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The Effect of a Blended Learning Instructional Model on the Mathematics Performance of Sixth and Seventh Grade Students in a Small Northeastern Urban School District

Debra Joseph-Charles

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Submitted in partial fulfillment of the

requirements for the degree of

Doctor of Education

College of Education

Seton Hall University

October 2019

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COLLEGE OF EDUCATION AND HUMAN SERVICES
SETON HALL UNIVERSITY

APPROVAL FOR SUCCESSFUL DEFENSE

Debra Joseph-Charles has successfully defended and made the required modifications to the text of the doctoral dissertation for the Ed.D. during this **Fall Semester 2019**.

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Abstract

Closing the achievement gap has been the focus of education reform for decades. Federal educational reform policies No Child Left Behind (2002) and Race to The Top (2009) renewed attention on the achievement gap and the quest to find ways to improve student outcomes. The latter addressed the needs of 21st century learners, and as such, the need to look towards new, innovative ways of addressing students' individual needs. In 2010, in its National Educational Technology Plan, *Transforming American Education: Learning Powered by Technology*, the USDOE stressed that there needed to be a shift in how students were educated, including shifting to technology-based learning. According to the USDOE, using technology to support instruction will be pivotal to improvements in student learning and the generation of data that would be the cornerstone of continuous improvements in schools (USDOE, 2010).

This study examined a blended learning model of instruction in an elementary school setting and its effect on student performance in mathematics. To determine if participation in blended learning instructional model affected student achievement, PARCC Spring 2018 mathematics scores were collected and analyzed for students in grades 6 and 7 in a small northeastern urban school district. The outcomes revealed mixed results; students in grade 6 had statistically higher scores than their counterparts who received instruction in a traditional instructional setting. This was not the case for students in grade 7; although their scores were numerically higher, the difference was not statistically significant.

Key words: Blended Learning, traditional instruction, student performance, mathematics, personalization, technology-based learning

Acknowledgements

This journey has been nothing short of miraculous. Oh, how great it is to rise above all of the challenges and to say it is done! Early on we are told that that the Doctoral Studies process is not for the faint of heart. Everyone stressed that the experience would be different for each person and that as we embarked on the journey, the focus was to finish. I have so many to thank for getting me to the finish line, these next few paragraphs cannot begin to tell the story. The order in which I mention each name does not in any way rank the significance of their impact on my achievement. I extend my heartfelt gratitude to each of these outstanding people.

To my Seton Hall University mentors, colleagues, and friends, my advisor, Dr. Daniel Gutmore: thank you for your guidance, support and encouraging words; to my second reader, Dr. Elaine Walker your quiet, warm and targeted feedback helped to solidify my thinking and, therefore, the direction of this research; to Dr. Sethi: my support during a critical part of this work, this outcome would have been very different if you were not a part of this process, and to the members of Cohort XVII who kept me focused and refused to let me give up or give in: thank you.

To my committee member and friend Dr. Roberta Schorr, who planted the first seed of inquiry and kept checking in and checking up on me throughout the years: Thank you for always being a champion for children and for always believing that we can make a difference.

To my husband, Erwin Roger Charles, my encourager, my supporter, my challenger, and my believer, my example of hard work and determination: you have taken your vows seriously and have been by my side “in sickness and in health” and I am so grateful for that. Thank you for loving me and for ensuring that I could get to the end of this journey.

To my father Nathaniel Joseph, who ensured that I understood the power of education: my only regret is that you are not here to see the fruits of your labor; to my mother, Josephine Joseph: you have been the example of determination and strength. I appreciate every sacrifice you have made to ensure my success.

To my children Saeeda and Sadik: I love you both; thank you for your love and support. This example is for you. I know that you have looked on and seen that anything is possible.

To my other cheerleaders, those who are family, friends, and colleagues: thank you for all the calls to check in, to inquire about progress and to proclaim, “You can do it!” I thank you!

Dedication

> "You are where you are today because you stand on somebody's shoulders. And wherever you are heading, you cannot get there by yourself. If you stand on the shoulders of others, you have a reciprocal responsibility to live your life so that others may stand on your shoulders. It's the quid pro quo of life. We exist temporarily through what we take, but we live forever through what we give." – **Vernon Jordan**

This work is dedicated to my children, my daughter Saeeda and my son Sadik.

As you continue to make your way, be reminded that all things are possible. I pray that you imitate the examples of love, family, achievement and unconditional support that you have been a witness to as a member of this family. May you each continue on a path that brings you total joy and fulfilment.

I love and celebrate each of you.

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Chapter 1: Introduction

Addressing the Achievement Gap between various student groups has been the focus of educators in the United States and worldwide for decades. In the United States, research studies into the causes of gaps in student achievement began with the publication of the Coleman Report (Equality of Educational Opportunity) in 1996. It has become a focal point of education reform efforts. In addition to groups like The Education Trust, Democrats for Education Reform and the Education Equality Project, States, School Districts, including building level Administrators, and others have made it their mission to close the achievement gap.

In the beginning, emphasis on the achievement gap concentrated on the performance gap between African Americans and their white peers. Data from the 1960s indicated that the gap ranged from a half a standard deviation (S.D.) deficit among black children in elementary school to more than a full S.D. difference by 12th grade (Gorey, 2009). In a Policy Information report, from the Educational Testing Service, it is noted that gaps in school achievement among racial/ethnic groups and between students from different socioeconomic circumstances are well documented (Barton & Coley, 2009). Additionally, the passage of No Child Left Behind legislation (2002) reaffirmed that one of the most significant challenges still facing educators and policymakers is the lower academic performance of African Americans, Hispanics and Native Americans in comparison to Caucasians and Asian American students (Kim & Sunderman, 2005). This legislation ensured that there must be a focus on disaggregating test data to identify the performance of all subgroups. In other words, NCLB widened the focus to examine the similar academic disparity between students from low-income families and their wealthier counterparts and forced scholars and policymakers to focus on gaps in achievement based on

other variables such as sex, English-language proficiency, and learning disabilities (Ansell, 2011).

In January 2002, President George W. Bush signed the No Child Left Behind Act. This framework for education reform, with its focus on accountability, flexibility, and choice, was aimed at closing the achievement gap for all students. No Child Left Behind required that all students attending a public school in the United States achieve proficiency based on standards meet or exceed the proficiency standards set by their State for Language Arts and Mathematics by the end of the 2014 school year. In July 2009, President Barack Obama declared, "America will not succeed in the 21st century unless we do a far better job of educating our sons and daughters… the Race starts today…" (Obama, 2009). With this came the Race to the Top challenge to educators. This framework for education reform emphasized designing and implementing rigorous standards and high-quality assessments. Additionally, the aim was to attract and retain effective teachers and leaders in America's classrooms whose use innovative and efficient approaches would turn-around struggling schools. Additionally, the framework called for the utilization of supporting data systems that inform decisions and improve instruction.

These Federal educational reform policies (No Child Left Behind and Race to The Top) renewed the attention on the achievement gap and how to address the questions related to improvement in student outcomes. With a focus on the newly created Common Core Standards and a call to address the needs of 21st Century learners, district and school leaders are forced to look towards new, innovative ways of addressing students' individual needs. Schools in urban areas, with their diverse student populations, found this challenge even more daunting than their suburban counterparts. According to Hudley (2013), "The education that poor, urban students in

public schools receive is demonstrably insufficient to make them competitive with their more advantaged, middle, and upper-income peers."

One of the facets of the No Child Left Behind Act (NCLB, 2001) and Race to the Top is the requirement of measuring school and student progress by annual State assessments. Educators would use data from these annual assessments to address student needs and therefore improve the learning of all students. This focus on measuring school and student progress has led to an increase in the prevalence and importance of State mandated testing (high stakes). School districts, administrators, and teachers are being held increasingly accountable for the achievement of their students. The States and Federal Government use this student achievement data on State assessments as a measure of the progress and success of schools and districts. With the advent of the Race for the Top legislation (2009), the stakes are higher, and as such, many states have reformed their evaluation standards for teachers and school leaders to address the accountability factor for student outcomes.

Public Schools and those who lead them are being held accountable for student achievement and academic growth based on the results of these tests. PARCC (The Partnership for Assessment of Readiness for College and Careers) is New Jersey's equivalent of a high stakes test. Students in grades 3-8 and 11 must test on norm-referenced tests (Young & Zucker, 2004). It measures individual student achievement against other students who have been subject to the same test and testing standards.

With a focus on improving student performance on these State mandated tests, school and District leadership and teachers have been challenged to reform practices that have not yielded the desired outcomes. According to Mitchell, Lee, and Herman (2000, p. 22), "School leaders are expected to chart the effectiveness of their strategies and use complex and often conflicting state,

district, and local assessments to monitor and assure progress." They continued that the new demands on schools and Districts to monitor their efforts at providing all students with the tools and strategies needed to achieve are based on a faulty assumption. This assumption is that school leaders and teachers are capable of utilizing assessment data to determine where students are in their academic progress and why, and to establish improvement plans that are targeted, responsive, and flexible.

In 2010, the United States Department of Education addressed the need for a shift in how students are educated. In its National Educational Technology Plan, Transforming American Education: Learning Powered by Technology, the idea that there needed to be a focus on using technology to provide engaging and meaningful learning experiences and content. Technology-based Learning. according to the USDOE would be pivotal to the improvement in student learning and the generation of data that would be the cornerstone of continuous improvements in schools" (USDOE, 2010). The plan emphasized the need to utilize technology to provide all learners with engaging and empowering learning experiences. The new instructional model it noted should focus on what is taught, how it is taught and how this is aligned to what students need to know, how they learn, where and when they will learn. "It brings state-of-the-art technology into learning to enable, motivate, and inspire all students, regardless of background, languages, or disabilities, to achieve. It leverages the power of technology to provide personalized learning and to enable continuous and Lifelong Learning" (NETP, 2010).

With the challenge of improving student achievement, narrowing the achievement gap, and preparing American students to be 21st century learners who are college and career ready, school leaders face a daunting task. They must find a way to lead, fully accepting the view that teaching and learning must be transformed to keep pace with instructional models that were

becomingly increasingly technology focused and rooted in the understanding that "If we teach today's students as we taught yesterday's, we rob our children of tomorrow" (Dewey, 1915).

Background

The advent of Online Learning represented a fundamental shift in the delivery and instructional model of teaching and learning. Its evolution can be traced through the stages of web-based distance learning, the supplementing of textbooks with web-based content and resources, the extension of the school day through flipped classroom models to a mixture of online learning and face to face instruction by the classroom teacher. The latter is the focus of this study. This instructional model has been seen as having the potential to impact how District Leaders, Administrators, and teachers optimize and maximize student productivity in a traditional teacher-led setting. Christensen, Horn, and Staker (2013) defined blended learning as an educational program where students learn partly through digital or online learning with some measure of student control over time, place, path, and pace and at least partially at a supervised brick-and-mortar location away from home. The modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience" (Christensen, Horn, & Staker, 2013). Its rise is rooted in the cultural shift in instruction and learning and can be attributed to the thrust towards using technological advances to address the needs of 21st century learners.

The increased adoption and availability of digital learning technologies have led to increased levels of integration of computer-mediated instructional elements into the traditional F2F learning experience (Bonk & Graham, 2005). This blended learning model of instruction has seen steady growth in the number of districts and the individual school, which has turned to use it to address their challenges with improving student outcomes. For example, one study noted

that by 2010, every State had some form of blended learning available to at least some of its public school students; 55% of school districts made online classes available to their students, and 78% of those that did also incorporated some blend of online learning with traditional classroom learning experiences for the students involved, which was estimated total of 1.8 million students enrolled in online courses (Queen & Lewis, 2011).

Blended learning opportunities for students in a K-12 setting have ballooned in the last decade. In fact, according to the International Association for K-12 Online Learning (2013) almost all the 1.8 million distance education course enrollments that occurred in K-12 schools for the 2009-2010 school year were blended learning courses. Other estimates place the total number of K-12 students involved in online learning much higher; the Innosight Institute concluded that by 2010, the number was over four million (Staker, 2011). Learning that combines online, and face-to-face delivery of instruction is not merely a theory or construct—it is an instructional model shift being implemented by schools throughout the country and the world (iNACOL, 2015).

Problem Statement

Although blended learning is not a new paradigm in education, little is known about its implementation in the Elementary school setting and more so its effectiveness in addressing student achievement. In a 2011 study, Queen and Lewis estimated that close to 2 million K-12 public school students were participating in instruction described as Blended Learning. The literature on Blended Learning, however, has been mainly focused on Higher Learning institutions. This, the focus on Higher Learning institutions was highlighted by an Oliver and Stallings study in 2014, which noted a significant problem with the current research on Blended Learning. After summarizing the research, which compared the blended learning instructional

model with that of traditional classroom learning, the authors noted three studies that indicated blended learning produces equal learning improvement, and eight studies indicating that it produces better mathematics achievement results. Of the 11 studies cited to document the efficacy of blended learning, only two had a focus on K-12 education. Additionally, 114 articles and studies referenced in their article but only 12 had a K-12 focus (Chaney, 2016).

Despite the growing popularity of Blended Learning, researchers have focused little attention on the effectiveness of combining traditional classroom instruction and online learning on student outcomes. One can describe the research at best as modest and more so concentrated on higher education. There is, therefore, an identifiable gap in the research about K-12 education.

There is scare empirical literature on Blended Learning in the K-12 setting. More so, the focus of these studies has been on definitions, the effectiveness of different models, and the effectiveness of blended learning when compared with complete online programming or traditional instruction (Halverson, Graham, Spring, & Drysdale, 2012). The importance of understanding the effectiveness of a blended learning model of Mathematics instruction on Elementary School students when compared with traditional classroom instruction is essential for those charged with addressing student achievement in this climate of accountability. It can provide valuable information to policy makers, educational leaders, and teachers.

Purpose of the Study

Determining the effects of implementing a blended learning model in elementary Mathematics classrooms on student outcomes is the purpose of this quasi-experimental study. The study's objective is to determine whether a blended learning model of instruction, improved the Mathematics achievement of students in an Elementary School setting. This blended learning model consists of utilizing a station rotation model. In this model, students receive initial

instruction from the classroom teacher, then they transition to four stations- namely small group instruction (taught by the classroom teacher), technology station (students work on adaptive technology to address deficiencies or to advance those who are performing at or above grade level), independent problem-solving station and a fluency station where students work on fluency and automaticity of grade level or deficient fluencies. The purpose was to determine whether significant differences exist when comparing the achievement on the New Jersey PARCC Assessment of Elementary Students who participated in a Blended Learning approach to Mathematics instruction with that of students who were exposed to a traditional model of instruction.

The design is a quasi-experimental study with non- randomized groups. The independent variables were blended learning which incorporates elements of traditional classroom learning but combines them with online teaching and learning activities (Staker, 2011) and traditional classroom learning which is characterized by face-to-face and direct teaching by a teacher with no significant online learning (Staker & Horn, 2012). The dependent variable was the Spring 2018 PARCC Grades 6 and 7 mathematics assessment scores.

Research Questions

The following research question and subsidiary questions was used to guide this quasi-experimental study of the impact of a Blended Learning Model of instruction on the achievement scores of Elementary School students in grades 6 and 7 on the PARCC assessment in Mathematics.

What is the impact of implementing a blended learning model of mathematics instruction on the mathematics achievement of elementary school students, as measured by the Spring 2018 Grade 6 and 7 PARCC mathematics assessment scores, when compared to the mathematics

achievement of Grades 6 and 7 students who received mathematics instruction using a traditional instructional model?

Student performance data in the following areas (1) overall achievement (2) performance levels, (3) gender, and (4) the subgroups of economically disadvantaged and ethnicity/race (Hispanic/Latino, American Indian or Alaska Native, Asian, Black/African American, Native Hawaiian or other Pacific Islander, White, two or more races, not indicated) is used to address the following subsidiary research questions:

Subsidiary Question 1

How much variance in the Spring 2018 PARCC mean scale score can be explained by the predictor variables treatment, gender, race/ethnicity, and SES?

Subsidiary Question 2

Is there a statistically significant difference in the Spring 2018 Grades 6 and 7 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and the performance levels of students receiving instruction using a traditional model of instruction when controlling for gender, ethnicity/race, and SES (Economically Disadvantaged)?

Subsidiary Question 3

To what extent is there a difference in the performance of students who had a blended learning experience for one year as opposed to those who had the experience two years?

Null Hypotheses

H1$_0$: There was no statistically significant difference in the mean scores of Elementary School students on the Spring 2018 PARCC Mathematics assessment who are receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional

model of instruction.

H2$_0$: The predictor variables treatment, gender, ethnicity/race and SES (Economically Disadvantaged) do not account for any variation in the mean scaled scores on the Spring 2018 PARCC mathematics assessment of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction.

H3$_0$: There was no statistically significant difference in the Spring 2018 Grade 6 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction when controlling gender, ethnicity/race and SES (Economically Disadvantaged).

H4$_0$: There was no statistically significant difference in the performance on the PARCC Mathematics assessment of students who are exposed to the blended learning model of instruction in mathematics for one year and those exposed for two years.

Significance of the Study

The significance of the study is rooted in the quest to close the achievement gap for students in urban school districts. More so, it is to contribute to the search to find and apply proven methods of school improvement to all schools with the view to not only improving student outcomes and teacher practice but to help students from all backgrounds attain an authentic 21st-century education (Schmoker, 2009). With the advent of the No Child Left Behind Act (2001) and Race to the Top (2008), the focus of educational reform has been on using scientifically or empirically based research to provide evidence of what works in schools and school districts (Dynarski, Clarke, Cobb, Finn, Rumberger, & Smink, 2008; Slavin, 2008). Additionally, disparities in the performance of minorities and their more affluent counterparts continue to permeate these discussions.

Conceptual Framework

The underlying framework for this research will focus on the Theory of Personalized Learning; the research behind addressing the individual needs of varied learners and the role of the learner in the construction of their Learning (Bray & McClaskey, 2015). In the development of their theory of personalized Learning, Bray and Mc Claskey (2015) draw on the works of Vygotsky, Dewey, Brunner Csikszentmihalyi, and Dweck. They address the learner in the context of the period in which they are part of the educational system Generation, Y and Z. Bray and McClaskey made a clear distinction between personalized Learning, differentiation, and individualization of the learning process. To answer the question of who learners are, they addressed the shortcomings of learning theories that focus on learning styles, multiple intelligences and the use of standardized tests to determine success in learning content that is taught. They investigated how the brain works and examined the merits of the work of Mayers and Rose, Universal Design for Learning (UDL).

The Blended Learning model, as outlined in this study, will utilize the authors' view of the learner as addressed in their theory of Personalized Learning. At the center of the model of Blended Learning used in this study are the core four as described by Education Elements- Data-Driven Decision Making, student reflection and ownership, technology integration, and targeted instruction. Bray and McClaskey's (2015) work supports the notion of the development of Personal Learner profiles, developed by learners with the help of teachers and perhaps parents, which identifies how learners learn best based on their strengths, challenges, interests, aspirations, talents, and passions (Bray & McClaskey, 2015).

Summary of Methodology

This investigation utilized a quasi-experimental research design using pre- and post-test data for two cohorts of students. For the grade 4 to 6 cohort, data from Spring 2016 PARCC mathematics assessment (for students in grade 4) and Spring 2018 PARCCC mathematics assessment (for students in grade 6) administrations, were utilized. For the grade 5 to 7 cohort, data from Spring 2016 PARCC mathematics assessment (for students in grade 5) and Spring 2018 PARCC mathematics assessment were used. To address subsidiary question three, data from Spring 2016 PARCC mathematics assessment (students from grade 4) and Spring 2017 mathematics assessment (for students in grade 5) were used. The study compared the mean mathematics scale scores for sample populations on the 2016 PARCC and 2018 PARCC scores to analyze pre-and post-test treatment performance. Attention was given to various subgroups of students within the study. The analyses were performed at the treatment level throughout. The participants in this study were two groups of students, one group of Grade 4 students and one group of Grade 5 students during the 2015-2016 school year from Elementary schools within the Small Northeastern Urban Public School District. As students in grades 4 and 5 (in 2015-2016), all students received math instruction using the District's curriculum, instructional resources, and support in a traditional classroom. A Blended Learning instructional model was first introduced in the treatment school in the 2016-2017 school year. The measure of achievement is the PARCC mathematics assessment. The PARCC is a standards-based, criterion-referenced test administered in Mathematics and Language Arts, to students in Grades 3-11. The mathematics portion of the PARCC assesses what a student, at each grade level, should be able to proficiently demonstrate, based on his/her command of grade-level standards in each of four assessment sub-claims:

Major content

Additional and supporting content

Reasoning

Modeling

During the 2016- 2017 and 2017-2018 school years, the experimental treatment site implemented a blended learning model of instruction in all mathematics classrooms in grades 3-7; the District's mathematics curriculum was also used. During the same period, the control sites continued using a traditional model of instruction along with the District's curriculum.

Perceived Limitations

In this study, groups were not randomly assigned. The samples were selected from already existing populations. The study used two intact and matched comparison groups considered similar to the experimental treatment and control groups, for each cohort. The traditional instructional model control group has always been engaged in this type of instruction. The experimental treatment site implemented the Blended Learning model of instruction in mathematics in the 2016 school year.

This study did not control for some additional variables that could influence student outcomes. Some of these variables include control teacher effect, teacher quality, teachers' knowledge of mathematics content, or the varying levels of professional development related to mathematics instructional topics. Both groups, were exposed to the same level of District oversight concerning curriculum implementation and received the same level of District provided Professional Development with regards to Mathematics Instruction.

Each Elementary school in this District is mandated to provide 90 minutes of mathematics instruction. This study does not factor in additional time that students in each group

were exposed to additional mathematics instruction in the form of after-school programming or intervention periods designed to address students' individual needs. This study also did not investigate whether each group did receive the mandated 90 minutes of instructions as per district guidelines.

A final limitation of the study reflects the relatively small sample size, which potentially affects statistical power, type II error, and statistical significance (Cohen, 1988). Student mobility, restricting the study to a small urban school district, student mobility and restricting the analysis to in-district grades 4 and 5(2016) and 6 and 7 (2018) students who took both the Spring 2016 PARCC and the Spring 2018 PARCC at their respective sites will negatively impact the qualifying sample sizes. This would limit the possibility of generalizing about the findings to the broader community based on this study alone.

Delimitations

The scope of this study is the comparison of two elementary mathematics instructional models, Traditional (face to face) instructional model and Blended Learning instructional model, and the analysis of the differences among PARCC mean scale scores for all students in grades 5 to7 regardless of classification. The study delimited the population to students who, at the time of the study, were administered the PARCC 2016, PARCC 2017 and PARCC 2018 mathematics assessments.

Definition of Terms

ACHIEVEMENT GAP

The disparity in academic performance between groups of students- this can be examined among various success measures e.g. test scores, dropout rates, college completion rates. School which has the overall lowest subgroup performance (in our case it is our ESL/Bilingual and SPED

groups), a graduation rate below 75% and the widest gaps in achievement between different subgroups of students.

BLENDED LEARNING

A formal education program in which a student learns at least in part through online learning with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from home. The modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience. (Christensen, Horn, & Staker, 2013)

COMMON CORE STATE STANDARDS

The Common Core is a set of academic standards for English Language Arts and Mathematics. They outline what every student is expected to learn in each grade level, from kindergarten through high school.

COLLEGE AND CAREER READY

College and Career Ready describes a student who is ready for college and/or a career as evidenced by his/her ability to qualify for and succeed in entry-level, credit- bearing college courses leading to a baccalaureate or certificate, or career pathway-oriented training programs without the need for remedial or developmental coursework.

