2015

Blended learning in context: an exploration of the effectuality of math blended learning programs on minority students' standardized test scores

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BLENDED LEARNING IN CONTEXT: AN EXPLORATION OF THE EFFECTUALITY OF MATH BLENDED LEARNING PROGRAMS ON MINORITY STUDENTS' STANDARDIZED TEST SCORES

A dissertation submitted in partial satisfaction

of the requirements for the degree of

Doctor of Education in Organizational Leadership

by

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July, 2015

Leo Mallette, Ed.D. – Dissertation Chairperson

This dissertation, written by

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under the guidance of a Faculty Committee and approved by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

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DEDICATION

This dissertation is dedicated to my Lord and Savior Jesus Christ. Thank you Lord for you unconditional love. Your immense vision and spiritual support was truly the catalytic agent which catapulted me to pursue a doctoral degree and finish this dissertation. Thank you and I love you.

ACKNOWLEDGMENTS

While writing this dissertation my father was diagnosed with prostate cancer and congestive heart failure. Unfortunately, he died six months later. Although he did not live to see the culmination of all of my hard work, I know his support and love helped me finish my dissertation. Thank you dad and I will always love you.

To my best friend, my lovely mother, I love you so much. Thank you for encouraging me and keeping me spiritually fed.

To my spectacular Dissertation Chair Dr. Leo Mallette-You provided me with unlimited support, vision, and direction. You also never gave up on me and you empowered me to be relentless. Also special thanks to my committee members, Dr. Gayle Ball-Parker and Dr. June Schmieder-Ramirez. I was so blessed to have had such extremely wise and experienced people to help me with the planning and solidification of this dissertation.

VITA

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ABSTRACT

The purpose of this quantitative research study was to determine whether or not adopting a school-wide math blended learning (MBL) model led to significant differences in the Algebra I math standardized test scores on the California Standards Test (CST), between underrepresented minority students from Title I high schools in Los Angeles who had a school-wide MBL program during the 2011-2012 school year compared to underrepresented minority students from Title I high schools who did not have a school-wide MBL program. This study focused on the efficacy of the math intervention program, and was intended to further research in the area of blended learning. An one-way Analysis of Variance (ANOVA) data analysis technique was utilized and an alpha level of .05 was set as the criterion for the level of significance. Archived pre-existing standardized test data was collected from the 2011-2012 school year. The sample size consisted of the mean Algebra I CST test scores from African-American and Latino 9th grade students from 14 different Title I high schools in Los Angeles, CA. Select Title I high schools were matched to a comparison group of Title I high schools based on gender, ethnicity, and charter school designation. The results from hypotheses one, two, three, four, and five reflect that female and male African-American and Latino students who attended a Title I high school with a school-wide MBL program had a statistically significant difference in Algebra I scores compared to the students who did not. Hypothesis six indicated that there was not a statistically significant difference in Algebra I scores of students who attended Title I charter high schools compared to students who attended Title I non-charter high schools. For hypotheses one, two, three, four, and five the trend was in favor of the MBL programs. Overall, the statistical analysis indicated that there was strong evidence that MBL programs had a significant positive impact on the Algebra I test scores of all of the students who attended Title I high schools with a school-

wide MBL program as compared to the students who attended a Title I high school without a school-wide MBL program.

Chapter I: Introduction

The concern that the United States is not preparing an adequate number of professionals in the areas of science, technology, engineering, and mathematics (STEM) has recently been of grave importance (The Association of American Universities, 2006; The Business Roundtable, 2005). Although recent results from the National Assessment of Education Progress (NCES, 2006) demonstrate an increase in the knowledge of math amongst students, the large majority of U.S. students are still failing to reach sufficient levels of proficiency. In comparison to other nations around the world, the science and math achievement of American students appears to be inconsistent with America's title as a global technological hegemon and a leader in scientific innovation.

The economic evolution of the last 50 years has resulted in major changes in the United States. The U.S. economical market has shifted from the manufacturing of hard goods to evaluating and processing information. Within the United States' information driven economy, the most precious commodities are intellectual property and human capital. It has become apparent the potency of human capital in recent years in countries such as China and India. As China and India become better connected and acclimated to the global financial market, their governments have placed more emphasis on math achievement (Sheehy, 2012). This has led to increases in math programs and funding, and their improved scientific structure. This has also led to their advancements in medicine and agriculture and has diluted the United States supremacy as one of the global scientific hegemons (Marsh, 2012). Similarly, within the education arena, the overarching concern of both educators and policymakers is the inextricable link between U.S. students' poor math and science achievement and their declining scientific global competitiveness. This concern in maintaining the United States' status and competitive advantage in the world has precipitated subsequent action on the part of both policy makers and educators alike, to focus on closing the STEM achievement gap amongst Caucasian, Asian American students and underrepresented minority students (*in the context of this study underrepresented minority students refers to African-Americans and Latino students that are statistically underrepresented in STEM fields*).

Traditionally, the U.S. recruited its STEM workforce from a relatively homogenous talent pool consisting largely of White males. However, this pool has diminished substantially due not only to an increasingly smaller proportion of the total U.S. population but also to declining interest amongst high school students in pursuing careers in STEM. It is, therefore, of great importance to foster the desire to pursue STEM based careers amongst all ethnic groups especially amongst underrepresented minority groups such as African-Americans and Latinos, not only because there is a clear need to fill STEM jobs, but also because minority workers can improve and enhance the quality of STEM research and implementation insofar as they are likely to contribute a diverse array of new perspectives to bear on the STEM enterprise (Leggon & Malcom, 1994).

It has been reported that Blacks, Hispanics & Native Americans comprised 25% of U.S. population, 33% of school-age population but only 11% of STEM workforce and just 6% of engineering workforce (National Science Foundation, 2006). David Nagel (2008) in conjunction with the National Action Council for Minorities in Engineering (NACME) conducted a study which explored the widening STEM gap between White males and minority ethnic groups of African American and Latinos, or what he refers to as the *underrepresented* group. The following is summary of the general findings of the study:

- In the United States, out of 68,000 bachelor's degrees that were conferred in 2006, only 8,500 were given to underrepresented minorities;
- In terms of doctoral degrees in engineering, underrepresented minority students earned just 4 percent of the nation's doctoral degrees in engineering in 2008. (NACME, 2011)

The expanding ethnicity gap that exists in the number of students pursuing STEM careers in the United States (Nagel, 2008) is said to be a direct derivative of the poor math achievement of underrepresented minority students at the high school level. In 2011, it was reported that only 23% of Latino students and 17% of African Americans in Los Angeles County high schools were proficient in Algebra I while 47% of White students and 74% of Asian American students were proficient in Algebra I in Los Angeles County high schools (California Department of Education, Standardized Testing and Reporting (STAR) Results, 2011).

The achievement gap among underrepresented minority students in the areas of math is one reason why the No Child Left Behind (NCLB) Act of 2001 was established. Accountability among public schools is required to evaluate the quality of education that is provided to students. One assessment measure that grew out of the NCLB Act was The California Standards Test (CST), which is California's school accountability system. The CST was originally constituted in order to increase academic achievement and accountability amongst all students in the state of California. The CST allows each school and school district to acquire an annual assessment of student academic achievement held in accordance with the No Child Left Behind (NCLB) Act guidelines. One of the most important goals of the NCLB Act is to close the achievement gap in math between socioeconomically advantaged Asian and white students and socioeconomically disadvantaged minority students (Lagana-Riordan & Aguilar, 2009).

While the NCLB Act is a system that keeps schools accountable for school failure, there still is a need for a national plan of action in order to close the math achievement gap. There has been a proliferation of intervention programs in the last 15 years to improve and increase math grades amongst underrepresented minorities. There is approximately $2.8 billion invested by 13 federal civilian agencies to fund 207 math and science based education programs, yet substantial research is not available to determine whether these programs are effectively addressing the needs and complexities of minority students (Ashby, 2006). A large portion of this money has been designated to Title I schools throughout the United States. There are a totally of seven Titles that make up the Elementary and Secondary Act. Title I refers to the first title of the Elementary and Secondary Education Act, and includes programs aimed at disadvantaged students (No Child Left Behind, 2001), but little research has been conducted on schools that receive Title I funds. The research that has been done, however, show that minority students who attend Title I schools are performing poorly on the state mandated tests in the area of math.

Academic math intervention programs offered at Title I schools focus on closing the achievement gap by providing students with additional after-school and in-school support needed to become academically successful upon graduating from high school, and better prepared for the rigors of college. Bergin, Cooks, and Bergin (2007) point out that academic intervention are developed to address problems that are typically encountered by “racial, ethnic, and income groups” (p. 728).

There are currently a variety of different types of math intervention programs are being offered at some Title I schools. Most of the math intervention programs are either traditional face-to-face and computer-based only intervention programs. However, research shows that using either face-to-face teaching or computer-aided instruction (CAI) in isolation has proven to be ineffective for students struggling with math (Boylan, 2002; U.S. Department of Education, 2005).

One special type of personalized math intervention program that blends traditional modes of teaching with computer-aided instruction that has proven to be successful in terms of increasing math performance is called math blended learning. By definition blended learning in a K-12 context is instruction that combines online and face-to-face approaches (Picciano & Seaman, 2009). Blended learning is accomplished through the use of both virtual and live traditional classroom resources such as Internet libraries, content software, simulations, instructor-led lectures, hands-on labs, and real time field trips. Thus, blended learning offers all students the opportunity to learn concepts with both computer-based and face-to-face approaches that make acquiring information appropriate and comfortable.

The computer-based learning component of blended learning provides opportunities to engage in a manner relevant to students' abilities and interests so that he or she can achieve his or her full potential (U.S. Department of Education, 2005), while the face-to-face instruction component provides students with the essential didactic and social elements that are needed to be successful not only academically but socially.

The use of blended learning is more documented for a collegiate context than it is for a K-12 context (Halverson, Graham, Spring, & Drysdale, 2012). In terms of blended learning in a collegiate context Ross and Gage (2006) identify three forms of blended learning: (a) web-enhanced courses; (b) blended better known as hybrid and flipped classroom, wherein online activities are used to reduce or replace part of the face-to-face component; and (c) blended programs that allow students to self-select a mix of face-to-face, blended, and totally online courses to complete program requirements.

Staker and Horn (2012) identify the "flipped classroom" form of blended learning most prevalent in K-12 settings. In this approach to blending, the "flipped" part calls for students to watch or listen to lessons or lecture material outside of the face-to-face classroom and to do hands-on activities or guided practice during class time (Fulton, 2012).

Blended learning can vary in its deliver depending on whether it is used with a higher education or K-12 context, however, the test for "true" blended learning is the effective integration of the online instruction with the face-to-face instruction such that the two modes are merged as complementary components of a single, blended approach (Garrison & Kanuka, 2004).

Depending on the school, math blended learning takes place based on the teacher's discretion or it can be a school-wide adopted model in which all of the teachers are required to teach a particular subject using a computer-based instruction software for at least once a week this is called a school-wide blended learning program. For the purposes of this study a school-wide math blended learning program constitutes a school that requires all teachers to offer students traditional and computer-based math instruction for at least once a week for 45 minutes.

Varying members of math blended learning programs, including the participants, learn mechanisms and tips for advancing their math dexterity and perception. It is the intent of math blended learning programs to increase the academic performance of underrepresented students by providing a platform for self-discovery, different modes of developing critical thinking skills, technological skills, support, and knowledge which are all highly needed to succeed academically, and to be able to function in this fast-paced, high-tech, global world.

Statement of the Problem

A capacious amount of research has illuminated the need for more innovative ways to increase math scores. Moreover, there are a myriad of studies that have elucidated the different pedagogical techniques that foster mathematical dexterity of students, however, the problem is only a small portion of these studies have looked at the role of math blended learning in increasing scores in math amongst underrepresented minority students.

With the chronic underachievement of underrepresented minority students, educational institutions from kindergarten to the university level have been trying to address this problem. In response to and in conjunction with such policies, researchers should examine and report the prominent characteristics of math blended learning programs in order to determine whether the program characteristics are effective in increasing student success. Ascertaining whether specific math blended learning programs have any differential effects across diverse minority student populations would not only be valuable to the students, but also to local and federal institutions in terms of guiding curriculum and program development.

If researchers, pedagogues, and policy makers from all levels of the public and private education sector could empirically identify successful intervention programs and the prominent characteristics of the interventions employed, they would have a paradigm in which to draw from in order to implement similar programs to erase the inequities that exist in regards to the underrepresentation and underachievement of minority students within the education sphere.

Purpose of the Study

The purpose of this causal-comparative research design study was to determine whether or not adopting a school-wide math blended learning model led to significant differences in the Algebra I math standardized test scores on the California Standards Test (CST), between underrepresented minority students from Title I high schools in Los Angeles who had a school-wide math blended learning program during the 2011-2012 school year compared to underrepresented minority students from Title I high schools who did not have a school-wide math blended learning program.

Research Questions

In order to determine the efficacy of math blended learning programs on underrepresented minority student achievement on the California Standards Test (CST), the following research questions guided this study:

RQ1. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to 9th grade students who attended a Title I high school that did not have a school-wide math blended learning program?

RQ2. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between male 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to male 9th grade students who attended a Title I high school that did not have a school-wide math blended learning program?

RQ3. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between female 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to female 9th grade students who attended a Title I high schools that did not have a school-wide math blended learning program?

RQ4. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between African-American 9th grade students who attended a Title I high school with a school-wide math blended learning program as compared to African-American 9th grade students who attend a Title I high school that did not have a school-wide math blended learning program?

RQ5.Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between Latino 9th grade students who attended a Title I school with a school-wide math blended learning program as compared to Latino 9th grade students who attended a Title I school that did not have a school-wide math blended learning program?

RQ6. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between 9th grade students who attended a Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that had a school-wide math blended learning program?

Research Hypotheses

The research hypotheses that were utilized to support the research questions were:

$H1_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared to 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H1_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared to 9th grade students who attended Title I schools that did not have a school-wide math blended learning program.

$H2_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between male 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared male 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H2_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between male 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared male 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H3_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between female 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared female 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H3_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between female 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared female 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H4_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between African-American 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to African-American 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H4_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between African-American 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to African-American 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H5_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between Latino 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to Latino 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H5_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between Latino 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to Latino 9th grade students who attended Title I high schools that did not a school-wide math blended learning program.

$H6_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program.

$H6_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program.

Significance of the Study

The low representation of minority groups in the STEM fields represents an untapped and underutilized collection of potential talent that may hold the key to advances in technology and engineering and may be the answer to how the United States can remain a viable global contender. This study, in essence, will hopefully serve as a textual herald for all educational stakeholders to take note and become more involved in the eradication of the academic disparities amongst minority groups and non-minority student groups in math by implementing efficacious STEM based enrichment tactics within schools. The results of this study can contribute to theory, but also can be a framework for cultivating and implementing other sustainable and effective blended learning programs that can serve to help all students. Even private schools and independent tutoring agencies currently in place can create hybrid math blended learning programs of their own based upon the findings of this study. In addition, the methods used in the math blended learning programs found to be efficacious at the high school level could also be piloted at the middle school and even collegiate level. Beyond the education community, policymakers will find this research helpful in making informed and research based funding decisions needed to improve the retention and persistence of all students in math at all levels of the education system.

Nature of the Study

The intention of the study was to determine if students who participated in school-wide math blended learning programs score higher on the Algebra I section of the California Standards Test (CST) than students who were not in the program. This study is a quantitative study has a causal-comparative research design. Within causal-comparative studies investigators attempt to determine the cause of differences that already exist between or among groups of individuals. This is viewed as a form of Associative Research since both describe conditions that already exist as known as ex post facto (Kravitz, 2011). The basic design involves selecting two or more groups that differ on a particular variable of interest and comparing them on another variable(s) without manipulation.

A causal-comparative research design is sufficient for this study because, the research study used pre-existing data from 14 different Title I high schools in Los Angeles in order to compare the Algebra I scores on the CST of students who attended Title I high schools with a school-wide math blended learning program to those students who attended a Title I high school without a school-wide math blended learning program.

Theoretical Framework

A large component of blended learning is the learning by doing. To explore the components of blended learning more in-depth this researcher explored the learning theory of Constructivism.

Constructivists believe that students should learn to solve complex problems they will face in real life. Driscoll (1994) states, "Providing complex learning environments that incorporate authentic activity" (p. 376) is the first condition for learning. She explains further that "the computer offers an effective means for implementing constructivist strategies that would be difficult to accomplish in other media" (Driscoll, 1994, p. 376)

The constructivism theories of Vygotsky (1978) and Dewey (1938) was also explored within this study. Each of these theorists believed that learning is both socially and experientially and should be offered in a complex learning environment. This study examined these theories and look at the theories in relation to how they can be used as a framework to increase math blended learning amongst underrepresented minority students.

Vygotsky (1978) hypothesized that children could not develop cognitive skills unless there was a social context around the development of these skills. When students learn, they learn best from a combination of examples and from experiences in their lives. The learning is accomplished through interaction with teachers, tutors, or peers. According to Vygotsky, directed instruction or scripted reading is simply not sufficient for much of student learning because interaction between student and teacher is limited.

Dewey (1938) proposed and stood as an advocate for the theory of experiential education, which utilized the nature as the framework that helps individuals learn. Dewey believed that traditional means of teaching such as lecturing methods were ineffective and rather communication and hands-on experiences were much more effective and essential to academic learning and engagement.

Definition of Terms

The following terms have been defined for clarifying purposes and in order to prevent ambiguity when reading this study:

Academic achievement gap. For the purpose of this study, an academic achievement gap is defined as the differences in performance between various student demographic groups

(Anderson, Medrich, & Fowler, 2007). The achievement gap in regards to education refers to the disparity in academic performance between groups of students based on an array of characteristics including but not limited to: socioeconomic status and ethnicity (Potter, 2007).

