academic achievement on the TAKS science examination when the data are controlled for the same cohort?
6. Is there a difference between Hispanic students participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy Hispanic

related to academic achievement on the TAKS science examination when the data are controlled for the same cohort?

7. Is there a difference between African American students participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy African American related to academic achievement on the TAKS science examination when the data are controlled for the same cohort?

SLCNGA Findings. The effect of participating in an SLCNGA's on TAKS science mean score (using middle schools as a baseline) was not statistically significant. The SLCNGA's group category labeled "C3" was composed of middle school students not participating in an SLCNGA. A SLCNGA structure is not available in middle school. These students' scores served as a baseline group against which all comparisons were made. The middle school random intercept, as shown in Table 4, was 2,238.72 (SE = 173.48); $df = 10,574.82$ ($t = 12.91$) $p < .001$. On average, students not in a SLCNGA's (SLCNGA = 1) scored 127.07 points below the middle school mean (i.e. 2,111.65; $p > .05$). On average, students in an SLCNGA's (SLCNGA = 2) scored 115.56 points below the middle school mean (i.e. 2,123.16; $p > .05$).

Table 4
Summary of SLCNGA Estimates of Fixed Effects Science

| SLCNGA | Mean | SE | Sig | 95% Confidence Interval | |
|-----------|-----------|---------|------|-------------------------|-----------|
| | | | | LL | UL |
| Intercept | 2,238.725 | 173.481 | .000 | 1,898.669 | 2,578.781 |
| 1 | -127.073 | 173.237 | .463 | -466.652 | 212.504 |
| 2 | -115.562 | 173.238 | .505 | -455.143 | 224.018 |
| 3 | 0 | 0 | | | |

Note. CI=confidence interval; LL=lower limit; UL=upper limit.

Although the mean score performance for students in a SLCNGA was higher than those not in an SLCNGA (relative to the middle school mean as a reference), the difference

between the groups was not significant; nor were the mean differences between each group relative to the middle school means significantly different.

At-Risk & Sex Findings. On average at-risk students scored 163.96 points below the middle school mean on TAKS science (i.e. 2,074.76; $p < .001$). High school males scored 51.08 points higher (significant at $p < .001$, mean score of 2,289.80 points) than high school females on TAKS science (i.e. females = 2,238.72).

Ethnic Findings. Table 5 shows the fixed effects results by ethnicity. On average, Whites scored 64.83 points lower than the mean for middle school students ($M = 2,238.72$). The mean for Whites is 2,173.89, $p < .05$. Hispanics scored an average of 152.51 points lower than the mean for middle school students. The mean for Hispanics is 2,086.21, $p < .05$. White's and Hispanic's means were significantly different. African Americans scored 161.29 points lower (on average) than the mean for middle school students, with a mean of 2,077.44, $p < .05$.

Table 5
Summary of Ethnicity Estimates of Fixed Effects Science

| Ethnicity | Mean | SE | Sig | 95% Confidence Interval | |
|------------------|-----------|---------|------|-------------------------|-----------|
| | | | | LL | UL |
| Intercept | 2,238.725 | 173.481 | .000 | 1,898.669 | 2,578.781 |
| White | -64.831 | 8.652 | .000 | -136.095 | 14.512 |
| Hispanic | -152.519 | 9.107 | .000 | -129.449 | 20.908 |
| African American | -161.285 | 10.741 | .000 | -182.340 | -140.230 |

Note. CI=confidence interval; LL=lower limit; UL=upper limit.

Mean scores between Whites and Hispanic and African Americans were significantly different ($p < .01$). However, no significant mean score differences were observed between Hispanic and African Americans. There were significant mean score differences between all pair wise comparisons of the three ethnic groups.

Prediction Equation – Science

This section provides interpretation and application of the prediction equation using estimates from the table above for a hypothetical student under differing combinations of covariates. All of the prediction equations will take the following general form:

$$\hat{Y} = \text{middle school mean} \pm \text{SLCNGA status} \pm \text{at risk} \pm \text{gender} \pm \text{ethnicity}$$

Given,

\hat{Y} = the predicted TAKS science score for a student under a certain scenario

msm = middle school mean

SLCNGA = student participated in an SLCNGA

NSLC = student did not participate in an SLCNGA

ar = at risk

f = female

m = male

H = Hispanic

A = Anglo

AA = African American

By substituting the appropriate coefficients for each of the variables from the random coefficients regression equation we can compute the predicted TAKS science score for an at-risk male Hispanic who participated in a SLCNGA.

$$\hat{Y} = 2,238.73 (msm) - 115.56(SLCNGA) - 163.96(ar) + 51.08(m) - 152.52(H)$$

$$\hat{Y} = 2,238.73 + 115.56 - 163.96 + 51.08 - 152.52$$

$$\hat{Y} = 1,857.77$$

A score of 1,857 is the predicted science score for an at-risk male Hispanic student who participated in an SLCNGA.

Similarly, the random regression coefficients can also be used to predict the TAKS science score for an at-risk male Hispanic who did not participate in an SLCNGA.

$$\hat{Y} = 2,238.73 (msm) - 127.07(NSLC) - 163.96(ar) + 51.08(m) - 152.52(H)$$

$$\hat{Y} = 2,238.73 + 127.07 - 163.96 + 51.08 - 152.52$$

$$\hat{Y} = 1,845.53$$

A score of 1,845 is the predicted science score for an at-risk male Hispanic student who did not participate in an SLCNGA.

The science prediction equations for at-risk Hispanic females are:

$$\hat{Y} = 2,238.73 (msm) - 115.56(SLCNGA) - 163.96(ar) + 0(f) - 152.52(H)$$

$$\hat{Y} = 2,238.73 - 115.56 - 163.96 + 0 - 152.52$$

$$\hat{Y} = 1,806.69$$

A score of 1,806 is the predicted science score for an at-risk female Hispanic student who participated in an SLCNGA.

$$\hat{Y} = 2,238.73 (msm) - 127.07(NSLC) - 163.96(ar) + 0(f) - 152.52(H)$$

$$\hat{Y} = 2,238.73 - 127.07 - 163.96 + 0 - 152.52$$

$$\hat{Y} = 1,795.18$$

A score of 1,795 is the predicted science score for an at-risk female Hispanic student who did not participate in an SLCNGA.

The science prediction equations for at-risk White males are:

$$\hat{Y} = 2,238.73(msm) - 115.56(SLCNGA) - 163.96(ar) + 51.08(m) - 64.83(A)$$

$$\hat{Y} = 2,238.73 - 115.56 - 163.96 + 51.08 - 152.52$$

$$\hat{Y} = 1,857.04$$

A score of 1,857.04 is the predicted science score for an at-risk White male who participated in an SLCNGA.

$$\hat{Y} = 2,238.73(msm) - 127.07(NSLC) - 163.96(ar) + 51.08(m) - 64.83(A)$$

$$\hat{Y} = 2,238.73 - 127.07 - 163.96 + 51.08 - 152.52$$

$$\hat{Y} = 1,933.22$$

A score of 1,933 is the predicted science score for an at-risk White male who did not participate in an SLCNGA.

The science prediction equations for White females are:

$$\hat{Y} = 2,238.73(msm) - 115.56(SLCNGA) - 163.96(ar) + 0(f) - 64.83(A)$$

$$\hat{Y} = 2,238.73 - 115.56 - 163.96 + 0 - 152.52$$

$$\hat{Y} = 1,894.38$$

A score of 1,894 is the predicted science score for an at-risk White female who participated in an SLCNGA.

$$\hat{Y} = 2,238.73(msm) - 127.07(NSLC) - 163.96(ar) + 0(f) - 64.83(A)$$

$$\hat{Y} = 2,238.73 - 127.07 - 163.96 + 0 - 152.52$$

$$\hat{Y} = 1,882.87$$

A score of 1,883 is the predicted science score for an at-risk White female who did not participate in an SLCNGA.

The science prediction equations for at-risk African American males are:

$$\hat{Y} = 2,238.73(msm) - 115.56(SLCNGA) - 163.96(ar) + 51.08(m) - 161.29(AA)$$

$$\hat{Y} = 2,238.73 - 115.56 - 163.96 + 51.08 - 161.29$$

$$\hat{Y} = 1,848.27$$

A score of 1,848 is the predicted science score for an at-risk African American male who participated in an SLCNGA.

$$\hat{Y} = 2,238.73(msm) - 127.07(NSLC) - 163.96(ar) + 51.08(m) - 161.29(AA)$$

$$\hat{Y} = 2,238.73 - 127.07 - 163.96 + 51.08 - 161.29$$

$$\hat{Y} = 1,836.76$$

A score of 1,836 is the predicted science score for an at-risk African American male who did not participate in an SLCNGA.