DATA DRIVEN INSTRUCTION (DDI)

The ability to collect or gather information and act upon the results of the information; actions include recording results, interpreting results, decision-making planning and implementing instruction based on the data.

DATA DRIVEN DECISION MAKING (DDDM)

A DDDM focus uses student assessment data and relevant background information, to inform decisions related to planning and implementing instructional strategies at the district, school, classroom, and individual student levels.

FACE TO FACE INSTRUCTION

This type of instruction takes place in a traditional classroom and is characterized by the instructor and the students being in the same place at the same time, teaching and learning occurs at the same time. Instruction is led by the instructor and consists of lectures, whole group discussions, common assessments and assignments.

FLIPPED CLASSROOM

An instructional model that inverts the traditional learning environment. Instructional content is delivered outside of the classroom (online) and activities such as homework are addressed in the classroom.

GENERATION Y

The generation born in the 1980s and 1990s, comprising primarily the children of the baby boomers and typically perceived as increasingly familiar with digital and electronic technology.

GENERATION Z

The generation born somewhere between 1997 and the mid 2000's. They have used the Internet since a young age and are comfortable with technology and social media.

NJASK

The New Jersey Assessment of Skills and Knowledge (NJASK) was a standardized test administered by the New Jersey Department of Education to all New Jersey public-schooled students in grades 3-8. It assessed student achievement in language arts, math, and

science. The results of the elementary-level assessments were intended to be used to identify students who need additional instructional support in order to reach the Core Curriculum Content Standards.

NJCCCS

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

NO CHILD LEFT BEHIND

A 2002 federal law encompassing all public schools receiving public funding; it states that all children in the public education system will be proficient in the areas of Language Arts and Mathematics.

ONLINE LEARNING

Online learning is part the broader model of distance education where students can complete all or part of an educational program in a geographical location apart from the institution hosting the program.

PARCC

The Partnership for Assessment of Readiness for College and Careers (PARCC) is a consortium of states that collaboratively developed a common set of assessments to measure student achievement and preparedness for college and careers. They are aligned to the Common Core State Standards (CCSS) and were created to measure students' ability to apply their knowledge of concepts rather than memorizing facts.

PERSONALIZED LEARNING

Instruction that is paced to the learning needs, tailored to learning preferences and adapted to specific interests of different learners (Bray & Mc Claskey, 2015).

RACE TO THE TOP

Usually abbreviated **R2T**, **RTTT** or **RTT**, is a $4.35 billion contest created to spur innovation and reforms in state and local district K-12 education. It is funded by the ED Recovery Act as part of the American Recovery and Reinvestment Act of 2009. States were awarded points for satisfying certain educational policies, such as performance-based standard for teachers and principals, complying with Common Core standards, lifting caps on charter schools, turning around the lowest-performing schools, and building data systems.

SPIRAL CURRICULUM

A course of study in which students will see the same topics throughout their school career, with each encounter increasing in complexity and reinforcing previous learning.

STUDENT ACHIEVEMENT/OUTCOMES

The numeric increase or decrease in performance obtained by a child or children as demonstrated by regression, no growth or progress.

TECHNOLOGY-BASED LEARNING

Learning in which teachers use technology to teach and learners learn with aid of technology.

WEB-BASED LEARNING

The Internet is used as an instructional delivery tool to carry out various learning activities examples include a pure online learning (curriculum and learning are implemented strictly online) or hybrid (the instructor meets the students half of the time online and half of the time in the classroom).

Chapter 2: Literature Review

The launching of Sputnik (October 1957) forced the United States to redirect its focus on its education system, as it sought to position itself as a leader in K-12 student performance, especially in the areas of mathematics and science. With the passing of legislation (The National Defense Education Act, 1958) to address the performance of K-12 students in the United States, the federal government signaled that there would be a focus on improving its educational system to ensure that its students were competitive when compared with students from other developed countries. A focused shift in education: the learning of science and mathematics by K-12 students became a priority (Permuth & Dalzel, 2013).

Although several decades have passed, there continues to be a struggle to improve student performance in Mathematics in the United States. In fact, after years of educational reform, based on the most recent results of international measures of academic prowess (PISA 2015 and TIMSS 2015), there appears to have been no significant gains in mathematics for students in the US. Students in the 4th and 8th grade who participated in the Trends in International Mathematics and Science Study (TIMSS) in 2015 were ranked 10th out of 39 participating countries. Students who participated in the 2015 Programme for International Student Assessment (PISA) did not fare any better, ranking 41st out of 72 participating countries. With this as the backdrop, educators, politicians, researchers, and policymakers continue to investigate, develop and propose methods, strategies, and best practices that could have a positive impact on student achievement in mathematics. The National Commission of Excellence in Education in its publication of A Nation at Risk (1983) outlined the dire state of math education. It stated that we had squandered the gains in achievement made in during the Sputnik challenge we have in effect been committing an act of …educational disarmament (Nation at

Risk, 1983). Mathematics education and student performance in mathematics continue to demand attention in the quest to support the sustained improvement in the teaching and learning of mathematics.

Technology integration in the teaching and learning of mathematics has drawn the attention of educators as early as 2000. With increasing intensity, the leading mathematics organizations have endorsed the integration of technology in the classroom as is evidenced by statements related to the standards and recommendations for what should be taught in the mathematics classroom. The review of the most current standards and recommendations for mathematics educators have recommended technology integration at all K-12 grade levels (Association of Mathematics Teacher Educators AMTE, 2006; National Council of Teachers of Mathematics NCTM, 2014). The International Society for Technology in Education noted that to meet current educational quality standards, teachers and teacher educators should integrate technology into mathematics instruction and teacher preparation programs (ISTE, 2007; NCTM, 2003). Additionally, The Council for the Accreditation of Educator Preparation (CAEP) recently released explicit recommendations for teacher preparation programs concerning the integration of technology across the curriculum, based on the standards suggested by the ISTE for technology integration (Childress, 2014). The National Council of Teachers of Mathematics added that the informed use of technology allows students at varying academic levels to access mathematics content, extend conceptual understanding, increase problem-solving capabilities, and enhance their computational fluency (NCTM, 2008).

Technology integration has immensely transformed mathematics instruction. It has enabled mathematics teachers to engage students both creatively and cognitively by providing opportunities for students to receive individualized instruction that is virtually impossible for

teachers to provide. Technology-enhanced instruction allows students to actively participate and reorganize how they understand mathematics through higher-order thinking tasks (Stohl-Lee, Hollenbrands, & Holt-Wilson, 2010). It affects more than competency; it also influences how students think about and identify with mathematics (Hodges & Conner, 2011). Employing some of the benefits of technology-enhanced mathematics instruction to support student achievement is a significant challenge in mathematics education.

Methodology

The search for relevant studies began with the search of Library catalogs to find books, electronic books, multimedia reports archived by the Education Library and SHU libraries. I used the subject headings to locate full records of materials matching Blended Learning. To locate articles and other secondary sources, I accessed key electronic databases including, ProQuest, Science Direct, Google Scholar, Web of Science, ERIC and JSTOR, to search for relevant Literature recorded in journals, magazines, newspapers, conference reviews, reports, book articles, conference papers, policy papers and research synthesis. Some initial search terms included Blended Learning, technology, and mathematics, Blended Learning in elementary schools, blended learning versus face-to-face instruction, the impact of blended learning on students' outcome or performance, blended learning and student achievement in Mathematics.

The findings were used to identify additional articles, through the pursuit of references cited or authors noted in the reviewed literature.

Inclusion/Exclusion Criteria

1. The articles selected for this literature review were mainly based on empirical research.
2. Addressed the impact of digital technology as an instructional enhancement compared to traditional nontechnology instruction;

3. Used student achievement in mathematics as the dependent or outcome measure;
4. Reported an average effect size or sufficient data to calculate an average effect size;

Those excluded,

1. Did not relate to Blended Learning in a K-12 setting
2. Did not measure outcomes based on a summative assessment
3. Did not fall under the definition of blended learning used in this study.

Review of Literature

The Beginnings of Blended Learning

At the start of the conversations on blended learning, studies supported the idea of integrating online learning with traditional face-to-face learning. The pioneers Clooney et al. aimed to combine elements of play and work in a prekindergarten school to acquire blended activities (Cooney et al., 2000). In 2001, Voci and Young (2001) attempted to combine a technology component (e-learning) to their leadership development program. They aimed to benefit from the advantages of both methods of instruction simultaneously. The results of this study revealed an increase in the sense of teamwork, the establishment of common concepts and language, and a greater efficiency in-group learning (Voci & Young, 2001). Bonk et al. (2002) studied the effects of a blended learning approach on military students. They applied asynchronous internet-based learning in the first phase, synchronous learning in virtual collaborative chat tools and face-to-face learning in the third phase (Bonk et al., 2002). Their results showed that although online learning was favored as enjoyable and flexible, most of the learning occurred in the face-to-face phase (Bonk et al., 2002). Stewart (2002) advocated a mix of self-paced asynchronous work-based learning with synchronous face-to-face instructor-led learning in intercultural training.

Blended learning, a form of integrating technology in classroom instruction, is gaining notoriety in the field of education. In their piece on The Rise of K-12 Blended Learning, the authors noted that there were about 45,000 K–12 students took an online course in 2000; by 2009 this number had increased to more than 3 million students. Most of the growth occurred in blended-learning environments, in which students learn online in an adult-supervised environment at least part of the time (Horn & Staker, 2011). Picciano and Seaman (2009) noted that in their 2008 survey of U.S. K-12 administrators that 41% of responding public school districts had students enrolled in blended courses, and an additional 21% planned to enroll at least one student in a blended course by 2011.

Corresponding with this increase in the implementation of blended learning as an instructional method, research on blended learning has increased over the last decade. An investigation into its history revealed that Blended Learning is only in its second decade of practice and research. Experimentation with and research surrounding Blended Learning continues in the realms of definitions, contexts, models, perceptions, impact on student performance/ outcomes in various disciplines and various student populations. Most of the seminal work, however, has centered on blended learning in the context of higher education (Halverson, Graham, Spring, & Drysdale, 2012). Because of this divergence in the research and practice of blended learning, early studies focused on the various conversations surrounding blended learning. This helped determine a central theme and more so, the identification of areas in the research that may need further attention.

To this end, several works have emerged with a focus on identifying the most scholarship and research on blended learning (Haverson, Graham, Spring, Drysdale, & Henrie, 2014). This review utilized some of these works to identify and address the emergence and development of

blended learning in general and blended learning and its trends in mathematics education in particular. Once these trends were addressed, there was a focus on blended learning in the K-12 setting and its impact on student performance. There was also be an examination of the literature surrounding mathematics education and the theories which support the view that a blended learning environment would enhance students' ability to improve their performance in mathematics.

Defining Blended Learning

In any emerging field, definitions are an integral part of its evolution and its growth. Definitions are important since they help to cement an understanding of the term and support scholarly conversations surrounding the term. There have been several updates and expansions of the term blended learning, especially as it relates to K-12 environments. All definitions of blended learning, however, suggest that there is some combination of face-to-face instruction and computer-mediated instruction (Graham, 2006). Many definitions of blended learning have emerged in the literature. They range from some that are so broad that any instructional model that integrates the use of educational technology qualify, to those that are so limited and specific that they address specific percentage combinations of face-to-face instruction and instructional technology.

Some of the early definitions of blended learning described it as a learning program where more than one delivery mode is used with the objective of optimizing the learning outcome and cost of program delivery (Singh & Reed, 2001); as a combination of face-to- face with distance delivery systems, instead those who utilize blended learning environments are trying to maximize the benefits of both face-to-face and online methods (Osguthorpe & Graham, 2003); as a modern method dependent on technology and the use of instructional methods geared

towards solving the problems related to class management as well as learning-directed activities, which require accuracy and mastery Bersin (2003); as a means of tailoring learning and development to the needs of individuals through the integration of innovative and technological advances offered by online learning and the interaction and participation offered in the best of traditional learning (Thorne, 2003); as focused on optimizing students' achievement of learning objectives by applying the "right" personal learning technologies to watch the "right" personal learning style to transfer the "right" skills to the "right" person at the "right" time (Singh, 2003); as bringing traditional physical classes with elements of virtual education together (Finn & Bucceri, 2004). Blended learning was also viewed as a pedagogical approach that combined the effectiveness of teacher interaction and the opportunities to socialize in the classroom with the technologically enhanced active learning possibilities of the online environment it should be approached as a fundamental redesign of the instructional model (Dziuban, Hartman, & Moskal, 2004).

More recent definitions have sought to refine and expand what Blended Learning entails, focusing on the learning or instruction rather than the structure of the model. For example, Horn and Staker (2012) defined blended learning as a period of student learning at least partially in a supervised brick-and-mortar structure outside of the home and partially through online delivery with some measure of student control over time, place, path, and (or) pace. To clarify what is essential in a blended learning scenario, The Clayton Christenson Institute for Disruptive Innovation added that the modalities along each student's learning path within a course or subject should be connected to provide students with an integrated learning experience (2012). Several studies have also tried to categorize models and variations of Blended Learning. This has occurred mainly in studies that are more recent. As early as 2003, however, Osguthorpe and

Graham (2003) described three different blending models; a blend of learning activities (students benefit from face to face and online learning), a blend of students (students who receive face to face instruction are blended with online student) and blend of instructors (students receive instruction from one instructor in a face-to-face setting and another through an online environment). Staker and Horn (2011) used the characteristics such as teacher roles, scheduling, physical space, and delivery methods to identify six distinct models; face-to-face driver, rotation, flex, online lab, self-blend, and online driver. The Clayton Christensen Institute for Disruptive Innovation used the degree of online involvement in the model to categorize Blended Learning into four instructional models: rotation, flex, a la carte, and an enriched virtual model.

This study relied on Education Elements to address both the definition of and the categorization of models. The school in this study collaborated with Education Elements to provide its framework for the implementation, monitoring, and assessment of its blended learning program. According to Education Elements, blended learning utilizes technology to create a learning environment that facilitates students' daily opportunities for individualized learning and for teachers to have the opportunities, resources and time to differentiate small group instruction in a classroom. The Core 4, Integrated Digital Content, Targeted Instruction, Student Reflection & Ownership, and Data-Driven Decisions are integral components of its characterization of what constitutes Blended Learning. They identified five instructional models; Station Rotation Model with targeted small group instruction, Station Rotation Model, Station Rotation model with 2 teachers, Choose your adventure model, Launching, and Exploring weekly plan. This study focused on the Station Rotation model with small group pull out (at times based on either one or two teachers involved in the small group pull out.

The Station Rotation model, with small group pullout, started with the introduction of new learning in a whole group session as part of the face-to-face instruction or traditional instruction. The session included an introduction to the new learning, modeling, and guided practice for students. During the guided practice the teacher collects data to determine which students needed individualized intervention (additional practice on own, face to face instruction with a teacher, supplementing or acceleration on digital content, exploration using challenging real-world problem-solving opportunities).

Early Research Trends

Blended learning is gaining momentum in K-12 learning environments. This emphasizes the need to understand its usefulness and effectiveness better as it pertains to instruction and student outcomes. Because of its relatively brief history, research on blended learning has focused on fully online or "virtual learning" settings, and (or) with older adolescent or adult learners in higher education or industry settings (Blended Learning Research Clearing House 1.0, 2015). There is limited research evidence to date in public K-12 settings when examining its effectiveness as an instructional model. The research is even more sparse when trying to evaluate the impact of Blended Learning on students in mathematics classrooms. Since this study's focus is on the effectiveness of blended learning, although general trends are mentioned, the majority of the referenced studies focus on effectiveness.

Initial research centered on trying to find common ground on this new phenomenon of Blended learning. To this end, Halverson, Graham, Spring, and Drysdale (2012) researched Blended Learning by using Hazings (2011) Publish or Perish software to determine the most frequently cited articles, books, and journals. This enabled the identification of the scholars who were at the helm of conversation on blended learning. In 2013, the same authors, along with

Henri, focused on the themes developed and discussed in the research surrounding blended learning. Their research focused on the "60 most impactful articles and the 25 most impactful books" to identify the trends, methodologies, research questions addressed, and the theoretical frameworks referenced. In the 2011 work, the authors looked at the frequently cited works lists. In the 2013 work, they constructed a detailed analysis of themes based on the content of the most frequently cited works.

They identified and analyzed over 200 theses and dissertations written between 2000 and 2013 in the domain of blended learning. Their analysis documented the growth of blended learning research and identified demographic, methodological, and topical trends in the Blended Learning body of research. They found that 77% of research focused on higher education and that studies with a K-12 focus only emerged as late as 2008. 83% of the literature addressed a course level blend with only 10% addressing an institution-wide blend (as the current study plans to do). Regarding methodology, 34% used inferential statistics to analyze student performance and compared the effectiveness of blended learning to other models of instruction.

In a meta-analysis conducted by the U.S. Department of Education in 2009, 99 studies on online or blended learning for the period 1996 to 2006 were reviewed. The initial search did not find any studies that addressed an experimental or quasi-experimental study that focused on the comparison between the learning effectiveness of online and face-to-face instruction for K–12 students or provided sufficient data for inclusion in a meta-analysis. The search was extended to 2008 leading to the discovery of 176 online learning research studies that utilized an experimental or quasi-experimental design and objectively measured student-learning outcomes (Means, Toyama, Murphy, Bakia, & Jones 2009). Only nine of the 99 involved K–12 learners.

In their study of the past, present and future of blended learning: an in-depth analysis of the literature, Guzer and Caner (2013) discussed two trends that emerged from the most cited literature: perceptions of participants who are engaged in blended learning environments and effectiveness of the blended learning. Of the six articles they were able to utilize, two evaluated overall effectiveness (Deliağaoğlu & Yıldırım, 2008; El-Deghaidy & Nouby, 2009); four evaluated effectiveness as it related t to some independent variables such as satisfaction, achievement, behavior, learner support, critical thinking skills, participation, interaction, retention and affect (Akyüz & Samsa, 2009; Hughes, 2007; Melton et. al., 2009; Woltering et. al., 2009).

Hughes conducted studies on the effectiveness of blended learning in 2007 (the effectiveness of blended learning on learner support and retention); Milton et. al in 2009 (the effectiveness of blended learning on student satisfaction and student achievement); Akyuz and Samsa (2009) (the effectiveness of blended learning on critical thinking skills of students); Deliağaoğlu and Yıldırım (2008) (comparison of the effectiveness of blended learning with traditional learning); El-Deghaidy and Nouby (2008) the impact of blended e-learning cooperative approach (BeLCA) on the achievement of pre-service teachers, as well as their attitudes and cooperativeness.

Of the five studies discussed, four studies were conducted with college-level students or college graduates; none was in a K-12 setting. In the case of the Hughes study, she focused on decreasing face-to-face contact time and increased tutor support, especially for ‘at risk’ college undergraduates (Hughes, 2007). Milton et al. measured students’ course grades, satisfaction, and teacher evaluation in a nursing program. Akyuz and Samsa (2009) and Deliağaoğlu and Yıldırım (2008) used students enrolled in computer instruction and technology education for their study.

El-Deghaidy and Nouby (2008) conducted their study on twenty-six pre-service science teachers in an Egyptian university. Four of the six studies used a quasi-experimental research design, while one used an action research model.

Hughes's study results showed that a mixture of well-prepared blended learning along with the proactive help and encouragement for learners who are 'at-risk' improves coursework submission and module retention without extra effort (Hughes, 2007) Melton et. al. (2009) found that students in the blended class were significantly more satisfied than students in traditional class but that there was not any significant difference in the pre-test and post-test grades of students (Melton et al., 2009). Akyuz and Samsa indicated that the effectiveness of blended learning on critical thinking skills had not been observed in their study (Akyuz & Samsa, 2009) while in the Deliağaoğlu and Yıldırım study both groups had similar achievement levels and knowledge retention. They also found that both groups reported a high level of positive attitudes and course satisfaction, but satisfaction from the blended environment was higher (Deliağaoğlu & Yıldırım, 2008). El-Deghaidy and Nouby, found that achievement of students in the blended group was significantly higher than students in control group were. Additionally, they found that students' attitudes towards e-learning were significantly higher in the blended group. Regarding students' attitudes towards cooperativeness, no significant difference was found between both groups and blended learning was found to be as effective concerning attitudes and achievement.

The general findings in these studies which evaluated the effectiveness of blended learning on variables including achievement, satisfaction, motivation, attitude towards mathematics, cooperativeness, knowledge retention, critical thinking skills and drop-out rate for at-risk students concluded that there was no significant difference in the achievement of students in blended learning or traditional learning environments. Regarding variables like satisfaction,

motivation, drop-out rate for at-risk students, attitude and knowledge retention blended learning is observed as superior (Guzer & Caner, 2013).

Factors Influencing Mathematics Performance

Race/Ethnicity

NAEP data showed that a higher proportion of White and Asian/Pacific Islander students scored at or above the basic and proficient levels when compared with Black, Hispanic, and American Indian/Alaskan Native students and students from lower-income families at each assessed grade level in mathematics (NSB, 2012). Black students represented the lowest-performing subgroup. Black students scored mostly at or below the basic level. This group of students had the fewest number of students scoring at or above the proficient level. Analyses conducted by the NCES showed that Black and Hispanic students trailed their white counterparts by an average of more than twenty points on the grades 4 and 8 NAEP mathematics assessment; this represented a difference of roughly two grade levels (NCES, 2009, 2011).

Congress' 2002 reauthorization of federal assistance to elementary and secondary schools in the No Child Left Behind Act was in response to the consistent lower academic performance of African Americans, Hispanics and Native Americans in comparison to Caucasians and Asian American students (Kim & Sunderman, 2005). In 2002, the National Assessment of Educational Progress (NAEP) reported that students from low socioeconomic backgrounds, along with African by the 12 grade, poor and minority students are approximately four years behind. The Americans and Hispanics are already two years behind other students in the fourth grade.

Gender and Mathematics Performance

Gender differences in mathematics performance as much attention today as it did in the past. An examination of the literature found research on this topic from as early as the 1930s to

the present day. An examination of past research has revealed that males outperform females in mathematics (Hyde, Fennema, & Lamon, 1990a). Researchers agreed that males achieved better in mathematics than females (Ealls & Pox, 1932; Glennon & Callahan, 1968; Stroud & Lindquist, 1942). For example in a study of elementary school students, boys were superior on a test of basic arithmetic skills but by high schools girls attained higher scores on algebra and reading comprehension tests only, while the boys evidenced superiority on tests of geometry, general science, biology, physics, history, government, contemporary affairs, economics, and Latin (PsycINFO Database Record (c) 2016).

A 1984 meta-analysis of 102 studies to determine gender-related differences in mathematics achievement, found that of the 35 studies showing a significant effect size, 22 showed males outperforming females while 11 showed females outperforming males in mathematics. A closer examination of the data indicated, however, that of the 35 studies, 20 had no significant differences (mean effect of .10). Of those with significant differences (mean effect of .74 or higher); 11 showed boys performed better, and 4 showed girls with better performance in mathematics.

In an analysis of the 2000 Programme for International Student Assessment Project (OECD, 2001), Marks (2008) used data from 31 participating countries to determine how gender influenced student achievement in reading and mathematics. He concluded that gender gaps in reading and mathematics are highly correlated (p. 106). In a 4-year study analyzing gender differences on assessments, Willingham and Cole (1997) found that the data revealed that there was virtually no difference between females and males for 74 assessments at the 12th grade level across 15 subject areas. The gender gaps of the 1960s have since narrowed. Additionally, Else-Quest et al. (2010) examined patterns of gender differences cross-nationally. They analyzed the

2003 Trends in International Mathematics and Science Study and PISA results. They concluded that "on average, males and females differ very little in mathematics achievement, despite more positive math attitudes and effect among males" (p. 125). A 1990 meta-analysis by Hyde, Fennema, and Lamon (1990) found that by high school, boys tended to out-perform girls on mathematics tests that involve problem-solving. On the other hand, however, girls did better in computation; there is no gender difference in understanding concepts.