Academic performance index (API). The API was created as part of the state‘s Public Schools Accountability Act. In California, academic growth is measured in the schools by scoring the results ranging from 200 to 1000 points. However, the state education system established a goal of having each school score 800 points. The API scores are used by the state to rank all public and charter schools. Schools with similar demographics are compared by API scores.

Adequate yearly progress (AYP). AYP is a measurement used by different states which tracks academic progress as defined by the aggregate student scores of three Annual Measurable Objectives (AMO's) in Reading, Mathematics, and Attendance (Maryland State Department of Education [MSE], 2005).

Blended learning. This term is used for a formal education program in which a student learns at least in part through online delivery of content and instruction with at least partial instruction delivered and supervised at a brick-and-mortar location away from home (Staker & Horn, 2012).

Charter schools. Charter schools are choice public schools that have a contract, or charter (Weil, 2000), and are freed from certain regulations and bureaucratic rules, but accountable for their results (Finn, Manno, & Vanourek, 2000).

California standards tests (CST). the CST is used by the state of California to assess students on the state‘s academic content standards. These content standards are what students are expected to know and what teachers are expected to teach. Students in Grades 2 through 11 take the CST in the area of language arts and mathematics CSTs during the latter portion of the spring term. The results of the CST are then released in August. Students score at one of five levels ranging from *advanced* to *far below basic*. The federal goal requires all students to score *advanced* or *proficient*.

Efficacy. Capable of having the desired result or effect; effective as a means, measure, remedy of the problem of underrepresentation and underachievement of minority students in high school math and science, STEM collegiate programs and/or STEM careers.

Face-to-Face traditional instruction. In her book *Blended Learning in Grades 4-12*, Catlin Tucker (2012) described the term *traditional classroom* as a classroom usually set up with rows of desks facing a board at the front of the room. Students have pen and paper ready to take notes as the teacher lectures and projects information onto the board. In this classroom, the information flows from the teacher to the students (Tucker, 2012).

NCLB Act. The No Child Left Behind (NCLB) Act is the central federal law in pre-collegiate education, which reauthorizes the Elementary and Secondary Education Act. The NCLB Act are a set of measures designed to foster improvements and advances in student achievement and to hold states and schools more accountable for student progress (U.S. Department of Education, 2007a).

School-wide math blended learning programs. Blended learning programs that are adopted by the entire school, in which all math teachers have to incorporate math computer-based software within the classroom and/or math lab at least once a week for 45 minutes.

S.T.E.M. is an acronym for science, technology, engineering and mathematics. The STEM fields are collectively considered core technological underpinnings of an advanced society (National Science Board [NSB], 2012).

Title I. Title I refers to the first title of the Elementary and Secondary Education Act, and includes programs aimed at disadvantaged students. Title I Part A provides assistance to improve the teaching and learning of children in high-poverty schools to enable those children to meet challenging state academic content standards and academic achievement standards. (United States Department of Education, 2014)

Title I schools. Schools where at least 40 percent of the children in the school attendance area are from low-income families or at least 40 percent of the student enrollment are from low-income families are eligible to receive federal Title I funds (U.S. Department of Education, 2014).

Underrepresented minority students. In the context of this study underrepresented minority students refers to African-Americans and Latino students that are statistically underrepresented in STEM fields (Knox, 2005).

Assumptions

This study is based on the following assumptions:

1. The California Standards Test (CST) was administered to students at each school in a similar manner and according to California testing regulations.
2. The teachers were all trained properly in order to proctor the California Standards Test (CST).
3. The academic instruction that was provided was blended (face-to-face and with at least 90 minutes of computer-based instruction each week) and was available to all 9th grade students at the school.
4. The math blended learning program was administered by trained teachers certificated in the State of California.

Limitations

The following are the limitations of this study:

1. The collected data is only from 2011-2012 academic school year and analyzed scores for student in Grades 9 only in the subject area of Algebra I. Due to the fact that this study used data from the 2011-2012 academic school year any recommendations and/or generalizations to other populations may only be made if the populations are similar to the sample included within this research study.
2. Although the state of California currently has over 6,000 schools that identify themselves as Title I schools, the sample is limited to 14 Title I high schools, because this researcher focused on how the program affects high schools in the most impoverished areas with the most underrepresented minority students in the city of Los Angeles.

Summary

The lack of qualified STEM-based practitioners is a national problem. The lack of professionals that can fill STEM-based jobs is drawing attention to the underachievement of most students, especially underrepresented minority students, in the areas of math and science. One intervention that is currently being implemented in California high schools to increase achievement in the areas of math and science is math blended learning. This study sought to illuminate the palpable characteristics of effective math blended learning programs in hopes to one day implement and replicate them elsewhere, as well as, in order to identify solutions to reversing the trend of low performance in math amongst underrepresented minority students in the United States.

The structure of this dissertation is as follows: Chapter I has provided the introduction to the study including a statement of the problem, purpose of the study and the research questions to be investigated, as well as key terms and limitations. Chapter II will begin by looking at the educational system in a historical context, and will then explore the fiduciary and educational role of the U.S. government in provided the resources to facilitate growth in the area of math. Chapter II will also review relevant theory and empirical literature related to the problem under investigation. Finally, chapter III will provide an overview of the research methodology, design, population, analysis procedures and the data collection process that was utilized to complete this quantitative research study.

Chapter II: Review of the Literature

The purpose of this study was to examine achievement levels on the California Standards Test (CST) of high school students who participate in math blended learning programs and determine the degree to which math blended learning programs play a role in underrepresented minority student academic success. The literature review contains the following subsections: The Education System, The Role of Government in Closing the Academic Achievement Gap, The Math and Science Academic Achievement Gap, The Financial Role of Federal and State Governments in math and science Education, Charter School Spending, Title I Funding, Theoretical Perspectives on how to Escalate Academic Achievement, Social Constructivism, Math Computer-Based Learning in Context and , Blended Learning Programs and Standardized Testing Success. This literature review is shaped by the theoretical foundations of Vygotsky's (1978) constructivist approach, and Dewey's (1938) sociological and experiential theories on learning.

The Education System: Early Public Education

The early ideological framework of the United States' education system was shaped, in part, by the pedagogical perspectives and teachings of Plato and Aristotle. Plato believed that the role of education was to teach good character and leadership. In essence, he believed that the goal of education was to produce *social and happy citizens*. Therefore and ideally, the education of children, according to Plato was to begin at a young age. Aristotle believed that children should be educated, and that, education should occur within public places, as known as, a public school system in which, Aristotle believed the government should be responsible to construct (Curren, 2000).Yet, despite the declarations and writings of Plato and Aristotle, widespread public education across the world did not occur until the 20th century (Nosotro, 2013).

The Creation of Public Education in the United States

Once there was a consensus about the need for public schools in the United States, public education became more of a priority. So in 1791, the 10th Amendment to the U.S. Constitution made education a right for white males who owned property to be provided for and supported by the state. Yet, the state gave control of education to the local government entities, such as independent school districts. The focus of education in the United States steadily became the preservation of national strength through the advancement of western civilization and the establishment of a productive and cooperative citizenry (Marron, 2001; Mourad, 2001; Warren, 1988).

Until the 1840s the education system was highly localized and available only to wealthy people. Reformers who wanted all children to gain the benefits of education opposed this. Prominent among them were Horace Mann in Massachusetts and Henry Barnard in Connecticut (Ford, 2010). Horace Mann was a common-school reformer who cultivated and disseminated the publication of the *Common School Journal*, which illuminated educational issues for the general public. The concept of public school was born out of this movement in the mid-nineteenth century. Its founders, like Horace Mann, called it the "common" school. Common schools were funded by local property taxes, charged no tuition, and were open to all white children. The common-school reformers argued that common schooling could create good citizens, unite society and prevent crime and poverty. As a result of their efforts, free public education at the elementary level was available for all American children by the end of the 19th century.

The First Morrill Act, also known as the Land College Grant Act of 1862 was the first step toward a large governmental role in education (Williams, 1991). The First Morrill Act provided for each State to support their universities, by selling thousands of acres of land and using the funds as grants for colleges. However, the catch was that the state and universities within each state would then have to follow federal guidelines.

During the 20th century participation in both secondary and postsecondary education in the United States tremendously increased. At the onset of the 20th century about two percent of Americans from the ages of 18 to 24 were enrolled in a college. Near the end of the 20th century more than 60 percent of this age group, or over 14 million students, were enrolled in 3,500 four-year and two-year colleges (Institute for Alternative Futures, 2010).

Within the international sphere the U.S. education system was viewed as an open and equal system that rewarded intellectual capacity, and cognitive ability (Brodkin, 1999; Jiobu, 1988). However, it soon became apparent that the so called educational equalitarian system based on equal access, became increasingly more socially and racially stratifying (Kao & Thompson, 2003).

The perilous vicissitudes of the early American education system. Prior to the 20th century the public educational system in the United States, with all of its complexities, was originally highly localized and only available to the wealthy elite.

The first African-Americans arrived as slaves in the colonies in 1619. By the middle of the nineteenth century there were 4.5 million African-Americans in the United States. The only education given publicly to them was by the missionaries to convert them to Christians. And, most of the sentiments from the southern states toward educating blacks were filled with divisive and prejudiced rhetoric. Essentially, the southern states opposed the education of blacks because these states still saw slavery as a financial commodity. In spite of individual efforts, the education of African-Americans remained very low until Lincoln issued the Emancipation

Proclamation in 1863. Consequently, the African-American literacy rate that was around 5% in the 1860s rose to 40% in 1890 and by 1910 it was at 70% (Thattai, 2010).

During the 1950s, the desire to be educated grew amongst all Americans, in particular, amongst the socioeconomically disadvantaged minorities. However, segregation by race in public schools was still very much so common and prevalent in the United States. In the South African Americans and Whites were not allowed to attend school together. Segregation usually resulted in inferior education for African Americans, Latinos and Native Americans. Average public expenditures for white populated schools exceeded expenditures for minority populated schools. Consequently, the white populated schools were far superior to facilities in most minority populated schools (Thattai, 2010).

In 1954, the U.S. Supreme Court unanimously ruled in *Brown v. Board* of *Education of Topeka* that racial segregation in public schools was unconstitutional. The Supreme Court declared the notion of *separate but equal* schooling unconstitutional, saying *separate* was inherently unequal. Yet, more than 50 years later, there remained an educational system that still failed to address the educational needs of all children equally (Noguera & Wing, 2008; Rothestein, 2004).

Savage inequality, which according to Kozol is the disparities in education between schools of different classes and races, continued to characterize America's urban school systems throughout the 1960's. This was partly due to great variance in the financial, social, and cultural resources available to schools across districts–a legacy of local control and its interaction with housing markets (Kozol, 1991, 2005; Noguera & Wing, 2008; Rothestein, 2004). Subsequently, school leaders were left with the overabundance of ethnical, financial, and political issues, which impeded true equalitarian academics. Despite vigorous resistance for many years by many southern states, by 1980 the federal courts had largely succeeded in eliminating the system of legalized segregation in southern schools, yet, concurrently with the advent of the 1980s came an intense and enormous influx of drugs into urban communities. As a by-product, deterioration of facilities, parental negligence, crime and low expectations in urban schools began to mount (Kozol, 1991).

The marking of the fiftieth anniversary of the landmark *Brown v. Board of Education of Topeka*, Kansas Supreme Court decision in May 2004 led educators, analysts, politicians, and journalists to closely examine the state of public education for African-Americans and other children of color in the United States. The prevailing view was that *Brown* failed to deliver. Additionally, they found that the demographics of the country's schools had not changed in ways the authors of the landmark decision envisioned (Fenzel, 2009).

Whether cultivated by gerrymandering or socioeconomic political measures, principals and teachers in urban schools, especially those who service minority students, have to still cope with the residual unethical and racial underpinnings from the past. Even among those with the same level of academic attainment, African-American and Hispanic students lag behind White and Asian students. The Alliance for Excellent Education indicated in its report on the state of secondary education that, while fewer than 75% of eighth graders end up graduating from high school in five years, this dips to below 50% in urban communities. Dropping out of high school is related to a number of adverse consequences. For instance, in 2006 the U.S. Department of Commerce reported that the average income of person's ages 18 to 65 that had not completed high school was roughly $21,000 (U.S. Department of Commerce, 2006). By comparison, the average income of persons ages 18 through 65 who completed their education with a high school credential, including a General Educational Development (GED) certificate was over $31,400 (U.S. Census Bureau, 2007).

The Role of Government in Closing the Academic Achievement Gap

Critical theorists, according to Ford (2010), contend societal transformations must occur to dismantle the rigid economic structures and organizations that produce relationships of dominance and subordination in education (Ford, 2010). One way in which societal transformations in education can be stimulated is by federal intervention. The Tenth Amendment to the United States Constitution states: “The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people” (U.S. Constitution Amendment X). Since education is not mentioned in the Constitution, it is one of those powers reserved to the states. Hence, states have plenary, or absolute, power in the area of education. This means that it is States that establish schools and cultivate curricula, and determine requirements for enrollment and graduation. The configuration of education finance in America reflects this predominant State and local role. In the 1940s, as different state public education systems developed, disparities arose. With time these disparities became more prevalent and localized as statues used local property taxes to finance their own schools. Not until the passage of the Elementary and Secondary Act (ESEA) of 1965 did the Federal Government become actively involved in the financing of education. However, the Federal Government’s role became quickly weakened again as a byproduct of the 1973 San Antonio School District v. Rodrigues court decision, which removed federal courts from school financed.

At the inception of the Reagan Administration, more support for federal intervention for public education became more widespread. In 1983, a report written by the National

Commission on Excellence in Education entitled, *A Nation at Risk,* informed the government of the possible economic consequences of the academic achievement gap, which prompted many education reform efforts. Fisk wrote that *A Nation at Risk* created national, political awareness about education:

> The most important legacy of "A Nation at Risk" was to put the quality of education on the national political agenda—where it has remained ever since. The last 25 years have seen a succession of projects and movements aimed at increasing the quality of American primary and secondary schools: standards-based reform, the 1989 "education summit" that set six "national goals" for education, and the push for school choice, Proponents of each have taken pains to portray themselves as the heirs of "A Nation at Risk." (Fisk, 2008, p. 109)

Fundamentally*, A Nation at Risk* helped and provided Reagan the opportunity to address the standing of American education and the quality of the schools (Coppess, 2010; Fisk, 2008).

The No Child Left Behind Act (NCLB)

Yet another form of governmental invention occurred in 2002, when President George W. Bush signed the *No Child Left Behind* (NCLB) Act into law. It has been called a poverty program because of the belief that, for many, increased education is the means to escape a life of hardship (Anyon, 2005). The NCLB Act supports standards-based education reform, which, in essence, is based on the premise that establishing measurable goals can improve individual outcomes.

Additionally, NCLB requires states to develop and implement assessments to be distributed to all students as a prerequisite to receive federal funding for schools. Since the enactment of the NCLB Act of 2002, Congress increased federal funding of education, from $42.2 billion in 2001 to $54.4 billion in 2006.

The legislation of NCLB has been controversial. There have been also those who have openly disagreed with the law (Coppess, 2010). Opponents of the Act declare:

1. *No Child Left Behind* compromises the quality of teaching by forcing teachers to worry more about raising test scores than about promoting meaningful learning.

2. It punishes those who most need help and sets back efforts to close the gap between rich and poor, and between black and white. (Kohn, as cited in Meier & Wood, 2004, p. 79)

The role of the federal government in public education is still continuing to be refined since the implementation the NCLB Act. During his 2011 State of the Union Address, President Barack Obama announced that NCLB Act will be replaced by a new piece of governmental legislation called the *Race to the Top* (2011) in order to close the achievement gap specifically in the areas of math and science. During Obama's 2011 speech he outlined his vision for an America that's more determined, more competitive, better positioned for the future an America where we out-innovate, we out-educate, we out-build the rest of the world; where we take responsibility for our deficits; where we reform our government to meet the demands of a new age. Obama made it clear that innovation would come from the increase of math and science education in all schools, especially heavily underrepresented minority populated schools.

The Hispanic and African American math and science underachievement has been recognized as a national problem not just by President Obama, but by politicians and educators across the nation. Regrettably, data continues to suggest that math and science scores are not improving at a fast enough pace (NGA Center for Best Practices, 2011).

The Math and Science Academic Achievement Gap: A Descriptive Look into Minority Underachievement and Underrepresentation

President Barack Obama reaffirmed in November 2011, the United States' tenacious desire and interest in sustaining a dominated position in the global economy by cultivating the Educate to Innovate campaign for excellence in Science, Technology, Engineering and Mathematics (STEM) education. The objective of STEM education is to improve the quality of

STEM education and to open and widen STEM-based scholastic and career opportunities for students and groups currently underrepresented in STEM careers. Although millions of dollars has been spent over the last 20 years in order to improve math and science education and to close the math and science academic achievement gap, minorities continue to be greatly underrepresented in STEM collegiate programs and careers (Ashby, 2006). A recent study by Tyson, Lee, Borman and Hanson (2007) highlights the social and institutional practices that make the creation of equal representation of minorities in STEM fields difficult. In order to address the apparent social and institutional detriments and the disturbing issue of student underachievement in math and science education, interventions are needed that strategically target students who are underrepresented and underperforming in postsecondary STEM education (Le, 2010).