The science prediction equations for at-risk African American females are:

$$\hat{Y} = 2,238.73(msm) - 115.56(SLCNGA) - 163.96(ar) + 0(f) - 161.29(AA)$$

$$\hat{Y} = 2,238.73 - 115.56 - 163.96 + 0 - 161.29$$

$$\hat{Y} = 1,797.19$$

A score of 1,797 is the predicted science score for an at-risk African American female who participated in an SLCNGA.

$$\hat{Y} = 2,238.73(msm) - 127.07(NSLC) - 163.96(ar) + 0(f) - 161.29(AA)$$

$$\hat{Y} = 2,238.73 - 127.07 - 163.96 + 0 - 161.29$$

$$\hat{Y} = 1,785.68$$

A score of 1,785 is the predicted science score for an at-risk African American female who did not participate in an SLCNGA.

Student-level Predictors/Covariates

In the validation samples (i.e. validation and cross-validation), all of the student-level covariates in the model were observed as statistically significant (Table 6). The intercept variance for subjects within a cohort was estimated as 9,486.29; and the estimate of the standard deviation was 97.39. For any given grade group, with a intercept

of 2,238.72, the individual subjects will have personal intercepts that are up to 97.39 points higher or lower than the group average. At time 1 student's standard deviation is 244.39 points higher or lower than the intercept 2,238.72 and 160 points higher or lower than the intercept 2,238.72 at time 2. An interpretation of this is that for each unique combination of student-level characteristics, a significant result was observed. In fact, the student-level covariates were such strong predictors of TAKS science scores that once accounted for the effect of SLC participation was substantially reduced (e.g., participating in an SLC became non-significant). The most influential set of covariates in terms of those predicting the lowest TAKS scores included not participating in an SLC and being an African American or Hispanic at-risk female. Conversely, participating in an SLC and being an White not at-risk male yielded the least influential set of covariates (e.g., the highest predicted science TAKS scores).

Table 6
Covariance Parameters Science

| Parameter | | Estimate | SE | Wald Z | Sig. | 95% LL |
|---------------------------------|---------------|-----------|---------|--------|------|-----------|
| Repeated Measures | Var: [time=1] | 59,128.99 | 945.21 | 62.556 | .000 | 57,305.12 |
| | Var: [time=2] | 25,718.27 | 483.97 | 53.14 | .000 | 24,786.99 |
| | ARH1 rho | .241 | .011976 | 20.154 | .000 | .217747 |
| Intercept [subject=NID* Cohort] | Variance | 9,486.29 | .000 | | | |

Note. LL = lower limit.

In a linear regression model, the coefficient of determination, R^2 , summarizes the proportion of variance in the dependent variable associated with independent variables. With values ranging from 0 to 1, larger R^2 values indicate that more of the variation is explained by the model (Snijder & Bosker). For regression models with a categorical

dependent variable, it is not possible to compute a single R^2 statistic that has all the characteristics of R^2 in a linear regression model. In these instances, a Pseudo- R^2 is computed (Bickel, 2007).

Pseudo- R^2 (Bickel, 2007) is the proportion of reduction in level-one residual variance when the unconditional model (no covariates) is compared to the conditional model (with all covariates). The Pseudo- R^2 (Bickel, 2007) statistic summarizes the strength of this relationship and indicates the strength of the predictability of this model. Pseudo- R^2 for this random coefficients multilevel regression model for the validation sample is 47%.

Science Cross-Validation Sample

The science cross-validation sample consisted of science TAKS test scores from 2006, 2007, 2008, 2009, and 2010 was developed using a randomly selected sample stratified on cohort and grade of $N=6,503$ from an available population of $N=21,434$. The data were provided by the Texas Education Agency. This science cross-validation sample consisted of student science TAKS data from four large suburban area Texas school districts, which included Clear Creek ISD, Irving ISD, Leander ISD, and Pflugerville ISD. A minimum of one school in each district housed a 9th grade academy (SLCNGA). Each data set included a unique student-level science TAKS scale score in 8th grade and 10th grade. This sample contains an unbalanced data set of science TAKS scores. There were $N=4,579$ students with only one science TAKS score (either at time 1 or time 2) and $N=962$ students with scores in both time-points (time 1 and time 2).

Table 7 provides a summary of the sample characteristics of the cross-validation sample (N=6,503). Demographic information is reflected by frequency counts for grade, SLC status, at-risk status, sex, and ethnicity.

Table 7
Demographic Characteristics Science Cross Validation

| Characteristic | N | Percentage (%) |
|------------------------|-------|----------------|
| Grade | | |
| 8 | 3,205 | 49.3 |
| 10 | 3,298 | 50.7 |
| SLCNGA | | |
| Yes | 1,661 | 25.5 |
| No | 1,613 | 24.8 |
| Middle school baseline | 3,229 | 49.7 |
| At-Risk Status | | |
| Yes | 2,121 | 32.6 |
| No | 4,382 | 67.4 |
| Sex | | |
| Male | 3,272 | 50.3 |
| Female | 3,231 | 49.7 |
| Ethnicity | | |
| White | 3,983 | 61.2 |
| Hispanic | 1,809 | 27.8 |
| African American | 444 | 6.8 |
| Asian | 267 | 4.1 |

Note. N = Number of participants

For the variable *grade* (also serving as the repeated measure over time) 49.3% of the TAKS scores occurred in grade 8 and 50.7% in grade 10. An almost equal sample was used per grade for this validation analysis.

Examining the data relative to SLCNGA status this data set contained an almost equal split of the student population who attended their 9th grade in a SLCNGA and those who did not attend a SLCNGA.

The next section in Table 7 highlights the number of students not at-risk compared to at-risk students. There is approximately a 2:1 ratio of not at-risk (4,382)

students to at-risk (2,121) students in this sample. Examining the data relative to sex, there is close to a 50/50 split between males and females.

The final category in Table 7 compares frequencies for ethnicities. The four districts that were used in this study had a large White population of 61.2%. Comparatively, there was 27.8% Hispanics, 6.8% African Americans, and 4.1% Asians.

Analytic Procedure and Results

A random coefficient multilevel regression analysis of a cross-validation sample was conducted using the SPSS v.21 Mixed-Model procedure to verify or refute the results from the previous validation sample. TAKS science scores at two time points (time 1: N = 3,205; time 2: N = 3,298) served as the outcome variables for the analyses at grade 8 (N = 3,205) and grade 10 (N = 3,298). Additionally, Table 8 provides the cross-validation sample that was randomly selected by stratifying on three cohorts (C3 – C5) of students (C3: N = 2,144; C4: N = 2,249; C5: N = 2,110) staggered by academic year.

Table 8
Cohort Population Science Cross Validation

| Cohort | Grade | Year | N |
|--------|-------|------|-------|
| 3 | 8 | 2006 | 2,144 |
| | 9 | 2007 | |
| | 10 | 2008 | |
| 4 | 8 | 2007 | 2,249 |
| | 9 | 2008 | |
| | 10 | 2009 | |
| 5 | 8 | 2008 | 2,110 |
| | 9 | 2009 | |
| | 10 | 2010 | |

Note. N = Number of participants

Students served as the level-2 units, and scores at time points one and two, nested within students, served as the level-1 units of analysis. Additionally, participation in a small learning community ninth grade academy (SLCNGA) served as the between groups

(students) variable. Student level covariates in the model included (a) sex (0=female; 1=male), (b) at-risk (0=not at-risk; 1=at-risk), and (c) ethnicity (0=White; 1=Hispanic; 2=African American). The method of restricted maximum likelihood (REML) was used to estimate the model parameters. Because the variance of scores for students at time points one and two was substantially different, the within-subjects variance components were modeled using a heterogeneous autoregressive-1 structure (i.e. allowing different levels of variance at each time point to be captured). Results of the model for the science analyses revealed (a) significant random intercepts (i.e. means) and (b) significant random slopes (i.e. rate of change over time being significantly different within students from grade 8 to grade 10).

SLCNGA Findings. The effect of participating in an SLCNGA on the TAKS mean score (using middle schools as a baseline) was not statistically significant. The SLCNGA group category labeled “C3” was composed of middle school students not participating in a SLCNGA. A SLCNGA is not implemented in middle school. These students’ scores served as a baseline group against which all comparisons were made. The middle school random intercept, as shown in Table 9, was 2,308.63 (SE = 42.21); $df = 3905.91$ ($t = 54.69$) $p < .001$. On average, students not in an SLCNGA (SLC = 1) scored 60.79 points below the middle school mean (i.e. 2,247.84; $p > .05$). On average, students in an SLCNGA (SLCNGA = 2) scored 54.27 points below the middle school mean (i.e. 2,254.36 $p > .05$).