Socio-Economic Status and Mathematics Performance

In 1966, the Coleman Report (Equality of Opportunity, Coleman, Campbell, McPartland, Mood, Winfield, & York, 1966) found that contrary to the common belief of the times, schools had a small effect on student achievement when other factors were taken into consideration. They found that there was a strong correlation between student test scores and student's socio-economic status and background rather than school resources and teacher efficacy. In a similar study to determine the impact of students' socio-economic status, it found that middle-SES (socioeconomic status) and upper-SES students enter school with higher achievement levels in mathematics than lower-SES students (Secada, 1992). His review showed that there was a consistent pattern of disparities in mathematics achievement and growth, which were related to student SES. He noted that SES-based differences were higher among Whites than among African Americans or Hispanics in studies that established racial-ethnic groups.

Based on the 2006 NAEP report, mathematics (and science) achievement was found to differ based on family income (as measured by whether or not a student was eligible for the free or reduced-price school lunch program). At each grade level, in mathematics (and science) low SES students, those eligible for the free or reduced-price lunch program received lower average scores and were less likely to reach the proficient level than high SES students, those not eligible

for free or reduced lunch. The report found the differences to be substantial. For instance, students eligible for free or reduced lunch were at least three times less likely to have scores at or above the proficient level for their grade in mathematics (and science) (National Science Foundation, 2006).

Blended Learning and Its impact on Math Achievement

In their study of the Effect of Blended Learning in mathematics, Lin, Tseng, and Chiang, explored the impact of blended learning on the academic achievement and attitudes of 7th-grade students in Taiwan. They conducted a quasi-experimental study using Moodle (an online teaching platform) and traditional instruction. They used a pre-test-post-test design. Analyses of ANCOVA and MANCOVA indicated that students who were exposed to the blended learning model had a positive effect on learning outcomes as well as towards mathematics. The results of this study supported the view that the application of blended learning showed a significant effect on academic achievement for seventh-grade students, and achievement was not different because of gender and ability and that the blended learning instructional model showed a significantly positive effect on attitude toward mathematics for seventh-grade students (Lin, Tseng, & Chiang, 2016).

Awodeyi, Akpan, and Udo (2014) used a combination of conventional classroom instructional model, peer tutoring with WebCT (an e-learning tool) and web-based learning programming in their study of the effect of a blended learning approach to math instruction on Pre-Algebra students at a Nigerian University. They investigated the effect of blended learning approach on students' achievement as compared to purely online and offline/face-to-face approaches in learning pre-algebra course. The study revealed that using a blended learning approach improves students' achievement scores in pre-algebra as compared to other approaches

(i.e., online and offline/face-to-face learning) (Awodeyi, Akpan, & Udo, 2014). A randomized design was adopted to select a sample of 90 undergraduates; students were divided into groups of 30 to correspond with the three different experimental units.

Two experimental treatment groups were constructed to include the students in the purely online and blended learning groups while the control treatment group was designated for the students in the face-to-face learning group. The independent variables were the different instructional methods (i.e., online learning, blended learning, and offline/face-to-face learning) and gender, while the dependent variable was posttest exam scores and pretest scores as the covariate. An ANCOVA was utilized to test the null hypotheses at 0.05 level of significance. The study revealed that using a blended learning approach improves students' achievement scores in pre-algebra as compared to other approaches (i.e., online and offline/face-to-face learning) (Awodeyi, Akpan, & Udo, 2014).

Young's Technology-enhanced mathematics instruction: A second-order meta-analysis of 30 years of research provided a second-order meta-analysis of research conducted from 1985 to 2015. His study focused on the use of technology-enhanced instruction to support student achievement. He distinguished between computation enhancement technologies, instructional delivery enhancement technologies, and presentation and modeling enhancement technologies when examining the impact of technology on mathematics achievement. He further characterized the various enhancement technologies as supporting "doing mathematics" to "developing conceptual understanding" (Young, 2014). He examined the impact of digital technology as an instructional enhancement compared to traditional nontechnology instruction and used student achievement in mathematics as the dependent or outcome measure.

Although he found that there was a moderate cumulative effect of technology-enhanced instruction on mathematics achievement, he concluded that the cumulative effect of this second-order meta-analysis suggests that technology-enhanced mathematics instruction is an effective means to support mathematics achievement (Young, 2014). He noted that technology enhancement was a statistically significant moderator of the effects on mathematics achievement. All technology enhancements, whether computation, instructional delivery, or modeling, had a statistically significant mean effect on the mathematics achievement of students.

The Balentyne and Varga study (2016), Attitudes and Achievement in a Self-Paced Blended Mathematics Course, investigated the relationship between students' achievement and attitudes in a self-paced blended mathematics course. Twenty-three 8th grade students participated in the study. They were described as high ability students or students who receive above-average scores on mathematics achievement tests. They took the MAP test and ATMI to determine if there was a significant relationship between achievement growth while the course was in session and attitudes at the end of the course. Their findings concluded that there was a significant positive correlation between achievement growth and attitudes toward mathematics. Achievement growth was also significantly positively correlated with each of the four attitudinal factors studied: value, motivation, enjoyment, and self-confidence (Balentyne & Varga, 2016).

To determine the impact of the technology-based programs on students' math and reading performance, student attendance and disciplinary records, learning motivation and attitudes toward learning with computers and instructional and learning practices with an emphasis on differentiated teaching compared to traditional, Yigal Rosen and Dawne Beck-Hill (2012) conducted a mixed-methods design study. The study participants, fourth and fifth-grade students, and their teachers were from four elementary schools from the Dallas area; two schools were

used as experimental and the other two as the control group- a total of 476 students and 20 teachers. A pre-test and post-test, the TAXS (Texas Assessment of Knowledge and Skills), was used along with questionnaires which were given at the beginning and end of the school year. The results of the study showed a significant difference in gains on the TAKS test scores for the experimental group over the control group and 29% fewer absences than the control group (Rosen & Beck-Hill, 2012).

A 2012 study by Bowen, Chingos, Lack, and Nygren, measuring the effect on learning outcomes of an interactive learning online statistics course, randomly assigned students to take the course in a blended learning format. Findings were that learning outcomes were mostly the same— this mode of instruction did not harm students in the blended learning format in terms of pass rates, final exam scores, and performance on a standardized assessment of statistical literacy (Bowen, Chingos, Lack, & Nygren, 2012).

Day and Foley (2006) conducted a quasi-experiment over a 15-week semester with 46 students in two sections of the same course-one section using Web lectures and one using traditional lectures. The Web lecture section's grades were significantly higher than the traditional lecture section, and Web lecture students reported increasingly strong positive attitudes about the intervention. Davies, Dean, and Ball (2013) conducted a pretest/posttest quasi-experimental mixed methods design study to determine any differences in student achievement that might be associated with the instructional approach. They found no significant difference between the effectiveness and student perception of blended learning and regular classrooms. Student scores improved significantly between pre/post tests; the simulation group increased the least, and the hybrid group increased the most.

In 2017, Murray conducted a quasi-experimental quantitative study comparing blended learning and traditional instructional methodologies on student achievement on the New York State Regents Examination. He investigated the differences in students' performance on the Algebra I New York State Regents exams that used a blended learning instructional method as compared to a traditional learning instructional method. The independent variables were instructional methodologies (blended learning, traditional), and the dependent variable was student achievement. His findings were contrary to that of previous findings of Day and Foley (2006) who found that the web-lecture (blended learning) group's average grades were higher than that of the traditional group in all assignments and tests. Murray found that students in traditional learning schools on average performed better than their counterparts in iLeamNYC schools.

Further research yield studies that focused on elementary school students and the effectiveness of blending learning instruction when compared with traditional instruction. A study by Kholoud Subhi Yaghmour investigated the use of what he calls the Blended Education strategy in the achievement of third-grade students in mathematics. He used a semi-experimental method to examine the impact of using blended teaching (independent variable) versus using traditional teaching methods on student achievement (dependent variable). The results showed a statistical difference in the achievement of third-grade students in mathematics who received instruction in the blended learning method as opposed to those who received instruction in the traditional method.

Bani- Doumi and Al-Zoubi's study (2012) investigated the impact of blended learning on the achievement of fourth graders in mathematics and their motivation towards learning. Using an experimental design, he studied 71 students who were divided into 2 groups (38 experimental

group participants and 33 participants in the control group). The results revealed significant differences between the means in the achievement exam of the experimental and control group participants (Bani-Doumi & Al-Zoubi, 2012).

Al-Awadh and Yunis did another study on the impact of blended learning on math achievement in 2011. They examined the impact of blended learning on the achievement of eighth graders in solving equations' unit as well as the students' attitudes towards learning mathematics. Their study was also an experimental design and the participants were divided into a group of seventy-five students in the experimental group (taught using a blended learning model) and 73 in the control group (taught in a traditional instructional model). Results showed no significant impact on the achievement level, student attitudes towards math, student achievement in functions and equations solving, and their attitudes due to the teaching method and the achievement levels of the students (Al-Awadh & Yunis, 2011).

Although most of the studies examined, investigated the impact on blended learning on student achievement in mathematics, the majority did not take place in the United States. Additionally, although most of the studies were conducted in a K-12 setting, they did not address students in the grades examined in this study, students in grades 5-7. More so, the results were mixed when comparing the impact of blended learning instructional model and that of traditional instruction. Some results yield positive results for the blended learning groups, others for the traditional model, while others showed no significant differences in students who were exposed to blended learning environments as opposed to traditional teaching methods.

Theoretical Framework

The theoretical foundation of this study of Blended Learning is based on the Theory of Personalized Learning. As a pedagogical philosophy, personalized learning emerges from several

psychological constructs and theoretical frameworks. In their work, *Make Learning Personal, the What, Who, WOW, Where and Why*, Bray and Mc Claskey (2015) addressed the work of several theorists whose work supported their notion of personalization of learning. They also addressed learners in the context of brain research, learning styles, and the different generations of learners. This discussion focused on theories of learning and addressed the work of theorists, who supported the underlying tenets of personalized learning. The connection between these theories provides the groundwork for learning approaches that are defined by personalization.

To formulate the concept of Personalized Learning, Bray and McClaskey (2015) examined the work of several learning theories; examples include constructivist theories of Dewey, Vygotsky, and Bruner, Csikszentmihalyi' s Theory of Flow, Dweck's Mindset and Mayers and Rose's Universal Design for Learning. Other proponents of personalized learning addressed theories such as goal-oriented theory, self-determination theory, and self-regulation theory, all of which are closely linked with those mentioned in the work of Bray and McClaskey.

Vygotsky noted that learning and development are intricately intertwined and as such, occurred in concert with each other. His theory of learning centered on learners being allowed to developmental tools which would allow them to solve real-world problems. He characterized learning as a process by which students needed to know more than skills and facts. He proposed that learners should take charge of their learning. His theories stressed the fundamental role of social interaction where the community plays a central role in "making meaning" (Bray & McClaskey, 2015). A child's potential development involves those concepts that a child is ready to learn or can articulate with scaffolding techniques such as teacher prompting, or modeling or assistance from peers. (Houchens, et al., 2014). Vygotsky proposed that teaching should afford students the opportunity to explore instead of being restricted to their actual developmental level.

This actual developmental level is contrasted with potential development. The former described as those concepts/skills that the learner has mastered; the latter refers to those concepts that the learner is ready to learn or can articulate with assistance, for example, teacher prompting or modeling, assistance from peers or technology. Vygotsky's description of the zone of proximal development centered on the distance between content that is mastered and what is ready to be learned.

Vygotsky's theory of learning supports the Theory of Personalized Learning since it supports the importance of learners taking control of the learning. He envisioned learning as an active process in which learners construct new ideas or concepts based on their current and prior knowledge, social interactions, and motivation to learn (Bray & McClaskey, 2015). When learning is personalized emphasis can be placed on not just the development of learners based on what they can do, but support can be given to strengthening that zone of proximal development. This support can come from the teacher, a peer, or, as in the case of blended learning, technology.

John Dewey's influence on the theory of personalized learning is also note-worthy. His belief that curricula should be developed with children's interests in mind aligns with the views espoused by the Theory of personalized learning. Dewey proposed that learners are motivated by what interests them and as such, education should have some connection with society, the outside world, and what was taking place in real life. He also addressed the relevance of learning based on the needs of society. He felt that learners should be preparing for their role in society and that education should cater to the changing need of that society.

An examination on the foundations of personalized learning draws stark similarities between the beliefs of Dewey and the constructs of personalized learning. The idea of learners at

the center of the learning process is common to both schools of thought, as is the notion of learning being meaningful and relevant to the learner. Additionally, as with Dewey, personalized learning addresses students' interest by allowing for student voice in the choice of what and how they learn. In a personalized learning environment, teachers and the learners become partners in learning. The learner has a voice in determining how they will acquire information, choices in how they articulate what they know and how they engage with the content. When learners assume ownership and take responsibility for their learning, they are more motivated to learn and more engaged in the learning process (Bray & McClaskey, 2015).

Like Vygotsky, Jerome Bruner's theoretical framework centers on the idea of learning as an active process where learners construct new ideas or concepts based upon their current/past knowledge. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. Cognitive structure (i.e., schema, mental models) provides meaning and organization to experiences and allows the individual to "go beyond the information given" (InstructionalDesign.org). He addressed the notion that information shared during the learning process should be in a form that allows the learner to utilize what they know. As such, the curriculum should be constructed in a manner that gives the learner multiple opportunities to build on their existing knowledge.

Bruner's theory of instruction addressed the structuring of knowledge, effective sequencing of information, access to learning through multiple modes of representation and the idea that exploration was necessary for learners to access learning and engage in solving problems. Regarding structuring knowledge, Bruner felt that since there were many ways of structuring knowledge and many ways in which learners prefer to learn, how knowledge is structured, should be an essential part of the learning process. This, along with his notion of

effective sequencing, led to the emergence of his idea of the spiral curriculum. Spiraling the curriculum, Bruner felt, would support the structuring of information and the effective sequencing of information to allow learners to learn complex ideas first in a simplified manner and revisit it later in a more complex form.

Learning through exploration and access to multiple modes of representation, addressed the concepts of the learner as the center of the learning process and the social environment in which the learner is allowed to explore rather than be told. This bears similarities to Vygotsky's Theory of Learning. They both emphasized the social nature of learning, supporting the view that students should be supported by MKOs (Vygotsky's more knowledgeable others) and Bruner's teacher support through scaffolding. Students building on what they already know is the centerpiece of the two schools of thought — expanding on existing knowledge through the exploration of concepts that may be outside of students' natural developmental stages. For Vygotsky, this was the Zone of Proximal Development; for Brunner, this is teacher scaffolding and the use of a curriculum that spirals.

In a personalized learning environment, learners' demonstration of mastery is based on a competency-based model, not on seat time. In this personalized learning environment, teachers are expected to help all learners succeed in mastering skills (Bray & McClaskey, 2015). Bruner's spiraling of the curriculum provides learners with the opportunity to master skills or concepts based on contact with the learning at various times and different levels of complexity. Additionally, since teachers are expected to support student learning and ultimately their success, the notion of scaffolding by teachers is seen as critical to the Personalized Learning Theory. For Bruner, learning outcomes for learners should include not only concepts, categories, and

problem-solving procedures created previously by the culture, but also the ability to invent these things for oneself (Bray & McClaskey, 2015).

Csikszentmihalyi's theory of flow describes the struggle between challenging tasks or activities and skills. This addresses the idea of learner-centered environments that provide the flexibility and time to allow learners to get in the flow. According to Csikszentmihalyi, flow occurs when an activity challenges individuals, but they have the necessary skills to accomplish the task (Shernoff et al., 2003). Student engagement hinges on the ability of the learning environment to provide situations where there are appropriate challenges and the facilitation of developing and strengthening the skills needed to meet these challenges.

In a 2003 study of high school students, researchers found that students experienced higher levels of engagement and interest while doing group or individual work and that when students were involved in challenging activities that required high skill they were more interested in the activity and also reported higher levels of concentration as well as enjoyment upon completing the task (Shernoff et al., 2003). Personalized learning allows these activities to occur because of its flexible nature and choice of activities based on student needs. Teachers can engage students and allow them to get in "the flow" by involving learners in the design of what is learned and ensuring that the learning includes learners' interests and skill levels. This supports the successful development of activities that challenge each student.

One of the underlying tenets of personalized learning is for students to have their own goals as part of the learning process. Goal Orientation Theory addresses this by utilizing the concepts of goals as a dichotomy between mastery goals and performance goals (Ames & Archer, 1988). Mastery goals are described as a learner's desire to gain knowledge and understanding or to develop a new skill. The learner sees it as success and mastery that is fueled

by his or her own efforts. Performance goals address the learner's desire to appear competent when compared with peers (Ames & Archer, 1988). For researchers, it is the mastery goals that support the improvements in academic performance since students emphasize their efforts rather than that of their peers. In fact, rather than focusing on being on par with or even surpassing peers, students who aim to enhance their understanding of the subject matter have reported employing self-regulated and self-directed learning strategies (Ames, as cited in Ames & Archer, 1988). The connection to goal setting and personalized learning is stark. In personalized learning environments, learning begins with each learner. Learners understand their learning styles so they become active participants in designing their learning goals with the teacher. The learner takes responsibility for their learning. When they own and drive their learning, they are motivated and challenged as they learn, so they work harder than their teacher (Bray & McClaskey, 2015).

To set goals that are not only achievable but also rigorous, learners must believe that they are capable of learning. Carol Dweck proposed, through her research, that what one believes is what guides decisions in one's life. She explored the idea of mindsets making a distinction between fixed and growth mindsets. A mindset is described as the underlying beliefs people have about learning and intelligence. Persons with fixed mindsets believe that some people are capable of learning while others are not and that success in the learning process is based on ability, not on effort. Students with fixed mindsets compare themselves to others and give up easily when material proves challenging. On the other hand, a growth mindset describes a belief that all things are possible if one tries. It is based on the premise that intelligence and abilities can be developed. When learners believe they can get smarter, they understand that effort makes

them more successful; this leads to them make a more determined effort at learning and improving their outcomes.

According to Dweck (2010), learners with fixed mindsets focus on early successes as a determination of talent and know-how; those with growth mindsets believe that success is based on effort. They learn from failure and find setbacks motivating. They keep trying and do not give up if they want to learn or do something (Dweck, 2010). It is important in the conversation on Personalized Learning Theory since it addresses the learner-centered approach to learning. Learners with fixed mindsets must be identified and given support to change the mindset to one that is growth-oriented. In a personalized learning environment, teachers can determine each learner's needs and how they learn best. They can identify how each learner learns, their strengths, challenges, aptitudes, talents, and aspirations. Most importantly, teachers must understand how learners best gain access and engage with the content and how they can best express what they know and understand. This approach provides the foundation for all learners to take responsibility for their learning. When learners take ownership and responsibility for their learning, they are more motivated to learn and more engaged in the learning process (Bray & McClaskey, 2015).

The blended learning instructional model is built on the Theory of Personalized Learning and emphasizes that the learner should be the center of the learning process. Goal setting, using data to define the learner, planning activities that address the needs of each learner, having supports for learners in terms of teachers, peers and technology, and working to address learners taking ownership of their learner are all integral parts of the blended learning instructional model that will be discussed and examined in this study. Affording learners the time to work at their pace, the provision of opportunities to work towards mastery through practice, giving access to

challenging content and activities along with strengthening what is already known is also evident. Although Bray and Mc Claskey made a distinction between Blended Learning and Personalized Learning, they are based on the same premise and have been used interchangeably.

Chapter 3: Methodology

Research is a scientific, systematic search for appropriate information on a particular topic. It is a studious inquiry, examination, investigation or experimentation aimed at discovering and interpreting facts, a revision of accepted theories or laws based on new facts, or a practical application of such new or revised theories or laws (merriam-webster.com). It involves the manipulation of things, concepts or symbols to generalize to extend, to correct or to verify knowledge, whether that knowledge aids in the construction of theory or the practice of an art (Slesinger & Stephenson, Encyclopedia of Social Studies, 1930). Research is not just a process of the gathering of information; it is about answering unanswered questions or creating what does not currently exist. In many ways, research can be seen as a process of expanding the boundaries of our ignorance (Goddard & Melville, 2004).

This study aimed to use a research-based methodology to provide valid, informative, and most importantly, credible data on the effectiveness of a blended learning instructional model in mathematics in an urban elementary school setting. The study aimed to determine the difference, if any, between the achievement effects of one method of instruction (blended learning) and another (traditional instruction) on mathematics achievement as measured by the mathematics section of the Spring 2018 PARCC administration for grades 6 and 7. The scope of this study is the comparison of the differences in PARCC mean scale scores for students across the 7 elementary schools included in the study (one treatment school and the district which consists of other 6 elementary schools).

This chapter explains the methodology that was applied in this quasi-experimental study. The chapter outlines and describes the setting, participants, sampling, design, treatment materials, measurement instruments, and the procedures of data collection, data analysis, and

statistical analysis of this quasi-experimental study. Descriptions of each model of instruction and its place in the District's framework for mathematics instruction are included. When examining the PARCC assessment, its validity and reliability to support its strength as a measure of students' academic achievement are discussed.

Setting for the Study

The study took place within a small Northeastern urban public school district, a district categorized within a district factor group A. According to the NJDOE, the designation of district factor groups (DFGs) provides a systematic approach used to classify New Jersey school districts based on the socioeconomic status (SES) as observed in the communities serviced by the district (https://www.state.nj.us/education/finance). The NJDOE developed the DFGs in 1975 and has updated the DFGs four times to 1) incorporate current data from the Census Bureau and 2) make improvements to the methodology employed (nj.gov). This classification of the school district and schools represents the fourth version of the DFGs. District Factor Group A is the lowest rating and is indicative of the district's relative socioeconomic status.

To address student achievement, the Director of Mathematics for the district determined that there was a need for strategies that were new, progressive, innovative, and had a history of success. After conversations on curriculum, professional development for staff, various levels of student support, department research for alternative strategies to support academic improvement in mathematics, interest was piqued when examining the notion of blended learning as an alternative instructional model. After careful consideration by the district's Director of mathematics, one elementary school was chosen to be the pilot for using a blended learning instructional model in mathematics.

In the 2015-2016 school year, with the full support of the district's Mathematics Department, the treatment site embarked on its quest to implement a blended learning instructional model in all grade 3-7 mathematics classrooms. In August 2015, the district and school-level leadership were involved in the initial conversations on blended learning as an instructional model with one of the industry's leaders in design, professional development opportunities, support, and resources. The implementation proposal was presented to the Board of Education, for approval, in December 2015. Beginning in January 2016, the partnership between the district Mathematics Department, the treatment School and the institution charged with supporting the transition from traditional instruction to a blended learning instruction began.

Blended Learning Implementation

In December 2015, the Board of Education approved the implementation of a blended learning instructional model at the pilot site. The Director of Mathematics and the district then embarked on finding a vendor that would provide guidance and support for the implementation of a successful blended learning instructional model. Bids from 3 companies were received and vetted (presentation by the companies, history of success, ability to provide the outlined supports and cost). Education Elements was selected as the vendor and a Master Services Agreement (MSA) was signed in January 2016.

The MSA outlined the scope of work and outcomes for the development of a single school multi-year personalized learning plan, a single wave implementation and support for one elementary school and the building of capacity and understanding across school leaders for personalized learning. The scope of work was implemented in phases with a launch date of September 2016 as the official date that the pilot sit would transition to a full blended learning instructional model.