The National Center for Educational Statistics (NCES) reported in 2009 that there is a large disparity between how many white men entered STEM related fields in postsecondary education compared to minorities. Data at the postsecondary level indicates that the problem of student underrepresentation in the STEM field begins before they matriculate from secondary education. Hence, according to Tyson et al. (2007), a significant part of the problem of student underperformance and underrepresentation in STEM education originates at the secondary education level. In other words, the strongest predictor of student enrollment and achievement in a collegiate STEM programs is how they perform in math and science during high school.

It is clear that the intention of minority students to pursue STEM based careers, as well as, student achievement is contingent on the math achievement at the secondary level especially in Algebra I. However, Hispanics and African-American students, though taking comparable number of math and science courses in high school, are taking less rigorous courses than their

White and Asian counterparts (Tyson et al., 2007). Rigorous mathematics courses are not just important towards entering the pathway of a STEM program in postsecondary education but also developing a high level of proficiency in STEM courses and improving performance on standardized tests and college entrance exams (Tyson et al., 2007). Thus, all students must have access to such courses in order to enter postsecondary education institutions especially if their pursuit is to obtain a STEM degree. The National Assessment of Educational Progress (NAEP) is the only nationally representative, continuing assessment of elementary and secondary students' math and science knowledge. Riddle 2010 states, "Since 1969, NAEP has assessed students from both public and nonpublic schools at grades 4, 8, and 12. Students' performance on the assessment is measured on a 0-500 scale, and beginning in 1990 has been reported in terms of the percentages of students attaining three achievement levels: basic, proficient, and advanced" (p. 1).

Proficient is the level identified by the National Assessment Governing Board as the degree of academic achievement that all students should reach, and "represent solid academic performance. Students reaching this level have demonstrated competency over challenging subject matter" (NAEP, 2010, p. 1). In contrast, the board states that "Basic denotes partial mastery of the knowledge and skills that are fundamental for proficient work at a given grade." (NAEP, 2010, p. 1).

The most recent NAEP administration occurred in 2005. Between 1990 and 2005, according to the NAEP, although the proportion of elementary and secondary students achieving the proficient level or above has been increasing each year, overall math performance in these grades has been quite low. In fact, in 2006 the NCES reported that the percentage of students performing at the basic level did not improve in 15 years and about 40% of students continue to achieve only partial mastery of math (NCES, 2006). Because of the pattern of low achievement in the areas of math and science, federal and state government have been, within the last 10 years, trying new ways to allocate new streams of funding to organizations in order to increase students' math and science test scores and aptitude.

The Spending Portrait: The Financial Role of Government in STEM Education

According to the Government Accountability Office (GAO) 2005 survey, in 2004 there were 207 federal education programs designated to improve the quality of math and science education (U.S. Government Accountability Office, 2005). That same year, about $2.8 billion was appropriated for these programs, and approximately 71% ($2 billion) of those funds supported 99 programs in two agencies. The following table shows how much funding some of top organizations received:

Table 1

2004 Federal STEM Funding by Organization

ORGANIZATION NAME	FUNDING AMOUNT RECEIVED
National Institute of Health (NIH)	$998 million
National Science Foundation (NSF)	$997 million
Department of Education (ED) & Environmental Protection Agency (EPA)	$573 million
National Aeronautics and Space Administration (NASA)	$100 million

The Government Accountability Office (GAO) study found that most of the 207 programs had a multiplicity of goals, and were targeted at multiple groups. The findings revealed that federal STEM education programs are heavily geared toward attracting college graduates into pursuing careers in STEM fields by providing financial assistance at the graduate and postdoctoral levels and did not adequately promote math and science achievement at the K-12 level, rather the goals of these STEM based programs were only centered around post-K-12 endeavors. Again, most disconcerting, according to the GAO study was that K-12 math and science teacher education was not a major goal, and elementary and secondary students were the least frequent group targeted by federal STEM education programs (Kuenzi, 2008).

Government education spending in general. Total education funding has substantially increased over the last 10 years. By the end of the 2004-05 school year, it was estimated that education spending increased by 105 percent since 1992 (U.S. Department of Education, 2005). Even the amount of money that is spent per pupil has increased. In 2012, the amount of money soared to 108.5 billion dollars. Nonetheless, as aforementioned, the responsibility of primary and secondary education rest with the states under the Constitution of the United States. It is estimated that 83 cents out of every dollar spent on education is estimated to come from the state and local levels (45.6% from state funds and 37.1 percent from local governments). The federal government's share is only 8.3%, while the remaining 9% is provided by private institutions (National Center for Education Statistics, 2006). However, there remains an overwhelming national interest in the quality of America’s public schools. Thus, in order to supplement the states’ actions, the federal government provides assistance to schools.

On a fundamental level both the Elementary and Secondary Act (ESEA) and the NCLB Act were developed in an effort to raise achievement for all students and to close the academic achievement gap. However, despite the recent efforts by the federal government to close the achievement gap with such programs such as ESEA and the NCLB Act, and the increase of federal spending, the government still spends more money on defense, welfare, health care and pensions annually.

STEM based spending. According to the Academic Competitiveness Council (ACC) inventory, three agencies account for nearly 80% of all federal STEM education spending in fiscal year 2006. According to the ACC, 29% ($924 million) of total federal STEM funds went to NSF, 27% ($855 million) went to NIH (through the Department of Health and Human Services (HHS)), and 23% ($706 million) went to the United States Education Department (U.S. Department of Education, 2007b).

The House and Senate both passed the behemoth omnibus bill HR 2764 (formerly the State and Foreign Operations spending bill) better known as the *Consolidated Appropriations Act* on December 26, 2007.Within HR 2764, there are divisions in which the three STEM education-related appropriations bills are listed. In the STEM education related appropriation bills there are a variety of resources and funding resources listed, of which being the Robert Noyce Teacher Scholarship Program.

Apart from their differences, both the GAO and ACC found that federal STEM education programs had a collection of objectives, provided multiple types of assistance, and were targeted at multiple groups. Yet and still, both groups concluded that the federal effort is highly decentralized, could benefit from stronger coordination and more intervention and curriculum support (Ashby, 2006).

The recession in 2008, strapped budgets at the US local and state levels. In an attempt to offset those cuts, the government under the auspices of President Obama poured more money into education. In January of 2011, President Obama unveiled a $250 million initiative to improve science and math education using donations from a myriad of organizations, and high – tech businesses. In fact, in February of 2011 the Obama Administration proposed a budget, which included an additional 40% increase for STEM education.

Although there is substantial amounts of money being allotted to larger institutions of education, representatives of the GAO propose that there is still not enough money directly allocated to K-12 urban schools and organizations to help low-income minority students in the area of math and science.

The lack of financial math and science based initiatives for minorities in urban secondary schools. Similar to the GAO results, the Academic Competitiveness Council (ACC) study found that although much of the federal effort in this area comes through the National Science Foundation (NSF) and National Institutes of Health (NIH) support for graduate and post-doctoral study in the form of fellowships to increase the nation's research capacity, money is still not being provided to promote and proliferate math and science academic achievement at the elementary and secondary levels.

The ACC identified 27 federally funded STEM graduate and post-doctoral fellowship and traineeship programs with a total funding of $1.46 billion in Fiscal Year 2006. However, only 23% of federal STEM education funds actually went to 24 K-12 programs ($574 million) and 11 STEM "informal education and outreach" programs ($137million; Ashby, 2006).

The practice of disproportionate educational spending by federal government to help math and science academic achievement at the secondary level is important to highlight, because it establishes and continues to perpetuate an unequal playing field in math and science education. Ford (2010) states,

> Critical theorists posit the current system of education is a result of what happened in history. Blacks and Latinos comprise 80% of the student population in extreme poverty schools. The achievement gaps between white and minority students, as well as between low and average income students, persists. The quality of education a child receives remains tied to race, income, and neighborhood, strengthening critical theorists' arguments that the equality of education remains tied to governmental support and economic conditions perpetuating social stratification. (p. 49)

Minority subgroups, according to Ford, have traditionally produced low levels of academic achievement in comparison to the White counterparts because of the unequal dissemination of resources, such as technology, funding, and qualified teachers. Moreover, the most immense disparities in academic achievement are between racially and ethnically segregated secondary schools rather than between racially integrated schools (Hodge, Harrison, Burden, & Dixon, 2008).

The practice of financial and racial segregation is analyzed as a structural process in that, the process is an arrangement by which students and federal and state funding is strategically assigned to schools. This structural process continues to produce a relationship of subordination and domination in the K-12 public education system (Ford, 2010).

Federal and state school funding disparities continue to impact educational achievement and to exacerbate socioeconomic and race/ethnic differences in the K-12 educational system as a result of the current federal funding distribution and social framework (Aleman, 2006). Because U.S. public schools are funded almost entirely by state and local taxes, in the form of predominately property taxes, property-rich districts tax property owners at lower tax rates and still produce more revenue than property-poor districts taxing at the maximum rated allowed. This type of funding apparatus, which is highly decentralized, provides students with considerably different educational opportunities based on where they reside (Aleman, 2006; Kozol, 2005). Subsequently, this leaves urban minority populated schools with fewer resources (Orfield & Lee, 2007).

Charter School Spending

Because of poor academic achievement and fewer resources that are allocated to urban minority populated schools, there has been an insurgence of charter schools in urban areas. Charter Schools were first developed as an alternative to tradition public schools. On average charter school offers parents alternative modes of instruction and smaller classrooms.

Charter Schools, like traditional public schools, receive funding from governmental and local educational entities. As the Charter School Act sets forth, the primary source of revenue for charter schools is the base revenue limit. While the base revenue limit is a component of all public school funding, it is calculated differently than the total revenue limit that districts receive to fund their schools. Every school district has a different base revenue limit.

California has the highest number of charter schools of any state in the country with 1,131 schools serving over 500,000 students. But despite the success of charter schools, on average in the state of California, each charter school receives less federal and state money than district public schools. A report by the state Legislative Analyst's Office found that charter schools receive at least 7% less funding than traditional public schools across the board, or $395 per student, and as much as $1,000 per student for some charter schools (National Center for Education Statistics, 2006). Because of this, charter schools have to find innovative ways to raise money to provide students with extracurricular activities and intervention programs such as school-wide blended learning programs.

Title I Funding

One way charter schools supplement the lack of state funding they receive is through Title I funding. Charter schools are not included in Education's Title I formula calculations, but are guaranteed funding on an equal basis with other school districts (United States Department of

Education, 2004). Within the state of California there are thousands of both Charter and Traditional public schools that receive Title I funding to enhance school performance. The term Title I was the first title of the Elementary and Secondary Education Act, and includes programs aimed at disadvantaged students. Part A of Title I provides assistance to enhance and improve the quality of learning and teaching of students in high-poverty schools. The objective of Title I is to enable these students to meet challenging state academic content standards that are assessed via standardized testing (Tennessee Department of Education, 2010).

Each year the federal government appropriates over seven billion dollars to be used for the Title I program. Since the inception of Title I, funding has been designated for school districts that have large populations of economically disadvantaged students. Students are identified as economically disadvantaged if they meet the requirements for the free and reduced lunch program (U.S. Department of Education, 2014). According to the governing laws of Title I, Title I funds must be used to reduce class size, provide staff development, parent involvement activities, and, lastly, purchase materials and supplies to help student achievement. However, Title I funds are often spent on personnel and programs that do not directly impact low income students. Because Title I funds are often spent on personnel and programs that do not directly impact low income students, principals are still trying to come up with innovative ways to close the academic achievement gap between underrepresented minority students and their White and Asian counterparts. Also, because schools are allowed to spend Title I funds with minimal restrictions, there is no evidence that the materials purchased will actually improve student achievement.

Theoretical Perspectives on how to Escalate Academic Achievement

The academic achievement gap between low-income minorities and more affluent white students continues to persist (Chubb & Loveless, 2002; Ford, 2010; Kozol, 2005; Lavin-Loucks, 2006; Rothstein, 2004; Williams, 2003). Adelman (1999) and Swail (2000) note that the quality, and the rigor of students high school education is a predictor of degree completion and factor that helps to close the achievement gap.

Cokley's (2003) research on minority achievement questions the common assumption that the factor which causes minorities to underachieve in school is their lack of motivation. Instead, Cokley found that minority students do not lack motivation rather it is their educational environments that ultimately impact their achievement. Even more specifically, Cokley found that student' relationships with their peers, faculty, and mentors, to a large degree, influences and facilitates academic achievement. There is also research on the postsecondary level as well. Vincent Tinto's 1987 study found that minority student relationships with their faculty greatly influence their academic achievement. Tinto (1993) states that the experiences and social elements that help to acclimate and integrate the student into college also serve to enhance and strengthen the individual's commitment to their educational goals. Based upon the sociological perspective of Tinto's Attrition Model, it is not the character flaw or lack of motivation causing minority students' departure, but instead the responsibility of educational institutions to develop programs to connect these students to each other and faculty on campus and make learning more interesting and relevant for them (Ford, 2010).

Theoretical Foundations: A Look into Learning Environments and Learning Styles

There is a need to analyze the environment in all aspects of life (Schmieder-Ramirez & Mallette, 2007). When trying to understand the math development of students, especially for minority students, one should look at the student experiences and their classroom social environment. Some of the main elements for the success in mathematics courses include the learning styles and the learning environment. Pajak (2003) states, “It is very important that teachers who broaden their instructional repertoire to help build on the strengths while exploring different ways of teaching” (p. 130). “A growing body of research on minorities suggested that learning outcomes were enhanced when instruction is designed with students’ learning styles in mind” (Gylnn, Koballa & Thomas, 2005, p. 77).

One of the factors contributing to the poor success rate in mathematics for all students was teaching methodology. Reardon and Derner (2004) note that “learning is natural and is always taking place but that the typical structured classroom often fails to engage students” (p. 345). To experience the usefulness of mathematics outside the confines of the classroom, the lessons demonstrated, through play, by applying the use of mathematics in the real world.

Because minority students tend, on average, to have several external factors, such as low socioeconomic status, that are out of their control and that often times affect their grades, it is very important to look at how their school environments can be reshaped in order to facilitate, enhance and enrich the students’ learning experience. Several of the educational development programs and the traditional didactic “teacher to student” only instruction involve cognitive and social learning inefficiencies and deficits that do not engage minority students. Therefore, within this section the Constructivist theories of Vygotsky’s theory on social constructivist learning and Dewey’s (1938) experiential learning theory will be explored.

Constructivism. Learning theories have seen fluctuations of favor as the modern world and educational system have changed (Aguilera & Lahoz, 2008). One learning theory that has been used to explain the success of technology and social learning in schools is constructivism.

According to McKenna & Laycock (2004) constructivism encourages learning by interacting with the information, since knowledge is individually constructed based on personal interpretation. Therefore, teaching, for constructivists, should evolve to meet the needs of the students.

For the past 10 years teaching techniques have evolved in adaptation of newer resources and learning environments. Technological advances have created new tools for teaching and learning to the extent that government agencies heavily invested monetarily to encourage the use of technology in schools (Lawless & Pellegrino, 2007). This overt encouragement is also a response to the enormous movement of technology in the workforce. In order to learn and to keep up with this high-tech society, the constructivist student must build on his or her prior experiences, which is different from all other previous experiences of learners in the class. To facilitate an opportunity for all students to relate to their own experiences, the students should be in charge of what they are learning, account for differing learning styles, and the information given within a context the students can easily relate (Dalgarno, 2001).

As a facilitator, the teacher must be mindful of students' growth and learning needs. As such, authentic learning situations should be provided in a non-threatening environment, which encourages free thought without hesitation (Al-Weher, 2004).

Social constructivism. For Vygotsky (1978) the culture of social constructivism gives students the cognitive tools needed for development. Within this culture of learning adults such as teachers are conduits for the tools of the culture, including language. According to Vygotsky (1978) there are different stages and levels in which children development:

> Every function in the child's cultural development appears twice: first, on the social level and, later on, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to

> logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. (p. 57)

Vygotsky (1978), hypothesized that children could not develop cognitive skills unless there was a social context around the development of these skills first and then develop takes place within the child cognitively. Therefore, according to Vygotsky, students learn best from a combination of examples and from experiences in their lives like what takes place in a blended learning environment, wherein the student gets taught by the teacher and/or peers and then cognitively the student can further develop knowledge individually through computer simulations.

Zone of Proximal Development. Vygotsky (1978) defined the *Zone of Proximal Development* (ZPD) as follows, "It is the distance between the actual developmental levels as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers . . ." (p. 86). Namely, the ZPD refers to the layer of knowledge that is beyond that which the learner is currently capable of coping with. According to Vygotsky, the most effective way for a student to learn is to work collaboratively with another person. Dimitriadis & Kamberelis (2006) illuminate the three main features of ZPD as:

1. It stands for the joint effort of the consciousness's of the participants.
2. Participants play active instrumental parts.
3. The interactions are organized in dynamic ways.

Vygotsky's ZPD has salient educational implications with regard to what teachers, mentors, peers and/or parents can do to help children in their learning process (Dimitriadis & Kamberelis, 2006; Williams & Burden, 1997).

Educational implications of ZPD. In particular, the ZPD plays an important role for educators in helping underachieving minorities excel in math and science. Williams and Burden (1997) noted that the ZPD "suggests that the teacher should set tasks that are at a level just beyond that at which the learners are currently capable of functioning, and teach principles that will enable them to make the next step unassisted" (p. 65). By doing so, teachers can accomplish more difficult tasks. However, Daniels (1996) noted that because many researchers have interpreted the notion of the ZPD in varying ways and different degrees of complexity, in essence, Daniels states that there have been diverse models that have reconstructed Vygotsky's original theory. Therefore, as Williams and Burden (1997) noted, it would be the educators' role to find ways of using his concepts effectively.