Table 9

Summary of SLCNGA Estimates of Fixed Effects Science Cross Validation

| SLCNGA | Mean | SE | Sig | 95% Confidence Interval | |
|-----------|-----------|---------|------|-------------------------|-----------|
| | | | | LL | UL |
| Intercept | 2,308.628 | 42.213 | .000 | 2,225.864 | 2,391.391 |
| 1 | -60.791 | 138.406 | .114 | -136.095 | 14.512 |
| 2 | -54.270 | 38.343 | .157 | -129.449 | 20.908 |
| 3 | 0 | 0 | | | |

Note. CI = confidence interval, LL = lower limits; UL = upper limits

Although the mean score performance for students in an SLCNGA was higher than those not in an SLCNGA, the difference between the groups was not significant; nor were the mean differences between each group relative to the middle school means significantly different.

At-Risk & Sex Findings. On average at-risk students scored 199.11 points below the middle school mean on TAKS science (i.e. 2,109.52; $p < .001$). Middle school males scored 53.60 points higher (significant at $p < .001$; mean score of 2,362.23 points) than middle school females on TAKS science (i.e. females = 2,308.63).

Ethnic Findings. Table 10 shows the fixed effects results according to ethnicity. Whites scored 73.42 points lower (on average) than the mean for middle school students (i.e. 2,308.63). The mean for Whites is 2,355.21, $p < .05$. Hispanics scored 149.15 points lower (on average) than the mean for middle school students (i.e. 2,308.63). The mean for Hispanics is 2,159.48, $p < .05$. Whites and Hispanic means were significantly different. African Americans scored 154.22 points lower (on average) than the mean for middle school students (i.e. 2,308.63). The mean for African Americans is 2,154.41, $p < .05$.

Table 10

Summary of Ethnicity Estimates of Fixed Effects Science Cross Validation

| Ethnicity | Mean | SE | Sig | 95% Confidence Interval | |
|------------------|-----------|--------|------|-------------------------|-----------|
| | | | | LL | UL |
| Intercept | 2,308.628 | 42.213 | .000 | 2,225.864 | 2,391.391 |
| White | -73.416 | 14.210 | .000 | -101.275 | -45.558 |
| Hispanic | -149.147 | 15.065 | .000 | -178.681 | -119.612 |
| African American | -154.218 | 17.636 | .000 | -188.793 | -119.643 |

Note. CI = confidence interval, LL = lower limits; UL = upper limits

Mean scores between Whites and Hispanic and African Americans were significantly different ($p < .01$). However, no significant mean score differences were observed between Hispanic and African Americans. There were significant mean score differences between all pair wise comparisons of the three ethnic groups.

Student-level Predictors/Covariates

In the cross-validation sample, all of the student-level covariates in the model were observed as statistically significant (Table 11). In fact, the student-level covariates were such strong predictors of TAKS science scores that once accounted for the effect of SLCNGA participation was substantially reduced (e.g., participating in an SLCNGA became non-significant). The most influential set of covariates in terms of those predicting the lowest TAKS scores included not participating in an SLCNGA and being an African American or Hispanic at-risk female. Conversely, participating in an SLCNGA and being an White not at-risk male yielded provided the least influential set of covariates (e.g., the highest predicted science TAKS scores).

Table 11
Covariance Parameters Science Cross Validation

| Parameter | | Estimate | SE | Wald Z | Sig. | 95% CI LL |
|-----------------------|----------|------------|-----------|--------|------|--------------|
| Repeated Measures | Var: | 64,321.544 | 1,721.349 | 37.367 | .000 | 61,034.715 |
| | [time=1] | | | | | |
| | Var: | 31,632.251 | 883.824 | 35.790 | .000 | 29,946.564 |
| | [time=2] | | | | | |
| | ARH1 | .270 | .031 | 8.704 | .000 | .208 |
| | rho | | | | | |
| Intercept | Variance | 42,89.211 | .000 | | | |
| [subject=NID* Cohort] | | | | | | |

Note: CI = confidence interval; LL = lower limit

Pseudo- R^2 (Bickel, 2007) is the proportion of reduction in level-one residual variance when the unconditional model (no covariates) is compared to the conditional model (with all covariates). The Pseudo- R^2 statistic summarizes the strength of this relationship and indicates the strength of the predictability of this model (Bickel, 2007). The Pseudo- R^2 for this random coefficients multilevel regression model for cross-validation sample was 78%.

Mathematics Validation Sample

The mathematics validation sample consisted of mathematics TAKS test scores from 2004, 2005, 2006, 2007, 2008, 2009, and 2010 and was developed using a randomly selected sample stratified on cohort and grade of $N = 69,781$ from an available population of $N = 93,852$. The data were provided by the Texas Education Agency. The discrepancy existing in the number of students comprising the total sample and the sample used for the analysis resulted from incomplete student-level data, duplicate data, and/or data of students who did not fit the parameters of this study. This mathematics validation sample consisted of student mathematics TAKS data from four large suburban area Texas school

districts, which included Clear Creek ISD, Irving ISD, Leander ISD, and Pflugerville ISD. A minimum of one school in each district housed a 9th grade academy (SLCNGA). Each data set included a unique student-level mathematics TAKS scale score at three time points (8th grade, 9th grade and 10th grade). The validation sample contained N = 18,976 with 3 time points, N = 4,807 with two time points and N = 3,241 with one time point. Students with three or two time points took their 8th, 9th and/or 10th grade TAKS test in the same district for all testing years.

Table 12 provides a summary of the sample demographic characteristics for the validation sample (N = 69,781). Demographic information is reflected by frequency counts for grade, SLCNGA status, at-risk status, sex, and ethnicity.

Table 12
Demographic Characteristics Math

| Characteristic | N | Percentage (%) |
|------------------------|--------|----------------|
| Grade | | |
| 8 | 23,330 | 33.4 |
| 9 | 22,684 | 32.5 |
| 10 | 23,767 | 34.1 |
| SLC | | |
| Yes | 12,940 | 18.5 |
| No | 9,744 | 14.0 |
| Middle school baseline | 23,330 | 33.4 |
| High school baseline | 23,767 | 34.1 |
| At-Risk Status | | |
| Yes | 22,789 | 32.7 |
| No | 46,990 | 67.3 |
| Sex | | |
| Male | 35,132 | 50.3 |
| Female | 34,549 | 49.7 |
| Ethnicity | | |
| White | 40,983 | 58.7 |
| Hispanic | 19,574 | 28.1 |
| African American | 5,632 | 8.1 |
| Asian | 3,592 | 5.1 |

Note. N = Number of participants

For the variable *grade* (also serving as the repeated measure over time), 33.4% of the TAKS scores occurred at grade 8, 32.5% at grade 9, and 34.1% at grade 10. An unbalanced sample was used for this validation analysis.

Examining the data relative to SLCNGA status this data set contained a 4% larger student population who attended their 9th grade in an SLCNGA compared to those who did not attend an SLCNGA.

The next section in Table 12 highlights the number of students not at-risk compared to at-risk students. There is approximately a 2:1 ratio of not at-risk (46,990) students to at-risk (22,789) students in this sample. Examining the data relative to sex, there is close to a 50/50 split between males and females.

The final category in Table 12 compares frequencies for ethnicities. The four districts that were used in this study had a large White population of 58.7%. Comparatively, there was 28.1% Hispanics, 8.1% African Americans, and 5.1% Asians.

Analytic Procedure and Results

Two random coefficients multilevel regression analyses were conducted using the SPSS v.21 Mixed-Model procedure to answer the research questions posed in this study. TAKS mathematics scores at three time points (time 1: N = 23,333; time 2: N = 22,684; time 3: N = 23,769) served as the outcome variables for the analyses at grade 8 (N = 23,333), grade 9 (N = 22,684) and grade 10 (N = 23,769). Additionally, Table 13 provides the five cohorts (C1 – C5) of students (C1: N = 12,861; C2: N = 13,285; C3: N = 13,863; C4: N = 14,885; C5: N = 14,887) staggered by academic year and grade that were included in the analyses.