The phases corresponded with in-person academies. These consisted of foundations design, professional development/support, and monitoring. The foundation design academy addressed the District's vision and that of the school leadership; the design academy focused on evaluating, experiencing and choosing a design; the professional development /support academy addressed implementation and fidelity to the design; the monitoring academies involved walkthroughs, data conversations, and feedback on implementation and progress. Additional supports included virtual meetings, online resources, and periodic check-ins.

To support implementation and fidelity to the blended learning instructional model, district-level supervisors and coaches participated in the training, professional development, and virtual meetings. They, along with school leadership and the Director of mathematics, assisted with monitoring for fidelity. Additionally, an Assistant Principal was hired in August 2016, with the sole responsibility of providing support, monitoring, and assessing the implementation of the blended learning instructional model and its effects in the classroom.

Regarding the technology support for the implementation of the blended learning instructional model, a digital fair was held and teachers, school administrators and district supervisors and Director, spent several hours engaged in conversations, workshops, hands-on activities and demonstrations of digital content companies. Teachers and students then worked with the digital content for 30 days to determine which platform would yield the characteristics that would enhance the use, data collection, creation of individual student paths and the flexibility to adjust to any changes that are seen as necessary as implementation progressed. An adaptive platform was chosen.

Blended Learning Design

Several designs of blended learning exist. They include flipped classrooms, flex, a la carte, individual rotation, station rotation, lab rotation, and enriched virtual (Christensen, Staker, & Horn, 2013). During the design academy, staff and school and district leadership were exposed to several of these models. The academy was interactive, allowing for experiencing and experimenting with what each model entailed. After the workshop and several subsequent discussions, the rotational model with small group pullout was chosen as the model that would be implemented. The station rotation model with small group pull out as implemented at the treatment site, involved:

1. Whole group instruction (launch, the teaching of the lesson, guided practice, independent practice, and demonstration of learning).
2. Small group-rotations (teacher-led group, technology station, skills station, exploration station, enrichment, problem solving).

The core four appendix was an integral part of the model. It consisted of integrated digital content, targeted instruction data-driven decision making, and student reflection/ownership.

Tradition Instructional Model

In the 2015-2016 school year, all seven elementary schools, in the District, utilized Math in Focus: Singapore Math curriculum published by Houghton Mifflin Harcourt in grades K-5; grades 6 and 7 utilized Pearson's Connected Mathematics Program. In 2016-2017 and 2017-2018 grades 6 and 7 implemented the same curriculum as grades K-5, Math in Focus: Singapore Math curriculum published by Houghton Mifflin Harcourt. The curriculum guides (unit plans, the configuration of the mathematics block, and approved resources) were designed and supported by the mathematics department. District level supervisors and coaches provided professional

development and implementation support to all elementary school mathematics teachers in the district. Mathematics instruction involved a 90-minute block of instruction which was broken down into 3 distinct sections of instruction-whole group, independent practice, whole group summary of learning. All elementary schools in the district followed the outlined mathematics instructional model. The control group used this model during the research period of this study. In initial conversations of the pilot site, discussions centered on the following factors:

- Funding for the design, implementation, and support of the blended learning instructional model.
- School-related factors such as school leadership, teacher quality, and propensity for successful implementation of a school wide program.
- Student performance on the State Assessments (PARCC) when compared with the other elementary school.
- Knowledge of the components of a blended instructional model. (Site had been incorporating digital content during mathematics intervention periods).

Research Question

What is the impact of implementing a blended learning model of mathematics instruction on the mathematics achievement of elementary school students, as measured by the Spring 2018 Grades 6 and 7 PARCC mathematics assessment scores, when compared to the mathematics achievement of Grades 6 and 7 students who received mathematics instruction using a traditional instructional model?

Student performance data in the following areas (1) overall achievement (2) performance levels, (3) gender, and (4) the subgroups of economically disadvantaged and ethnicity/race (Hispanic/Latino, American Indian or Alaska Native, Asian, Black/African American, Native

Hawaiian or other Pacific Islander, White, two or more races, not indicated) is used to address the following subsidiary research questions:

Subsidiary Question 1

How much variance in the Spring 2018 PARCC mean scale score can be explained by the predictor variables treatment, gender, race/ethnicity, and SES?

Subsidiary Question 2

Is there a statistically significant difference in the Spring 2018 Grades 6 and 7 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and the performance levels of students receiving instruction using a traditional model of instruction when controlling for gender, ethnicity/race, and SES (Economically Disadvantaged)?

Subsidiary Question 3

To what extent is there a difference in the performance of students who had a blended learning experience for one year as opposed to those who had the experience two years?

Null Hypotheses

H1₀: There was no statistically significant difference in the mean scores of Elementary School students on the Spring 2018 PARCC mathematics assessment who are receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction.

H2₀: The predictor variables treatment, gender, ethnicity/race and SES (Economically disadvantaged) do not account for any variation in the mean scaled scores on the Spring 2018 PARCC mathematics assessment of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction.

H3$_0$: There was no statistically significant difference in the Spring 2018 Grade 6 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction when controlling gender, ethnicity/race and SES (Economically Disadvantaged).

H4$_0$: There was no statistically significant difference in the performance on the PARCC mathematics assessment of students who are exposed to the blended learning model of instruction in mathematics for one year and those exposed for two years.

Research Design

A quasi-experimental (non-randomized) design was used to determine if there is a relationship between the independent variable (instructional methodologies), and the dependent variable, students' performance in mathematics on the New Jersey State Assessment (PARCC). Descriptive and inferential statistics were performed on the data to determine the differences in students' mean scores on the Grades 6 and 7 PARCC mathematics assessment scores, as well as differences in achievement levels for various sub-groups of the sample. The preferable method for establishing differences between two variables is experimental research that utilizes a test and a control group (Creswell, 2014). The test or treatment group in this study is the grades 6 and 7 students who received mathematics instruction in a blended learning environment; the control group received mathematics instruction in a traditional setting. The 2016 and 2018 Spring mathematics PARCC administrations were utilized as the pre-test and post-tests respectively. The 2016 and 2017 Spring mathematics PARCC administrations were used to address subsidiary question 3. Randomization is generally the preferred method of participant selection (Gay, Mills, & Airasian, 2012). In this instance, this was not possible since students are assigned based on the school they attend according to the District's zoning guidelines.

Participants

Blended Learning Instructional Model (Treatment)

The treatment site implemented the blended learning instructional model in grades 3-7 mathematics classrooms beginning in the 2016-2017 school year, transitioning from the traditional model of instruction, which was in use during the 2015-2016 school year. Four hundred and ninety-eight (498) students in grade 3 through Grade 7 from the experimental treatment site were involved in the blended earning instructional model pilot in math during the 2016-2017 school year (249 males, 249 females; 53.2% Hispanics, 46.4% African Americans, and 0.4% other; 42% were designated English Language Learners; 11.6% were classified Students with Disabilities; 77.3% of students were designated Economically Disadvantaged). One hundred and seven (107) were 3rd graders, one hundred and eleven (111) were 4th graders, one hundred twenty-one (121) were 5th graders, eighty-seven (87) were 6th graders, and ninety-nine (99) were 7th graders. All students in grade 4 (6th graders for the 2017-2018 school year) from the experimental treatment site comprised the experimental treatment population. This was true for grade 5 students (7th graders for the 2017-2018 school year). To address the third subsidiary question, students in grade 4 (5th graders for the 2016-2017 school year) comprised the experimental treatment population.

Since this study focused on grades 6 and 7 students, this sample must be delineated to students who were enrolled at the treatment site during the 2015-2016 through the 2017-2018 school years. Students must also have valid PARCC mathematics score data from 2016, 2017 and 2018 Spring administrations of the PARCC mathematics assessment.

Traditional Instructional Model (Control)

The control sites continued mathematics instruction based on district guidelines of teacher-led instruction during whole group instruction, independent practice with teacher facilitation and whole group summary in grades 3-7 mathematics classrooms in the 2015-2016 through the 2017-2018 school year. One thousand three hundred and forty-two (1342) students in grade 3 through Grade 7 from the alternative treatment site were involved in the traditional instructional model in Math during the 2015-2016 through the 2017-2018 school year (637 males, 705 females; 24.4% Hispanics, 73% African Americans, and 2.6% other; 2.7% were designated English Language Learners; 11% were classified Students with Disabilities; 54.8 % of students were designated Economically Disadvantaged). Two hundred and seventy-six (276) were 3rd graders, three hundred and sixteen (316) were 4th graders, two hundred eighty-nine (289) were 5th graders, two hundred and sixty-two (262) were 6th graders and two hundred and sixty-three (263) were 7th graders. All students in grade 4 (6th graders for the 2017-2018 school year) from the experimental treatment site comprised the experimental treatment population. This was true for grade 5 students (7th graders for the 2017-2018 school year). To address the third subsidiary question, students in grade 4 (5th graders for the 2016-2017 school year) comprised the experimental treatment population.

Since this study focused on grades 6 and 7 students, this sample must be delineated to students who were enrolled at the treatment site during the 2015-2016 through the 2017-2018 school years. Students must also have valid PARCC mathematics score data from 2016, 2017 and 2018 Spring administrations of the PARCC mathematics assessment.

Instrumentation

The Partnership for Assessment of Readiness for College and Careers (PARCC), a consortium of states, worked collaboratively to develop a common set of assessments to measure student achievement and preparedness for college and careers. The PARCC mathematics assessments are aligned to the Common Core State Standards (CCSS). They were created to measure students' ability to apply their knowledge of concepts rather than memorizing facts. These assessments require students to solve problems using mathematical reasoning and to be able to model mathematical principles (NJDOE, 2014). This study compared the 2018 Spring PARCC mathematics scale score means for sampled grades 6 and 7 students in the treatment group (blended learning instruction) to the 2018 Spring PARCC mathematics scale score means for sampled Grades 6 and 7 students in the control group (traditional instruction).

Results for the PARCC are reported according to five performance levels that represent the knowledge, skills, and practices students are able to demonstrate. They are as follows:

- Level 1: Did not yet meet expectations
- Level 2: Partially met expectations
- Level 3: Approached expectations
- Level 4: Met expectations
- Level 5: Exceeded expectations

The Performance Level Descriptors (PLDs) indicate what a typical student at each level should be able to demonstrate based on his/her command of grade-level standards. In mathematics, the performance levels at each grade level are written for each of four assessment sub-claims:

- Major content
- Additional and supporting content

- Reasoning
- Modeling

The performance levels within each claim area are differentiated by several factors consistent with the Common Core's inclusion of standards for both mathematical content and mathematical practices and PARCC's Cognitive Complexity Framework for Mathematics (PARCC, 2015).

For each level of performance, students receive a score of between 650 and 850. There are different proficiency scores for each grade level, which corresponds to each level of attainment. Special attention was paid to ensuring that the correct score assignments were made to delineate between grade levels and performance levels.

Reliability and Validity

The Technical Reports for the PARCC administrations were used to address reliability and validity. The most recent report, published in March 2018, was used for this study. Information and data related to the Computer Based Test were used since this district utilized that mode of the assessment. In sections 8 and 9 of the report, the methods and results of its measurement of reliability and validity.

Reliability

PARCC utilized an internal-consistency measure to estimate the reliability of its tests. This measures the consistency of the performance of individuals across items within a test. Additionally, a reliability of clarification (estimation of students accurately placed into proficiency levels) and for constructed response items on the test, inter-rater reliability (the agreement between human scorers) were also used. The reliability coefficients are reported with scores that range from 0 to 1. "The higher the reliability coefficient for a set of scores, the more likely individuals would be to obtain very similar scores upon repeated testing occasions…"

(PARCC Technical Report, March 2018, p. 93). To measure the difference in score between those attained and those that would be attained if the test was reliable, PARCC assigned a standard error of measurement (SEM). "As the SEM increases, the variability of students' observed scores is likely to increase across repeated testing" (PARCC Technical Report, March 2018, p. 93).

An examination of the results shows that the average scale score reliability estimates for the grades 3-8 mathematics assessments ranged from .919 to .943; for the same grade span, the scale score SEM consistently ranged from 9.590 to 13.466. Reliability estimates were also given for subgroups (gender, race/ethnicity, economically disadvantaged, SWD and ELLs) by grade level. The average scale score reliability estimates for the grades 3-8 mathematics assessments when looking at subgroups by grade levels ranged from .89 (grade 7 African Americans and grade 7 economically disadvantaged) to 94 (grade 4 and 6 males). The scale score SEM for the subgroups ranged from 3.14 (7th grade African American) to 3.66 (Grade 6 not economically disadvantaged).

Validity

PARCC addressed validity by referring to the construction of the test and the items included on the test. Evidence of validity was provided using the test's internal structure and correlations between the test as a whole and its sub-claims. The latter was reported as Pearson correlation coefficients. Validity details are outlined in the 2018 PARCC Technical Report (March 2018).

Data Collection

For this study, publicly available 2015-2016, 2016-2017 and 2017-2018 enrollment, school performance, statewide assessment, and any available historical NJ School Performance

Report data retrieved from the New Jersey Department of Education's website were used. Enrollment counts were those reported as of October 15, 2015, October 15, 2016, and October 15, 2017, respectively. Student-level data was also used for this study. A request was made to the Superintendent of the small Northeastern urban public school district, by the researcher, for approval to collect and use data for this study. This permission was granted after an appearance before the District's Curriculum Committee which comprised the Superintendent, Deputy Superintendent, Board of Education member and curriculum and subject content Directors. Permission was also sought from the Seton Hall University's Internal Review Board. Throughout this study, data were reported in aggregate at either the "treatment" level or "control" level. The Director of Mathematics and Science provided the data, as per district directive.

Data Analysis

The results from the state-mandated PARCC mathematics assessment were used to examine the student achievement outcomes of Grades 5, 6 and 7 students across several demographic characteristics- race/ethnicity, gender, and economically disadvantaged status (SES). A quasi-experimental research design was employed, using pre-test and post-test data from the 2016 PARCC grade 4, the 2017 PARCC grade 5, and the 2018 PARCC grades 6 and 7 administrations, respectively. Grade 4 PARCC 2016 performance data were used as the measure of pre-treatment achievement for grade 6; grade 5 PARCC performance data were used as the pre-treatment achievement for grade 7. In an effort to address the impact of exposure to a blended learning model of instruction for a period of one or two years on student performance, student performance was analyzed from grades 4 to 5 to 6 and from grade 5 to 6 to 7. To compare the impact of one year or two years of exposure to a blended learning instruction model, grade, 2016 PARCC grade 4 performance data were used as the pre-treatment for PARCC grade

5 performance in 2017-one year and grade 6 -two year; PARCC 2016 grade 5 performance data were used as the pre-test for grade 6- one year and grade 7 -two year. A description of the dependent and independent variable is included in the table below.

Field	Description
Dependent Variables	Math Scale Score 2018- Continuous variable representing the 2018 PARCC scale scores Math Scale Score 2017- Continuous variable representing the 2017 PARCC scale scores
Independent Variables	
MathScaleScore 2016	Continuous variable representing the 2016 PARCC scale scores
Performance Level 2016	Categorical variable representing the 2016 PARCC proficiency levels; 1-Did not Meet Expectations, 2- Partially Met Expectations, 3-Aproaching Expectations, 4- Met Expectations, 5-Exceeded Expectations
Performance Level 2017	Categorical variable representing the 2017 PARCC proficiency levels; 1-Did not Meet Expectations, 2- Partially Met Expectations, 3-Aproaching Expectations, 4- Met Expectations, 5-Exceeded Expectations
Performance Level 2018	Categorical variable representing the 2018 PARCC proficiency levels; 1-Did not Meet Expectations, 2- Partially Met Expectations, 3-Aproaching Expectations, 4- Met Expectations, 5-Exceeded Expectations
Treatment	Dichotomous variable representing treatment status; Blended Learning Instructional Model, Traditional Instructional model
African American/ Hispanic	Dichotomous variable of representing race/ethnicity; African American or Hispanic
Economically Disadvantaged/SES	Dichotomous variable of representing socioeconomic status; economically disadvantaged (low SES) qualifying for free or reduced lunch, not economically disadvantaged (higher SES) not qualifying for free or reduced lunch.
Gender	Dichotomous variable representing gender; male or female

Table 1. Description of Variables

A series of preliminary analyses were utilized to address the groups' comparability before primary analyses were used to answer the questions posed in the study. The statistical analyses were conducted using IBM's statistical analysis software SPSS. A description of the statistical techniques performed and the relationships they explored are discussed in this chapter. To explore differences between groups independent samples t-tests, paired-samples t-tests, repeated measures analysis of variance and analysis of covariance were used. Multiple linear regression analyses were performed to explore the relationship among variables.

Independent Samples T-Tests

These were used to compare the mean scores of the two samples in the study. The results were used to determine the comparability of the groups by determining if there was a statistically significant difference in the mean scores of the treatment and control group.

Paired Samples T-Tests

These were used to compare the mean scores of each sample over a period of time. In this study, each cohort, either students in grades 4 to 5 to 6 or those in grades 5 to 6 to 7, was examined through the years 2016, 2017 and 2018 to determine any differences in the mean scores after one or two years of exposure to the treatment.

Repeated Measures ANOVA

Repeated Measures ANOVA was used to determine if there were any differences between related means after exposure to the blended learning instruction model to address the research question. They were also used to compare means at different times during the study in response to subsidiary question three.

ANCOVA

These were utilized to compare the impact of the two instructional models (blended learning and traditional learning) on the dependent variable. They were also beneficial, since the samples were not randomized, in attempting to reduce some of the differences that might exist between the groups. It was used to control for treatment, race/ethnicity, gender, and economically disadvantaged status (SES).

Multiple Regression

A multiple regression explains how much variance in the dependent variable can be explained by the independent variables. The multiple linear regression was performed to determine the amount of variance in Spring 2018 PARCC scores that could be explained by instruction in a blended learning model. It was also utilized to determine which of the covariates had an effect on students' mean scaled scores on the Spring 2018 and the strength of the effect. The covariates utilized in the regression equation were treatment, ethnicity/race, gender, and economically disadvantaged status. It was used to indicate the relative contribution of each of the independent variables. The tests report the statistical significance of the model as well as the individual independent variables.

Research Questions	Null Hypothesis	Statistical Technique
What is the impact of implementing a blended learning model of mathematics instruction on the mathematics achievement of elementary school students, as measured by the Spring 2018 Grade 6 and 7 PARCC mathematics assessment scores, when compared to	1…................ Dependent Variable Independent Variable	RM-ANOVA Grade 4 to Grade 6. Spring 2018 Grades 6 PARCC Scores Spring 2016 Grade 4 Math Scores Instructional model

the mathematics achievement of Grades 6 and 7 students who received mathematics instruction using a traditional instructional model?		
	1 .... Dependent Variable Independent Variable	RM-ANOVA for Grade 5 to Grade 7 Spring 2018 Grades 7 PARCC Scores Instructional model (IV)
Subsidiary Questions		
How much variance in the Spring 2018 PARCC mean scale score can be explained by the predictor variables treatment, gender, race/ethnicity, and SES?	2 ……................... Dependent Variable Independent Variable	Multiple Linear Regression Spring 2018 Grade 6 PARCC scores Treatment (Instructional model) Gender Ethnicity/Race SES (Economically Disadvantaged)
	2 ……................... Dependent Variable Independent Variable	Multiple Linear Regression. Spring 2018 Grade 7 PARCC Scores Treatment (Instructional model) Gender Ethnicity/Race SES (Economically Disadvantaged)
Is there a statistically significant difference in the Spring 2018 Grades 6 and 7 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and the performance levels of students receiving instruction using a traditional model of instruction when controlling for gender, ethnicity/race, SES (Economically Disadvantaged)?	3……...................... Dependent Variable Independent Variable	ANCOVA: for each of the covariates Spring 2018 Grade 6 Performance Levels Treatment (Instructional model) Gender Ethnicity/Race SES (Economically Disadvantaged Status)
	3…….................... Dependent Variable Independent Variable	ANCOVA: for each of the covariates Spring 2018 Grade 7 Performance Levels

		Treatment (Instructional model) Gender Ethnicity/Race SES (Economically Disadvantaged Status)
To what extent is there a difference in the performance of students who had a blended learning experience for one year as opposed to those who had the experience two years?	4……................ Dependent Variable Independent Variable	RM ANOVA, Paired T-test Spring 2017 Grade 5 and 6 PARCC Scores, Instructional Model (IV)
	4….................... Dependent Variable Independent Variable	RM ANOVA, Paired T-test Spring 2018 Grades 6 and 7 PARCC Scores Instructional model (IV)

Table 2. Summary of Analyses

Statistical Power and Effect Size

Effect size indicates the size of the differences between the groups. For all independent samples t-tests, Eta squared was used to calculate effect sizes of statistically significant outcomes. It ranges from 0 to 1 and represents the proportion of variance in the dependent variable that can be explained by the independent variable. A size of .01 equates to a small effect, .06 equates to a moderate effect and .14 equates to a large effect (Cohen, 1998, pp. 284-7). In the analyses of correlation and regression, the Pearson correlation was used to calculate effect sizes of statistically significant outcomes where the rough guideline for determining size is 0.1, small; 0.3, medium; 0.5, large (Cohen, 1988, 1992). For analyses of variance, effect sizes are reported as partial eta squared; the guideline for determining size is 0.01, small; 0.06, medium; 0.138, large (Bruin, 2006).

One research question, three subsidiary questions, and their accompanying null hypotheses were analyzed and discussed. Implications for theory, knowledge, practice, policy, and future research are discussed in Chapter V.

Chapter 4: Data Analysis

The purpose of this study was to investigate the effect of a blended learning instructional model on the achievement of grades 6 and 7 students as measured by their performance on the PARCC 2018 mathematics assessment. The study also examined the amount of variance in the PARCC mean scale score that could be explained by the predictor variable treatment and the covariates gender, ethnicity/race and economically disadvantaged (SES). Additionally, the independent variable number of years in the blended learning instructional model was used to determine its impact on student performance. The results and findings used to address the problems posed in Chapter 1 are discussed in this chapter. Multiple data analyses were conducted, and the results are reported and summarized to answer the primary research question, subsidiary questions, and test the hypotheses. The data collection and the subsequent data analysis for this study were driven by study's goal. The goal was to use a research-based methodology to provide valid, informative, and credible data on the impact of a blended learning method of instruction on the mathematics performance of elementary school students when compared with students who experienced instruction using a traditional instructional model.

Research Questions

A quasi-experimental study (non-randomized) was used to answer the following research and subsidiary questions.

Research Question

What is the impact of implementing a blended learning model of mathematics instruction on the mathematics achievement of elementary school students, as measured by the Spring 2018 Grade 6 and 7 PARCC mathematics assessment scores, when compared to the mathematics

achievement of Grades 6 and 7 students who received mathematics instruction using a traditional instructional model?

Subsidiary Question 1

How much variance in the Spring 2018 PARCC mean scale score can be explained by the predictor variables treatment, gender, race/ethnicity, and SES?

Subsidiary Question 2

Is there a statistically significant difference in the Spring 2018 Grades 6 and 7 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and the performance levels of students receiving instruction using a traditional model of instruction when controlling for gender, ethnicity/race, and SES (Economically Disadvantaged)?

Subsidiary Question 3

To what extent is there a difference in the performance of students who had a blended learning experience for one year as opposed to those who had the experience two years?

Null Hypotheses

$H1_0$: There was no statistically significant difference in the mean scores of elementary school students on the Spring 2018 PARCC mathematics assessment who are receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction.

$H2_0$: The predictor variables treatment, gender, ethnicity/race and SES (Economically Disadvantaged) do not account for any variation in the mean scaled scores on the Spring 2018 PARCC mathematics assessment of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction.

H3$_0$: There was no statistically significant difference in the Spring 2018 Grade 6 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction when controlling gender, ethnicity/race and SES (Economically Disadvantaged).