Scaffolding. Scaffolding is the provision of sufficient support to promote knowledge acquisition when skills are being introduced to students. These supports may include the following:

- Properties (such as books, videos, computers, and/or textiles)
- A captivating task
- Outlines and guides

These supports are steadily removed as students develop autonomous learning strategies, thus promoting their own affective and cognitive learning skills. Dimitriadis and Kamberelis (2006) noted that scaffolding works to move learners into the nearest reaches of their incompetence and helps the learners become competent there. Vygotsky suggested that even complex tasks can be achieved with the assistance of an effective parent and/or educational instructor. Hence, Vygotsky argued that educational instructors need to facilitate and foster more diverse modes of teaching. One way is through blended learning.

The theory of inquiry. Like Vygotsky, John Dewey (1938) believed that education is an experiential hands-on process. Education cannot, according to Dewey, be internalized until experienced. Education must be "hands on" and it should be experienced. Thus, educators should find mechanisms to consistently show students how to connect knowledge to real life. Dewey posits that effective teaching combines what is meaningful to the child and couples it with tactics and technologies and efficacious methodologies. Dewey’s ideas went on to influence many other influential experiential models and advocates. Many researchers even credit him with the influence of Project Based Learning (PBL) and Computer-Based Learning which places students in the active role of researchers.

Dewey's theory, the *Theory of Experience*, stresses that education is a system, and a child is a part of the system. The following is a brief contextual summation of Dewey’s (1916) views on learning:

> One of the weightiest problems with which the philosophy of education has to cope is the method of keeping a proper balance between the informal and the formal, the incidental and the intentional, modes of education. When the acquiring of information and of a technical intellectual skill do not influence the formation of a social disposition, ordinary vital experience fails to gain in meaning, while schooling, in so far, creates only sharps in learning—that is, egoistic specialists. (p. 9)

Because children are a part of the learning system, according to Dewey, the child must be included in the learning process (Park, 2009). Dewey’s philosophy of education is shaped by his belief of balances and diverse modes of education in order to help learners reach their full intellectual equilibrium. The balance of learning and teaching via diverse modes is often offered through an effective blended learning program.

The Social and Experiential Context: The Efficacy of Blended Learning

Creating balanced and individualized rich curriculum for minority students is one of the most effective ways to assist students when thinking in regards to helping minorities achieve in math. Klug and Whitfield (2003) stated that knowledge attainment among these students is quite experiential in nature and a relevant curriculum embodies experiential learning. Experiential learning through computer-based simulations should be taught so that minority students are able to make the multifaceted, multilayered connections incorporating their worldview with the learning opportunities in public schools. While a need for social interaction, like that found in a traditional face-to-face classroom should be of importance as well. Thus, instruction should incorporate a wholistic picture, rich in teacher-based instruction, cultural and social connections, and technology.

Experiential learning. In traditional classrooms students are presented with predigested information from a point of view based on the teacher's point of view. In blended learning classrooms, the students orient their own path of exploration and resolution to knowledge construction (Mvududu, 2005). The constructivist model of blended learning suggests that teachers should operate more as facilitators allow their students to expend energy struggling with problems, which may or may not have right solutions (Mvududu, 2005). The students' temporary state of confusion leads to the confidence needed to achieve understanding. The mental experimentation learners engage in a blended learning classroom allows them to experience new ideas, interpret, reason and reflect on the encounters, as well as the process of reasoning itself (Gholson & Craig, 2006).

Social learning. McManus, Dunn, and Denig (2003) "found that math students who learned using hands-on manipulative and technological activities had higher math achievement and math attitude scores than students who learned using traditional lecture" (p. 97). Vygotsky and Dewey believed that learning is both socially and experientially based. Bruner (1966) emphasized that the learning process itself is as important as the acquisition of learning. Both

Bruner and Vygotsky stated that learning is not accomplished in a vacuum; it is a social activity. Learning theories of Bruner and Vygotsky support the concept that children must experience to learn.

Like Bruner and Vygotsky Albert Bandura believed that learning should take place in a largely social context. The conceptualization of Social Learning Theory was created by Albert Bandura (1977, 1982a). Bandura states that humans are adaptive and creative and that human life has evolved more from social interactions than from biological selection. According to Bandura (1982a),

> Reciprocal determinism is the idea that behavior is controlled or determined by the individual, through cognitive processes, and by the environment, through external social stimulus events. The basis of reciprocal determinism should transform individual behavior by allowing subjective thought processes transparency when contrasted with cognitive, environmental, and external social stimulus events. (p. 25)

As said by Bandura, learning is a reciprocal process between the learner and the environment. Essentially, learning is experiential and is triggered by a variety of social stimuli.

The theory of Social Learning consists of two main parts, the Triadic Reciprocal Model of Social Learning and the Theory of Self-Efficacy, Outcome Expectations, and Goals. The Triadic Reciprocal Model is a model that describes and illustrates learning as a byproduct of the reciprocal interaction among an individual's environment, self-concept and the individual's behavior. The interplay of these three elements together affects how a person learns according to Bandura (1982b). The Triadic Reciprocal model, as defined by Bandura (1986), is a fully bidirectional model. The following figure illustrates the bidirectional interaction:

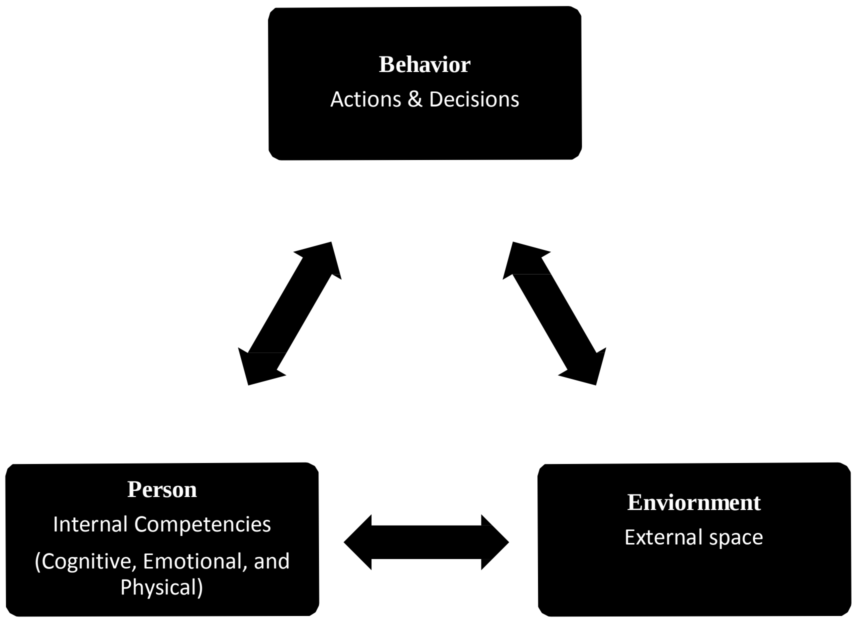

Figure 1. An example of Bandura's triadic reciprocal model

Self-concept/person. The idea of *person*, often referred to as self-concept, was conceptualized by Bandura in order to explore and demonstrate how internal events affect perceptions and actions. These internal events are guided by personal and cognitive factors, beliefs, traits, and emotions. Bandura (1986) emphasizes five cognitive factors: These are the capability to symbolize, have forethought, learn vicariously, self-regulate, and self-reflect. Furthermore, Bandura (1986) did suggest that personal traits, such as one's gender or ethnicity and emotions, inform the self-concept, yet less emphasis is placed on the emotional factors.

Environment. According to Bandura (1989), there are two elements that are critical to the learning process: the emotional responses from other and social support. The emotional responses from others as a mechanism that can either serve to weaken or strengthen learned responses. Social support from others serves to teach individuals appropriate prosaically behaviors (Mortimer & Shanahan, 1995). Environmental supports, such as teacher or mental supports have been shown to be associated with students' vocational and educational self-efficacy.

Behaviors. Bandura noted that the person's abilities to learn are strengthened through the imitation of others that serve as models. Behaviors can be transmitted via live, symbol and verbal models. The following is a condensed table of the models:

Table 2

Bandura's Environmental Models

Live Models	Symbol Models	Verbal Models
Parents	Television	Radio
Mentors	Computer Based Videos	Music
Teachers		

The degree to which all of the models contribute to learning is important. However, the live models serve as the students' first role model and consistently operate as an important and very influential role model throughout the students learning undertakings.

Finally, the *triadic reciprocal* interactions are associated with students' learning experiences (Bandura, 1986).The learner's behavior is guided by cognitive processes that are reciprocal. From these reciprocal interactions for learning, adolescents develop cognitive motivators of learning, such as self-efficacy, outcome expectations, and goals (Bandura, 1997).

Bandura's Theory of Self-efficacy

Bandura (1989, 1993) has delineated determinants of thoughts, behaviors and feelings which make up one's self-efficacy. Self-efficacy is people's judgments about their abilities to execute actions that are required to attain and perform designated types of performances. Bandura's (1986) *Outcome Expectancy Theory* emphasizes that the motivations behind choice are related to rewards that the individual perceives should or will occur. Bandura (1993) stated that the level of performance by a student depends on the degree to which that student perceives their self-efficacious potency. Fluctuations in self-efficacy thinking do occur, therefore, stimuli should be situated around the student in such a way as to foster intrinsic motivation within the student. Hence, there is a connection among self-efficacy, expectancy, and motivation.

Additionally, *Self-Efficacy* and *Outcome Expectancy Theory* suggest that factors that increase individuals' self-efficacy will thereby increase their aspirations toward and persistence in educational and career goals (Karunanayake & Nauta, 2004). According to Bandura's theory of social learning (1977), adolescents tend to pursue those activities for which they are most efficacious (i.e., self-confident). For example, if students who are efficacious about their capabilities to be successful in math and science are more likely to engage and pursue a career in the STEM field and do well on standardized tests. Bandura's theory postulates also that self-efficacy is the student's "difference variable" that allows them in aversive and challenging circumstances and unresponsive social systems to live efficaciously despite their environmental conditions (Bandura, 1984b). Moreover, achievement strategies, effort intensity, and tenacity in seeking solutions to barriers (Covington & Omelich, 1979a) are also predicted by self-efficacy.

In 1945, Julian Rotter suggested that the effect of behavior has an impact on the motivation of people to engage in that specific behavior. Subsequently, people seek to avoid negative consequences, while desiring positive results. When a person has a positive outcome from a behavior, that person would more likely engage in that same behavior again to get the same results. This social learning theory therefore suggests that behavior is greatly influenced by environmental factors, and not psychological factors alone.

Bandura (1977) expanded on Rotter's ideologies, as well as earlier work by Miller (1941) and the social learning theory of Vygotsky (1978). Bandura revised social theory incorporates aspects of behavioral learning.

Bandura summation of social learning theory posits that in order for students to learn and model behavior they must: remember what they observe, have the ability to reproduce the behavior, and have the motivation to want to adopt the behavior.

Blended learning. A growing area of instruction that is addressing the issue of both teacher led instruction and experiential and social learning is the concept of blended learning. The term blended learning is a new term that had very few references before the year 2000 (Bliuc, Goodyear, & Elli, 2007). Definitions of blended learning are quite broad. One basic definition of blended learning is "Blended learning systems combine face-to-face instruction with computer-mediated instruction" (Graham, 2006, p. 5). Another similar definition comes from Driscoll (2002) where she defines blended learning as the combination of "any form of instructional technology with face-to-face instructor-led training" (p. 1).

The results of using blended learning appear to be promising. Means, Toyama, Murphy, Bakia, and Jones, (2009) found that effect sizes were larger for blended learning than for purely online learning when compared to face-to-face learning. Many of the results appear to be contingent on the student's involvement in the learning process. The more time students spend in the learning process, the greater their level of achievement and the more positive their view of blended learning (Means, et al., 2009).

Studies involving blended learning allow instructors to better define their role in the instructional process. As a result of their study, Utts, Sommer, Acredolo, Maher, and Matthews (2003) felt that the time their class spent with an instructor should be more interactive. They felt that the role of the instructor should be that of a motivator and explainer with the students providing input as to what would be explained. The instructor should be available to answer questions in a face-to-face setting rather than electronically. The software system that was used seemed to be sufficient in providing the instruction, but an instructor was needed to help students with their understanding of the concepts.

Due to the changing economic landscape of the world, goals and standards in math and science education have been reformed. Instructional focus has shifted towards inquiry methods of instruction to address the demand for greater scientific literacy among students. One report that has been of particular influence in the STEM debate is from the National Academy of Sciences (NAS) —*Rising Above the Gathering Storm*. This influence is perhaps due to the clear targets and concrete programs laid out in the report including strengthen the skills of current math and science teachers and quadruple the amount of high school math and science courses taking (Kuenzi, 2008).

To enlarge the pipeline, however, the most important and most effective mechanism that NAS states and supports is the expansion of programs such as *statewide specialty high schools* for STEM immersion and blended learning through laboratory experience and other research opportunities (Kuenzi, 2008). Students engaging in inquiry-based and blended learning are allowed to engage as novice participants in a community of science practitioners, with instructors to guide them. This form of cognitive apprenticeship is a social process of scaffolding that allows students to practice and internalize habits of scientific inquiry (Brown, Collins, & Duguid, 1991; Vygotsky,1978).

Researchers opposed to constructivist learning theory have challenged instruction using a blended learning and inquiry-based learning approach in the classroom (Kirschner, Sweller, &

Clark, 2006). In 2007, Hmelo-Silver, Duncan, and Chinn responded directly to Kirschner, Sweller, & Clark (2006) to make the case for inquiry-based learning as an appropriate and effective method of learning science.

Pedagogues and researchers agree that the importance of understanding mathematics, and especially science, exists in the process of inquiry, blended learning and investigation. In 1964, education reformer John Dewey advocated the idea that learning math and science should reflect the authentic practice of science, an open-ended process driven by inquiry. Thus, blended learning and inquiry-based learning is an effective and viable intervention and enrichment strategy towards goals of promoting active learning and motivation of students in science and math education. Blended learning in general fosters three components: free self -expression, creativity and social participation.

Free self-expression. Friedrich Froebel, German pedagogue and creator of kindergarten, most important contribution to educational theory was his belief in "self-activity" and play as essential factors in child education. Play was a time when children manipulated blocks and other materials without the interference of adults. After being exposed to the educational techniques of Germany, Froebel felt that education was full of rigidity. Therefore, Frobel examined ways in which to intensify children's innate desire to be freely expressive. Dr. Edward Hallowell, author of the Childhood Roots of Adult Happiness states, "If you trust the process...and recognize play and fun as essential elements of the process, if you allow a student to be a student first and an adult later, something amazing happens. The student becomes who he or she is meant to become" (Hallowell, 2009, p. 14). The teacher's role was not to drill or indoctrinate the children, according to Hallowell, but rather to encourage their self-expression through individual and group activities. Froebel devised toys that were designed to stimulate learning through collaborative play activities accompanied by songs and music.

Social participation. Because a portion of blended learning still takes place within a traditional classroom setting, there is still a level of social participation amongst the students. A cooperative group is nontraditional teaching style that reduces prejudice when cross-cultural contact situations are cooperative (Dossey & Jones, 1993). Interventions must address the need to promote participation and interest of underrepresented students in math and science beyond secondary and postsecondary education through immersive experiences in research facilities. Collaborative groups provide the social interaction that often deepens learning and the interpersonal support and synergy necessary for creatively solving the complex problems of teaching and learning. When students are placed into groups they begin to advocate on behalf of their group, which directly increases teamwork. However, educators usually underestimated the effective qualities which manifest after the students collaborate.

Creativity**.** Like the other cultivated byproducts of blended learning, creativity helps to foster learning and motivates students to achieve. Creativity is about the power of imagination. Those who process creativity place the highest value on revelations of the human spirit. Creativity thrives in an environment that allows questions, exploring, observing and skill-building. Therefore, Froebel spent an enormous amount of time detailing the importance of developing creativity within the home and classroom through a variety of materials. Building anticipation before a trip or lesson, digging deeply into material during the lesson, and keeping the ideas alive for some time after the lesson are also ways to keep the creative processes going.

Math Computer-Based Learning in Context: The ALEKS and Rev Prep Programs.

Publishers and software companies are developing many products and online programs to meet this growing need and desire to offer schools better modes to incorporate online instruction with face-to-face instruction. These companies claim that their products will greatly increase a student's ability to learn (ALEKS, 2008b; Pearson Education, 2006). Two such inquiry-based math computer-based programs that are often used in Title I high schools in Califronia are The ALEKS and Revolution Prep programs.

The ALEKS system. One web-based system for mathematics instruction is Assessment and Learning in Knowledge Spaces (ALEKS). ALEKS is an intelligent-tutoring system that provides instruction to students and assesses them on that knowledge. ALEKS is based on theoretical work in the field of Knowledge Space Theory begun by Dr. Jean-Claude Flamagne. Knowledge Space Theory is not a theory of how one learns, rather it is a theory of the order in which different concepts can be learned and how everything that a person knows about a subject can be deduced from determining whether a person knows or does not know a few topics (ALEKS Corporation, 2008a; Flamagne, Koppen, Villano, Doignon, & Johannesen, 1990).

The first time a student uses ALEKS, he or she is assessed to determine his or her current knowledge of mathematics. The student's knowledge is assessed using a small number of questions, approximately 30, that are chosen based on the answers to previous questions. After the assessment, ALEKS presents the student with a list of topics that he or she is ready to learn. The student can then select a problem from this list, and ALEKS presents practice problems to teach the topic. The student can then select another topic that he or she is ready to learn. The student is periodically reassessed by ALEKS to determine if the student has actually mastered the topics covered.