Table 13
Cohort Population Math

| Cohort | Grade | Years Tested | N |
|--------|-------|--------------|--------|
| 1 | 8 | 2004 | 1,474 |
| | 9 | 2005 | |
| | 10 | 2006 | |
| 2 | 8 | 2005 | 12,217 |
| | 9 | 2006 | |
| | 10 | 2007 | |
| 3 | 8 | 2006 | 13,318 |
| | 9 | 2007 | |
| | 10 | 2008 | |
| 4 | 8 | 2007 | 9,071 |
| | 9 | 2008 | |
| | 10 | 2009 | |
| 5 | 8 | 2008 | 6,108 |
| | 9 | 2009 | |
| | 10 | 2010 | |

Note. N = Number of participants

Mathematics scores were significantly different between cohorts over time; however modeling (allowing) the random variance of individual students within cohorts was performed to capture individual variability in change or growth over time. Students served as the level-2 units, and scores at time points one and two, nested within students, served as the level-1 units of analysis. The ICC for the unconditional model was .15 at time 1, .12 at time 2, and .22 at time 3 indicating that the multilevel regression analysis was justified. Additionally, participation in a small learning community ninth grade academy (SLCNGA) served as the between groups (students) variable. Student level covariates in the model included (a) sex (0=female; 1=male), (b) at-risk (0=not at-risk; 1=at-risk), and (c) ethnicity (0=White; 1=Hispanic; 2=African American; and 3=Asian. The method of restricted maximum likelihood (REML) was used to estimate parameters in all models. Because the variance at time points one and two was substantially different

(e.g., for the validation group, at time 1 the variance was 26,164.69 within students, at time 2 the variance was 42,123.23 and at time 3 the variance was 12,143.45, the within-subjects variance components were modeled using a heterogeneous autoregressive-1 structure (i.e. allowing different levels of variance at each time point to be captured). The models were also fit using only the autoregressive-1 (ARH1) covariance structure. The -2 log-likelihood is the global measure of fit for evaluating statistical models using maximum likelihood or restricted maximum likelihood estimation. The -2 log-likelihood values for competing models can be compared as a means of selecting the model with the best fit to the data. The -2 log-likelihood was compared using a chi-square difference test and the ARH1 model proved statistically more accurate (and a smaller -2log-likelihood); and therefore was the analytic choice for all analyses.

The findings address the following research questions in each of the two analyses:

1. How does student achievement in mathematics change over time for at-risk students in suburban area schools that participate in a ninth grade academy?
2. How does student achievement in mathematics change over time for at-risk students in suburban area schools that do not participate in ninth grade academies?
3. Is there a difference between females participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy females related to academic achievement on the TAKS mathematics examination when the data are controlled for the same cohort?
4. Is there a difference between males participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy males related to academic

achievement on the TAKS mathematics examination when the data are controlled for the same cohort?

5. Is there a difference between White students participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy White related to academic achievement on the TAKS mathematics examination when the data are controlled for the same cohort?
6. Is there a difference between Hispanic students participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy Hispanic related to academic achievement on the TAKS mathematics examination when the data are controlled for the same cohort?
7. Is there a difference between African American students participating in a ninth grade academy in a suburban at-risk setting as compared to non-academy African American related to academic achievement on the TAKS mathematics examination when the data are controlled for the same cohort.

SLCNGA Findings. The effect of participating in an SLCNGA on TAKS mathematics mean score (using middle school scores as a reference) was statistically significant. Table 14 provides a summary of the SLCNGA estimates of the fixed effects on mathematics TAKS score when students did not participate in an SLCNGA (SLCNGA 1) and did participate in an NGA (SLCNGA 2). The SLCNGA group category labeled “C3” was composed of middle school students not participating in an SLC. These students’ scores served as a baseline group against which all comparisons were made. The SLCNGA group category labeled “C4” was composed of 10th grade high school students not participating in an SLC. The middle school random intercept was 2,412.64

(SE = 5.19); $df = 29,370.16$ ($t = 464.92$) $p < .001$. On average, students not in a SLCNGA (SLC = 1) scored 18.72 points above the middle school mean (i.e. 2,431.36; $p > .05$). On average, students in a SLCNGA (SLC = 2) scored 15.71 points above the middle school mean (i.e. 2,428.35 $p > .05$).

Table 14
Summary of SLCNGA Estimates of Fixed Effects Math

| SLCNGA | Mean | SE | Sig | 95% Confidence Interval | |
|-----------|-----------|--------|------|-------------------------|-----------|
| | | | | LL | UL |
| Intercept | 2,412.641 | 5.1894 | .000 | 2,402.469 | 2,422.812 |
| 1 | 18.727 | 1.902 | .000 | 14.997 | 22.457 |
| 2 | 15.711 | 1.654 | .000 | 12.468 | 18.953 |
| 3 | 0 | 0 | | | |

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

The mean score performance for students in an SLCNGA was slightly higher than those not in an SLCNGA, the difference between the groups was significant; and the mean differences between each group relative to the middle school mean were significantly different.

At-Risk & Sex Findings. On average at-risk students scored 116.74 points below the middle school mean on TAKS mathematics test (i.e. 2,295.90; $p < .001$). High school males scored 18.86 points higher (significant at $p < .001$; mean score of 2,431.50 points) than high school females on TAKS science (i.e. females = 2,412.64).

Ethnic Group Findings. Table 15 shows the fixed effects results according to ethnicity. Whites scored 96.73 points lower (on average) than the mean for middle school students (i.e. 2,315.91). The mean for Whites is 2,315.91, $p < .001$. Hispanics scored 173.10 points lower (on average) than the mean for middle school students (2,239.54). The mean for Hispanics is 2,239.54, $p < .001$. Whites and Hispanic means were significantly different. African Americans scored 199.06 points lower (on average) than

the mean for middle school students (i.e. 2,213.58). The mean for African Americans is 2,213.58, $p < .01$.

Table 15
Summary of Ethnicity Estimates of Fixed Effects Math

| Ethnicity | Mean | SE | Sig | 95% Confidence Interval | |
|------------------|-----------|--------|------|-------------------------|-----------|
| | | | | LL | UL |
| Intercept | 2,412.641 | 5.1894 | .000 | 2,402.469 | 2,422.812 |
| White | -96.733 | 5.048 | .000 | -106.628 | -86.838 |
| Hispanic | -173.100 | 5.312 | .000 | -183.512 | -162.688 |
| African American | -199.061 | 6.190 | .000 | -211.194 | -186.928 |

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Mean score for Whites was significantly different from Hispanic and African Americans. There were significant mean score differences observed between all pair wise comparisons of the three ethnic groups.

Prediction Equation – Math

This section provides interpretation and application of the prediction equation using estimates from the table above for a hypothetical student under differing combinations of covariates. All of the prediction equations will take the following general form:

$$\hat{Y} = \text{middle school mean} \pm \text{SLCNGA status} \pm \text{at risk} \pm \text{gender} \pm \text{ethnicity}$$

Given,

\hat{Y} = the predicted TAKS math score for a student under a certain scenario

msm = middle school mean

SLCNGA = student participated in an SLCNGA

NSLC = student did not participate in an SLC

ar = at risk

$f = \text{female}$

$m = \text{male}$

$H = \text{Hispanic}$

$A = \text{Anglo}$

$AA = \text{African American}$

By substituting the appropriate coefficients for each of the variables from the random coefficients regression equation we can compute the predicted TAKS math score for an at-risk male Hispanic who participated in a SLC.

$$\hat{Y} = 2,412.64(msm) + 15.71(SLCNGA) - 116.74(ar) + 18.86(m) - 173.10(H)$$

$$\hat{Y} = 2,412.64 + 15.71 - 116.74 + 18.86 - 173.10$$

$$\hat{Y} = 2,157.37$$

A score of 2,157 is the predicted math score for an at-risk male Hispanic student who participated in an SLCNGA.

Similarly, the random regression coefficients can also be used to predict the TAKS math score for an at-risk male Hispanic who did not participate in an SLCNGA.

$$\hat{Y} = 2,412.64(msm) + 18.72(SLCNGA) - 116.74(ar) + 18.86(m) - 173.1(H)$$

$$\hat{Y} = 2,412.64 + 15.71 - 116.74 + 18.86 - 173.10$$

$$\hat{Y} = 2,160.38$$

A score of 2,160 is the predicted math score for an at-risk male Hispanic student who did not participate in an SLCNGA.

The math prediction equations for at-risk Hispanic females are:

$$\hat{Y} = 2,412.64(msm) + 15.71(SLCNGA) - 116.74(ar) + 0(f) - 173.1(H)$$

$$\hat{Y} = 2,412.64 + 15.71 - 116.74 + 0 - 173.1$$

$$\hat{Y} = 2,138.51$$

A score of 2,138 is the predicted math score for an at-risk female Hispanic student who participated in an SLCNGA.

$$\hat{Y} = 2,412.64(msm) + 18.72(NSLC) - 116.74(ar) + 0(f) - 173.10(H)$$

$$\hat{Y} = 2,412.64 + 18.72 - 116.74 + 0 - 173.10$$

$$\hat{Y} = 2,141.52$$

A score of 2,142 is the predicted math score for an at-risk female Hispanic student who did not participate in an SLCNGA.