H4$_0$: There was no statistically significant difference in the performance on the PARCC mathematics assessment of students who are exposed to the blended learning model of instruction in mathematics for one year and those exposed for two years.

The study used the results from the state-mandated PARCC mathematics assessment to examine the student achievement outcomes of Grades 6 and 7 students across several demographic characteristics (e.g., race/ethnicity, gender, Economically Disadvantaged-SES). A quasi-experimental research design was employed, using 2016 performance data for grades 4 and 5 as the pre-test and 2018 performance data for grades 6 and 7 as the post-test data. To address subsidiary question 3, grade 2016 PARCC grade 4 performance data were used as the pre-treatment for PARCC grade 5 performance in 2017 (one year) and grade 6 (two years); PARCC 2016 grade 5 performance data were used as the pre-test for grade 6 (one year) and grade 7 (two years).

Analysis and Results

Sample

The student participants in grades 6 and 7 were students in a small Northeastern urban school District. The original treatment group consisted of eighty-seven (87) sixth graders and ninety-nine (99) seventh graders. The original control group consisted of two hundred and sixty-two (262) sixth graders and two hundred and sixty-three (263) seventh graders. Students who comprised the final sample were students who were enrolled during the 2015-2016 through the

2017-2018 school years. Students must also have valid PARCC mathematics score data from 2016, 2017 and 2018 Spring administrations of the PARCC mathematics assessment. Demographic information was collected via the school district's data management system and the State's publicly available information system (the school performance report) and utilized to eliminate students who did not meet these criteria. Tables 1 and 2 display the demographic information for the students included in the final sample.

Demographic Group	Category	# of Students	Percent
Race/Ethnicity			
Treatment	African American	30	35
	Hispanic	56	65
Control	African American	158	75
	Hispanic	53	25
Gender			
Treatment	Female	45	52.3
	Male	41	47.7
Control	Female	98	46.5
	Male	113	53.5
Economically Disadvantaged			
Treatment	Yes	74	86
	No	12	14
Control	Yes	153	72.5
	No	58	27.5

Table 3. Demographic Information for Treatment and Control Group for Grade 6

Demographic Group	Category	# of Students	Percent
Race/Ethnicity			
Treatment	African American	33	52
	Hispanic	30	48
Control	African American	117	67
	Hispanic	57	33
Gender			
Treatment	Male	33	52
	Female	30	48
Control	Male	86	49
	Female	88	51
Economically Disadvantaged			
Treatment	Yes	48	76
	No	15	24
Control	Yes	119	68
	No	15	32

Table 4. Demographic Information for Treatment and Control Group for Grade 7
(Total Control: n=211, Treatment: n=86)

A series of preliminary analyses utilizing Independent t-tests for equality of means were employed in the study to determine the comparability of the groups. The primary analyses, Repeated Measures ANOVA, multiple linear regression, ANCOVA and paired t-tests, were utilized to determine the effect of the independent variables (treatment, gender, economically disadvantaged, and race/ethnicity, SES) on the dependent variable, performance on the mathematics portion of the Grade 6 and 7 PARCC Assessment. One research question, three subsidiary questions, and their accompanying null hypotheses were analyzed and discussed. IBM's statistical analysis software, SPSS version 25.0 was utilized for data analysis. Differences

were reported only if the comparisons were statistically significant, where $p < 0.05$. Implications for theory, knowledge, practice, policy, and future research are discussed in Chapter V.

At the treatment level, Independent Samples t-tests (examining assumptions based on Equal Variances) were conducted to establish adequate comparability based on the Spring 2016 PARCC for grades 4 and 5. Pre-test scale scores, performance level and key demographics (race/ethnicity, gender, and economically disadvantaged (SES) between the treatment sample and the control sample were analyzed to ensure that "treatment status" did not give initial advantage to either group. In other words, this was to satisfy the assumption that the groups were homogeneous. The results of the preliminary analyses are discussed below.

Preliminary Analysis

For grade 6 there was no significant difference in the pre-test mean scale score of the Control group, traditional instructional model (M= 726.48, SD=28.046) and Treatment group, blended learning instructional model M=730.00, SD=24.861; $t(295)= -1.012$, $p = 0.312$ (two-tailed). The magnitude of the difference in the means (means difference = -3.52, 95% CI: -10.36 to 3.32) was very small (eta squared = .003). When comparing performance levels there was also no significant difference in the pre-test performance levels of the Control group, (M= 2.54, SD= 1.034) and the Treatment group M=2.65, SD=0.991; $t(295)= -0.848$, $p = 0.397$ (two-tailed). The magnitude of the difference in the means (means difference = -0.111, 95% CI: -0.368 to 0.146) was very small (eta squared = 0.002). In both instances, it can be concluded that there is no significant differences between the groups.

For grade 7 there was a significant difference in the pre-test mean scale score of the Control group, traditional instructional model (M= 725.32, SD=31.11) and Treatment group, blended learning instructional model M=735.44, SD=25.65; $t(235)= -2.313$, $p = 0.022$ (two-

tailed). The magnitude of the difference in the means (means difference = -10.123, 95% CI: -18.035 to -2.210) was small (eta squared = .02); the treatment explains only 2 percent of the variance in scale scores. When comparing performance levels, there was also a significant difference in the pre-test performance levels of the Control group, (M= 2.53, SD= 1.062) and the Treatment group M=2.89, SD=0.935; t(235)= -2.483, p = 0.014. The magnitude of the difference in the means (means difference = -0.354, 95% CI: -0.637 to -0.072) was very small (eta squared = .02); the treatment explains only 2 percent of the variance in scale scores. It can be concluded that there are significant differences between the groups.

Research Question

What is the impact of implementing a blended learning model of mathematics instruction on the mathematics achievement of elementary school students, as measured by the Spring 2018 Grade 6 and 7 grade mathematics assessment scores, when compared to the mathematics achievement of Grades 6 and 7 mathematics assessment scores of students who received mathematics instruction using a traditional instructional model?

Null Hypothesis 1

H1₀: There was no statistically significant difference in the mean scores of Elementary School students on the Spring 2018 PARCC mathematics assessment who are receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction.

Grade 6

A Repeated Measures ANOVA was conducted to compare mean scale scores on the PARCC mathematics assessment of students based on the instructional model. It was used to explore an assumed cause and effect relationship between the independent variable (treatment -

blended learning instructional model) and the dependent variable 2018 Spring PARCC mathematics scores. It was used to compare the mean scores of the students who received instruction in the blended learning instructional model and those who were instructed using the traditional model. The analyses included descriptive statistics, Box's Test of Equality of Covariance, Levene's Test of Equality of Error Variances, Tests within-subjects, and estimated marginal means results. Primary assumption testing was conducted to check for normality, linearity, homogeneity of variance-covariance matrices, and multicollinearity. An examination of the descriptive statistics showed that the treatment group (N=86) had a higher numerical mean (M=735) than the control group (N=211) (M=727.55). To test the assumption that the covariance matrices of the dependent variables were equal across all groups, a Box's Test of Equality of Variances was performed. Based on the results, $p > .001$, the assumption that the covariance for each group is equal is supported.

	Treatment	Mean	Std. Deviation	N
2016 TestScaleScore	Control	726.48	28.046	211
	Treatment	730.00	24.861	86
	Total	727.50	27.168	297
2018 TestScaleScore	Control	727.55	28.957	211
	Treatment	735.28	24.278	86
	Total	729.79	297	

Table 5. Descriptive Statistics for Control and Treatment Groups TestScaleScore 2016 and 2018 Grade 6

The results showed that there was a statistically significant difference between the control and treatment groups on the interaction effect, PARCC*Treatment $F (1, 295)= 3.93$, $p=0.048$; partial eta squared=0.01. The students' who were instructed using a blended learning

instructional model had a statistically significantly higher PARCC mathematics score than those who were instructed using a traditional instructional model. The profile plot also supports this. An inspection of the plot suggests that the effect of the treatment (blended learning instructional model) although significant, is relatively small.

The main effect, PARCC, was also statistically significant $F(1, 295) = 8.92$, $p=0.003$; partial eta squared=0.02. There was a statistically significant difference in scores on the PARCC regardless of exposure to blended learning or traditional models of instruction; students had statistically significantly higher PARCC mathematics scores on the 2018 assessment.

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
PARCC	Sphericity Assumed	1230.029	1	1230.029	8.922	0.003	0.029	8.922	0.845
	Greenhouse-Geisser	1230.029	1	1230.029	8.922	0.003	0.029	8.922	0.845
	Huynh-Feldt	1230.029	1	1230.029	8.922	0.003	0.029	8.922	0.845
	Lower-bound	1230.029	1	1230.029	8.922	0.003	0.029	8.922	0.845
PARCC * Treatment	Sphericity Assumed	542.15	1	542.15	3.932	0.048	0.013	3.932	0.507
	Greenhouse-Geisser	542.15	1	542.15	3.932	0.048	0.013	3.932	0.507
	Huynh-Feldt	542.15	1	542.15	3.932	0.048	0.013	3.932	0.507
	Lower-bound	542.15	1	542.15	3.932	0.048	0.013	3.932	0.507
Error (PARCC)	Sphericity Assumed	40672.187	295	137.872					
	Greenhouse-Geisser	40672.187	295	137.872					
	Huynh-Feldt	40672.187	295	137.872					
	Lower-bound	40672.187	295	137.872					

Table 6. Test Within Subjects Interaction Effect (PARCC*Treatment) and Main Effect (PARCC)

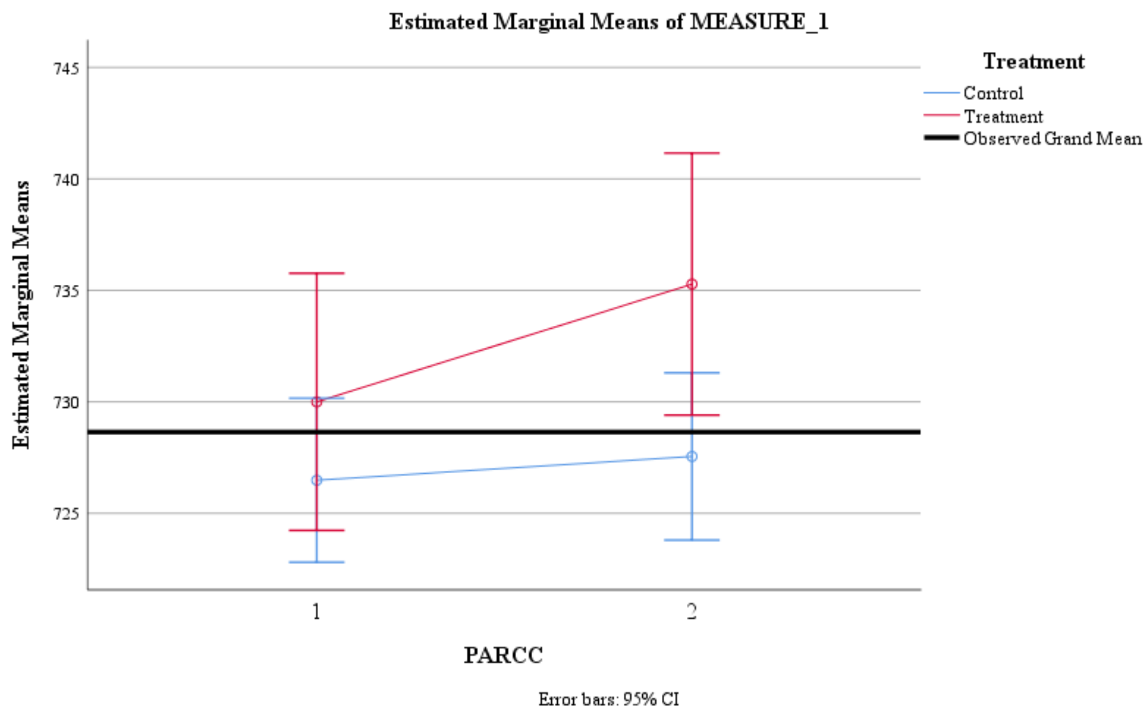

Figure 1. Estimated Marginal Means of Measure_1

Pairwise comparisons were conducted to determine which scores differed significantly from each other. The results indicate that with respect to treatment although students in the blended learning instruction group scored 5.623 points higher on the 2018 PARCC than the participants in the traditional instruction group, the difference was not statistically significant. Regarding the main effect, however, there was a statistically significant difference in the PARCC scores of students regardless of the instructional model. PARCC scores were 3.173 points higher in 2018 than in 2016.

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Control	Treatment	-5.623	3.345	0.094	-12.21	0.959
Treatment	Control	5.623	3.345	0.094	-0.959	12.21

Based on estimated marginal means
a. Adjustment for multiple comparisons: Least Significant Difference (equivalents to no adjustments.

Table 7. Pairwise Comparison of Estimated Marginal Means (Treatment)

(I) PARCC	(J) PARCC	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
2016	2018	-3.173*	1.062	0.003	-5.263	-1.082
2018	2016	3.173*	1.062	0.003	1.082	5.263

Based on estimated marginal means
* The mean is statistically significant at the .05 level.
a. Adjustment for multiple comparisons: Least Significant Difference (equivalents to no adjustments.

Table 8. Pairwise Comparison of Estimated Marginal Means (PARCC)

Grade 7

An examination of the descriptive statistics showed that the treatment group (N=63) had a higher numerical mean (M=745.89) than the control group (N=174) (M=733.04).

	Assigned Treatment	Mean	Std. Deviation	N
2016 TestScaleScore	Control	725.32	31.112	174
	Treatment	735.44	25.645	63
	Total	728.01	30.041	237
2018 TestScaleScore	Control	733.04	28.584	174
	Treatment	745.89	25.613	63
	Total	736.46	28.348	237

Table 9. Descriptive Statistics for Control and Treatment Groups TestScaleScore 2016 and 2018 Grade 7

A Repeated Measures ANOVA was performed to assess the impact of the instructional model on PARCC scores. The results showed that there was no statistically significant difference between the control and treatment groups on the interaction effect, PARCC*Treatment $F(1, 235) = 1.563$, $p=0.212$; partial eta squared=0.01. The students' who were instructed using a blended learning instructional model did not have statistically significantly higher PARCC mathematics scores than those who were instructed using a traditional instructional model. Regarding the main effect, PARCC, there was a statistically significant difference on the PARCC, $F(1, 235) = 69.40$, $p=0.000$; partial eta squared=0.228. There was a statistically significant difference in scores on the PARCC regardless of exposure to blended learning or traditional models of instruction; students had statistically significantly higher PARCC mathematics scores on the 2018 assessment. There were improvements in grade 7 2018 PARCC mathematics assessment scores in both the blended learning instructional group and the traditional learning instructional group.

	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PARCC	Sphericity Assumed	7629.195	1	7629.195	69.401	0.000	0.228
	Greenhouse-Geisser	7629.195	1	7629.195	69.401	0.000	0.228
	Huynh-Feldt	7629.195	1	7629.195	69.401	0.000	0.228
	Lower-bound	7629.195	1	7629.195	69.401	0	0.228
PARCC * Treatment	Sphericity Assumed	171.862	1	171.862	1.563	0.212	0.007
	Greenhouse-Geisser	171.862	1	171.862	1.563	0.212	0.007
	Huynh-Feldt	171.862	1	171.862	1.563	0.212	0.007
	Lower-bound	171.862	1	171.862	1.563	0.212	0.007
Error (PARCC)	Sphericity Assumed	25833.378	235	109.929			
	Greenhouse-Geisser	25833.378	235	109.929			
	Huynh-Feldt	25833.378	235	109.929			
	Lower-bound	25833.378	235	109.929			

a. Computed using alpha = 0.05

Table 10. Test Within Subjects Interaction Effect (PARCC*Treatment) and Main Effect (PARCC)

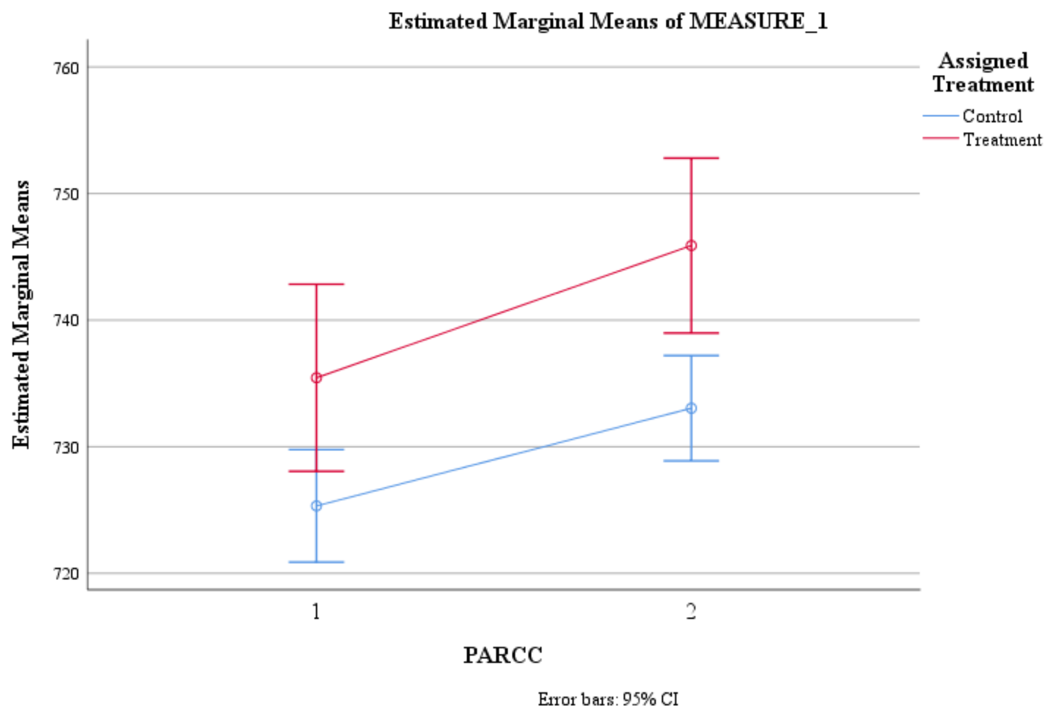

Figure 2. Estimated Marginal Means of Measure_1

Pairwise comparisons were conducted to determine which scores differed significantly from each other. The results indicate that with respect to treatment, students in the blended learning instruction group scored 11.486 points higher on the 2018 PARCC than the participants in the traditional instruction group, the difference was statistically significant. Regarding the main effect, there was also a statistically significant difference in the PARCC scores of students regardless of the instructional model. PARCC scores were 9.081 points higher in 2018 than in 2016 regardless of the instructional model; students, in general, scored 9.081 whether they were exposed to a blended learning instructional model or a traditional instructional model.

(I) PARCC	(J) PARCC	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
2016	2018	-9.081*	1.09	0	-11.229	-6.934
2018	2016	9.081*	1.09	0	6.934	11.229

Based on estimated marginal means
* The mean is statistically significant at the .05 level.
a. Adjustment for multiple comparisons: Least Significant Difference (equivalents to no adjustments.

Table 11. Pairwise Comparison of Estimated Marginal Means (PARCC)

Null Hypothesis 2

H2₀: The predictor variables treatment, gender, ethnicity/race and SES (Economically Disadvantaged) do not account for any variation in the mean scale scores on the Spring 2018 PARCC mathematics assessment of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction.

Correlation

The relationship between student performance as measured by 2018 PARCC mathematics scale scores and treatment as determined by exposure to a blended learning instructional model was investigated using the Pearson correlation coefficient; relationships between the student performance, race/ethnicity, gender, and economically disadvantaged status were also investigated. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity.

Grade 6

	Grade 6 2018 Test Scale Score
Treatment	0.126*
Gender	0.074
Race/Ethnicity (Hispanic)	-0.012
Race/Ethnicity (African American)	-0.014
Economically Disadvantaged (SES)	-0.054

Note: * -Statistically significant at level 0.05 (2-tailed)

Table 12. Correlation between PARCC Mathematics Scale Scores, Treatment, Gender, Race/Ethnicity, and Economically Disadvantaged (SES)

There were small positive correlations between treatment ($r = 0.126$, $n = 297$, $p < 0.05$) and gender ($r = 0.074$, $n = 297$, $p > .05$) on PARCC 2018 scale scores. Being exposed to a blended learning model of instruction and students' gender were associated with higher 2018 PARCC mathematics scores. There were small negative correlations between Race/ethnicity (Hispanic) ($r = -0.012$, $n=297$, $p > 0.05$), Race/ethnicity (African American) ($r = -0.014$, $n = 297$, $p > 0.05$) and Economically Disadvantaged Status ($r = -0.014$, $n=297$, $p > 0.05$). Race/ethnicity both Hispanic and African American and Economically Disadvantaged was associated with lower 2018 PARCC mathematics scale scores. The differences were not statistically significant.

A multiple linear regression was performed to predict PARCC 2018 scale mathematics scores based on treatment, gender, ethnicity/race, and Economically Disadvantaged status. The regression equation was not statistically significant ($F (5, 290) = 2.101$, $p > .05$) with an R

squared value of 0.035. The model showed a small proportion of variance in the 2018 PARCC mathematics performance (3.5%) was attributed to the combination of predictor variables treatment, gender, African American, Hispanic, and Economically Disadvantaged Status. Coefficient statistics revealed that the predictor variable treatment was the only variable within the model explaining a statistically significant proportion of variance in performance (Beta = 0.144 (explaining 2.1% of variance), $t(296) = 2.29$, $p<0.05$. The covariates gender, race/ethnicity, and Economically Disadvantaged Status were not significant predictors of performance in this model.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.187[a]	0.035	0.018	27.637	2.015

a. Predictors: (Constant), Economic Disadvantage Status, Gender, Hispanic or Latino, Treatment, Black or African American
b. Dependent Variable: 2018 MathTestScaleScore

Table 13. Model Summary of Linear Multiple Regression Model (Treatment, Gender, Hispanic, African American and Economic Disadvantaged Status)

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	8022.691	5	1604.538	2.101	0.065[b]
	Residual	221497.468	290	763.784		
	Total	229520.159	295			

a. Dependent Variable: 2018 MathTestScaleScore

b. Predictors: (Constant), Economic Disadvantage Status, Gender, Hispanic or Latino, Treatment, Black or African American

Table 14. ANOVA of Linear Multiple Regression Model (Treatment, Gender, Hispanic, African American and Economic Disadvantage Status)

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	747.73	13.498		55.4	0					
Treatment	8.808	3.846	0.144	2.29	0.023	0.125	0.133	0.132	0.846	1.181
Gender	3.741	3.221	0.067	1.162	0.246	0.073	0.068	0.067	0.996	1.004
Hispanic or Latino	-19.329	12.506	-0.336	-1.55	0.123	-0.009	-0.09	-0.089	0.07	14.205
Black or African American	-17.044	12.689	-0.295	-1.34	0.18	-0.014	-0.079	-0.077	0.069	14.461
Economic Disadvantage Status	-5.448	3.87	-0.083	-1.41	0.16	-0.059	-0.082	-0.081	0.964	1.037

a. Dependent Variable: 2018 MathTestScaleScore

Table 15. Coefficient Statistics of Linear Multiple Regression Model (Treatment, Gender, Hispanic, African American and Economic Disadvantage Status)

Grade 7

	Grade 7 2018 Test Scale Score
Treatment	0.201*
Gender	0.101
Race/Ethnicity (Hispanic)	0.170**
Race/Ethnicity (African American)	-0.170**
Economically Disadvantaged (SES)	-0.001

Note: * -Statistically significant at level 0.05 (2-tailed)
**- Statistically significant at level 0.01 (2-tailed)

Table 16. Correlation between PARCC Mathematics Scale Scores, Treatment, Gender, Race/Ethnicity, and Economically Disadvantage Status (SES)

There were small positive correlations between gender ($r = 0.101$, $n= 237$, $p < 0.05$) and Race/ethnicity (Hispanic) ($r = 0.170$, $n= 237$, $p < .05$) and PARCC 2018 scale scores. Students' gender and race/ethnicity (Hispanic) were associated with higher 2018 PARCC mathematics scores. There were small negative correlations between Race/ethnicity (African American) ($r = -0.170$, $n=235$, $p < 0.05$) and Economic Disadvantage Status ($r = -0.001$, $n=235$, $p > 0.05$). Race/ethnicity (African American) and Economic Disadvantage Status were associated with lower 2018 PARCC mathematics scale scores.