The Revolution Prep system. The Revolution Prep system is a high-stakes assessment software design to increase math skills and knowledge for students (Revolution Prep, 2014). The

Revolution Prep system has built its business by offering technology-based solutions for both advanced placement courses as well as curriculum to help failing high school students. Revolution Prep sells its courses to public schools where teachers often deliver those courses in a classroom setting. Even when students are working on the same courses, they are working at their own pace. Teachers can also choose to help students one-on-one or in small groups.

Los Angeles Unified School District (LAUSD) works with Revolution Prep to provide its software to all 11th and 12th graders in the district who have not passed the state exit exams. Some schools within LAUSD have even adopted a school-wide math blended learning model which allows all students to get access to Revolution Prep computer-based interventions.

Together the ALEKS and Revolution Prep computer-based math programs combined with traditional face-to-face teaching models are said to motivate students, build their math skills, self-confidence, overall academic knowledge and make up a large percentage of the math blended learning programs in California high schools.

Blending Learning Programs and Standardized Testing Success

The advent of standardized testing occurred in 1908 with the first Intelligence Quotient Test, better known as the IQ test (Zangwil, 1987). IQ scores are used as predictors of educational achievement, special needs, job performance and income. Similar to the use of IQ tests in the early 20th century; standardized tests are still being used to determine academic achievement within the educational system. Since the early 1900s, the public school system has produced standardized test results where disadvantaged students, minority and poor, continuously score lower than their counterparts, White middle and upper class students. The *No Child Left Behind* (NCLB) Act (2002), which leads to the obligatory use of standardized tests nationally, requires states to develop and implement assessments to be distributed to all students as a prerequisite to receive federal funding for schools. In 2010, The Center on Education Policy collected, synthesized, and analyzed data from a variety of different state websites and from data from state standardized tests reports to determine how many schools in each U.S. state did not make adequate yearly progress (AYP) under the *No Child Left Behind* Act. The report found that the majority of the states, including D.C., more than 25% of the schools did not make AYP (Dietz, 2010).

In California, the state standardized test that measures the degree to which California students' achieve academically is called the California Standards Test (CST). The CST is a part of the STAR program and includes several content areas. The CST in English and mathematics for Grades 2 through 11 became part of the STAR program in 1999, but today The CSTs in history and science are also administered and used in terms of calculating a school's academic performance index (API). All of the content areas of the CST are aligned to state-adopted standards that describe what students should know and be able to do in each grade and subject tested (Standardized Testing and Reporting, 2008).

Presently, the STAR testing program in California illustrates that there is a direct correlation between disadvantaged minority students and low standardized test scores especially in the areas of math and science. Subsequently a huge achievement gap remains, with Black and Hispanic students failing the exams in much higher numbers than Whites and Asians (Rinde, 2011). School data reports show that only 16% of Latino students and 14% of African American students are performing proficiently in Algebra I on the CST in Los Angeles County (Dataquest, 2009).

The goal of academic blended learning programs is to provide educationally and economically disadvantaged students with the skills, knowledge, and general college preparatory information needed to the close the academic achievement gap and enter and succeed in college in a larger academic and social context (Swail & Perna, 2002).

Although there is research that shows a positive relationship between the academic intervention programs that have increased test scores, there is still a great amount of research that needs to be done to confirm if math blended learning programs can indeed increase math scores consistently.

Conclusion

When students are taught math skills through nontraditional and traditional teaching means, like those find in math blended learning programs, research shows that there is a positive impact in academic performance. Encouraging students to do well on a high-stakes test by providing an effective math blended learning programs can promote a positive attitude toward testing which will encourage them to do well. In order to implement a comprehensive program, all aspects of what motivates students to persist should be taken into consideration. Based upon the reviewed literature it seems that a program that includes face-to-face instruction, technology, appropriate math computer software, projects and inquiry for minority students could be quite impactful. Singularly these components have proven effective, so collectively one could surmise the potential for maximum benefits. Math blended learning programs contain all of the various interventions and enrichments discussed in one comprehensive package. Chapter III will, therefore, showcase the methodology that was used to analyze the relationship of math blended learning programs and standardized test scores and herein will attempt to determine the efficacy of these programs.

Chapter III: Methodology

This causal-comparative quantitative research study was designed to evaluate the efficacy of math blended learning programs. In order to examine if there was an elevated level of performance on the Algebra I math section of the California Standards Test (CST) of underrepresented minority high school students who attended Title I schools that had a school-wide math blended learning, this researcher compared the scores of underrepresented minority high school students who attended a Title I high school that did not have a school-wide math blended learning program during the 2011-2012 school year.

This study focused on the following sub-groups: ethnicity, gender and charter school designation. Data from 14 Title I high schools within the city of Los Angeles was analyzed. And a total of six research questions were examined in order to determine the level of effectiveness of school-wide math blended learning programs as it relates to ethnicity, and gender sub-groups. This chapter will present the research design, research methodology, population selected for the study, instrumentation, reliability, validity, data collection procedures, data analysis, and ethical considerations of the study.

Restatement of the Problem

With the chronic underachievement of underrepresented minority students in the area of math, educational institutions from kindergarten to the university level have been trying to address this problem. In response to and in conjunction with such policies, researchers should examine and report the prominent characteristics of math blended learning programs in order to determine whether the program characteristics are effective in increasing student success. Ascertaining whether specific math blended programs have any differential effects across diverse minority student populations would not only be valuable to high school students, but also to state, local and federal institutions in terms of guiding curriculum and program development.

If researchers, pedagogues, and policy makers from all levels of the public and private education sector could empirically identify successful math blended learning programs and the prominent characteristics of the interventions employed, they would have a paradigm in which to draw from in order to implement similar programs to erase the inequities that exist in regards to the underrepresentation and underachievement of minority students within the education sphere.

Restatement of the Purpose

The purpose of this causal-comparative research design study was to determine whether or not adopting a school-wide math blended learning model led to significant differences in the Algebra I math standardized test scores on the California Standards Test (CST), between underrepresented minority students from Title I high schools in Los Angeles who had a school-wide math blended learning program during the 2011-2012 school year compared to underrepresented minority students from Title I schools who did not have a school-wide math blended learning program. Though one of the goals of math blended learning programs is to increase math achievement, the emphasis or perceived effectiveness of these programs varies due to the fact that each program is tailored to fit the unique needs of the students served.

Restatement of the Research Questions

In order to understand the efficacy of math blended learning programs on underrepresented minority student achievement on the California Standards Test (CST), the following research questions guided the investigation on variance in scores that was obtained from the treatment group, students who attended Title I high schools with a school-wide math blended learning program, and the control group, students who attended Title I high schools without a school-wide math blended learning program during the 2011-2012 academic school year:

RQ1. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to 9th grade students who attended a Title I high school that did not have a school-wide math blended learning program?

RQ2. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between male 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to male 9th grade students who attended a Title I high school that did not have a math blended learning program?

RQ3. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between female 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to female 9th grade students who attended a Title I high schools that did not have a math blended learning program?

RQ4. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between African-American 9th grade students who attended a Title I high school with a school-wide math blended learning program as compared to African-American 9th grade students who attend a Title I high school that did not have a school-wide math blended learning program?

RQ5. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between Latino 9th grade students who attended a Title I school with a school-wide math blended learning program as compared to Latino 9th grade students who attended a Title I school that did not have a school-wide math blended learning program?

RQ6. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between 9th grade students who attended a Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program?

Restatement of the Research Hypotheses

The research hypotheses that were utilized to support the research questions are:

$H1_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared to 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H1_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared to 9th grade students who attended Title I schools that did not have a school-wide math blended learning program.

$H2_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between male 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared male 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H2_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between male 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared male 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H3_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between female 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared female 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H3_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between female 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared female 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H4_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between African-American 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to African-American 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H4_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between African-American 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to African-American 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H5_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between Latino 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to Latino 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H5_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between Latino 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to Latino 9th grade students who attended Title I high schools that did not a school-wide math blended learning program.

$H6_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program.

$H6_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program.

Research Methodology

This research study quantitatively investigated the effectuality of math blended learning programs. Quantitative research was used for this study to make statistical connections between the data and determine if the hypotheses were statistically significant. Quantitative research explains phenomena by collecting numerical data that are analyzed using mathematically based methods (Aliaga & Gunderson, 2002). The type of data that was used for this study is pre-existing data to determine if students who attended a Title I school that had a school-wide math blended learning program scored higher on the Algebra I math section of the California Standards Test (CST) than students who did not attend a Title I school that did not have a school-wide math blended learning program.

Research Design

The research design that was utilized in this study is causal-comparative. The causal-comparative method, also known as the ex-post-facto method, attempts to discover, or deduce, how and why a particular phenomenon occurs (Boissoneaum & Wayne, 1996). Causal-comparative educational research also attempts to identify a causative relationship between an independent variable and a dependent variable (the independent and dependent variables for this study will be outlined later on in this chapter). However, when conducting causal-comparative research this relationship is more suggestive than proven as the researcher does not have complete control over the independent variable. If the researcher had control over the variables, then the research would be classified as true experimental research (Minnesota State University, 2013). In this regard, causal-comparative research is similar to experimental research, yet causal-comparative research does not prove cause-and-effect relationships. Kerlinger (1973) stated that "…causal-comparative research is systematic empirical inquiry in which the scientist does not have direct control of independent variable because their manifestations have already occurred" (p. 148). In causal-comparative studies, according to Kerlinger, the resulting data from empirical inquiry process are usually analyzed by t-tests, or analysis of variance.

The most critical element to conducting causal-comparative research is to start with significant differences among two or more groups, and to search for possible causes for, or consequences of, this difference. From the select Title I high schools, this researcher compared two groups of students. GROUP 1, the treatment group, the 9th grade students from Title1 high schools that had a school-wide math blended learning program, and GROUP 2, the comparison group, the 9th grade students who attended a Title I high school without a school-wide math blended learning program during the 2011-2012 school year. This researcher then analyzed the mean scores of the Algebra I standardized test scores to determine whether there was an elevated level in achievement on the Algebra I section of the California Standards Test (CST) between 9th grade students who attended a Title I high school with a school-wide math blended learning program compared to 9th grade students who did not.

The independent variable in this research study was the math blended learning program. The dependent variable was the performance on the Algebra I section of the California Standards Test (CST) and the moderator variables were ethnicity, gender, and charter school designation. A moderator variable, according to Field (2006), is a variable that changes (increases or decreases) the otherwise established effect of the independent variable upon the dependent variable. Including a moderator variable or variables in a research study provides more information than just using one single independent variable.

Unit of Analysis

Population. Archived de-identified pre-existing test score data from 14 Title I high schools within the city of Los Angeles was used for this study. Combined, the Title I high schools selected for this research study were ethnically diverse and included two main groups: African American, and Latino. This demographic diversity was needed in order to answer the research questions.

Sample. Purposive sampling was used to select the participating high schools. Purposive sampling is when based on previous knowledge of a population and the specific purpose of the research (Patton, 1990) investigators use personal judgment to select a sample. In this case, the sample size derived from the total number of 9th grade students who attended Title I schools that had a school-wide math blended learning program during the 2011-2012 academic school year, and a comparison group of 9th grade students who attended Title I schools that did not have a school-wide math blended learning program. This researcher controlled for gender and ethnicity by matching the treatment group and the comparison group by gender, ethnicity and charter school designation.

Instrumentation

Archived pre-existing data of Algebra I scores from one school year, the 2011-2012 academic school year, was used in order to compare the CST performance of the 9th grade students who attended schools that had and did not have school-wide blended learning programs, therefore there is no instrument that was used for this study.

This researcher acquired the public student data from the California Department of Education Website, http://star.cde.ca.gov/ (California Department of Education, 2014).

Validity

Validity is used to determine whether research measures what it intended to measure and to approximate the truthfulness of the results. To measure the validity of an instrument or measurement, a collection of trained experts assemble to test whether or not a particular instrument is deemed valid. The validity of the California Standards Test (CST) was determined by several experienced educational specialist whom converge yearly to discuss the accuracy of the content elements of the standardized test and determine whether or not the content of the test is indeed valid.

Content validity refers to the degree in which the content of a test is congruent with the purpose of the testing, as determined by subject matter experts. Content validity also provides information about how well an item measures its intended construct. Such validity is determined by a critical review of the items by experts in the field. For the CST, these reviews are conducted by a number of experts in their designated areas from both the California Department of Education (CDE) and the Educational Testing Service (ETS). CDE content consultants each have extensive experience in K–12 assessments, particularly in their subjects of expertise, and many are former teachers. At a minimum, each CDE content consultant holds a bachelor's degree; most have advanced degrees in their area of expertise.

Reliability

There are different types of reliability in quantitative research which relate to such dimensions as stability of a measurement over time, and the degree to which a measurement remains the same. Joppe defines reliability as:

> …the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. (Joppe, 2000, p. 1)

According to Joppe reliability encompasses the extent to which results of a study can be reproduced under similar procedures. In the case of the California Standards Test (CST), because it is administered in accordance to the No Child Left Behind Act on an annual basis and is reproduced each year under similar measurements it is considered reliable.

Reliability addresses the ability to replicate the findings since research findings are considered more valid if repeated observations produce similar results (Merriam, 1998). During this study, the process to obtain student data and the same categorical data was retrieved the same way across all schools.

Data Collection

The data collection steps and data analysis procedures will be elucidated within the next two sections of this Chapter. As a means to measure the efficacy of math blended learning programs, student test data was examined from 14 selected Title I high schools within the city of Los Angeles. The following table is a sequential outline of the data collection steps and procedures that was utilized during this study. Following Table 2, a more detailed narrative of each data collection step will be given.

Table 2

Data Collection and Data Analysis Procedure Outline

Procedural Steps
1. Identified which schools in the city of Los Angeles were Title I schools during the 2011-2012 school year.
2. This researcher then collected the student data and Algebra I CST mean scores for 9th grade students from all 14 Title I schools from the California Education Standardized Testing and Reporting (STAR) website.

(continued)

Procedural Steps
3. Next, this researcher organized all of the collected student data and divided the data into two groups: GROUP 1, the treatment group, which was composed of the student data and the Algebra I test scores of the students who attended Title I schools with a school-wide math blended learning program during the 2011-2012 school year and GROUP 2, the comparison group, was composed of the student data and Algebra I CST data of the students who attended Title I schools that did not have a school-wide math blended learning program.
4. Code data
5. Following the coding process, the data was exported into SPSS wherein the statistical analyses was performed and;
6. An one-way Analysis of Variance (ANOVA) was utilized to analyze and compare the mean scale scores of the treatment and comparison groups

The preceding table has outlined the different steps that were used to collect, organize, and analyze all of the school and student data for this study. Henceforth, a more detailed narrative of each step will be drawn.

Step 1.During the onset of the data collection process the Title I high schools within the city of Los Angeles was identified and 14 Title I high schools were selected based on similar student demographics. Table 3 below lists the Los Angeles zip codes that have Title I high schools, the most underrepresented minority student populations, and the greatest poverty levels:

Table 3

Percentage of Population Below Poverty Level and Title I school by Los Angeles Zip Code (2012)

#	Zip Code	City	Population	% Poverty Level	Title I schools? Y/N
1.	90058	Los Angeles, California	3,624	77.43 %	Y

(continued)

#	Zip Code	City	Population	% Poverty Level	Title I schools? Y/N
2.	90017	Los Angeles, California	20,689	67.15 %	Y
3.	90059	Los Angeles, California	38,123	65.78 %	Y
4.	90002	Los Angeles, California	44,584	61.74 %	Y
5.	90003	Los Angeles, California	58,187	61.27 %	Y
6.	90021	Los Angeles, California	3,003	60.70 %	Y
7.	90013	Los Angeles, California	9,727	60.25 %	Y
8.	90011	Los Angeles, California	101,214	59.69 %	Y
9.	90037	Los Angeles, California	56,691	59.13 %	Y
10.	90001	Los Angeles, California	54,481	58.97 %	Y
11.	90044	Los Angeles, California	87,366	56.88 %	Y
12.	90015	Los Angeles, California	15,134	56.07 %	Y
13.	90033	Los Angeles, California	49,418	52.98 %	Y
14.	90006	Los Angeles, California	62,765	50.62 %	Y
15.	90061	Los Angeles, California	24,503	50.50 %	Y
16.	90057	Los Angeles, California	43,986	48.32 %	Y
17.	90023	Los Angeles, California	47,468	46.12 %	Y
18.	90031	Los Angeles, California	38,409	45.25 %	Y
19.	90007	Los Angeles, California	45,021	44.82 %	Y
20.	90005	Los Angeles, California	43,014	44.78 %	Y
21.	90014	Los Angeles, California	3,518	42.73 %	Y
22.	90029	Los Angeles, California	41,697	41.59 %	Y
23.	90038	Los Angeles, California	32,557	41.28 %	Y
24.	90063	Los Angeles, California	55,666	40.86 %	Y
25.	90018	Los Angeles, California	47,127	40.81 %	Y
26.	90022	Los Angeles, California	68,688	38.82 %	Y
27.	90062	Los Angeles, California	29,279	38.42 %	Y
28.	90020	Los Angeles, California	42,383	36.08 %	Y
29.	90026	Los Angeles, California	73,671	35.79 %	Y
30.	90004	Los Angeles, California	67,850	35.66 %	Y
31.	90016	Los Angeles, California	46,968	33.85 %	Y
32.	90028	Los Angeles, California	30,562	33.46 %	Y
33.	90047	Los Angeles, California	47,105	31.96 %	Y
34.	90008	Los Angeles, California	30,840	31.52 %	Y
35.	90019	Los Angeles, California	67,510	30.43 %	Y
36.	90032	Los Angeles, California	46,942	28.50 %	Y
37.	90043	Los Angeles, California	44,761	27.89 %	Y
38.	90065	Los Angeles, California	47,524	26.87 %	Y
39.	90042	Los Angeles, California	64,660	26.10 %	Y

Step 2. Fourteen Title I schools, seven that have school-wide math blended programs and seven high schools that do not, was purposively selected based on similar school and student demographics. Once 14 schools were selected, the Algebra I student CST score data for the 14

Title I high schools was obtained from the California Education Standardized Testing and Reporting (STAR) results database.