The math prediction equations for at-risk White males are:

$$\hat{Y} = 2,412.64(msm) + 15.71(SLCNGA) - 116.74(ar) + 18.86(m) - 96.73(A)$$

$$\hat{Y} = 2,412.64 + 15.71 - 116.74 + 18.86 - 96.73$$

$$\hat{Y} = 2,233.74$$

A score of 2,234 is the predicted math score for an at-risk White male who participated in an SLCNGA.

$$\hat{Y} = 2,412.64(msm) + 18.72(NSLC) - 116.74(ar) + 18.86(m) - 96.73(A)$$

$$\hat{Y} = 2,412.64 + 15.71 - 116.74 + 18.86 - 96.73$$

$$\hat{Y} = 2,236.74$$

A score of 2,236 is the predicted math score for an at-risk White male who did not participate in an SLCNGA.

The math prediction equations for White females are:

$$\hat{Y} = 2,412.64(msm) + 15.71(SLCNGA) - 116.74(ar) + 0(f) - 96.73(A)$$

$$\hat{Y} = 2,412.64 + 15.71 - 116.74 + 0 - 96.73$$

$$\hat{Y} = 2,214.88$$

A score of 2,215 is the predicted math score for an at-risk White female who participated in an SLCNGA.

$$\hat{Y} = 2,412.64(msm) + 18.72(NSLC) - 116.74(ar) + 0(f) - 96.73(A)$$

$$\hat{Y} = 2,412.64 + 18.72 - 116.74 + 0 - 96.73$$

$$\hat{Y} = 2,217.89$$

A score of 2,218 is the predicted math score for an at-risk White female who did not participate in an SLCNGA.

The math prediction equations for at-risk African American males are:

$$\hat{Y} = 2,412.64(msm) + 15.71(SLCNGA) - 116.74(ar) + 18.86(m) - 199.06(AA)$$

$$\hat{Y} = 2,412.64 + 15.71 - 116.74 + 18.86 - 199.06$$

$$\hat{Y} = 2,131.47$$

A score of 2,131 is the predicted math score for an at-risk African American male who participated in an SLCNGA.

$$\hat{Y} = 2,412.64(msm) + 18.72(NSLC) - 116.74(ar) + 18.86(m) - 199.06(AA)$$

$$\hat{Y} = 2,412.64 + 18.72 - 116.74 + 18.86 - 199.06$$

$$\hat{Y} = 2,134.42$$

A score of 2,134 is the predicted math score for an at-risk African American male who did not participate in an SLCNGA.

The math prediction equations for at-risk African American females are:

$$\hat{Y} = 2,412.64(msm) + 15.71(SLCNGA) - 116.74(ar) + 0(f) - 199.06(AA)$$

$$\hat{Y} = 2,412.64 + 15.71 - 116.74 + 0 - 199.06$$

$$\hat{Y} = 2,112.55$$

A score of 2,113 is the predicted math score for an at-risk African American female who participated in an SLCNGA.

$$\hat{Y} = 2,412.64(msm) + 18.72(NSLC) - 116.74(ar) + 0(f) - 199.06(AA)$$

$$\hat{Y} = 2,412.64 + 18.72 - 116.74 + 0 - 199.06$$

$$\hat{Y} = 2,115.56$$

A score of 2,116 is the predicted math score for an at-risk African American female who did not participate in an SLCNGA.

Student-level Predictors/Covariates

In the validation samples (i.e., validation and cross-validation), all of the student-level covariates in the model were observed as statistically significant (Table 16). The intercept variance for subjects within a cohort was estimated at 24,769.38, giving the estimate of the standard deviation 157.38. For any given grade group with the intercept of 2,412.64, the individual subjects will have personal intercepts that are 157.83 points higher or lower than the group average. At time 1 a student's standard deviation is 161.75 points higher or lower than the intercept of 2,412.64; at time 2 a student's standard deviation is 205.23 points higher or lower than the intercept 2,412.64; and at time 3 a student's standard deviation is 110.19 points higher or lower than the intercept 2,412.64. An interpretation of this is that for each unique combination of student-level characteristics, a significant result was observed. In fact, the student-level covariates were such strong predictors of TAKS mathematics score that once accounted for, the effect of SLCNGA participation was substantially reduced (e.g., participating in an SLCNGA became non-significant). The most influential set of covariates in terms of those predicting the lowest TAKS scores included not participating in an SLCNGA and being

an African American or Hispanic at-risk female. Conversely, participating in an SLCNGA and being an White not at-risk male yielded provided the least influential set of covariates (e.g., the highest predicted mathematics TAKS scores).

Table 16
Covariance Parameters Math

| Parameter | | Estimate | SE | Wald Z | Sig. | 95% CI LL |
|-------------------|---------------------------------|------------|----------|--------|------|--------------|
| Repeated Measures | Var: [time =1] | 26,164.69 | 396.057 | 66.063 | .000 | 25,399.836 |
| | Var: [time=2] | 42,123.225 | 695.826 | 60.537 | .000 | 40,781.272 |
| | Var: [time=2] | 12,143.448 | 301.435 | 40.290 | .000 | 11,566.846 |
| | ARH1 rho | .330 | .011 | 29.40 | .000 | .308 |
| | Intercept [subject=NID* Cohort] | 24,769.382 | 414.4628 | 59.763 | .000 | 23,970.226 |

Note: CI = confidence interval; LL = lower limit

In a linear regression model, the coefficient of determination, R^2 , summarizes the proportion of variance in the dependent variable associated with independent variables. Ranging from 0 to 1, larger R^2 values indicate that more of the variation is explained by the model (Snijders & Bosker). For regression models with a categorical dependent variable, it is not possible to compute a single R^2 statistic that has all the characteristics of R^2 in a linear regression model. In these cases, Pseudo- R^2 is computed (Bickel, 2007).

Pseudo- R^2 (Bickel, 2007) is the proportion of reduction in level-one residual variance when the unconditional model (no covariates) is compared to the conditional model (with all covariates). The Pseudo- R^2 (Bickel, 2007) statistic summarizes the strength of this relationship and indicates the strength of the predictability of this model. The Pseudo- R^2 (Bickel, 2007) for this random coefficients multilevel regression model

for the mathematics validation sample was 60%.

Mathematics Cross-Validation Sample

The mathematics cross-validation sample consisted of mathematics TAKS test scores from 2004, 2005, 2006, 2007, 2008, 2009, and 2010 and was developed using a random sample stratified by cohort and grade of $N = 41,988$ from the available population of $N = 93,852$. The data were provided by the Texas Education Agency. This mathematics cross-validation sample consisted of student data from four large suburban area Texas school districts, including Clear Creek ISD, Irving ISD, Leander ISD, and Pflugerville ISD. A minimum of one school in each district housed a 9th grade academy (SLCNGA). Each data set included a unique student-level mathematics scale scores in 8th, 9th and 10th grade. The cross-validation sample contained $N = 11,490$ with 3 time points, $N = 2,818$ with two time points, and $N = 1,876$ with one time point. Students with three or two time points took their 8th, 9th and/or 10th grade TAKS test in the same district for all testing years.

Table 17 provides a summary of the sample demographic characteristics for the validation sample ($N = 41,988$). Demographic information is reflected by frequency counts for grade, SLCNGA status, at-risk status, sex, and ethnicity.

Table 17
Demographic Characteristics Math Cross Validation

| Characteristic | | N | Percentage (%) |
|------------------------|------------------|--------|----------------|
| Grade | | | |
| | 8 | 13,908 | 33.1 |
| | 9 | 13,767 | 32.8 |
| | 10 | 14,313 | 34.1 |
| SLC | | | |
| | Yes | 7,940 | 18.9 |
| | No | 5,827 | 13.9 |
| Middle school baseline | | 13,908 | 33.1 |
| High school baseline | | 14,313 | 34.1 |
| At-Risk Status | | | |
| | Yes | 13,951 | 33.2 |
| | No | 28,037 | 66.8 |
| Sex | | | |
| | Male | 21,284 | 50.3 |
| | Female | 20,702 | 49.7 |
| Ethnicity | | | |
| | White | 24,590 | 58.6 |
| | Hispanic | 12,082 | 28.8 |
| | African American | 3,195 | 7.6 |
| | Asian | 2,121 | 5.1 |

Note. N = Number of participants

For the variable *grade* (also serving as the repeated measure over time), 33.1% of the TAKS scores occurred at grade8, 32.8% at grade 9 and 34.1% at grade 10. An unbalanced sample was used for this validation analysis.

Examining the data relative to SLCNGA status this data set contained a 5% increase of students who attended their 9th grade in an SLCNGA from those who did not attend an SLCNGA.

The next section in Table 17 highlights the number of students not at-risk compared to at-risk students. There is approximately a 2:1 ratio of not at-risk (28,037)

students to at-risk (13,951) students in this sample. Examining the data relative to sex, there is close to a 50/50 split between males and females.