A multiple linear regression was calculated to predict PARCC 2018 scale mathematics scores based on treatment, gender, ethnicity/race, and economically disadvantaged status. The

results revealed that there were no significant predictors of PARCC 2018 scaled scores given the predictor of treatment, race/ethnicity, gender, and economically disadvantaged status. The model showed a small proportion of variance in the 2018 PARCC mathematics performance (7.4%) was attributed to the combination of predictor variables treatment, gender, African American, and Economic Disadvantage Status with an ($F (4, 236) = 4.642$, $p < .05$) with an R squared value of 0.074. Coefficient statistics revealed that the predictor variable treatment and African American variables within the model explained a statistically significant proportion of variance in performance; regarding treatment (Beta = 0.180) (explaining 3.2% of variance), $t(232) = 2.80$, $p<0.05$, for African American (Beta = - 0.159) (explaining 2.5% of variance), $t(232) = - 2.361$, $p<0.05$. When it was calculated replacing the predictor variable African American with Hispanics (to address collinearity concerns), the model did not change. Coefficient statistics revealed that the predictor variables treatment and Hispanic explained a statistically significant proportion of variance in performance; regarding treatment (Beta = 0.180) (explaining 3.2% of variance), $t(232) = 2.80$, $p<0.05$, for Hispanics (Beta = 0.159) (explaining 2.5% of variance), $t(232) = - 2.361$, $p<0.05$. The variables gender and Economic Disadvantage Status were not significant predictors of performance in this model.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.272[a]	0.074	0.058	27.512	1.81

Coefficients[a]
a. Predictors: (Constant), Economic Disadvantage Status, Gender, Assigned Treatment, African American
b. Dependent Variable: 2018 TestScaleScore

Table 17. Model Summary of Linear Multiple Regression Model- Treatment, Gender, African American and Economic Disadvantaged Status

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14052.92	4	3513.229	4.642	0.001[b]
	Residual	175599.9	232	756.896		
	Total	189652.8	236			

a. Dependent Variable: 2018 TestScaleScore
b. Predictors: (Constant), EconomicDisadvantageStatus, Gender, Assigned Treatment, African American

Table 18. ANOVA of Linear Multiple Regression Model (Treatment, Gender, African American and Economic Disadvantage Status)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	738.926	5.204		141.98	0
	Assigned Treatment	11.518	4.113	0.18	2.8	0.006
	Gender	6.108	3.576	0.108	1.708	0.089
	African American Ethnicity	-9.289	3.934	-0.159	-2.361	0.019
	Economic Disadvantage Status	-3.99	4.13	-0.064	-0.966	0.335

Coefficients[a]

Table 19. Coefficient Statistics of Linear Multiple Regression Model (Treatment, Gender, African American and Economic Disadvantage Status

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	729.636	3.878		188.169	0
	Assigned Treatment	11.518	4.113	0.18	2.8	0.006
	Gender	6.108	3.576	0.108	1.708	0.089
	Hispanic Ethnicity	9.289	3.934	0.159	2.361	0.019
	EconomicDisadvantageStatus	-3.99	4.13	-0.064	-0.966	0.335

Table 20. Coefficient Statistics of Linear Multiple Regression Model (Treatment, Gender, Hispanic and Economic Disadvantaged Status)

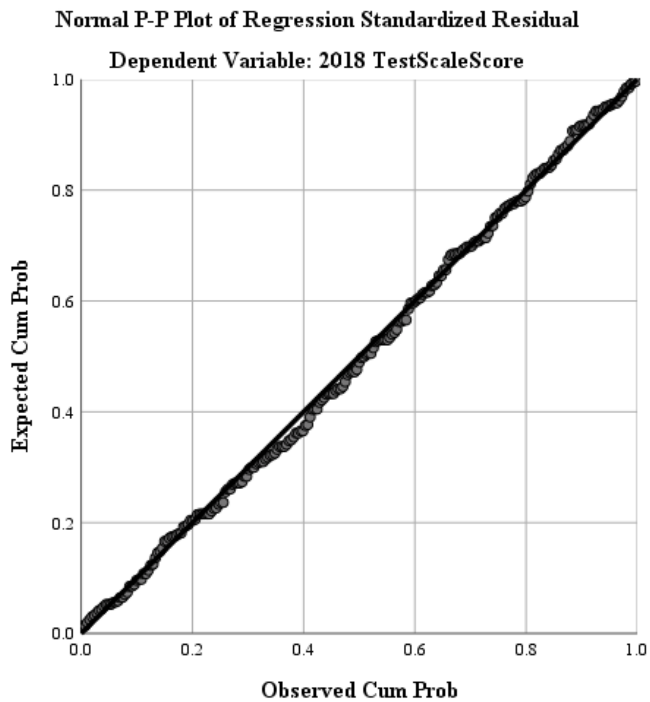

Figure 3. Normal P-P Plot of Regression

Null Hypothesis 3

H3$_0$: There was no statistically significant difference in the Spring 2018 Grade 6 PARCC mathematics assessment performance levels of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction when controlling gender, ethnicity/race and SES (Economically Disadvantaged). Performance levels differentiate students' attainment levels on the PARCC. Students are assigned levels based on scores ranging from 650 to 850 points. Level 1(Did not yet meet expectations), Level 2 (Partially met expectations), Level 3 (Approached expectations), Level 4 (Met expectations), and Level 5 (Exceeded expectations).

One-way between-subjects analyses of covariance were conducted to compare the performance levels on the 2018 PARCC of the control and treatment groups. The independent variables were the instructional models (blended learning, traditional instructional model), and the dependent variable was performance levels on the 2018 PARCC mathematics assessment. Gender, race/ethnicity, and Economic Disadvantaged Status were used as the covariates in this analysis. Preliminary checks were conducted to ensure that the assumptions of normality, linearity, homogeneity of variance, homogeneity of regression slopes, and the reliable measurement of the covariate. All assumptions were satisfied in all instances except for gender, where the homogeneity of variance was not satisfied.

Grade 6

The mean performance levels of the treatment (N= 86) was 2.87 (SD = 0.96); the mean performance levels of the control (N= 211) was 2.62 (SD = 1.06).

Treatment	Mean	Std. Deviation	N
Control (Traditional Instructional Model)	2.62	1.06	211
Treatment (Blended learning Model)	2.87	0.955	86
Total	2.69	1.036	297

Table 21. Descriptive Statistics of ANCOVA-Test Performance Level Dependent Variable 2018 Test Performance Level

Gender

Results indicated that there were no significant differences between the control and treatment groups on the 2018 PARCC performance levels, (F (1, 294) = 3.60, p = 0.059, partial eta squared = 0.012.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4.553[a]	2	2.277	2.139	0.12	0.014
Intercept	987.509	1	987.509	927.718	0	0.759
Sex	0.55	1	0.55	0.517	0.473	0.002
Treatment	3.835	1	3.835	3.603	0.059	0.012
Error	312.948	294	1.064			
Total	2467	297				
Corrected Total	317.502	296				

Table 22. Test Between Subjects Effects ANCOVA-Test Performance Level Controlling Gender
Dependent Variable: 2018 TestPerformanceLevel

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Traditional Instructional Model)	2.618[a]	0.071	2.478	2.757
Treatment (Blended learning Model)	2.868[a]	0.111	2.649	3.088

a. Covariates appearing in the model are evaluated at the following values: Gender = 0.48.

Table 23. Estimated Marginal Means of ANCOVA- Treatment, Controlling for Gender
Dependent Variable: 2018 TestPerformanceLevel

Race and Ethnicity (Hispanics)

Results indicated that there were significant differences between the control and treatment groups on the 2018 PARCC performance levels f (F (1, 294) = 5.187, p = 0.023 partial eta squared = 0.017.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5.765[a]	2	2.883	2.719	0.068	0.018
Intercept	1054.468	1	1054.468	994.474	0	0.772
Hispanic Ethnicity	1.762	1	1.762	1.662	0.198	0.006
Treatment	5.5	1	5.5	5.187	0.023	0.017
Error	311.736	294	1.06			
Total	2467	297				
Corrected Total	317.502	296				

Table 24. Tests Between-Subjects Effects ANCOVA-TestPerformance Level, Controlling Hispanic
Dependent Variable: 2018 TestPerformanceLevel

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Traditional Instructional Model)	2.597[a]	0.072	2.455	2.74
Treatment (Blended learning Model)	2.919[a]	0.117	2.689	3.149

a. Covariates appearing in the model are eval
following values: Hispanic = 0.38.

Table 25. Estimated Marginal Means of ANCOVA- Treatment, Controlling for Hispanic
Dependent Variable: 2018 TestPerformanceLevel

Race and Ethnicity (African Americans)

The results of this analysis indicated that there were significant differences between the control and treatment groups on the 2018 PARCC performance levels (F (1, 294) = 4.243, p = 0.040 partial eta squared = 0.014.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4.526[a]	2	2.263	2.122	0.122	0.014
Intercept	780.358	1	780.358	731.67	0	0.714
Black or African American	0.619	1	0.619	0.581	0.447	0.002
Treatment	4.526	1	4.526	4.243	0.04	0.014
Error	312.497	293	1.067			
Total	2463	296				
Corrected Total	317.024	295				

a. R Squared = 0.014 (Adjusted R Squared = 0.008)

Table 26. Tests of Between-Subjects Effects ANCOVA-TestPerformance Level, Controlling for African American
Dependent Variable: 2018 TestPerformanceLevel

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Traditional Instructional Model)	2.607[a]	0.073	2.463	2.751
Treatment (Blended learning Model)	2.902[a]	0.118	2.67	3.133

Table 27. Estimated Marginal Means of ANCOVA- Treatment, Controlling for African American
Dependent Variable: 2018 TestPerformanceLevel

Economically Disadvantaged Status

The results of this analysis indicated that there were no significant differences between the control and treatment groups on the 2018 PARCC performance levels for (F (1, 294) = 4.293, p = 0.297 partial eta squared = 0.014.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5.165[a]	2	2.582	2.431	0.09	0.016
Intercept	509.118	1	509.118	479.229	0	0.62
Economic Disadvantage Status	1.162	1	1.162	1.093	0.297	0.004
Treatment	4.561	1	4.561	4.293	0.039	0.014
Error	312.337	294	1.062			
Total	2467	297				
Corrected Total	317.502	296				

a. R Squared = 0.016 (Adjusted R Squared = 0.010)

Table 28. Tests of Between-Subjects Effects ANCOVA-TestPerformance Level, Controlling for Economic Disadvantage Status
Dependent Variable: 2018 TestPerformanceLevel

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Traditional Instructional Model)	2.610[a]	0.071	2.47	2.75
Treatment (Blended learning Model)	2.886[a]	0.112	2.666	3.107

Table 29. Estimated Marginal Means of ANCOVA- Treatment, Controlling for Economic Disadvantage Status
Dependent Variable: 2018 TestPerformanceLevel

Grade 7

The mean performance levels of the treatment (N= 63) was 3.29 (SD = 0.91); the mean performance levels of the control (N= 174) was 2.77 (SD = 1.05).

Assigned Treatment	Mean	Std. Deviation	N
Control (Traditional Instructional Model)	2.77	1.05	174
Treatment (Blended Learning Model)	3.29	0.906	63
Total	2.91	1.037	237

Table 30. Descriptive Statistics of ANCOVA-TestPerformance Level

Gender

Results indicated that there were significant differences between the control and treatment groups on the 2018 PARCC performance levels, (F (1, 234) = 12.376, p = 0.001, partial eta squared = 0.05.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	15.447[a]	2	7.723	7.577	0.001	0.061
Intercept	896.475	1	896.475	879.52	0	0.79
Sex	3.151	1	3.151	3.091	0.08	0.013
Treatment	12.615	1	12.615	12.376	0.001	0.05
Error	238.511	234	1.019			
Total	2257	237				
Corrected Total	253.958	236				

a. R Squared = 0.061 (Adjusted R Squared = 0.053)

Table 31. Tests of Between-Subjects Effects ANCOVA-Test Performance Level, Controlling Gender
Dependent Variable: 2018 TestPerformanceLevel

Assigned Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Traditional Instructional Model)	2.768[a]	0.077	2.617	2.919
Treatment (Blended learning Model)	3.291[a]	0.127	3.04	3.541

Covariates appearing in the model are evaluated at the following values: Gender = 0.50.

Table 32. Estimated Marginal Means of ANCOVA- Treatment, Controlling for Gender
Dependent Variable: 2018 TestPerformanceLevel

Race and Ethnicity (Hispanics)

Results indicated that there were significant differences between the control and treatment groups on the 2018 PARCC performance levels f (F (1, 234) = 9.680, p = 0.002 partial eta squared = 0.040.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	15.269[a]	2	7.634	7.484	0.001	0.06
Intercept	978.908	1	978.908	959.678	0	0.804
Hispanic	2.973	1	2.973	2.914	0.089	0.012
Treatment	9.874	1	9.874	9.68	0.002	0.04
Error	238.689	234	1.02			
Total	2257	237				
Corrected Total	253.958	236				

a. R Squared = 0.060 (Adjusted R Squared = 0.052)

Table 33. Tests of Between-Subjects Effects ANCOVA-Test Performance Level, Controlling Hispanic
Dependent Variable: 2018 TestPerformanceLevel

Assigned Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Traditional Instructional Model)	2.782[a]	0.077	2.631	2.934
Treatment (Blended learning Model)	3.252[a]	0.129	2.998	3.506

a. Covariates appearing in the model are evaluated at the following values: Hispanic = 0.38.

Table 34. Estimated Marginal Means of ANCOVA- Treatment, Controlling for Hispanic
Dependent Variable: 2018 TestPerformanceLevel

Race and Ethnicity (African Americans)

The results of this analysis indicated that there were no significant differences between the control and treatment groups on the 2018 PARCC performance levels (F (1, 233) = 1.492, p = 0.223 partial eta squared = 0.006.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	15.269[a]	2	7.634	7.484	0.001	0.06
Intercept	869.133	1	869.133	852.059	0	0.785
Black Or African American	2.973	1	2.973	2.914	0.089	0.012
Treatment	9.874	1	9.874	9.68	0.002	0.04
Error	238.689	234	1.02			
Total	2257	237				
Corrected Total	253.958	236				
Corrected Total	253.958	236				

a. R Squared = 0.060 (Adjusted R Squared = 0.052)

Table 35. Tests of Between-Subjects Effects ANCOVA-TestPerformance Level, Controlling African American
Dependent Variable: 2018 TestPerformanceLevel

Assigned Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Traditional Instructional Model)	2.782[a]	0.077	2.631	2.934
Treatment (Blended learning Model)	3.252[a]	0.129	2.998	3.506

a. Covariates appearing in the model are evaluated at the following values: AfricanAmerican = 0.62

Table 36. Tests of Between-Subjects Effects ANCOVA-Test Performance Level, Controlling Economic Disadvantage Status
Dependent Variable: 2018 TestPerformanceLevel

Economically Disadvantaged Status

The results of this analysis indicated that there were significant differences between the control and treatment groups on the 2018 PARCC performance levels for ($F(1, 234) = 11.940$, $p = 0.001$ partial eta squared = 0.049.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12.334[a]	2	6.167	5.972	0.003	0.049
Intercept	578.422	1	578.422	560.17	0	0.705
EconomicDisadvantageStatus	0.038	1	0.038	0.036	0.849	0
Treatment	12.329	1	12.329	11.94	0.001	0.049
Error	241.624	234	1.033			
Total	2257	237				
Corrected Total	253.958	236				

a. R Squared = 0.049 (Adjusted R Squared = 0.040)

Table 37. Tests of Between-Subjects Effects ANCOVA-TestPerformance Level, Controlling Economic Disadvantage Status
Dependent Variable: 2018 TestPerformanceLevel

Assigned Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Traditional Instructional Model)	2.770[a]	0.077	2.618	2.921
Treatment (Blended learning Model)	3.287[a]	0.128	3.035	3.54

a. Covariates appearing in the model are evaluated at the following values: EconomicDisadvantageStatus = 0.70.

Table 38. Estimated Marginal Means of ANCOVA- Treatment, Controlling for Economically Disadvantaged Status
Dependent Variable: 2018 TestPerformanceLevel

Null Hypothesis 4

$H4_0$: There was no statistically significant difference in the performance on the PARCC Mathematics assessment of students who are exposed to the blended learning model of instruction in mathematics for one year and those exposed for two years.

Grade 4 to 5 to 6

A Repeated Measures ANOVA and paired t-tests were conducted to compare scores on PARCC mathematics assessment of students based on the instructional model for one year. Descriptive statistics, Box's Test of Equality of Covariance, Levene's Test of Equality of Error Variances, Tests within-subjects, and estimated marginal means results are shown in tables 39 to 42. Primary assumption testing was conducted to check for normality, linearity, homogeneity of variance-covariance matrices, and multicollinearity. An examination of the descriptive statistics showed that the treatment group (N=86) had a higher numerical mean (M=729.44) after one year of exposure to a blended learning instructional model than the control group (N=209) (M=697.62). For exposure for two years, the treatment group (N=86) also had a higher numerical mean (M=735.28) than the control group (N=209) (M=727.44). To test the assumption that the covariance matrices of the dependent variables were equal across all groups, Box's Test of Equality of Variances was performed. Based on the results, $p < .001$, the assumption that the covariance for each group is equal is not supported.

	Treatment	Mean	Std. Deviation	N
2016 TestScaleScore	Control	726.62	28.144	209
	Treatment	730	24.861	86
	Total	727.6	27.229	295
2017 TestScaleScore	Control	697.62	150.251	209
	Treatment	729.44	23.574	86
	Total	706.89	127.837	295
2018 TestScaleScore	Control	727.65	29.074	209
	Treatment	735.28	24.278	86
	Total	729.87	27.938	295

Table 39. Descriptive Statistics for Control and Treatment Groups TestScaleScore 2016, 2017 and 2018 Grade 4 to 5 to 6

A Repeated Measures ANOVA was performed to assess the impact of the instructional model on PARCC scores. It indicated that there was no statistically significant difference between the control and treatment groups on the interaction effect, PARCC*Treatment F (1.026, 586)= 2.636, p=0.105; partial eta squared=0.009. The students' who were instructed using a blended learning instructional model did not have a statistically significantly higher PARCC mathematics score than those who were instructed using a traditional instructional model. Regarding the main effect performance, there was a statistically significant difference in scores on the PARCC regardless of exposure to blended learning or traditional models of instruction, F (1.026, 586)= 4.107, p=0.043; partial eta squared=0.014.

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
PARCC	Sphericity Assumed	44677.793	2	22338.897	4.107	0.017	0.014
	Greenhouse-Geisser	44677.793	1.026	43553.37	4.107	0.043	0.014
	Huynh-Feldt	44677.793	1.03	43393.432	4.107	0.042	0.014
	Lower-bound	44677.793	1	44677.793	4.107	0.044	0.014
PARCC * Treatment	Sphericity Assumed	28681.906	2	14340.953	2.636	0.072	0.009
	Greenhouse-Geisser	28681.906	1.026	27960.058	2.636	0.105	0.009
	Huynh-Feldt	28681.906	1.03	27857.382	2.636	0.105	0.009
	Lower-bound	28681.906	1	28681.906	2.636	0.106	0.009
Error (PARCC)	Sphericity Assumed	3187657.963	586	5439.689			
	Greenhouse-Geisser	3187657.963	300.564	10605.573			
	Huynh-Feldt	3187657.963	301.672	10566.627			
	Lower-bound	3187657.963	293	10879.379			

Table 40. Test Within Subjects Interaction Effect (PARCC*Treatment) and Main Effect (PARCC)

Pairwise comparisons were conducted to determine which scores differed significantly from each other. The results indicated that with respect to treatment students in the blended learning group scored 14.280 points higher on the 2018 PARCC than the students in the control group.; the difference was statistically significant.

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Control	Treatment	-14.280*	6.109	0.02	-26.303	-2.258
Treatment	Control	14.280*	6.109	0.02	2.258	26.303

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalents to no adjustments.
b. * The mean is statistically significant at the .05 level

Table 41. Pairwise Comparison of Estimated Marginal Means (Treatment)

An inspection of the profile plot suggests that the effect of the treatment (blended learning instructional model) although statistically significant, is relatively small.

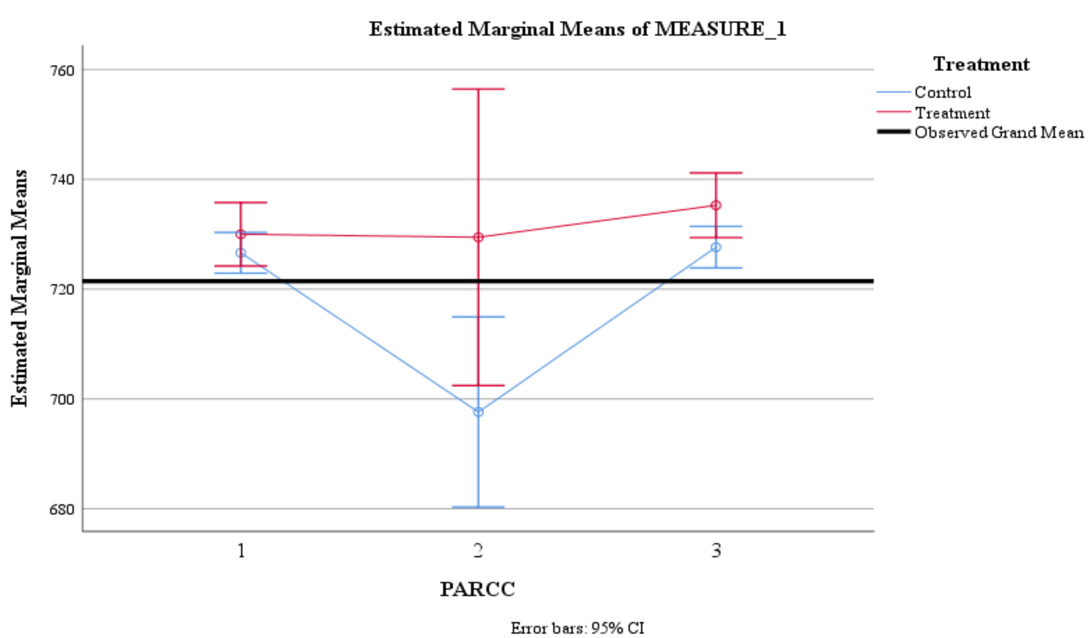

Figure 4. Profile Plot of Estimated Marginal Means for TestScale Score for 2016 to 2017 to 2018

Regarding the main effect PARCC, regardless of the instructional model, there was not a statistically significant difference in mean scale scores from 2016 to 2017; mean scale scores were 14.779 higher in 2016 than in 2017. From 2016 to 2018, there was a statistically significant difference in the mean scale scores; they were 3.154 higher in 2018 than in 2016. This suggests that students on average performed significantly better after two years in the blended learning instructional model than after one year.