Step 3. Next, in order to organize the school and student test score data, a Microsoft Excel spreadsheet was created and contained columns for a school ID number, and Algebra I mean scores based on the following sub-groups: ethnicity and gender. Table 5 is an example of the proposed data collection spreadsheet that was used:

Table 4

Sample Data Collection Spreadsheet for each Title I High School (2011-2012)

High School Number	Math Blended Learning Program?	Charter School	Gender Alg. 1 Mean Score (female)	Gender Alg.1 Mean Score (male)	Ethnicity Alg. 1 Mean Score (African-American)	Ethnicity Alg.1 Mean Score (Latino)
01	Yes	No	434	640	600	598
02	No	Yes	530	720	545	623

Step. 4 Once all of the student data was collected the sample was then divided into two groups: GROUP 1, the treatment group, was composed of the mean test scores of the 9th grade students who attended schools with a school-wide math blended learning programs and GROUP 2, the comparison group, which was composed of the student Algebra I mean test scores of 9th grade students who did not attended Title I schools that had a school-wide math blended learning program during the 2011-2012 school year.

Data Analysis Procedures

Step 5. Upon the completion of creating both GROUP 1 and GROUP 2, the data was coded. Table 5 illustrates how the research variables were coded.

Table 5

Coding Variables

Variable	Code
Math blended learning program (MBL)	
MBL Participating School	1
Non-MBL Participating School	2
Title I High Schools	
High School 1	1
High School 2	2
High School 3	3
High School 4	4
High School 5	5
High School 6	6
High School 7	7
High School 8	8
High School 9	9
High School 10	10
High School 11	11
High School 12	12
High School 13	13
High School 14	14
Ethnicity	
African-American (AA)	1
Latino (L)	2
Gender	
Female (F)	1
Male (M)	2
Charter School Designation	
Charter School	1
Non-charter School	2

Table 5 outlines the coding process. As cited above, the students' ethnicity was coded as 1 – African American; 2 – Latino; 3 – Other. Male students were coded using the number 1, and female students were coded using the number 2.

Step 6. After the coding process, variable information was then carefully organized by research question and research hypothesis as shown in Table 6.

Table 6

Research Design Data Analysis Breakdown

RQ; RH	IV	ICV	DV	M
RQ 1	MBL	none	CST M	MSS
RH: $H1_1$& $H1_0$				
RQ 2	MBL	Gender M	CST M	MSS
RH: $H2_1$& $H2_0$				
RQ 3	MBL	Gender F	CST M	MSS
RH: $H3_1$& $H3_0$				
RQ 4	MBL	Ethnicity AA	CST M	MSS
RH: $H4_1$& $H4_0$				
RQ 5	MBL	Ethnicity L	CST M	MSS
RH: $H5_1$& $H5_0$				
RQ 6	MBL	Charter or Non-Charter School	CST M	MSS
RH: $H6_1$& $H6_0$				

Note. *RQ* = Research Question; *IV* = Independent Variable; *ICV* = Independent Categorical Variables; *DV*= Dependent Variable; *M* = Measurement; RH = Research Hypothesis; *MBL* = Math Blended Learning Program; *Gender F* = Gender Female; *Gender M* = Gender Male; *Ethnicity AA* = Ethnicity African American; *Ethnicity L*= Ethnicity Latino; *CST M* = California Standards Test (CST) Math; *MSS* = Mean Scale Score.

Step 7. Following the synthesizing process, the data was exported into the statistical program called SPSS.

Step. 8 An one-way Analysis of Variance (ANOVA) was utilized to analyze and compare the mean scale scores of the treatment and comparison groups.

Within an ANOVA statistical model, the one-way dimension signifies that there is usually one dependent variable which is continuous, and one independent variable which is categorical. The dependent variable is measured as a numeric (average of a measurement) and the independent variable is an attribute (Mertler & Vannatta, 2002). For example, the flow chart in figure 2 outlines the independent, moderator and the dependent variables that were presented in this study:

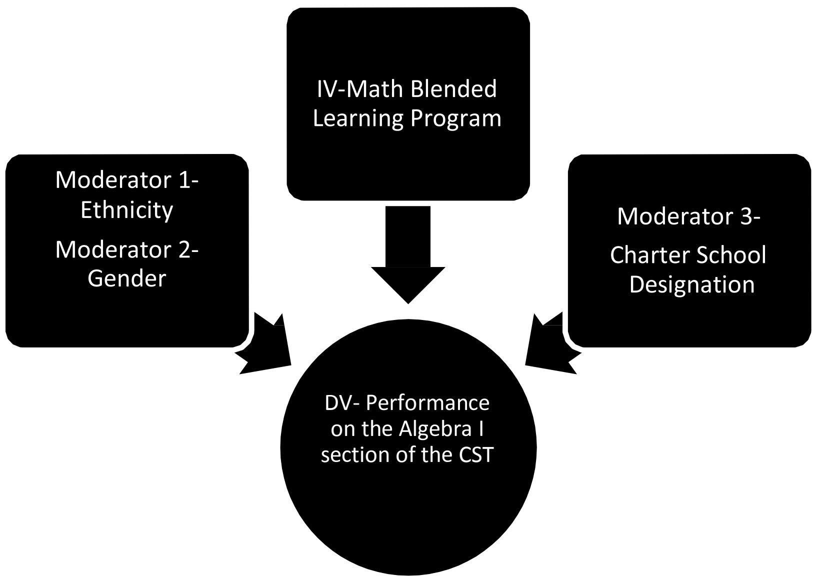

Figure 2. The independent, moderator, and dependent variables of the study.

In this study the independent variable was the school-wide math blended learning program provided by the high schools. School-wide math blended learning programs are blended learning programs that are adopted by the entire school, in which all math teachers have to incorporate math computer-based software within the classroom and/or math lab at least once a week for 45 minutes. The independent categorical variables, or moderator variables, were ethnicity, gender, and charter school designation. And the dependent variable was the performance on the Algebra I math section of the CST. According to the chart, this study attempts to determine the degree to which math blended learning programs and the presence of ethnicity and gender have a significant effect on the dependent variable (performance on the Algebra I section of the CST).

In order to analyze the significance of the independent variable on the dependent variable an ANOVA was performed. The ANOVA allowed the total variation of scores to be divided into two scores which consists of variance between and within groups. Between-group variance was determined in order to estimate the population variance based on how far away group one's, the treatment group, specific mean was from the group two's, the comparison group, specific mean. Ultimately, by comparing mean test scores, this study sought to determine if the math blended learning program the students received led to a significant increased level of achievement on the Algebra I math section of the CST.

Ethical Considerations and IRB Plan

Data collection did not begin until this researcher received approval from the Institutional Review Board (IRB) application to Pepperdine University. Because this researcher used public archived de-identified pre-existing data, there was not any interaction and contact with any high school students, consequently; there were no possibilities for harm to participants in this study. This study did not include any interaction or contact between any students, administrators and the researcher; therefore, no informed consent was required.

All data collected was kept confidential and no identifying information was revealed or made available to the public. The protection of the each high school's name was upheld by de-identifying each high school's name. Hence, no ethical issues were encountered during this research study. The electronic data was password protected and paper copies will be kept in a locked file cabinet and will be destroyed in three years.

Chapter Summary

Chapter III provided an overview of the research methodology, design, analysis procedures and the data collection process that was employed to complete this quantitative research study. The purpose of the research was to determine whether or not math blended learning programs led to significant differences in the math standardized test scores on the CST for 9th grade students who attended Title I high schools that had school-wide math blended learning programs. The standardized test data that was used to measure student performance was archived and de-identified. Chapter III has elucidated the ways in which the de-identified information was collected and coded. Moving forward, chapter IV will present the analytical and statistical outcomes of the research. And chapter V will entail a discussion of the summary of the results; discussion of the results in relation to the literature; implications; limitations; and recommendations for further research.

Chapter IV: Results

The purpose of this study was to determine whether or not adopting a school-wide math blended learning model leads to significant differences in the Algebra I math standardized test scores on the California Standards Test (CST), for underrepresented minority students from Title I high schools who attended a school with a school-wide math blended learning program compared to underrepresented minority students from Title I high schools who did not have a school-wide math blended learning program. This chapter will present the findings of the data analyses that were used to answer the research questions and test the research hypotheses. This chapter will also provide an overview of the demographic data, analysis of data, the results, and a summary of the data analysis. Additionally, how the research hypotheses were tested and whether or not each hypothesis was keep or rejected will also be discussed.

Demographic Data

This researcher used data from 14 Title I high schools in Los Angeles, CA. Primarily all 14 Title I high schools were composed of African-American and Latino students. Asian-American and White students only consisted of less than 1% of the student population from each of the Title I high schools. The sample size was composed of only 9th grade students from each school who were enrolled during the 2011-2012 academic school year. From the 14 Title I high schools there were a total of 3,318 9th grade students, 809 of which were African-American and 2,509 of which were Latino.

The following table shows some close figures of each high school's student population. In order to maintain each school's anonymity the exact number of students that attended each school is not disclosed:

Table 7

Title I High Schools' Student Population Approximations

Title I High Schools	Student Population Approximations (9th grade students)
High School 1	+/-400
High School 2	+/-300
High School 3	+/-100
High School 4	+/-200
High School 5	+/-200
High School 6	+/-300
High School 7	+/-100
High School 8	+/-100
High School 9	+/-400
High School 10	+/-300
High School 11	+/-100
High School 12	+/-400
High School 13	+/-300
High School 14	+/-100

This study does not look at each of the 3,318 students individual Algebra I CST scores, instead this study analyzes the mean Algebra I scores of the subgroups based on gender, ethnicity, and charter school designation from each of the 14 Title I high schools.

Six research hypotheses were tested to compare the mean Algebra I scores of the 9th grade African-American and Latino students from the Title I high schools that had a school-wide

Math Blended Learning (MBL) program compared to the mean Algebra I scores from the 9th grade students that did not have a school-wide MBL program. In order to test each hypothesis this researcher compared two groups of students from the 14 Title I high schools. GROUP 1, the treatment group, was composed of the 9th grade students from Title1 high schools that had a school-wide math blended learning program, and GROUP 2, the comparison group, was composed of the 9th grade students who attended a Title I high school without a school-wide math blended learning program during the 2011-2012 school year. This researcher then analyzed the mean scores of the Algebra I standardized test scores to determine whether there was an elevated level in achievement on the Algebra I section of the California Standards Test (CST) between 9th grade students who attended a Title I high school with a school-wide math blended learning program compared to 9th grade students who did not. A discussion of the data analysis conducted to test each research hypothesis and question as well as the additional statistical analysis are discussed in the results section of this chapter.

Analysis of Data

In order to explicate the differences in the data, the quantitative data analysis technique that was utilized was the one-way Analysis of Variance (ANOVA). For the level of significance, an alpha level of .05 was set as the criterion. By comparing standardized test scores, the ANOVA allowed this researcher to determine if the MBL academic intervention caused a significant increased level of achievement on the Algebra I section of the CST compared to the achievement of students who were not in the program.

In this study the independent variable was the school-wide math blended learning program that was provided by the Title I high schools. The independent categorical variables, or moderator variables, were ethnicity, gender, and charter school designation. And the dependent variable was the performance on the Algebra I section of the CST. This study was intended to determine the degree to which math blended learning programs and the presence of ethnicity, gender, and charter school affiliation have a significant effect on the dependent variable (performance on the Algebra I section of the CST). The analysis of data was conducted with the computerized Statistical Package for Social Science (SPSS) program.

The Title I high schools that had a school-wide math blended learning program (MBL), the treatment group, were coded using the number one, whereas the Title I high schools without a school-wide math blended learning program (non-MBL) were coded with the number two. The Title I high schools, gender, ethnicity, and charter categories were coded using the numbers one through 12. Table 8 provides an illustration of how each one of these variables were coded for the study.

Table 8

Coding Variables

Variable	Code
Math blended learning program (MBL)	
MBL Participating School	1
Non-MBL Participating School	2
Title I High Schools	
High School 1	1
High School 2	2
High School 3	3
High School 4	4
High School 5	5
High School 6	6
High School 7	7
High School 8	8
High School 9	9
High School 10	10
High School 11	11
High School 12	12
High School 13	13
High School 14	14

(continued)

Variable	Code
Ethnicity	
African-American (AA)	1
Latino (L)	2
Gender	
Female (F)	1
Male (M)	2
Charter School Designation	
Charter School	1
Non-charter School	2

After the coding process, variable information was carefully organized by research question and research hypothesis as shown in Table 9.

Table 9

Research Design Data Analysis Breakdown

RQ; RH	IV	ICV	DV	M
RQ 1	MBL	none	CST M	MSS
RH: $H1_1$& $H1_0$				
RQ 2	MBL	Gender M	CST M	MSS
RH: $H2_1$& $H2_0$				
RQ 3	MBL	Gender F	CST M	MSS
RH: $H3_1$& $H3_0$				
RQ 4	MBL	Ethnicity AA	CST M	MSS
RH: $H4_1$& $H4_0$				

(continued)

RQ; RH	IV	ICV	DV	M
RQ 5	MBL	Ethnicity L	CST M	MSS
RH: $H5_1$ & $H5_0$				
RQ 6	MBL	Charter or Non-Charter School	CST M	MSS
RH: $H6_1$ & $H6_0$				

Note. *RQ* = Research Question; *IV* = Independent Variable; *ICV* = Independent Categorical Variables; *DV*= Dependent Variable; *M* = Measurement; RH = Research Hypothesis; *MBL* = Math Blended Learning Program; *Gender F* = Gender Female; *Gender M* = Gender Male; *Ethnicity AA* = Ethnicity African American; *Ethnicity L*= Ethnicity Latino; *CST M* = California Standards Test (CST) Math; *MSS* = Mean Scale Score.

Results

This part of Chapter IV provides an overview of the results of the data analysis used to test each research hypotheses in order to answer the research questions. An one-way Analysis of Variance (ANOVA) was used to test each hypothesis to determine if the school-wide MBL program intervention students received caused a significant increased level of achievement on the Algebra I section of the California Standards Test (CST) compared to students who did not receive the with a school-wide MBL program intervention. The significance of the data analyses were based on two groups whose mean Algebra I scores may differ significantly from one another at the $p = < .05$ level.

Research Question 1. RQ1. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to 9th grade students who attended a Title I high school that did not have a school-wide math blended learning program?

Research Hypothesis 1. $H1_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared to 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H1_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared to 9th grade students who attended Title I schools that did not have a school-wide math blended learning program.

Statistical analysis for research hypothesis 1. This researcher tested research hypothesis one (RQ1) by taking the mean CST Algebra I score of the 9th grade students who attended Title I high schools with a school-wide MBL program, and compared it to the mean Algebra I score of the 9th grade students who did not have a MBL program. An one-way Analysis of Variance (ANOVA) was conducted to determine whether or not there was a statistically significant difference in the scores.

Results for research hypothesis 1. The mean score in Algebra I for 9th grade students who attended Title I high schools with a school-wide MBL program was 319.4571, and the mean score in Algebra I for 9th grade students who attended a Title I high school without a MBL program was 277.5143 ($F = 7.482$, $p = .018$). As shown in Table 10, the results from the one-way Analysis of Variance (ANOVA) indicate that there was a statistically significant difference between the Algebra I mean scores among the students who attended a school with a school-wide MBL program compared to students who attend did not.

Table 10

One-Way ANOVA Algebra I CST Scores, MBL Participating Title I High Schools and Non-MBL Participating Title I High Schools

Variable	*N*	*M*	*SD*	*SE*	*P*
Algebra I Scores:					
MBL high schools	7	319.4571	39.23098	10.842	.018
Non-MBL high schools	7	277.5143	10.33077	10.842	.018

Note. *N* = number of schools; *M* = Mean, average score for each group; *SD* = Standard Deviation, the standard measure of variability around the mean; *SE* = Standard Error, standard deviation divided by square root of *N*; *P* = Significance Value, degree of significance**.**

The preceding data provides strong evidence that school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the 9th grade students who attended Title I high schools with a school-wide MBL program compared to 9th grade students who attended a Title I high school without a school-wide MBL program. The results of hypothesis one indicates to accept the alternate hypothesis and reject the null hypothesis, because the students that had the program did perform significantly higher on the Algebra I section of the CST.

Research Question 2. RQ2. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between male 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to male 9th grade students who attended a Title I high school that did not have a math blended learning program?

Research Hypothesis 2. $H2_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between male 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared male 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H2_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between male 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared male 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

Statistical Analysis for Research Hypothesis 2. Research hypothesis two (RQ2) was tested by taking the mean CST Algebra I score of the male 9th grade students who attended Title I high schools with a school-wide MBL program, and compared it to the mean Algebra I score of the male 9th grade students who did not have a school-wide MBL program. An one-way Analysis of Variance (ANOVA) was conducted to determine whether or not there was a statistically significant difference in the scores.

Results for Research Hypothesis 2. The mean score in Algebra I for male 9th grade students who attended Title I high schools with a school-wide MBL program was 317.9286, and the mean score in Algebra I for male 9th grade students who attended a Title I high school without a MBL program was 276.6571 ($F = 6.806$, $p = .023$). As shown in Table 11, the results from the one-way Analysis of Variance (ANOVA) indicate that there was a statistically significant difference between the Algebra I mean scores among the male students who attended a school with a school-wide MBL program compared to male students who attend did not.