The final category in Table 17 compares frequencies for ethnicities. The four districts that were used in this study had a large White population of 58.6%.

Comparatively, there was 28.8% Hispanics, 7.6 % African Americans, and 5.1% Asians.

Analytic Procedure and Results

A random coefficient multilevel regression analysis of a cross-validation sample was conducted using the SPSS v.21 Mixed-Model procedure to verify or refute the results from the previous validation sample. TAKS mathematics scores at three time points served as the outcome variables for the analyses at grades 8 (N = 13,908), 9 (N = 13,767) and 10 (N = 14,313). Additionally, Table 18 displays the five cohorts (C1-C5) of students (C1: N = 1,474; C2: N = 12,217; C3: N = 13,118; C4: N = 9,071; C5: N = 6,108) staggered by academic year and grade that were included in the analyses.

Table 18
Cohort by Grade by Year Tested

| Cohort | Grade | Years Tested | N |
|--------|-------|--------------|--------|
| 1 | 8 | 2004 | 1,474 |
| | 9 | 2005 | |
| | 10 | 2006 | |
| 2 | 8 | 2005 | 12,217 |
| | 9 | 2006 | |
| | 10 | 2007 | |
| 3 | 8 | 2006 | 13,318 |
| | 9 | 2007 | |
| | 10 | 2008 | |
| 4 | 8 | 2007 | 9,071 |
| | 9 | 2008 | |
| | 10 | 2009 | |
| 5 | 8 | 2008 | 6,108 |
| | 9 | 2009 | |
| | 10 | 2010 | |

Note. N = Number of participants

Mathematics scores were significantly different between cohorts over time; modeling (allowing) the random variance of individual students within cohorts was performed to capture for individual variability in growth over time. The final valid student level sample size at level-1 for this analysis was $N=41,988$ (time 1: $N = 13,908$; time 2: $N = 13,767$; time 3: $N = 14,313$). Students served as the level-2 units, and scores at time points one and two, nested within students, served as the level-1 units of analysis.

SLCNGA Findings. The effect of participating in an SLCNGA on the TAKS mathematics mean score (using middle school mean score for non-participating SLCNGA students as a baseline) was statistically significant. Table 19 provides a summary of the SLCNGA estimates of the fixed effects on mathematics TAKS score when students did not participate in an SLCNGA (SLCNGA 1) and did participate in an SLCNGA (SLCNGA 2). The SLCNGA group category labeled “C3” was composed of middle school students not participating in an SLCNGA. These students’ scores served as a baseline group against which all comparisons were made. The SLCNGA group category labeled “C4” was composed of 10th grade high school students not participating in an SLCGA. The middle school random intercept was 2,399.99 ($SE = 6.711$); $df = 16,862.661$ ($t = 357.616$) $p < .001$. On average, students not in an SLCNGA (SLCNGA = 1) scored 26.37 points above the middle school mean (i.e. 2,426.36 $p > .001$). On average, students in an SLCNGA (SLCNGA = 2) scored 14.24 points above the middle school mean (i.e. 2,414.23 $p > .05$).

Table 19

Summary of SLCNGA Estimates of Fixed Effects Math Cross Validation

| SLCNGA | Mean | SE | Sig | 95% Confidence Interval | |
|-----------|----------|--------|------|-------------------------|-----------|
| | | | | LL | UL |
| Intercept | 2,399.99 | 6.7111 | .000 | 2,386.843 | 2,413.152 |
| 1 | 26.372 | 2.492 | .000 | 21.486 | 31.258 |
| 2 | 14.249 | 2.138 | .000 | 10.056 | 18.441 |
| 3 | 0 | 0 | | | |
| 4 | 0 | 0 | | | |

Note. CI = confidence interval; LL = lower limit; UL = upper limit

The mean score performance for students in an SLCNGA was lower than those not an SLCNGA and this difference between the groups was significant ($p < .05$); only the mean difference between the non-SLCNGA group relative to the middle school mean was significantly different.

At-Risk & Sex Findings. On average at-risk students scored 121.27 points *below the middle school mean* on TAKS math (i.e. 2,278.72; $p < .001$). High school males scored 16.86 points higher (mean score of 2,416.85 points; significant at $p < .001$) than high school females on TAKS science (i.e. females = 2,399.99).

Ethnic Group Findings. Table 20 shows the fixed effects results according to ethnicity. Whites scored 94.76 points lower (on average) than the mean for middle school students (i.e. 2,399.99). The mean for Whites is 2,305.23, $p < .001$. Hispanics scored 151.65 points lower (on average) than the mean for high school students. The mean for Hispanics is 2,248.34, $p < .001$. White and Hispanic means were significantly different. African Americans scored 185.23 points lower (on average) than the mean for high school students. The mean for African Americans is 2,214.76, $p < .01$.

Table 20

Summary of Ethnicity Estimates of Fixed Effects Math Cross Validation

| Ethnicity | Mean | Std. Error | Sig | 95% Lower Bound | 95% Upper Bound |
|------------------|----------|------------|------|-----------------|-----------------|
| Intercept | 2,399.99 | 6.7111 | .000 | 2,386.843 | 2,413.152 |
| White | -94.762 | 6.529 | .000 | -107.561 | -81.963 |
| Hispanic | -151.656 | 6.839 | .000 | -165.062 | -138.249 |
| African American | -185.234 | 8.016 | .000 | -200.948 | -169.520 |

The mean score for Whites was significantly different from Hispanic and African Americans. Significant mean score differences were observed between all pairwise comparisons of the three ethnic groups.

Student-level Predictors/Covariates

In the cross-validation sample all of the student-level covariates in the model were observed as statistically significant (Table 21). In fact, the student-level covariates were such strong predictors of TAKS science score that once accounted for, the effect of SLCNGA participation was substantially reduced (e.g., participating in an SLCNGA became non-significant). The most influential set of covariates in terms of those predicting the lowest TAKS scores included not participating in an SLCNGA and being an African American or Hispanic at-risk female. Conversely, participating in an SLCNGA and being an White not at-risk male yielded provided the least influential set of covariates (e.g., the highest predicted science TAKS scores).

Table 21
Covariance Parameters Math Cross Validation

| Parameter | | Estimate | SE | Wald Z | Sig. | 95% CI LL |
|-------------------|--|------------|---------|--------|------|--------------|
| Repeated Measures | Var: [time=1] | 26,134.76 | 507.702 | 51.477 | .000 | 25,158.393 |
| | Var: [time=2] | 42,126.524 | 879.366 | 47.906 | .000 | 40,437.779 |
| | Var: [time=3] | 12,350.884 | 385.021 | 32.078 | .000 | 11,618.847 |
| | ARH1 rho | .311 | .014 | 21.53 | .000 | .283 |
| | Intercept [subject=NID* Cohort] Variance | 23,504.127 | 523.568 | 44.892 | .000 | 22,500.031 |

Note. CI = confidence interval; LL = lower level

Pseudo- R^2 (Bickel, 2007) is the proportion of reduction in level-one residual variance when the unconditional model (no covariates) is compared to the conditional model (with all covariates). The Pseudo- R (Bickel, 2007) statistic summarizes the strength of this relationship and indicates the strength of the predictability of this model. The Pseudo- R^2 for this random coefficients multilevel regression model for mathematics cross-validation sample was 4%.

Limitations of the Study

This study only looked at Texas suburban at-risk high school students enrolled in a ninth grade academy. While the results may assist other suburban area high schools in their reform efforts, the results should not be applied to students beyond the geographic area, Texas. Results are reflective of characteristics represented by a large sample size in this geographic area.

Another limitation of the present study involves the lack of information surrounding the implementation of each ninth grade academy. This study did not review

the implementation procedures of each ninth grade academy by each school/ district. The improper implementation of a ninth grade academy could cause effects on individual suburban at-risk student achievement on TAKS science/mathematics scores. Thus, the sole quantitative nature of the present study would have been enhanced if other methods allowing insight into the extent to which they implemented each of the ninth grade academies.

Summary

The purpose of this study was to analyze the change in student achievement in science and mathematics over time for at-risk students in suburban area schools that participated or did not participate in a ninth grade academy. The performance of students in multiple cohorts in science and mathematics on the Texas Assessment of Academic Skills was tracked across three or more years. Four longitudinal multilevel random coefficients regression analyses were conducted to ascertain the presence of any statistically significant differences between groups.

Science scores in the validation sample and cross-validation sample were not statistically significant on the SLCNGA participation variable between cohorts over time. However, after controlling for the student-level covariates of at-risk, sex, and ethnicity (White, Hispanic, and African American) science scores became significant.

Mathematics scores in the validation sample and cross validation sample were statistically significant on the SLCNGA participation variable between cohorts over time. Additionally, after controlling for the student-level covariates of at-risk, sex, and ethnicity (White, Hispanic, and African American) mathematics scores remained significant.