(I) PARCC	(J) PARCC	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
2016	2017	14.779	8.161	0.071	-1.283	30.841
	2018	-3.154*	1.067	0.003	-5.254	-1.054
2017	2016	-14.779	8.161	0.071	-30.841	1.283
	2018	-17.933*	8.135	0.028	-33.943	-1.923
2018	2016	3.154*	1.067	0.003	1.054	5.254
	2017	17.933*	8.135	0.028	1.923	33.943

Based on estimated marginal means
* The mean is statistically significant at the .05 level.
a. Adjustment for multiple comparisons: Least Significant Difference (equivalents to no adjustments.

Table 42. Pairwise Comparison of Estimated Marginal Means (PARCC)

A paired-samples t-test was conducted to evaluate the impact of the blended learning model of instruction on students' PARCC mathematics scale score from 2016 to 2017 to 2018. For the control group there was a statistically significant decrease in PARCC mathematics scale scores from 2016 (M= 726.62, SD =28.144) to 2017 (M= 697. 62, SD= 150.251), t (208) =

2.777, $p < 0.05$ (two-tailed). The mean decrease in PARCC scale scores was 29 points with a 95% confidence interval ranging from 8.414 to 49.586. The eta squared statistic (.04) indicated a small effect size. For the period 2017 to 2018 there was a statistically significant increase in PARCC mathematics scale scores for 2017 (M= 697.62, SD =150.251) to 2018 (M= 727.65, SD= 29.074), $t(208) = -2.886$, $p < 0.05$ (two-tailed). The mean increase in PARCC scale scores was 30.029 points with a 95% confidence interval ranging from -50.542 to -9.515. The eta squared statistic (0.04) indicated a small effect size.

For the treatment group, there was not a statistically significant decrease in PARCC mathematics scale scores from 2016 (M= 730.00, SD =24.861) to 2017 (M= 729.44, SD= 23.574), $t(86) = 0.374$, $p > 0.05$ (two tailed). The mean decrease in PARCC scale scores was 0.558 points with a 95% confidence interval ranging from 8.414 to 49.586. The eta squared statistic (.00) indicated no effect size. For the period 2017 to 2018 there was a statistically significant increase in PARCC mathematics scale scores for 2017 (M=729.44 , SD =23.574) to 2018 (M= 735.28, SD= 24.278), $t(208) = -3.646$, $p < 0.05$ (two tailed). The mean increase in PARCC scale scores was 5.837 with a 95% confidence interval ranging from -2.406 to -9.020. The eta squared statistic (.06) indicated a moderate effect size.

Grade 5 to 6 to 7

An examination of the descriptive statistics showed that the treatment group (N=63) had a higher numerical average (M=730.56) after one year of exposure to a blended learning instructional model than the control group (N=174) (M=725.97). For exposure for two years, the treatment group (N=63) also had a higher numerical average (M=745.89) than the control group (N=174) (M=733.04). To test the assumption that the covariance matrices of the dependent variables were equal across all groups, Box's Test of Equality of Variances was performed.

Based on the results, p < .001, the assumption that the covariance for each group is equal is not supported.

	Assigned Treatment	Mean	Std. Deviation	N
2016 TestScaleScore	Control	725.32	31.112	174
	Treatment	735.44	25.645	63
	Total	728.01	30.041	237
2017 TestScaleScore	Control	725.97	31.094	174
	Treatment	730.56	27.311	63
	Total	727.19	30.147	237
2018 TestScaleScore	Control	733.04	28.584	174
	Treatment	745.89	25.613	63
	Total	736.46	28.348	237

Table 43. Descriptive Statistics for Control and Treatment Groups TestScaleScore 2016, 2017 and 2018 Grade 5 to 6 to 7

A Repeated Measures ANOVA was performed to assess the impact of the instructional model on PARCC scores. It indicated a statistically significant difference between the control and treatment groups on the interaction effect, PARCC*Treatment F (2, 820.254)= 6.805, p=0.000; partial eta squared=0.028. The students' who were instructed using a blended learning instructional model did not have a statistically significantly higher PARCC mathematics score than those who were instructed using a traditional instructional model.

Regarding the main effect performance, there was also a statistically significant difference in scores on the PARCC regardless of exposure to blended learning or traditional models of instruction, F (1, 470)= 54.347, p=0.000; partial eta squared=0.188.

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PARCC	Sphericity Assumed	13100.818	2	6550.409	54.343	0.000	0.188
	Greenhouse-Geisser	13100.818	1.98	6616.278	54.343	0.000	0.188
	Huynh-Feldt	13100.818	2	6550.409	54.343	0.000	0.188
	Lower-bound	13100.818	1	13100.818	54.343	0.000	0.188
PARCC * Treatment	Sphericity Assumed	1640.508	2	820.254	6.805	0.001	0.028
	Greenhouse-Geisser	1640.508	1.98	828.502	6.805	0.001	0.028
	Huynh-Feldt	1640.508	2	820.254	6.805	0.001	0.028
	Lower-bound	1640.508	1	1640.508	6.805	0.01	0.028
Error (PARCC)	Sphericity Assumed	56652.589	470	120.537			
	Greenhouse-Geisser	56652.589	465.32	121.75			
	Huynh-Feldt	56652.589	470	120.537			
	Lower-bound	56652.589	235	241.075			

Table 44. Test Within Subjects Interaction Effect (PARCC*Treatment) and Main Effect (PARCC)

Pairwise comparisons were conducted to determine which scores differed significantly from each other when comparing the treatment to the control group. The results indicated that with respect to treatment students in the blended learning group scored 9.185 points higher on

the 2018 PARCC than the students in the control group.; the difference was statistically significant.

(I) Assigned Treatment	(J) Assigned Treatment	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	95% Confidence Interval for Difference
					Lower Bound	Upper Bound
Control	Treatment	-9.185*	4.096	0.026	-17.255	-1.115
Treatment	Control	9.185*	4.096	0.026	1.115	17.255

Based on estimated marginal means
a. Adjustment for multiple comparisons: Least Significant Difference (equivalents to no adjustments.
b. * The mean is statistically significant at the .05 level

Table 45. Pairwise Comparison of Estimated Marginal Means (Treatment)

An inspection of the profile plot suggests that the effect of the treatment (blended learning instructional model) although statistically significant, is relatively small.

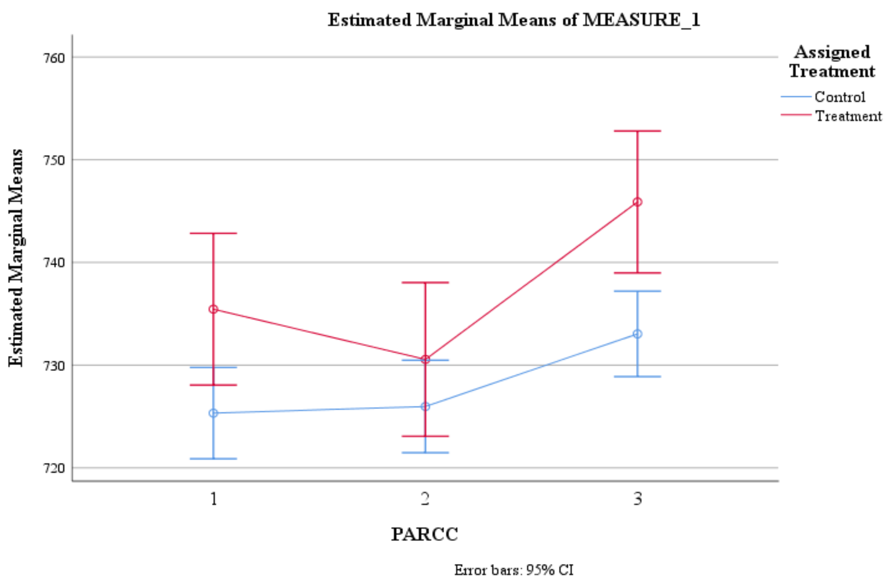

Figure 5. Estimated Marginal Means of Measure_1

Regarding the main effect PARCC, regardless of the instructional model, there was not a statistically significant difference in mean scale scores from 2016 to 2017; mean scale scores were 2.120 points higher in 2016 than in 2017. From 2016 to 2018, there was a statistically significant difference in the mean scale scores; they were 9.081 points higher in 2018 than in 2016. This suggests that students on average performed significantly better after two years in the blended learning instructional model than after one year.

(I) PARCC	(J) PARCC	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
2016	2017	2.12	1.189	0.076	-0.223	4.463
	2018	-9.081*	1.09	0	-11.229	-6.934
2017	2016	-2.12	1.189	0.076	-4.463	0.223
	2018	-11.201*	1.143	0	-13.453	-8.95
2018	2016	9.081*	1.09	0	6.934	11.229
	2017	11.201*	1.143	0	8.95	13.453

Based on estimated marginal means

* The mean is statistically significant at the .05 level.
a. Adjustment for multiple comparisons: Least Significant Difference (equivalents to no adjustments.

Table 46. Pairwise Comparison of Estimated Marginal Means (PARCC)

A paired-samples t-test was conducted to evaluate the impact of the blended learning model of instruction on students' PARCC mathematics scale score from 2016 to 2017 to 2018. For the control group there was no statistically significant increase in PARCC mathematics scale scores from 2016 (M= 725.32, SD = 31.112) to 2017 (M= 725.97, SD= 31.094), t (173) = 1.773 , p> 0.05(two-tailed). The mean decrease in PARCC scale scores was 0.65 points with a 95% confidence interval ranging from -3.072 to 0.597. The eta squared statistic (.02) indicated a small effect size. For the period 2017 to 2018 there was a statistically significant increase in PARCC mathematics scale scores for 2017 (M= 725.97, SD =2.357) to 2018 (M= 733.04, SD= 2.167), t (173) = 2.167 , p< 0.05(two-tailed). The mean increase in PARCC scale scores was 7.07 points with a 95% confidence interval ranging from -9.451 to -4.687. The eta squared statistic (.03) indicated a small effect size.

For the treatment group, there was a statistically significant decrease in PARCC mathematics scale scores from 2016 (M= 735.44, SD =3.231) to 2017 (M= 730.56, SD=3.441), t (62) = 2.403 , p> 0.05(two-tailed). The mean decrease in PARCC scale scores was 4.88 points with a 95% confidence interval ranging from 0.822 to 8.956. The eta squared statistic (0.09) indicated a small effect size. For the period 2017 to 2018 there was a statistically significant increase in PARCC mathematics scale scores for 2017 (M=730.56 , SD =3.441) to 2018 (M= 745.87, SD= 3.227), t (63) = -8.423 , p< 0.05 (two-tailed). The mean increase in PARCC scale scores was 15.33, with a 95% confidence interval ranging from -18.972 to -11.694. The eta squared statistic (0.53) indicated a large effect size.

Review of the Findings

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

Research Question

What is the impact of implementing a blended learning model of mathematics instruction on the mathematics achievement of elementary school students, as measured by the Spring 2018 Grades 6 and 7 mathematics assessment scores, when compared to the mathematics achievement of Grades 6 and 7 students who received mathematics instruction using a traditional instructional model?

Null Hypothesis 1

$H1_0$: There was no statistically significant difference in the mean scores of Elementary School students on the Spring 2018 PARCC Mathematics assessment who are receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional

model of instruction.

Grade 6

A Repeated Measures ANOVA was performed to assess the impact of the instructional model on PARCC scores. There was a statistically significant difference between the control and treatment groups F (1, 295)= 3.93, p=0.048; partial eta squared=0.01. Students who were instructed using a blended learning instructional model had a statistically significantly higher 2018 PARCC mathematics scale score that those who were instructed using a traditional instructional model. There was also a statistically significant difference in scale scores on the 2018 PARCC F (1, 295)= 8.92, p=0.003; partial eta squared=0.02. Regardless of exposure to blended learning or traditional models of instruction. Students had statistically significantly higher 2018 PARCC mathematics scale scores from 2016 to 2018. Regardless of the instructional model, scale scores in 2018 were 3.173 points higher than in 2016.

When examining the average scale scores on the 2018 PARCC mathematics assessment, there was no statistically significant difference in the average PARCC scores between the treatment (blended learning) and the control group (traditional instructional model) F (1, 295)= 2.826, p=0.094; partial eta squared=0.009. The average score for those receiving instruction using the blended learning instructional model was 732.64 and 727.017 for those receiving instruction using the traditional instructional model. Although the effect of the treatment (blended learning instructional model) was significant, it was relatively small. The null hypothesis was rejected.

Grade 7

There was no statistically significant difference between the control and treatment groups F (1, 235)= 1.563, p=0.212; partial eta squared=0.01. The students who were instructed using a

blended learning instructional model did not have a statistically significantly higher PARCC mathematics score than those who were instructed using a traditional instructional model. However, there was a statistically significant difference in scores on the PARCC regardless of exposure to blended learning or traditional models of instruction, $F(1, 295) = 69.40$, $p=0.000$; partial eta squared=0.228. Students had statistically significantly higher PARCC mathematics scores from 2016 to 2018. Regardless of the instructional model, scores in 2018 were 11.486 points higher than in 2016.

There was a statistically significant difference in the average PARCC scores between the treatment (blended learning) and the control group (traditional instructional model) $F(1, 235) = 7.870$, $p=0.005$; partial eta squared=0.032. The average score for those receiving instruction using the blended learning instructional model was 740.667 and 729.181 for those receiving instruction using the traditional instructional model. However, the effect of the treatment (blended learning instructional model) although significant, is relatively small. Fail to reject the null hypothesis.

Subsidiary Question 1

How much variance in the Spring 2018 PARCC mean scale score can be explained by the predictor variables treatment, gender, race/ethnicity, and SES?

Null Hypothesis 2

$H2_0$: The predictor variables treatment, gender, ethnicity/race and SES (Economically Disadvantaged) do not account for any variation in the mean scaled scores on the Spring 2018 PARCC mathematics assessment of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction.

A multiple linear regression was calculated to predict PARCC 2018 scale mathematics scores based on treatment, gender, ethnicity/race, and economically disadvantaged status. For grade 6 the results revealed that there were no significant predictors of PARCC 2018 scaled scores given the predictor of treatment, race/ethnicity, gender, and economically disadvantaged status. The model showed that 3.5% of the variance in the 2018 PARCC mathematics performance was attributed to the combination of predictor variables treatment, gender, African American, Hispanic and Economic Disadvantage Status with an ($F (5, 290) = 2.101$, $p > .05$) with an eta squared of 0.035. Coefficient statistics revealed that the predictor variable treatment was the only variable within the model explaining a statistically significant proportion of variance in performance (explaining 2.1% of variance). The variables gender, race/ethnicity, and Economically Disadvantaged Status were not significant predictors of performance in this model. Reject the null hypothesis for treatment; fail to reject the null hypothesis for gender ethnicity/race and Economic Disadvantage Status.

Grade 7

There were no significant predictors of PARCC 2018 scaled scores given the predictor of treatment, race/ethnicity, gender, and Economic Disadvantage Status. The model showed that 7.4% of the variance in the 2018 PARCC mathematics performance was attributed to the combination of predictor variables treatment, gender, African American, and Economic Disadvantage Status with an ($F (4, 236) = 4.642$, $p < .05$) with an eta squared of 0.074. Coefficient statistics revealed that the predictor variable treatment, Hispanic and African American variables within the model explained a statistically significant proportion of variance in performance; regarding treatment 3.2% of variance, $t(232) = 2.80$, $p<0.05$, for African American 2.5% of variance and Hispanic 3.2% of variance were attributed to the 2018 PARCC

scale scores. The variables gender and Economic Disadvantage Status were not significant predictors of performance in this model. Reject the null hypothesis for treatment, Hispanic and African American; fail to reject for gender and Economic Disadvantage Status.

Subsidiary Question 2

Is there a statistically significant difference in the Spring 2018 Grades 6 and 7 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and the performance levels of students receiving instruction using a traditional model of instruction when controlling for gender, ethnicity/race, and SES (Economic Disadvantage Status)?

Null Hypothesis 3

H30: There was no statistically significant difference in the Spring 2018 Grade 6 PARCC mathematics assessment performance levels of students receiving mathematics instruction using a blended learning model and students receiving instruction using a traditional model of instruction when controlling gender, ethnicity/race and SES (Economic Disadvantage Status).

An ANCOVA was conducted to compare the performance levels on the 2018 PARCC of the control and treatment groups. The independent variables were the instructional models (blended learning, traditional instructional model), and the dependent variable was performance levels on the 2018 PARCC mathematics assessment. Gender, race/ethnicity, and economically disadvantaged status were used as the covariates in these analyses.

Grade 6

For the covariate gender, there were no statistically significant differences between the control and treatment groups on the 2018 PARCC performance levels, (F (1, 294) = 3.60, p = 0.059, partial eta squared = 0.012. For all other covariates, Hispanics (F (1, 294) = 5.187, p =

0.023 partial eta squared = 0.017, African Americans (F (1, 294) = 4.243, p = 0.040 partial eta squared = 0.014 and Economically Disadvantaged Status F (1, 294) = 4.293, p = 0.039 partial eta squared = 0.014 there were statistically significant differences between the control and treatment groups on the 2018 PARCC performance levels.

Grade 7

For the covariates Gender (F (1, 234) = 12.376, p = 0.001, partial eta squared = 0.05, Hispanics (F (1, 234) = 9.680, p = 0.002 partial eta squared = 0.040, and Economic Disadvantage Status F (1, 234) = 11.940, p = 0.001 partial eta squared = 0.049 there were significant differences between the control and treatment groups on the 2018 PARCC performance levels. For African Americans there were no significant differences between the control and treatment groups on the 2018 PARCC performance levels F (1, 233) = 1.492, p = 0.223 partial eta squared = 0.006. The null hypothesis was rejected for gender, Hispanics and Economic Disadvantage Status.

Subsidiary Question 3

To what extent is there a difference in the performance of students who had a blended learning experience for one year as opposed to those who had the experience two years?

Null Hypothesis 4

H40: There was no statistically significant difference in the performance on the PARCC Mathematics assessment of students who are exposed to the blended learning model of instruction in mathematics for one year and those exposed for two years.

Grade 6

A Repeated Measures ANOVA and paired t-tests were conducted to compare scores on PARCC mathematics assessment of students based on the instructional model. There was no

statistically significant difference between the control and treatment groups on the interaction effect, F (1.026, 586)= 2.636, p=0.105; partial eta squared=0.009 but a statistically significant difference on the main effect, PARCC, F (1.026, 586)= 4.107, p=0.043; partial eta squared=0.014. The students' who were instructed using a blended learning instructional model did not have a statistically significantly higher PARCC mathematics score than those who were instructed using a traditional instructional model. Regarding the main effect performance, there was a statistically significant difference in scores on the PARCC regardless of exposure to blended learning or traditional models of instruction, F (1.026, 586)= 4.107, p=0.043; partial eta squared=0.014.

Students had statistically significantly lower PARCC mathematics scores from 2016 to 2017 and statistically significant higher scores from 2017 to 2018. Regardless of the instructional model, scores were 14.779 lower in 2017 than in 2016, 3.154 higher in 2018 than in 2016, and 17.933 higher in 2018 than in 2017.

There was no statistically significant difference in the average PARCC scores between the treatment (blended learning) and the control group (traditional instructional model) F (1, 293)= 5.465, p=0.020; partial eta squared=0.018. The average score for those receiving instruction using the blended learning instructional model was 731.574 and 717.293 for those receiving instruction using the traditional instructional model. Although the effect of the treatment (blended learning instructional model) was statistically significant, it was relatively small.

A paired-samples t-test was conducted to evaluate the impact of the blended learning model of instruction on students' PARCC mathematics scale score from 2016 to 2017 to 2018. For the control group there was a statistically significant decrease in PARCC mathematics scale

scores from 2016 (M= 726.62, SD =28.144) to 2017 (M= 697. 62, SD= 150.251), t (208) = 2.777, p< 0.05(two-tailed). The mean decrease in PARCC scale scores was 29 points. For the period 2017 to 2018 there was a statistically significant increase in PARCC mathematics scale scores from 2017 (M= 697.62, SD =150.251) to 2018 (M= 727.65, SD= 29.074), t (208) = -2.886 , p< 0.05 (two-tailed). The mean increase in PARCC scale scores was 30.029. In both instances, the effect size was small.

For the treatment group, there was not a statistically significant decrease in PARCC mathematics scale scores from 2016 (M= 730.00, SD =24.861) to 2017 (M= 729.44, SD= 23.574), t (86) = 0.374 , p> 0.05 (two-tailed). The mean decrease in PARCC scale scores was 0.558 points For the period 2017 to 2018 there was a statistically significant increase in PARCC mathematics scale scores for 2017 (M=729.44 , SD =23.574) to 2018 (M= 735.28, SD= 24.278), t (208) = -3.646 , p< 0.05 (two-tailed). The mean increase in PARCC scale scores was 5.837. From 2016 to 2017 the effect size was small, but from 2017 to 2018 there was a moderate effect size.

Grade 7

There was a statistically significant difference between the control and treatment groups F (2, 470)= 6.805, p=0.000; partial eta squared=0.188 and a statistically significant difference on PARCC, F (1, 470)= 54.347, p=0.000; partial eta squared=0.188. The students' who were instructed using a blended learning instructional model had a statistically significantly higher PARCC mathematics scale score that those who were instructed using a traditional instructional model. There was a statistically significant difference in scores on the PARCC regardless of exposure to blended learning or traditional models of instruction, F (1, 470)= 54.347, p=0.000; partial eta squared=0.188. Students had statistically significantly higher PARCC mathematics

scores from 2017 to 2018 (after two years of being exposed to a blended learning instructional model). Regardless of the instructional model, scores were 2.120 points higher in 2016 than in 2017, 9.081 points higher in 2018 than in 2016, and 11.201 points higher than in 2018 than in 2017.

There was a statistically significant difference in the average PARCC scores between the treatment (blended learning) and the control group (traditional instructional model) $F (1, 235)= 5.028$, $p=0.026$; partial eta squared=0.021. The average score for those receiving instruction using the blended learning instructional model was 737.296 and 728.111 for those receiving instruction using the traditional instructional model. The effect of the treatment (blended learning instructional model) was significant.

The results of the paired samples t-test indicated that for the control group there was no statistically significant increase in PARCC mathematics scale scores from 2016 (M= 725.32, SD = 31.112) to 2017 (M= 725.97, SD= 31.094), $t (173) = 1.773$, $p> 0.05$ (two-tailed). The mean decrease in PARCC scale scores was 0.65 points. For the period 2017 to 2018 there was a statistically significant increase in PARCC mathematics scale scores for 2017 (M= 725.97, SD =2.357) to 2018 (M= 733.04, SD= 2.167), $t (173) = 2.167$, $p< 0.05$ (two-tailed). The mean increase in PARCC scale scores was 7.07 points. The effect size was small.

For the treatment group, there was a statistically significant decrease in PARCC mathematics scale scores from 2016 (M= 735.44, SD =3.231) to 2017 (M= 730.56, SD=3.441), $t (62) = 2.403$, $p> 0.05$ (two-tailed). The mean decrease in PARCC scale scores was 4.88 points with a 95% confidence interval ranging from 0.822 to 8.956. The effect size was small. For the period 2017 to 2018 there was a statistically significant increase in PARCC mathematics scale scores for 2017 (M=730.56 , SD =3.441) to 2018 (M= 745.87, SD= 3.227), $t (63) = -8.423$, p<

0.05 (two-tailed). The mean increase in PARCC scale scores was 15.33. The effect size was large.