Table 11

One-Way ANOVA Algebra I CST Scores, MBL Participating Title I High Schools (Male Student Mean Score) and Non-MBL Participating Title I High Schools (Male Student Mean Score)

Variable	*N*	*M*	*SD*	*SE*	*P*
Algebra I Scores:					
MBL high schools (male students)	7	317.9286	39.23098	11.187	.023
Non-MBL high schools (male students)	7	276.6571	10.33077	11.187	.023

Note. N = number of schools; *M* = Mean, average score for each group; *SD* = Standard Deviation, the standard measure of variability around the mean; *SE* = Standard Error, standard deviation divided by square root of *N*; *P* = Significance Value, degree of significance**.**

The preceding data provides strong evidence that school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the male 9th grade students who attended Title I high schools with a MBL program compared to male 9th grade students who attended a Title I high school without a MBL program. The results of hypothesis one indicates to accept the alternate hypothesis and reject the null hypothesis, because the male students that had the program did perform significantly higher on the Algebra I section of the CST.

Research Question 3. RQ3. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between female 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to female 9th grade students who attended a Title I high schools that did not have a math blended learning program?

Research Hypothesis 3. $H3_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between female 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared female 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H3_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between female 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared female 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

Statistical analysis for research hypothesis 3. Research hypothesis three (RQ3) was tested by taking the mean CST Algebra I score of the female 9th grade students who attended Title I high schools with a school-wide MBL program, and compared it to the mean Algebra I score of the female 9th grade students who did not have a school-wide MBL program. An one-way Analysis of Variance (ANOVA) was conducted to determine whether or not there was a statistically significant difference in the scores.

Results for research hypothesis 3. The mean score in Algebra I for female 9th grade students who attended Title I high schools with a school-wide MBL program was 322.100, and the mean score in Algebra1 for female 9th grade students who attended a Title I high school without a MBL program was 278.6143 (F = 8.235, p = .014). As shown in Table 12, the results from the one-way Analysis of Variance (ANOVA) indicate that there was a statistically significant difference between the Algebra I mean scores among the female students who attended a school with a school-wide MBL program compared to female students who attend did not.

Table 12

One-Way ANOVA Algebra I CST Scores, MBL Participating Title I High Schools (Female Student Mean Score) and Non-MBL Participating Title I High Schools (Female Student Mean Score)

Variable	*N*	*M*	*SD*	*SE*	*P*
Algebra I Scores:					
MBL high schools (female students)	7	322.1000	38.14258	10.715	.014
Non-MBL high schools (female students)	7	278.6143	12.34928	10.715	.014

Note. *N* = number of schools; *M* = Mean, average score for each group; *SD* = Standard Deviation, the standard measure of variability around the mean; *SE* = Standard Error, standard deviation divided by square root of *N*; *P* = Significance Value, degree of significance**.**

The preceding data provides strong evidence that the school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the female 9th grade students who attended Title I high schools with a MBL program compared to female 9th grade students who attended a Title I high school without a MBL program. The results of hypothesis one indicates to accept the alternate hypothesis and reject the null hypothesis, because the female students that had the program did perform significantly higher on the Algebra I section of the CST.

Research Question 4. Q4. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between African-American 9th grade students who attended a Title I high school with a school-wide math blended learning program as compared to African-American 9th grade students who attend a Title I high school that did not have a school-wide math blended learning program?

Research Hypothesis 4. $H4_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between African-American 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to African-

American 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

H4$_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between African-American 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to African-American 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

Statistical analysis for research hypothesis 4. Research hypothesis four (RQ4) was tested by taking the mean CST Algebra I score of the African-American 9th grade students who attended Title I high schools with a school-wide MBL program, and compared it to the mean Algebra I score of the African-American 9th grade students who did not have a school-wide MBL program. An one-way Analysis of Variance (ANOVA) was conducted to determine whether or not there was a statistically significant difference in the scores.

Results for research hypothesis 4. The mean score in Algebra I for African-American 9th grade students who attended Title I high schools with a school-wide MBL program was 300.8143, and the mean score in Algebra I for African-American 9th grade students who attended a Title I high school without a MBL program was 275.0143 ($F = 6.404$, $p = .026$). As shown in Table 13, the results from the one-way Analysis of Variance (ANOVA) indicate that there was a statistically significant difference between the Algebra I mean scores among the African-American students who attended a school with a school-wide MBL program compared to African-American students who attend did not.

Table 13

One-Way ANOVA Algebra I CST Scores, MBL Participating Title I High Schools (African-American Student Mean Score) and Non-MBL Participating Title I High Schools (African-American Student Mean Score)

Variable	*N*	*M*	*SD*	*SE*	*P*
Algebra I Scores:					
MBL high schools (African-American students)	7	300.8143	24.28370	7.209	.026
Non-MBL high schools (African-American students)	7	275.0143	11.74158	7.209	.026

Note. *N* = number of schools; *M* = Mean, average score for each group; *SD* = Standard Deviation, the standard measure of variability around the mean; *SE* = Standard Error, standard deviation divided by square root of *N*; *P* = Significance Value, degree of significance**.**

The preceding data provides strong evidence that the school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the African-American 9^{th} grade students who attended Title I high schools with a MBL program compared to African-American 9^{th} grade students who attended a Title I high school without a MBL program. The results of hypothesis one indicates to accept the alternate hypothesis and reject the null hypothesis, because the African-American students that had the program did perform significantly higher on the Algebra I section of the CST.

Research Question 5. RQ5.Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between Latino 9^{th} grade students who attended a Title I school with a school-wide math blended learning program as compared to Latino 9^{th} grade students who attended a Title I school that did not have a school-wide math blended learning program?

Research Hypothesis 5. $H5_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between Latino 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to Latino 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

H5$_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between Latino 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to Latino 9th grade students who attended Title I high schools that did not a school-wide math blended learning program.

Statistical analysis for research hypothesis 5. Research hypothesis five (RQ5) was tested by taking the mean CST Algebra I score of the Latino 9th grade students who attended Title I high schools with a school-wide MBL program, and compared it to the mean Algebra I score of the Latino 9th grade students who did not have a school-wide MBL program. An one-way Analysis of Variance (ANOVA) was conducted to determine whether or not there was a statistically significant difference in the scores.

Results for research hypothesis 5. The mean score in Algebra I for Latino 9th grade students who attended Title I high schools with a school-wide MBL program was 318.1714, and the mean score in Algebra I for Latino 9th grade students who attended a Title I high school without a MBL program was 283.2143 (F = 5.319, p = .040). As shown in Table 14, the results from the one-way Analysis of Variance (ANOVA) indicate that there was a statistically significant difference between the Algebra I mean scores among the Latino students who attended a school with a school-wide MBL program compared to Latino students who attend did not.

Table 14

One-Way ANOVA Algebra I CST Scores, MBL Participating Title I High Schools (Latino Student Mean Score) and Non-MBL Participating Title I High Schools (Latino Student Mean Score)

Variable	*N*	*M*	*SD*	*SE*	*P*
Algebra I Scores:					
MBL high schools (Latino students)	7	318.1714	37.68942	10.718	.040
Non-MBL high schools (Latino students)	7	283.2143	13.69750	10.718	.040

Note. *N* = number of schools; *M* = Mean, average score for each group; *SD* = Standard Deviation, the standard measure of variability around the mean; *SE* = Standard Error, standard deviation divided by square root of *N*; *P* = Significance Value, degree of significance**.**

The preceding data provides strong evidence that school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the Latino 9th grade students who attended Title I high schools with a MBL program compared to Latino 9th grade students who attended a Title I high school without a MBL program. The results of hypothesis one indicates to accept the alternate hypothesis and reject the null hypothesis, because the Latino students that had the program did perform significantly higher on the Algebra I section of the CST.

Research Question 6. RQ6. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between 9th grade students who attended a Title I charter high school that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program?

Research Hypothesis 6. H6$_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program.

$H6_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program

Statistical analysis for research hypothesis 6. Research hypothesis six (RQ6) was tested by taking the mean CST Algebra I score of the 9th grade students who attended charter Title I high schools with a school-wide MBL program, and compared that score to 9th grade students at non-charter Title I high schools that also had a MBL program. An one-way Analysis of Variance (ANOVA) was conducted to determine whether or not there was a statistically significant difference in the scores.

Results for research hypothesis 6. The mean score in Algebra I for 9th grade students who attended charter Title I high schools with a school-wide MBL program was 322.3667, and the mean score in Algebra I for 9th grade students who attended an non-charter Title I high school with a MBL program was 317.2750 (F = 2.103, p = .163). As shown in Table 15, the results from the one-way Analysis of Variance (ANOVA) indicate that there was not a statistically significant difference between the Algebra I mean scores among the students who attended a charter school with a school-wide MBL program compared to students who attended an non-charter school.

Table 15

One-Way ANOVA Algebra I CST Scores, MBL Participating Title I Charter High Schools and MBL Participating Title I non- Charter High Schools

Variable	*N*	*M*	*SD*	*SE*	*P*
Algebra I Scores:					
MBL Charter high schools	3	322.3667	19.08857	11.973	.163
MBL non-Charter high schools	4	317.2750	53.10752	13.116	.163

Note. *N* = number of schools; *M* = Mean, average score for each group; *SD* = Standard Deviation, the standard measure of variability around the mean; *SE* = Standard Error, standard deviation divided by square root of *N*; *P* = Significance Value, degree of significance**.**

Results for Research Hypothesis 6. The data indicates that there was not a significant difference between the mean scores of the charter and non-charter schools that had a school-wide MBL program. Because there is insufficient evidence to conclude a significant difference in the Algebra I mean scores, the alternate hypothesis is rejected and the null hypothesis is accepted. Although there is insufficient evidence to conclude a significant difference, the fact that the other five research hypotheses were accepted indicates that the academic intervention, school-wide MBL programs, seems to be effective in increasing Algebra I test scores for underrepresented minority students.

Summary

Chapter IV provided the results of the data analysis of data that was collected from the Algebra I mean scores on the California Standards Test (CST) of 9th grade students who attended Title I high schools with a school-wide MBL program, and a matched comparison group of Algebra I mean scores from 9th grade students attended Title I high schools without a school-wide blended learning program during the 2011-2012 school year. In order to analyze the data an one-way Analysis of Variance (ANOVA) was conducted to answer the six research questions and to test each hypothesis with the purpose of determining whether or not there was a statistically significant difference in the Algebra I scores. The results from the ANOVA statistical analysis indicated that there was a statistically significant difference between the mean Algebra I scores on the CST of 9th grade female, male, Latino and African-American students who attended Title I schools with a school-wide MBL program during the 2011-2012 school year. However, there was not a significant difference between the Algebra I mean scores of 9th grade students who attended charter Title I high schools that had a school-wide MBL program compared 9th grade students who attended non-charter Title I high schools that had a school-wide MBL program.

The following will be discussed within chapter V: summary of the study, population and sample, a final restatement of the purpose, and the research methodology of the study. Additionally, a summary of the results and conclusion, a discussion of the results and how they pertain to the literature, and recommendations for further research will be explicated as well.

Chapter V: Summary, Conclusions, and Recommendations

This causal-comparative quantitative research study was designed to evaluate the efficacy of school-wide math blended learning (MBL) programs. In order to examine if there is an elevated level of performance on the Algebra I math section of the California Standards Test (CST) of underrepresented minority high school students who attended Title I schools that had a school-wide math blended learning, this researcher compared the scores of underrepresented minority high school students who attended a Title I high school that did not have a school-wide math blended learning program during the 2011-2012 school year.

This study focused on the following sub-groups: ethnicity, gender and charter school designation. A total of six research questions were examined by using data from 14 Title I high schools within the city of Los Angeles. The purpose of chapter V is to provide a summary and overview of the study, discuss the results, as well as, discuss some recommendations for further research.

Summary of the Study

The expanding ethnicity gap that exists in the number of students pursuing STEM careers in the United States (Nagel, 2008) is said to be a direct derivative of the poor math achievement of underrepresented minority students at the high school level. With the low standardized test scores in public schools, particularly Title I schools, among underrepresented students, the NCLB Act of 2001 mandated that supplemental educational services be provided to students. One type of intervention strategy and services that has been implemented recently in Title I schools is math blended learning (MBL). MBL is an academic intervention approach to address the problem of the poor math performance in the United States amongst all students, especially for underrepresented minority students in Title I schools. These MBL programs target student groups such at-risk and underrepresented minority students by provided supplemental online academic support.

The intention of this study was to determine if underrepresented minority students who participate in school-wide math blended learning programs score higher on the Algebra I section of the CST than students who did attend a school with a school-wide math blended learning program.

Purpose of the Study

The purpose of this causal-comparative research design study was to determine whether or not adopting a school-wide math blended learning model led to significant differences in the Algebra I math standardized test scores on the CST, between underrepresented minority students from select Title I high schools in Los Angeles who had a school-wide math blended learning program during the 2011-2012 school year compared to underrepresented minority students from select Title I schools who did not have a school-wide math blended learning program. Though one of the goals of math blended learning programs is to increase math achievement, the emphasis or perceived effectiveness of these programs varies due to the fact that each program is tailored to fit the unique needs of the students served.

Population and Sample

Population. Archived de-identified pre-existing test score data from 14 Title I high schools within the city of Los Angeles was used for this study. Combined, the Title I high schools selected for this research study are ethnically diverse and include two main groups: African American, and Latino. This demographic diversity was needed in order to answer the research questions.

Sample. Purposive sampling was used to select the Title I high schools. Purposive sampling is when based on previous knowledge of a population and the specific purpose of the research (Patton, 1990) investigators use personal judgment to select a sample. In this case, the sample size derived from the total number of 9th grade students who attended Title I high schools that had a school-wide math blended learning program during the 2011-2012 academic school year, and a comparison group of 9th grade students who attended Title I schools that did not have a school-wide math blended learning program. This researcher controlled for gender and ethnicity by matching the treatment group and the comparison group by gender, ethnicity and charter school designation.

Research Methodology

This research study quantitatively investigated the effectuality of math blended learning programs. Quantitative research was used for this study to make statistical connections between the data and to determine if the hypotheses were statistically significant. Quantitative research explains phenomena by collecting numerical data that are analyzed using mathematically based methods (Aliaga & Gunderson, 2002). The type of data that was used for this study was pre-existing data to determine if students who attended a Title I high school that had a school-wide math blended learning program scored higher on the Algebra I section of the CST compared to 9^{th} grade students who attended a Title I high school that did not have a school-wide math blended learning program.

Summary of the Results and Conclusions

In order to examine if there was an elevated level of performance on the Algebra I math section of the CST for underrepresented minority 9^{th} grade high school students who attended a Title I high school that had a school-wide math blended learning program, this researcher compared the scores of underrepresented minority high school 9th grade students who attended a Title I high school that did not have a school-wide math blended learning program during the 2011-2012 school year. The following are the research questions, research hypotheses, and the results and conclusions of the research analysis:

Research Question 1. RQ1. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to 9th grade students who attended a Title I high school that did not have a school-wide math blended learning program?

Research Hypothesis 1. $H1_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared to 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H1_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared to 9th grade students who attended Title I schools that did not have a school-wide math blended learning program.

RQ 1: Conclusion. The CST Algebra I mean score from 9th grade students from the Title I high schools highlighted the statistical significance of math blended learning (MBL) programs. From all of the 9th grade students who attended Title I high schools with a school-wide MBL program, the mean score in Algebra I was 319.4571, and the mean score in Algebra I for the 9th grade students who did not attend a Title I high school with a school-wide MBL program was 277.5143 (F = 7.482, p = .018).

Based on the ANOVA statistical analysis, the results indicated that the school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the 9th grade students who attended Title I high schools with a MBL program compared to 9th grade students who attended a Title I high school without a MBL program. Therefore, this researcher accepts the alternate hypothesis and rejects the null hypothesis since the 9th grade students who attended a Title I high school with a school-wide MBL program did score significantly higher on the Algebra I section of the California Standards Test (CST) compared to 9th grade students who attended a Title I high school without a school-wide MBL program.

Research Question 2. RQ2. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between male 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to male 9th grade students who attended a Title I high school that did not have a math blended learning program?

Research Hypothesis 2. $H2_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between male 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared male 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H2_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between male 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared male 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

RQ 2: Conclusion. The CST Algebra I mean scores from male 9th grade students from the Title I high schools highlighted the statistical significance of MBL programs. From all of the male 9th grade students who attended the Title I high schools with a school-wide MBL program, the mean score in Algebra I was 317.9286, and the mean score in Algebra I for the male 9th grade students who attended a Title I high school without a school-wide MBL programs was 276.6571 (F = 6.806, p = .023).

Based on the ANOVA statistical analysis, the results indicated that that school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the male 9th grade students who attended Title I high schools with a MBL program compared to male 9th grade students who attended a Title I high school without a MBL program. The results of hypothesis two indicate this researcher accepts the alternate hypothesis and rejects the null hypothesis since the male 9th grade students who attended a Title I high school with a school-wide MBL program did score significantly higher on the Algebra I section of the California Standards Test (CST) compared to male 9th grade students who attended a Title I high school without a school-wide MBL program.

Research Question 3. RQ3. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between female 9th grade students who attended a Title I high school that had a school-wide math blended learning program as compared to female 9th grade students who attended a Title I high schools that did not have a math blended learning program?