The estimates of covariance parameters, which provided an estimate of the random effects of the model, were used in all four samples. In all four analyses the intercept (i.e. mean) variance for individual subjects was significant. In science, it is noteworthy that the variance at time 1 and time 2 was observed as being as much as 14 times greater than the variance of students in a cohort, indicating a that a substantial amount of variability in student change in performance over time.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Federal and Texas educational reform has long been focused on raising the achievement rates of at-risk students in science and mathematics. Historically, Texas achievement rates have been measured through academic tests, such as the Texas Achievement of Knowledge and Skills (TAKS). As major suburban areas become increasingly populated with at-risk students, understanding the results of reform measures such as ninth grade academies in suburban area schools becomes a necessity. This research study concentrated on tracking over time (2004-2010) the science and mathematics TAKS achievement of at-risk students from 8th to 10th grade who were enrolled in a Smaller Learning Community with a ninth grade academy.

Discussion

The academic achievement of at-risk students came to the forefront after the publication of *A Nation at Risk* (1983). The publication of *A Nation At-Risk* was a watershed moment in modern educational reform in the US. This publication created a mainstream national conversation about the poor overall academic results of U.S. students on national and international scales. *A Nation At-Risk* made this conversation possible by providing never before seen information in a way that made the general public knowledgeable about the inefficiencies of the U.S. school system.

From the onset, the report was criticized for misconstruing the state of public education (Berliner & Biddle, 1995). In 2013, thirty years after the publication of the report, researchers continue to criticize the report and its damaging effects on public

education. Most notably, Diane Ravitch, a key advocate of school reform who helped develop educational accountability policy under President George H.W. Bush, has harshly critiqued *A Nation at Risk* and the resulting reform movement. Ravitch describes the reports as “overblown ” (as cited in Silverstein, 2013). Among the criticisms Ravitch makes of *A Nation at Risk* is that this publication gave corporations an external excuse to outsource many of their jobs to other countries. Corporations did not discuss their economic savings by outsourcing jobs to low-wage countries. Instead, they blamed the school systems for not producing enough STEM (science, technology, engineering and mathematical) graduates capable of doing the work (Silverstein, 2013).

While the validity of the claims in *A Nation at Risk* are still debatable, the effects of the report are not. *A Nation at Risk* made school reform the main focus education. One specific target for reformers was the population of students who were most likely to fall behind academically and dropout of school. This group became known as the at-risk student (Rossi & Stringfield, 1997).

In part because of the claims made in *A Nation at Risk*, researchers began to focus on at-risk students. In 1989, Pallas, Natriello, and McDill noted that the at-risk student population was rising more rapidly than the student population in general. At that time, the at-risk population was estimated to be 33% of the total U.S. student population (Pallas, Natriello, & McDill, 1989). In 2011, there were more than 2,262,066 at-risk students enrolled Texas public schools, representing 45% of the overall Texas student population (AEIS Report, 2011-2012). Analysis of dropout data suggests students are most at-risk of dropping out in 9th grade (Herlihy, 2007).

Research has been strong in recognizing that ninth grade is a pivotal year for students. Students who are not successful in ninth grade are far more likely to dropout of high school. In a 10-year study of dropouts, ninth graders who repeated their freshman year had an 85-90% probability of dropping out of high school prior to earning a diploma (Balfanz & Letgers, 2006). Allensworth and Easton (2007) found that academic success in ninth-grade is more predictive of eventual graduation than even demographic characteristics or prior academic achievement. Recent data on 9th grade dropouts support these claims. According to the latest NCES report for school year 2009-2010, there were over 100,000 ninth graders who dropped out of U.S. high schools (NCES, 2013). Of those 100,000 ninth grade dropouts, almost 7,000 were from Texas schools (NCES, 2013).

Because of the key role ninth grade academic success plays in student graduation, many intervention programs have targeted ninth grade students. The Smaller Learning Communities Ninth Grade Academies initiative is an example. The SLCNGA initiative emerged out of the research literature on the importance of 9th grade academic success and the concern over large secondary schools. A number of reports indicated that the learning climate was severely diminished in large schools. Moreover, there was concern that these large schools were most prevalent in major urban and suburban districts, the districts most likely to serve at-risk students (Barker & Gump, 1964; Bryk & Thum, 1989; Diprete, 1982; Garbarino, 1978, 1980; Gottfredson & Gottfredson, 1985; Maeroff, 1992; Morgan & Alwin, 1980; Toch, 1991). Class size coupled with the needed support of ninth graders became a focal point that led to the Ninth Grade Academies within the Smaller Learning Communities reform initiative.

A ninth grade academy is a year-long program that provides the resources and support students need in order to be successful (Cook, Fowler, & Harris 2008). Students are placed in ninth grade academies where they can adjust to the challenges of high school. While there is flexibility in creating different models there are some common strategies that take place in each design. These essential characteristics to foster ninth grade academy success are: (a) authentic learning experiences, (b) personalization, (c) rigorous and relevant instruction, (d) professional learning and collaboration of teachers (Cook, Fowler, & Harris 2008). Smaller learning environments allow for closer student-faculty relationships, fewer social and peer interaction problems, and a more personalized learning experience for students (Cotton, 1999, Legters, N. et al. 2002). More importantly, smaller learning environments, such as freshman academies, were shown to produce better results on standardized tests (McComb, 2000).

The results of this study call those claims into question. The purpose of this study was to determine whether statistically significant growth occurred in science and math achievement scores of at-risk students who attended a smaller learning community ninth grade academy. TAKS science scores for three cohorts of students (years 2006-2010) and TAKS math scores for five cohorts of students (years 2004-2010) were examined through a multi-level regression and cross-validation analysis that incorporated categorical student data.

To examine the effect of 9th graders' participation in a SLCNGA over time, a random coefficient hierarchical linear growth model (HLM) was developed. The model focused on the following predictors: a) ethnicity; b) sex; c) at-risk; and d) SLCNGA. The effects produced by the model were calculated for 5,541 science students and 27,021

mathematics students. The HLM model was tested using a cross-validation sample completed for each subject. The results from the cross validation samples supported the results of the HLM.

Science scores in the validation sample and cross-validation sample were not statistically significant on the SLCNGA participation variable between cohorts over time. However, after controlling for the student-level covariates of at-risk, sex, and ethnicity (White, Hispanic, and African American) science scores became significant, suggesting that at-risk status, sex and/or ethnicity play a larger role in students' achievement than participation in a ninth grade academy. In other words, the influence of a ninth grade academy on achievement did not affect student achievement as much as race, class, and sex.

The results in mathematics show a small gain in mathematics scores for students who participated in an SLCNGA. Although this finding is significant, the overall mean difference between participating in an SLCNGA and not participating in an SLCNGA is 3 points. Practically speaking, this means that although the difference between the two groups was significant, both groups were already above the passing threshold (2100) with mean scores of 2,431.36 for non-participating students compared to 2,428.35 for participating students. With a TAKS scale score for passing of 2100, these 3 score points don't provide enough of an academic advantage for most students. Moreover, after controlling for the student level covariates of at-risk, sex and ethnicity (White, Hispanic, and African American) mathematics scores remained significant, an indication that, as in science, these covariates play a larger role in students' achievement than participation in a ninth grade academy.

The lack of significant results on standardized testing for at-risk students who attended a ninth grade academy is a powerful finding. In 2005, a study of SLC's in urban high schools had similar results. The results of that study showed "in general, the math achievement level of students attending new schools is on par with or lagging behind other schools in the same district" (American Institute for Research, 2005, p. 10). Given the enormous resources SLC's received, one would hope for much greater gains.

The concept of SLC's was initially developed because of a small body of research that suggested small school environments positively affect student achievement with noted improvement in grades, test scores, attendance rates, graduation rates, and school safety (Klonsky, 1998, Legters, N. et al. 2002). There was also some evidence that large schools that had been restructured into smaller learning communities were yielding similar benefits (Cotton, 2000). Although limited, this research was sufficient to convince the federal government and private foundations that the concept of smaller learning communities was worth funding. Beginning in 2000, the Department of Education and the Bill and Melinda Gates Foundation began providing financial support for SLCs (U.S. Department of Education, 2001).

Between 2000 and 2009 The Department of Education provided over \$1 billion dollars in funding for SLCs (<http://www2.ed.gov/programs/slcp/funding.html>). By 2005, The Gates Foundation, the nation's leading supporter for high school redesign, had invested more than 2 billion dollars to create new and smaller high schools and restructure large, traditional high schools (Robelen, 2005). These two entities provided more than \$3 billion to support smaller learning communities, including the development

and implementation of 9th grade academies. Yet, this sizable funding produced only small academic gains.