CHAPTER 5: SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The primary purpose of this study was to determine the impact of a blended learning instructional model on the performance of elementary school students in grades 5, 6, and 7 on the PARCC mathematics assessment. The study took place in a small Northeastern urban public school district. The state identified the district as a Factor Group A district based on socio-economic status. Two cohorts of participants were identified: cohorts grade 4 to grade 6 and grade 5 to grade 7 for the years 2016 to 2018. The treatment group was students who received instruction using a blended learning model, while the control group was students who received mathematics instruction using a traditional model. Participants were identified as those students in each cohort who remained at their school for their fourth, fifth and sixth-grade years for cohort grade 4 to grade 6; for cohort grade 5 to grade 7, students remained at their school for grades five, six and seven. Additionally, each participant must have taken the PARCC mathematics assessment for each of the years that they remained at the school.

The treatment sample was students who were receiving mathematics instruction using a blended learning model, for grade 4 to 6 cohort consisted of 86 students; there were 211 students in the sample for the control group (students who received instruction using a traditional model). For grade 5 to 7, the cohort consisted of 63 students; there were 174 students in the sample for the control group, students who received instruction using a traditional model.

This study employed a quasi-experimental research design, using post hoc pre- and post-test data from 2016, 2017, and 2018 administrations of the PARCC mathematics assessment. Multiple analyses were utilized to determine the comparability of the groups and control for

initial differences, then to determine if exposure to a blended learning instructional model is related to differences in performance on the PARCC mathematics assessment for grades 5, 6 and 7 students when compared to students who received their mathematics instruction using a traditional instructional model. The research was guided by one overarching research question and three subsidiary questions. All primary analyses and their findings are reported in aggregate at the treatment level. The findings, conclusions, and perspective implications for theory, knowledge, practice, policy, and future research are discussed in this chapter.

Connections to Previous Research

To address the continuing educational gap and need to transform the educational system, the United States Department of Education through its National Educational Technology Plan, Transforming American Education: Learning Powered by Technology, put forward the notion of using technology to provide engaging and meaningful learning experiences and content for all students. According to the USDOE, Technology-based Learning opportunities would be pivotal to the improvement in student learning …." (USDOE, 2010). The plan stressed the need to utilize technology to provide all learners with engaging and empowering learning experiences. Blended learning is not a new concept to education, however, its implementation in the Elementary school setting and its effectiveness in addressing student achievement is not well documented. Most of the literature on blended learning has focused on higher learning institutions, as was discussed by Oliver and Stallings (2014). Based on their study, three studies were found to support that blended learning at least provided students with an equal learning opportunity while eight studies indicated that being exposed to a blended learning model of instruction produced better mathematics achievement results. Of the 114 studies and articles referenced in their article, only a total of 12 had a K-12 focus (Chaney, 2016). There is,

therefore, scare empirical data that address blended learning in the K-12 setting and more so blended learning's impact on student performance. This study was intended as part of the growing conversation on blended learning in the K-12 setting and its effectiveness as a model for mathematics instruction in elementary school classrooms when compared with traditional classroom instruction.

Summary of Findings

The research question examined the impact of implementing a blended learning model of mathematics instruction on the mathematics achievement of elementary school students, as measured by the Spring 2018 Grades 5, 6 and 7 mathematics assessment scores, when compared to the mathematics achievement of Grades 5, 6 and 7 students who received mathematics instruction using a traditional instructional model. An analysis found that the results differed by cohort. For the grade 4 to 6 cohort, there was a statistically significant difference in the PARCC scale score between treatment and control groups; the treatment group's improvement on PARCC scores was significantly higher than the control group. The difference in the mean scores was not statistically significant. For the grade 5 to 7 cohort, there was no statistically significant difference in the scale scores of the treatment group and control group, but there was a statistically significant difference in the mean score. The treatment group's PARCC scores were higher. Overall, it was found that there was a statistically significant difference in scale scores, on the 2018 PARCC mathematics assessment, regardless of the instructional model. It can be concluded that although the results were mixed and PARCC scores increased regardless of the instructional model, students in the treatment group had higher PARCC mathematics scores than those in the control group.

The first subsidiary question investigated how much variance in the Spring 2018 PARCC mean scale score can be explained by the predictor variables treatment, gender, race/ethnicity, and SES. Using a multiple linear regression to predict PARCC 2018 scale mathematics scores based on treatment, gender, ethnicity/race and economically disadvantaged status it was found that the regression model was not significant predictor of PARCC 2018 scaled scores given the predictor of treatment, race/ethnicity, gender and Economic Disadvantage Status for either cohort. For grade 4 to 6 cohort however, the coefficient treatment within the model explained a statistically significant proportion of variance in performance (explaining 2.1% of variance). For the grade 5 to 7 cohort the regression model was statistically significant. Within the model the predictor variables treatment, Hispanic and African American were found to explain a statistically significant proportion of variance in performance (treatment 3.2%, African American 2.5%, and Hispanic 3.2%). An examination of these results reveals that although treatment explained a statistically significant proportion in performance, the proportion was extremely small. The same can be said of race/ethnicity when looking at African Americans and Hispanics for cohort grade 5 to grade 7.

The second subsidiary question addressed if there is a statistically significant difference in the Spring 2018 Grades 6 and 7 PARCC mathematics assessment performance level of students receiving mathematics instruction using a blended learning model and the performance levels of students receiving instruction using a traditional model of instruction when controlling for gender, ethnicity/race, and SES (Economic Disadvantage Status). An ANCOVA was conducted to compare the performance levels on the 2018 PARCC of the control and treatment groups. Analyses revealed mixed results based on the cohort. For the grade 4 to 6 cohort, there were statistically significant differences in performance levels on the 2018 PARCC mathematics

assessment between the treatment and control groups for the covariates, Hispanics, African Americans, and Economic Disadvantage Status. With reference to gender there was no statistically significant difference in performance levels. For the grade 5 to 7 cohort for the covariates Gender, Hispanics and Economic Disadvantage Status, there were statistically significant differences between the treatment and control groups on the 2018 PARCC performance levels. Regarding African Americans, there were no significant differences between the control and treatment groups on the 2018 PARCC performance levels.

The third subsidiary question examined to what extent there is a difference in the performance of students who had a blended learning experience for one year as opposed to those who had the experience two years. Based on RM ANOVA and paired t-tests analyses of the comparison between the scale scores on PARCC mathematics assessment of students based the instructional model, there was no statistically significant difference between the control and treatment groups on the interaction effect (treatment) but a statistically significant difference on the main effect (PARCC) for grades 4 to 5 to 6; the same results were found for grades 5 to 6 to 7. Results of paired- samples t-tests (used to evaluate the impact of the blended learning model of instruction on students' PARCC mathematics scale score from 2016-2017-2018) revealed that for the control group there was a statistically significant difference in PARCC mathematics scale scores from 2016 to 2017 to 2018. For the treatment group, the results were mixed. There was a statistically significant difference from 2017 to 2018 but not from 2016 to 2017.

When examining the results for the grade 5 to 6 to 7 cohort, there was a statistically significant difference between the control and treatment groups and on the main effect PARCC. The results of the paired samples t-tests revealed that for the control group there was no statistically significant difference in PARCC mathematics scale scores from 2016 to 2017, but

there was a statistically significant difference in PARCC mathematics scale scores for 2017 to 2018. For the treatment group, there was a statistically significant difference in PARCC mathematics scale scores from 2016 to 2017 and for 2017 to 2018. Based on the analyses, it can be suggested that the blended learning instructional model had more of an impact after two years. For both cohorts, there were statistically significantly higher scores for the treatment group from 2017 to 2018. The results were mixed after one year of treatment.

Implications

This study contributes to the literature on the impact of utilizing a blended learning instructional model in mathematics on student performance for students in an elementary school setting. The findings could have important implications for educators at the national, state, district, school, and classroom levels. An examination of the results of this study can support decisions on teaching and learning as it relates to impacting student performance in mathematics. The results were mixed. The study showed that the students who received instruction using a blended learning instructional model had statistically significantly higher PARCC scores than their peers who received instruction using a traditional instructional model for students in the grade 4 to 6 cohort. For students in grade 5 to 7 cohort, although both groups were shown to have higher PARCC scores regardless of the instructional model, the treatment group scores were overall higher than the control group. The findings did not provide consistent evidence to support the effectiveness of blended learning implementation in improving students' mathematics scores.

The literature supporting the integration of technology as an innovative addition to teaching and learning referenced the trends towards blended learning. The North American Council for Online Learning noted that the blended learning model would become the most

predominant model of education in K-12 education (Means et al., 2013). This idea is supported by Barbour, Archambault, and DiPietro (2013), who found that blended learning has experienced the most significant growth of any educational model currently being implemented in K-12 education.

When examining the impact of blended learning on student performance, online education has been found to be underperforming when compared to traditional education (Miron & Urschel, 2012). The implementation of a blended model in a K-12 environment has been found to provide the support and face-to-face interaction that have been associated with enhanced student achievement (Schorr & McGriff, 2011). While this study's scope is narrow, it contributes to the existing literature as the findings may be relevant to schools with similar demographics. The overall findings of this study indicate that blended learning instructional model may be a viable alternative to a traditional instructional model as it relates to mathematics instruction in an elementary school setting.

Recommendations for Policy and Practice

There were no conclusive findings that favored a blended learning model of instruction as opposed to the traditional instructional model. The results varied based on grade level and length of time utilizing the instructional model. Whereas the blended learning model was utilized only from 2016 to 2018, the traditional model was utilized previously by both the treatment and control groups. Even if there was conclusive data to support one instructional model over the other, this is but one study, confined to a small urban district in one state in one country. It added to the conversation on the need to explore alternatives to the traditional methods of teaching. As there continues to be concern over achievement gaps in education, those who are charged with creating and enacting policy must examine all viable options for improving student outcomes. As

is evidenced by NCLB and, its more recent counterpart, RTTP, calls for the prioritization of funding around state efforts to address the achievement gaps between high- and low-performing students, minority and nonminority students, and disadvantaged students and their more advantaged peers has intensified.

Recommendations for Policy

The increase in demand for K-12 blended learning opportunities for students is coupled with the need for educators who can effectively teach in this new context. Researchers have recently discussed the importance of infusing blended teaching into pre-service experiences (Archambault, DeBruler, & Friedhoff, 2014). Others have stressed the importance of modeling blended teaching principles in pre-service teachers' methods courses (Shand & Glassett Farrelly, 2017). At the federal level, there needs to be incentives for States to invest in teacher training programs aimed at equipping teachers' use of technology in the classrooms. These programs must be a part of any new teacher preparedness program.

In order for educator preparation programs, districts, and schools to conduct effective professional development for future blended teachers, the unique competencies of blended teaching need to be identified (Graham, Borup, Pulham, & Larsen, 2017). This can be addressed at the federal level but can also be addressed at the State level. This is to facilitate a consistent message of what blended learning is and what it is not. Perhaps guidelines can be given to the states, where state needs can be assessed and adjustments made based on those needs. This will allow districts, teacher preparedness institutions, and teachers to be able to identify and assess teacher readiness and diagnose the knowledge and skill base needed to have the greatest impact on student achievement.

Districts must allow schools the autonomy to utilize those guidelines to adopt programming based on the schools' needs as assessed by school-level data. One size does not fit all. Many districts set mandatory programs, curriculum, means of delivery, and resources to be utilized by all schools in the district. An examination of district level data often shows schools that excel, those that cope and those that are struggling. Affording schools the option to utilize innovative methods to address the needs of their students can have a positive impact on student performance. Leaders at all levels who are interested in transforming the education system through blended learning must create autonomous spaces where they can encourage innovative modelling within the context of outlined regulatory standards.

In response to the former Secretary of Education, Arne Duncan's statement on the funding shortfalls, blended learning may reduce the per-student cost of education by allowing for an increase in the number of students per teacher (Kenney & Newcombe, 2011). For example, this can be accomplished using a blended learning model that divides the class into groups: one receiving direct instruction while another is participating in online learning. Another could be involved in independent work, and another could be working as a team. This would allow for larger class sizes while the physical size of the group receiving direct instruction, at any given time, would be smaller, all based on the needs and preferences of the learner.

Recommendations for Practice

Famed educator John Dewey in his critique of the educational systems of his era, noted that there was a need for educators to adopt new instructional approaches based on future societal needs. He stated that schools in the 20th century should reorganize their curricula, stress freedom and individuality, and respond to the changing demands of the workforce. Dewey noted that "if we teach today's as we taught yesterday's, we rob them of tomorrow" (Dewey, 1915). As

we examine the current resources available to students, teachers, parents, and educators, on the whole, there are a plethora of electronic tools available to support the learner. Attempting to teach generations Y and Z students as generations of students have been taught previously can prove counterproductive. Classrooms must, therefore, be re-invented to adjust for these technologic changes. Students must be allowed to function in a manner that addresses their individual needs; learning has to be personalized. Students must be allowed to learn at their own pace. This necessitates a change in the role of the teacher, the use of real-time data, tracked using technology, and an examination and adoption of new models of instruction made possible by the wave of new digital technologies.

In this paper, I examined one of these new models of instruction which is facilitated by the use of digital technology. Blended learning is one example of how schools and districts are attempting to address the need for a change in the way instruction is delivered. The literature on innovations in educations highlights several such examples. For instance, the New York City School of One outlines a model where a team-teaching model targets individual students creating an individualized daily playlist with a variety of instructional activities geared to their needs- including time with a teacher, an online tutorial, a video game, or various types of electronic resources. Student progress is tracked electronically, and students move to the next level when they have demonstrated appropriate skill mastery. In this current educational climate, there should be no model representing one size fits all.

Recommendations for Future Study

This study contributes to the conversation on blended learning at the K-12 level, specifically at the elementary level. The following are suggested topics for future research.

Recommendation 1

Current seventh, eighth, ninth, and tenth-grade students within the small Northeastern urban public school district were the fourth, fifth, sixth, and seventh who were the participants in this study. Standardized assessment data for these grades, in addition to other meaningful indicators of performance, can be used to make longitudinal comparisons to determine the differential effects of treatment over multiple years. Future research could replicate the current study to measure student mathematics achievement on a longitudinal basis.

Recommendation 2

This study utilized PARCC performance data to show how two instructional models impacted student performance. The PARCC assessments were replaced by the NJSLA in 2019 as the standardized assessment utilized to determine if students meet the requirements of the federal Elementary and Secondary Education Act. The NJSLA assessments are intended to be consistent with the rigors of the PARCC as a measure of students' problem solving, communication, and reasoning skills. Using the 2018-2019 PARCC assessment as the dependent measure, future research could extend the current study, using the same intact groups to measure their mathematics performance. This can be used to determine any lasting effects of being in a blended learning instructional model.

Recommendation 3

One focus of this study was the time students were exposed to a blended learning instructional model. It was found that there were statistically significant differences in performance for students in grades 4 to 6. Although not statistically significant for grades 5 to 7, the students showed that students who were exposed to blended learning had higher PARCC

scores than those in the traditional instruction model. Future research can examine if differences were based on grade level or age of participants.

Recommendation 4

As District Factor Groupings are closely tied to socio-economic status (a variable typically found to be a significant predictor of student performance), future research could expand the current study to include other schools/districts in the same district factor groupings that are utilizing a blended instructional approach to mathematics instruction. This would increase the sample size, thereby achieving greater degrees of statistical power (Cohen, 1988).

Recommendation 5

This study did not differentiate between student classifications based on language or learning challenges or disabilities. Students in both the treatment and control groups were a mixture of general education, students with disabilities, and English Language Learners. After establishing adequate comparability of the treatment groups, future research could replicate the current study to include special classifications of students which were not addressed in this study.

Recommendation 6

One of the underlying tenets of blended learning is that of student ownership of their own learning. Connected to that is the notion that students' learning styles, specific needs, and preferences are critical to the successful implementation of blended learning models. Future studies should be conducted about the relationship between blended learning for at-risk students or high performing students and their relationship to their academic performance.

Recommendation 7

This study did not address teacher practice as a factor that could influence student outcomes. Another study could be used to investigate best practices and pedagogy in teaching K-12 students in blended learning environments. As more schools plan to adopt blended learning models, research and development efforts should consider the supports teachers and students need to more effectively benefit from blended learning environments (Blended Learning Report, 2014).

Recommendation 8

Additional research could involve an investigation of an effective professional development curriculum on blended learning for K-12 teachers. In their study *K-12 Blended Teaching Readiness*, Graham, Borup, Pullam, and Larsen (2017) noted that they were unable to find any existing studies which examined pre-service teacher preparation for blended classrooms. They noted that only limited case studies examining blended learning professional development for in-service teachers (Acree, Gibson, Mangum, Wolf, Kellogg, & Branon, 2017). There is a need to identify blended teaching competencies, diagnose teacher readiness, and provide targeted professional development for blended teaching will strengthen outcomes for teachers and their students in blended learning classrooms (Graham, Borup, Pullam, & Larsen, 2017).

Recommendation 9

Future studies could address the self-directedness of the K-12 learner, especially those in the elementary school setting. Post-secondary studies on blended learning have found that in addition to improvements in student achievement, there was an increase in student satisfaction (Laumakis et al., 2009). Additionally, there were signs that it may also increase learner self-directedness (Herman & Banister, 2007), which has been found to positively influence student

achievement (Fakolade & Adeniyi, 2010). According to Oliver and Stallings (2014), blended learning has been associated with increasing student literacy skills, time management, independent work skills, and increased motivation. These could all be the focus of future studies.

Summary

Chapter 1 of this research study outlined the impetus for finding more innovative instructional methods to address the achievement gap that has plagued the United States for decades. It outlined current U.S. reform policies and efforts designed to encourage states to address gaps in achievement as it relates to students across the United States. This study examined one of the more recent attempts at providing students with an alternative to the traditional instructional method of classroom instruction. Chapter I included the purpose of the study, statement of the problem, research question and subsidiary questions, research hypotheses, the significance of the study, research design, limitations and delimitations of the study, and definitions of the relevant terms.

Chapter 2 contained a review of the relevant literature, outlining the quest for educational reforms in general as it relates to mathematics learning and performance, an examination of the history behind blended learning, early research trends, factors which affect mathematics performance and the impact of blended learning instructional methods on student achievement. It concludes with an examination of the theoretical framework which supports the notion of a blended learning instructional model in mathematics.

Chapter 3 presented the setting for the study, treatment, participants, subsidiary research questions and their accompanying null hypotheses, research design, data collection, instrumentation, instrument reliability and validity, procedures, and methods of data analysis.

Chapter 4 presented the results and findings of this study. Multiple data analyses were conducted, and the results were reported and summarized to answer the research question, three subsidiary questions, and test the accompanying hypotheses. Results were reported using statistical significance and effect sizes. Commentary summarizing the findings can be found in chapter 4.

Chapter 5 presented the findings, conclusions, potential implications for practice, policy, and future research.

Concluding Thoughts

More research is needed in order to answer questions surrounding whether blended learning works, who it benefits and under what conditions is it most effective. Regardless of the core research questions being investigated, future studies would benefit from examining the underlying constructs which define the instructional and pedagogical aspects of both blended and traditional learning environments, so that findings can be linked to specific instructional practices and conditions. This can then be utilized to address student learning and teachers' instructional practices with the sole purpose of improvement.

In this digital age, blended learning is poised to become a catalyst in the education of students in the K-12 setting. It allows for the redesign of the educational/instructional model based on the instruction that allows each student to work at his/her own pace and helps each child feel and be successful at school. Utilizing technology, blended-learning models supports student learning by allowing flexibility in learning modalities and timely and frequent feedback on performance and needs. As teachers, schools, and Districts receive student achievement data in real-time, there can be a focus on personalizing learning and support for students. This

necessitates that schools move away from the monolithic instruction of batches of students toward a modular, student-centric approach (Christiansen, Horn, & Johnson, 2008).

According to the Blended Learning Research Clearinghouse 1.0 (2015), individualized instruction is difficult to implement, scale, or sustain in traditional classrooms, but can be facilitated by blended learning. This study indicated effect sizes of small to large when examining the effect of blended learning on performance, with the largest effect size related to grades 5 to 7 after two years of being engaged in the blended learning model. Studies have shown that since blended learning allows for the teachers to work with small groups at a time based on need, the group size and providing instruction that is direct, explicit, and closely aligned with students' students' needs and prior knowledge has been shown to have effect sizes ranging from 0.65 (Hattie, 2003) to as high as 2.0 (Bloom, 1984). Blended learning appears to offer a viable alternative to the traditional instructional model as it relates to mathematics instruction in the setting outlined in this study.

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Appendices

Appendix A: Letter to District

[redacted]

November 15, 2018

[redacted] Interim Superintendent of the [redacted] Public Schools,

I am writing to request permission to conduct a research study in the [redacted] Public School. I am currently enrolled at Seton Hall University as a Doctoral Candidate in their Executive K-12 School Administration program. I am in the process of writing my dissertation entitled, *The impact of a Blended Learning Instructional Model on the Mathematics performance of Elementary School students.*

In the school year 2015-2016, your District was one where there was mathematics instruction using both a blended learning model and a traditional model. My research study will determine the impact, if any, on the PARCC scores of students who had instruction in the Blended Learning model of instruction. I will be utilizing the 2016 PARCC scores in Mathematics for students in grades 3-5 and the 2018 PARCC scores in Mathematics for students in grades 5-7. No staff will be involved in the research project.

In order to conduct this research, I will need to granted access to anonymous PARCC test data, coded with only student identification numbers. There will be no interruption to instructional time or programming. If approved, the data utilized, in this study, will remain confidential and anonymous. There will be no costs incurred by the District before, during or after this study. The completed dissertation will be evaluated by Dr. Daniel Guthmore, my mentor. Upon successful completion of this study, I will supply you, hence the District, with a written report.

As the District, continues to utilize Blended Learning, as an instructional model in Mathematics classes, my research will provide information, data and evidence that will support the goals of your school District. More importantly, it may assist with decisions that are made to support curriculum and instruction. This research study will provide information that may be used to in the District's quest to provide a variety of educational experiences for your 21st Century learners.

I would greatly appreciate your approval to conduct this study. If necessary, I am willing to meet with you to discuss this study. I will welcome the opportunity to answer any questions or address concerns that you may have in reference to this study. If you support my request for permission to conduct this research, please provide a signed letter to that effect indicating that you are giving consent for me to conduct this study in your district.

Respectfully,

Debra Joseph-Charles

Debra Joseph-Charles
Doctoral Candidate
Seton Hall University

Appendix B: Letter of Approval from District

[redacted]

[redacted]
ADMINISTRATION BUILDING
[redacted]
Tel: (973) [redacted] Fax: (973) [redacted]
Website: [redacted]

[redacted]
Interim Superintendent of Schools

[redacted]
Deputy Superintendent

December 20, 2018,

Dear Mrs. Joseph-Charles,

Your request to conduct educational research utilizing data from [redacted] Public Schools district has been approved. I would like to reiterate that the names of students, staff and the District must be kept anonymous.

Please contact Dr. [redacted] to receive the information needed.

Sincerely,

[redacted]
Deputy Superintendent of Schools

Appendix C: IRB Letter

SETON HALL UNIVERSITY
1856

March 27, 2019

Debra Joseph-Charles
[redacted]

Dear Ms. Joseph-Charles,

The Research Ethics Committee of the Seton Hall University Institutional Review Board office has reviewed your research proposal entitled "The Impact of a Blended Learning Instructional Model on Mathematics Achievement of Elementary School Students in a Small Northeastern Urban School District" and categorized it as exempt (reflecting the intent of the new federal regulations).

Enclosed for your records is the signed Request for Approval form.

If used, Informed Consent documents and recruitment flyers are no longer stamped.

Thank you for you cooperation.

Sincerely,

Mary F. Ruzicka, Ph.D.
Professor
Director, Institutional Review Board

cc: Dr. Daniel Gutmore

Office of Institutional Review Board
Presidents Hall • 400 South Orange Avenue • South Orange, NJ 07079 • Tel: 973.313.6314 • Fax: 973.275.2361 • www.shu.edu

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