Research Hypothesis 3. $H3_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between female 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared female 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H3_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between female 9th grade students who attended Title I high schools that had a school-wide math blended learning program as compared female 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

RQ 3: Conclusion. The CST Algebra I mean scores from female 9th grade students from the Title I high schools highlighted the statistical significance of the MBL programs. From all of the female 9th grade students who attended the Title I high schools with a school-wide MBL program, the mean score in Algebra I was 322.1000, and the mean score in Algebra I for the female 9th grade students who did not attend a Title I school with a school-wide MBL programs was 278.6143 (F = 8.235, p = .014).

Based on the ANOVA statistical analysis, the results indicated that the school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the female 9th grade students who attended Title I high schools with a MBL program compared to female 9th grade students who attended a Title I high school without a MBL program. The results of hypothesis three indicates this researcher accepts the alternate hypothesis and rejects the null hypothesis since the female 9th grade students who attended a Title I high school with a school-wide MBL program did score significantly higher on the Algebra I section of the California Standards Test (CST) than female 9th grade students who attended a Title I high school without a school-wide MBL program.

Research Question 4. RQ4. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between African-American 9th grade students who attended a Title I high school with a school-wide math blended learning program as compared to African-American 9th grade students who attend a Title I high school that did not have a school-wide math blended learning program?

Research Hypothesis 4. $H4_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between African-American 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to African-American 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H4_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between African-American 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to African-American 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

RQ 4: Conclusion. The CST Algebra I mean scores from African-American 9th grade students in the Title I high schools highlighted the statistical significance of math blended learning (MBL) programs. From all of the African-American 9th grade students who attended the selected Title I high schools with a school-wide MBL program, the mean score in Algebra I was

300.8143, and the mean score in Algebra I for the African-American 9th grade students who attended a Title I school with a school-wide MBL programs was 275.0143 ($F = 6.404$, $p = .026$).

Based on the ANOVA statistical analysis, the results indicated that that school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the African-American 9th grade students who attended Title I high schools with a MBL program compared to African-American 9th grade students who attended a Title I high school without a MBL program. The results of hypothesis three indicates this researcher accepts the alternate hypothesis and rejects the null hypothesis since the African-American 9th grade students who attended a Title I high school with a school-wide MBL program did score significantly higher on the Algebra I section of the California Standards Test (CST) compared to African-American 9th grade students who attended a Title I high school without a school-wide MBL program.

Research Question 5. RQ5.Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between Latino 9th grade students who attended a Title I school with a school-wide math blended learning program as compared to Latino 9th grade students who attended a Title I school that did not have a school-wide math blended learning program?

***Research Hypothesis 5*.** $H5_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between Latino 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to Latino 9th grade students who attended Title I high schools that did not have a school-wide math blended learning program.

$H5_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between

Latino 9th grade students who attended Title I high schools with a school-wide math blended learning program as compared to Latino 9th grade students who attended Title I high schools that did not a school-wide math blended learning program.

RQ 5: Conclusion. The CST Algebra I mean scores from Latino 9th grade students in the Title I high schools highlighted the statistical significance of MBL programs. From all of the Latino 9th grade students who attended the Title I high schools with a school-wide MBL program, the mean score in Algebra I was 318.1714, and the mean score in Algebra I for the Latino 9th grade students who did not attend a Title I school with a school-wide MBL programs was 283.2143 ($F = 5.319$, $p = .040$).

Based on the ANOVA statistical analysis, the results indicated that the school-wide math blended learning programs had a significant positive impact on the Algebra I scores of the Latino 9th grade students who attended Title I high schools with a MBL program compared to Latino 9th grade students who attended a Title I high school without a MBL program. The results of hypothesis three indicates this researcher accepts the alternate hypothesis and rejects the null hypothesis since the Latino 9th grade students who attended a Title I high school with a school-wide MBL program did score significantly higher on the Algebra I section of the California Standards Test (CST) than Latino 9th grade students who attended a Title I high school without a school-wide MBL program.

Research Question 6. RQ6. Is there a significant difference, as measured by performance on the CST, of the test scores in Algebra I between 9th grade students who attended a Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program?

Research Hypothesis 6. $H6_a$. The experimental hypothesis indicates there will be a significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program.

$H6_0$. The null hypothesis indicates there will be no significant difference, as measured by performance on the California Standards Test (CST), of the test scores in Algebra I between 9th grade students who attended Title I charter high schools that had a school-wide math blended learning program compared to 9th grade students who attended Title I non-charter high schools that did have a school-wide math blended learning program.

RQ 6: Conclusion. From the 9th grade students who attended Title I charter high schools with a school-wide MBL program, the mean score in Algebra I was 322.3667, and the mean score in Algebra I for the 9th grade students who attended a non-charter Title I school with a school-wide MBL programs was 317.2750 (F = 2.103, p = .163).

Based on the ANOVA statistical analysis, the results indicated that there was not a statistically significant difference between the mean Algebra I scores of the 9th grade students who attended the Title I charter high schools with a MBL program compared to 9th grade students who attended Title I non-charter high schools with a MBL program. The results of hypothesis six indicates this researcher rejects the alternate hypothesis and accepts the null hypothesis since the students who attended a charter Title I high school with a school-wide MBL program did not score significantly higher on the Algebra I section of the CST compared to the students who attended a non-charter Title I high school with a school-wide MBL program.

The data outcomes that came forth from the analyzing process proved to be positive in regards to the implementation of school-wide MBL programs in Title I high schools. The data outputs from the one-way Analysis of Variance (ANOVA) statistical analyses indicated that there was a statistically significant difference between the mean Algebra I scores of the female, male, African-American and Latino subgroups who attended Title I high schools with a school-wide MBL program compared to female, male, African-American and Latino subgroups who attended Title I schools without a school-wide MBL program. However, evidence shows that although the MBL program was efficacious for the 9^{th} grade students, data shows that it did not matter whether the MBL program was implemented at a charter or non-charter school, therefore, demonstrating that charter school designation or affiliation did not impact student test scores.

The Results and Its Relationship to the Literature

The results from research hypotheses one, two, three, four, and five found that there was a statistically significant difference in the mean Algebra I scores of African-American, Latino, female and male 9^{th} grade students who attended Title I high schools with a school-wide MBL program as compared to African-American, Latino, female and male students who attended Title I high schools without a school-wide MBL program and supports that blended learning is effective. The evidence that blended learning is effective has been supported by some research studies put forth in recent years. As stated within this study's literature review, the results of using blended learning appear to be promising. In a meta-analytic research study conducted by James Kullik, (2003) Kullik evaluated the impact of blended learning over the last 25 years. Kullik (2003) reviewed 61 studies including seven studies performed in the area of math and the results from the studies yielded an estimated magnitude of a relation of 0.38 for increased math test scores when blended learning was provided to the students. The results of this study indicated that the program had a positive effect on student achievement.

As discussed in the literature review, Means, Toyama, Murphy, Bakia, and Jones (2009) found that effect sizes were larger for blended learning than for purely online learning when compared to face-to-face learning. Many of the results appear to be contingent on the student's involvement in the learning process. The more time students spend in the learning process, the greater their level of achievement and the more positive their view of blended learning (Means, et al., 2009).

The benefits of blended learning prompted a review of more contemporary studies and literature related to math blended learning in K-12 classrooms. One research study performed by Cheung and Slavin (2011), set out to find if education technology applications improved math achievement in K-12 classrooms compared to traditional teaching methods without education technology. Cheung and Slavin (2011) synthesized and analyzed data form 75 studies including 56,000 students at the K-12 level revealed a significant, positive effect in math with educational technology (Cheung & Slavin, 2011, p. 11). Among the different types of educational technology applications studied, including comprehensive technological models, and computer managed learning (CML), Cheung and Slavin found that Computer-Aided Instruction (CAI) had the largest effect on math achievement.

In October 2012, The Next Generation Learning Challenges (NGLC), which is an organization that transforms education for students through blended learning, supported the sentiments of Means, Toyama, Murphy, Bakia, and Jones (2009). In fact, NGLC gave $5.4 million in grants for 13 new schools that use personalized blended learning at the secondary and post-secondary levels. One of the recipients of the grant was Rio Salado College in Phoenix, Arizona, because the school was able to exhibit how to develop low-cost and high-quality blended learning programs to help increase student achievement (Boyle, 2012)

Dziuban, Hartman, and Moskal (2012) believe in order to reach student learners, a more technological rich learning environment may be beneficial. They believe that the blending of traditional teaching and the use of technology, known as blended learning, may be advantageous for addressing students who might need extra practice (2012).

The Results and Its Connection to the Theoretical Framework

The evidence from this study that MBL programs are effective is supported by the theories of Vygotsky and Dewey in that they believed

- directed instruction or scripted reading is simply not sufficient for much of student learning because interaction between student and teacher is limited and:
- traditional means of teaching such as lecturing methods were ineffective and rather communication and hands-on experiences were much more effective and essential to academic learning and engagement.

Blended Learning and Common Core Standards

The newest reform in education to meet the No Child Left Behind Act in the United States is the Common Core State Standards Initiative (CCSSI). The CCSSI is a state---directed effort coordinated by the National Governors Association for Best Practices. Currently, 45 states in the U.S. have formally adopted the Common Core Standards in their K-12 schools, with California being one of the last states to adopt the standards (National Governors Association, 2012).

There are Common Core Standards for several content areas including English language arts and math. The creators of the math standards conclude that research demonstrates that the mathematics curriculum in high-performing countries are more focused and coherent than that of the U.S. and that the initiating of the new Common Core Standards will address the overwhelming achievement gap not just amongst minority and non-minority students, but also amongst American students and students from high-performing countries.

The Common Core Standards were created by utilizing a research-based scaffold approach that combines procedural skill with conceptual understanding, which is embedded within most of the online math blended learning programs. Therefore, there has been a dramatic shift within the last 10 years in California K-12 schools to implemented more computer-based blended learning programs in order to help students passed the upcoming Common Core assessments.

Implications

The implications of this study are that school-wide math blended learning (MBL) programs have a significant positive impact on the California Standards Test (CST) test scores in Algebra I for students who attended Title I high schools in Los Angeles. After a thorough review of various research studies and literature, this researcher was unable to locate any prior research studies that compared CST Algebra I scores for minority students at Title I high schools who attended a school-wide math blended learning program as compared to students who attended Title I schools without a school-wide MBL program. As such, additional research is required to confirm the findings. Because of the efficacy of MBL programs had on the underrepresented minority students from the selected Title I high schools, it is this researchers sentiments that it would be advantageous for school-wide MBL programs to be implemented in every high school throughout Los Angeles.

The literature and data collected allowed the researcher to investigate the value and importance of the math blended learning (MBL) programs, programs that provide math intervention strategies and services to underrepresented students to help them perform better on standardized tests. School leaders, teachers and other educational stakeholders can take advantage of the findings and results of this study, which reiterates that blended learning programs have a significant positive impact on underrepresented students'. This data also can be used in order to implement more school-wide blended learning programs in other high schools.

Limitations

There were some limitations connected with this study. The sample was limited to only 14 Title I high schools in Los Angeles. Any results, recommendations, and conclusions engendered from this research study will only be applicable to these 14 high schools. Additionally, the data collected was limited to only one academic school, the 2011-2012 school year, which was from August 2011 through June 2012. Therefore, any recommendations produced may be limited to this one academic school year.

The student sub-groups, sample sizes for each sub-group, location of the sample, and amount of data this researcher was able to collect were other limitations. The sample of this study included the following sub-groups: ethnicity, gender, and charter school designation. This constitutes to a subject characteristics threat since the samples' subgroups were not equal. The researcher controlled for this threat by using the mean Algebra I scores, as well as this researcher selected a comparison group of Title I high schools that closely matched the Title I high schools in the treatment group demographically in terms of grade, ethnicity and gender.

Finally, the data collected was limited to the California Standards Test (CST) mean Algebra I scores. An instrumentation threat was controlled since this is a criterion-based state mandated standardized test that is administered to all students in the state of California in accordance with the No Child Left Behind Act.

Recommendations for Further Research

The goal of academic blended learning programs is to provide educationally and economically disadvantaged students with the skills, knowledge, and general college preparatory information needed to the close the academic achievement gap and enter and succeed in college in a larger academic and social context (Swail & Perna, 2002).

Although there is research that shows a positive relationship between academic intervention programs such as math blended learning that have increased test scores, there is still a great amount of research that needs to be done to confirm if math blended learning programs can indeed increase math scores consistently in most schools.

Based on the results of this study, and the absence of pertinent research literature that is relevant to the research questions offered in this study, this researcher proposes the following recommendations for further research:

1. This study was conducted by examining the scores of ninth grade students who were enrolled in Algebra I, this researcher recommends the study be expanded to include other grade levels and subjects. This will allow researchers to see the further effects of math blended learning and how math blended learning might increase academic achievement for students of different ages.
2. More in-depth statistical analyses that extend beyond an one-way Analysis of Variance (ANOVA) should be conducted in order to detect any additional variables and/or factors such as socio-economic status that may have influenced the results of this study.

3. The study results were in favor of school-wide MBL programs. Research hypotheses one, two, three, four, and five indicated that there was a statistically significant difference in Algebra I scores of underrepresented minority students who attended Title I schools with a school-wide MBL program compared to underrepresented minority students who did not. Conversely, the results from hypothesis six indicated that the was not a statistically significant difference in the Algebra I scores of the students who attended Title I charter high schools with a MBL program compared to students who attended Title I non-charter high schools that had a MBL program, which calls into light a need to examine more charter high schools to see if any characteristics of charter schools are indeed more beneficial for student achievement.
4. This study only examine the effects of MBL programs on underrepresented minority students in Title I high schools. Further research should be done to analysis school-wide MBL programs affects on other ethnic and racial sub-groups.
5. This study focused on how MBL programs impacted student standardized scores, but did not analyze how these programs impact students' perceptions of STEM careers or how these programs influenced their decision to attend college. Therefore, there is a need for a qualitative study to explore students' attitudes and perceptions of MBL programs.
6. The scope of this study was narrow and only incorporated 14 Title I schools out of hundreds in Los Angeles, CA. A meta-analysis research study of not just school-wide MBL programs, but blended learning programs in general in the state of California could provide additional pertinent information for improving these programs' educational mechanisms and models.

7. Lastly, this study only focused on the math performance of students during one academic year, 2011-2012. Further research studies should be conducted to examine the effects of MBL programs over a longer period of time.

Conclusion

This study was conducted in order to determine if school-wide math blended learning (MBL) programs had a statistically significant impact on the Algebra I standardized test scores of underrepresented minority students' who attended Title I high schools with a MBL program as compared to underrepresented minority students who attended a Title I high school without a school-wide MBL program. While the results of the study did not show significant differences in Algebra I for the 9th grade students who went to charter Title I high schools compared to non-charter Title I high schools, the trend was in favor of the MBL programs and the results ultimately indicated that they were efficacious. Overall, the results show that students who attended Title I high schools with a school-wide MBL program performed significantly better.

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APPENDIX A

CST Data Use Response

Dear Ms. Verrett:

Thank you for writing to us regarding use of CST scores.

Since all test scores reported on the California Department of Education's Web site are without students' personal information, it is public information for viewers to read and consume. In terms of research, you will have to go through the internal review board (IRB) process in your organization/school in order to proceed.

If you have further questions regarding the use of data in the Dataquest, please contact the Data Request Office at dro@cde.ca.gov or 916-327-0219. If you have questions regarding test reporting, please contact me.

Sincerely Yours,

Jane Liang, Ed.D.

Education Research and Evaluation Consultant
California Assessment of Student Performance and Progress (CAASPP) Office
Assessment Development and Administration Division
California Department of Education
(916) 322-1854
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APPENDIX B

IRB Approval Letter

PEPPERDINE UNIVERSITY

Graduate & Professional Schools Institutional Review Board

April 28, 2014

Shannon Verrett

Protocol #: E0314D09
Project Title: Blended Learning in Context: The Exploration of the Effectuality of Math Blended Learning Programs on Minority Students' Standardized Test Scores

Dear Ms. Verrett:

Thank you for submitting your application, *Blended Learning in Context: The Exploration of the Effectuality of Math Blended Learning Programs on Minority Students' Standardized Test Scores,* for exempt review to Pepperdine University's Graduate and Professional Schools Institutional Review Board (GPS IRB). The IRB appreciates the work you and your faculty advisor, Dr. Mallette, have done on the proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations (45 CFR 46 - http://www.nihtraining.com/ohsrsite/guidelines/45cfr46.html) that govern the protections of human subjects. Specifically, section 45 CFR 46.101(b)(2) states:

> (b) Unless otherwise required by Department or Agency heads, research activities in which the only involvement of human subjects will be in one or more of the following categories are exempt from this policy:
>
> **Category (2) of 45 CFR 46.101**, research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: a) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

In addition, your application to waive documentation of consent, as indicated in your **Application for Waiver or Alteration of Informed Consent Procedures** form has been **approved**.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit a **Request for Modification Form** to the GPS IRB. Because your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the GPS IRB.
A goal of the IRB is to prevent negative occurrences during any research study. However, despite our

best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the GPS IRB as soon as possible. We will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the GPS IRB and the appropriate form to be used to report this information can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* (see link to "policy material" at http://www.pepperdine.edu/irb/graduate/).

Please refer to the protocol number denoted above in all further communication or correspondence related to this approval. Should you have additional questions, please contact Kevin Collins, Manager of the Institutional Review Board (IRB) at gpsirb@peppderdine.edu. On behalf of the GPS IRB, I wish you success in this scholarly pursuit.

Sincerely,

Thema Bryant-Davis, Ph.D.
Chair, Graduate and Professional Schools IRB

cc: Dr. Lee Kats, Vice Provost for Research and Strategic
Initiatives Mr. Brett Leach, Compliance Attorney
Dr. Leo Mallette, Faculty Advisor