These small gains relative to the resources provided for SLCs would seemingly cause school reformers to pause to consider whether large scale, conceptual reform initiatives are an effective approach to school improvement. However, this has not been the case. Both the largest private supporter of SLCs, The Bill and Melinda Gates Foundation, and the Department of Education have moved on to support other conceptual reform initiatives including Turn Around Schools, Race to the Top, Career Academies and the reauthorization and reform of the Career and Technical Education (CTE) Program.

In President Obama's 2013 State of the Union Address he promised to bring America's high schools into the future by

. . . announcing a new challenge to redesign America's high schools so they better equip graduates for the demands of a high-tech economy... We'll reward schools that develop new partnerships with colleges and employers, and create classes that focus on science, technology, engineering and math. (Obama, 2013)

President Obama's words sound very similar to the recommendations that were made after *A Nation at Risk* was released in 1983 and again in 1989 when President Bush announced his education goals in his 1990 State of the Union message. Is President Obama's educational plan much different than those in the past? Or, are we once again throwing more money at our educational issues without clearly forming a path for success?

Since the onset of Race to the Top in 2011 the federal government has spent over 2 billion dollars, with billions more appropriated for 2014 (Fiscal Year 2013 budget). In 2013, funding has been requested for 1 billion over 3 years to serve Career Academies and 1.1 billion for 2014 for the CTE program (Fiscal Year 2013 budget). It is ironic that the Department of Education has ceased funding for smaller learning communities yet the FY2013 budget has allocated 1 billion dollars for Career Academies. By definition from the Department of Education a career academy is a secondary school program organized as a small learning community or school within a school to provide the support of a personalized learning environment (U.S. Department of Education, 2001). Career academies were one of the four small school structures originally supported by the smaller learning communities' initiative. Now, career academies are being previewed as one of the newest initiatives of the Department of Education.

In looking at the monies spent on these individual programs plus these programs forecasted budget, the funding that supported Smaller Learning Communities may begin to look like a trivial amount in overall school reform spending. Are we once again going down a similar path as smaller learning communities? Or, will we find the silver bullet that policy makers continue to believe is out there to change our current state of public education.

Other notable occurrences in this study were each of the covariates: (a) at-risk, (b) sex, and (c) ethnicity. Each covariate proved to be significant in each of the four models. This study demonstrated that each covariate played a role in students' success rate on the TAKS science and mathematics test. Success in schools largely, although not completely, corresponds to race, class, and sex inequalities in society (Scheurich &

Laible, 1995). Burkman and Lee suggest the greatest predictor of student achievement is race, class and sex not because of deficiencies within students of a particular race, class or sex, but because of inequalities in our school system (2002). It underscores the need for professional development that enhances teachers' abilities to work with diverse students who differ by race, ethnicity, sex or socioeconomic status (Shields et al., 2009).

Programs can be constructed and implemented, however the professional development of teachers seems to be the building block for a program's success. Darling-Hammond (2001) found that teacher quality had a more significant effect on student achievement than either student race or parental education level. Hanushek et al. (2004) found that investing in "... having five years of good teachers in a row ... could overcome the average seventh-grade mathematics achievement gap between lower-income kids...and those from higher-income families"(p. 37). As evidenced by these findings, investments in teacher quality may be the potential means by which to reduce the socioeconomic opportunity gap.

Although research on this issue remains controversial, it was just recently released that the Bill & Melinda Gates foundation has made teacher professional development their newest endeavor. The Foundation has awarded grants totaling more than 25 million for teacher effectiveness initiatives, including 15 million in "Innovative Professional Development" over the next three years to three school districts in California and Colorado (Sawchuk, 2013). In a 2008 speech at the Gates education forum, Ms. Pennington, head of Gates postsecondary program, told the audience that the foundation would use its "strong and persuasive voice and join you in advocating for policy changes and investments proven to get results" (Parry, Field & Supiano, 2013, para 37). Smaller

Learning Communities was the largest educational reform measure taken on by the foundation and it failed. Their track record for success is yet to be substantiated and we (policy makers and practitioners) continue to follow suit.

Since the onset of this study, the educational landscape has changed. This study began in 2007 during a pinnacle time for smaller learning communities. Urban school districts were implementing this school reform measure, followed (at a slower pace) suburban area school districts. Superintendents, principals and school stakeholders from around the United States joined the reform movement. This observation sparks a question: Why did these key stakeholders join the smaller learning communities' reform effort? Was it for the money that was tied to the program, was it because of the initial research that was conducted in small schools, or was it simply because everyone else was doing it.

Key stakeholders probably had their own reasons for adopting the smaller learning communities initiative. As I undertook this research project collecting the data from TEA, scrubbing the data, and analyzing the data in a meaningful way took me over a year. School leaders don't have the bandwidth to do their own research. They must rely on studies, such as this one to make decisions about their schools. However, is research alone enough of a reason to move forward on a school improvement plan?

School leaders need to be keenly aware of the needs of their school, students, teachers, and parents before implementing the next "big" thing. While there were some schools that flourished with smaller learning communities, specifically ninth grade academies, the larger school population did not flourish. Looking inside of the school to see what is needed for success, the obstacles of implementation, and determining whether

those obstacles can be overcome are decisions that need to be made before attempting to move with any school improvement plan. Every school improvement initiative may not be right for every school, as demonstrated by the research results of smaller learning communities and ninth grade academies.

In 2011, policy makers have ended the \$88 million in grants for all Smaller Learning Communities. In 2013, funding will end for all grant awardees that were due support based on their previous grant award. School stakeholders are beginning to move to the next model of effective schools and school improvement. Hopefully, choosing the next model to place in schools will be done with more successful results than this one.

Implications for Future Research

The findings observed in this study indicated that additional research would be quite useful. First, the present study should be replicated for other suburban at-risk groups outside of Texas. Geographical restraints can have a definitive impact on the results of a study. A replication of the study would establish support or lack of support for the model developed in this study.

Second, a replication of the study in the same schools including English Language Arts could provide additional insight into the TAKS achievement rates of all major core subjects. It could provide the schools with a well-rounded look at TAKS achievement gains due to the implementation of ninth grade academies.

There are numerous covariates that can be used in a hierarchical linear model. This study could be repeated using additional relevant covariates. Additional covariates such as: (a) years of teaching experience by each science/math teacher, (b) free and

reduced lunch participation (c) rate of absenteeism might lead to greater insight on the reasons for lack of academic achievement on the TAKS science and mathematics tests.

Teachers were one of the most influential factors in student achievement (Darling-Hammond, 2004). Okpala, Smith, Jones and Ellis (2000) revealed a positive relationship between more than 10 years of teacher experience and students mathematics achievement. Vanderhaar, Munoz, and Rodosky (2006) found that “free and reduced-priced lunch participation, average teaching of experience of teachers, and previous test scores were the most robust predictors of student achievement” (p. 30).

Other covariates that assess the history of professional development and certification programs attended by teachers could be included and might provide the results necessary for school personnel in establishing policies for their veteran and new to the field teachers. Darling-Hammond (2000) reports “measures of teacher preparation and certification are by far the strongest correlates of student achievement in reading and mathematics, both before and after controlling for student poverty and language status” (p. 1).

Furthermore, a mixed methods study could offer additional insight into the academic achievement of at-risk students on the TAKS science/mathematics test. Using the mixed-method framework, a researcher might gain a different perspective on at-risk academic achievement of science/mathematics TAKS test by including in-depth interviews concerning the implementation of each ninth grade academy. For example, did the school implement and sustain the administrative leadership and space components of ninth grade academies yet falter on keeping the dedicated ninth-grade faculty and interdisciplinary teaming components. Differences among the strength of the ninth grade

academy implementation could play a crucial role on the academic achievement of TAKS in science/mathematics on suburban at-risk students.

Summary

The present study contributes to the comprehensive research on ninth grade academies by incorporating a specific focus on the effects of ninth grade academic achievement of suburban at-risk students on state mandated tests. School size and its influence on academic achievement have long been discussed in literature (Cotton, 1996; Gladden 1998; Greenwald 1996; Harnisch 1987; Huang& Howley, 1993; Ramierz 1992). This study was able to focus on a sub-set that is often not observed, at-risk suburban students. The large sample size, three years of data from each subject, and three to five cohorts provide provocative insights into the effects of ninth grade academies for at-risk suburban students. In short, this study suggests that in spite of the initial promise of SLCs, this approach to school reform may not be an effective one, at least for at-risk suburban youth. These findings have the potential to affect the decision making process of superintendents, board members and administrators on implementing ninth grade academies in suburban schools. With more reform measurement being pushed through by the Obama Administration educational stakeholders need to understand the true effectiveness of programs before school-wide implementation takes place.

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