THE EFFECT OF BLENDED LEARNING ON MATH AND READING ACHIEVEMENT IN A CHARTER SCHOOL CONTEXT

by

Terry Andrew Chaney

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

In spite of its growing popularity, researchers have focused little attention on the effectiveness of combining traditional classroom instruction and online learning, a practice generally referred to as blended learning. The modest research on blended learning to date has tended to focus on higher education, leaving a significant gap in the research regarding K-12 education. Even less attention has been given to blended learning in charter school K-12 education. Framed within Vygotsky's theory of social development, the purpose of this causal-comparative research study was to determine if there were any significant differences when comparing charter school students who participated in a blended learning approach to reading and math with students who studied the two subjects in fully online classes and with students who studied them in traditional classrooms with no online learning. The design was causal-comparative with a nonrandomized control group. The study compared the archived 2014 State of Texas Assessments of Academic Readiness scores of 1797-2298 students in one charter management organization: students in a blended learning environment, students who received traditional classroom instruction, and students who used fully online learning. Analysis of Variance (ANOVA) was used in combination with appropriate post-hoc comparisons to evaluate group means. The study determined that there is not a statistically significant relationship between traditional, blended, and fully online students and math scores, nor between traditional and blended learning students and reading scores. However, there was a statistically significant relationship between fully online students and higher reading scores.

Keywords: blended learning, hybrid learning, cyberschool, online learning, traditional classroom learning, virtual school, State of Texas Assessments of Academic Readiness (STAAR), charter school

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Adequate Yearly Progress (AYP)

Advanced Placement (AP)

Analysis of covariance (ANCOVA)

Cost-of-education index (CEI)

Institutional Review Board (IRB)

Liberty University (LU)

State of Texas Assessments of Academic Readiness (STAAR)

Texas Education Agency (TEA)

CHAPTER ONE: INTRODUCTION

Background

Queen and Lewis (2011) estimated that nearly two million K-12 public school students participated in learning that blended traditional classroom instruction with online learning—a practice known as blended learning. However, Oliver and Stallings (2014) highlighted a significant problem in the existing research on blended learning. When the authors summarized the research comparing blended learning with traditional classroom learning, they noted three studies that indicated blended learning produces equal learning improvement, and eight studies indicating that it produces better achievement. Of these 11 studies cited to document the efficacy of blended learning, only two had a focus on K-12 education. Furthermore, of the 114 articles and studies referenced in their own article, a total of 12 had a K-12 focus. Nevertheless, the authors were comfortable in arguing that their recommendations drawn from the research still applied to K-12, though "with certain recommendations likely more crucial for K–12 settings" (Oliver & Stallings, 2014, p. 59). This illustrates the noteworthy problem regarding the current state of research on blended learning: the small amount of early research done so far tends to focus on higher education where the students are adults rather than focusing on the K-12 context where they are children.

In addition, there are nearly 2.6 million charter school students in America (National Alliance for Public Charter Schools, 2014a), and large numbers of them have embraced and employed blended learning (Watson, Murin, Vashaw, Gemin, & Rapp, 2013). However, the lack of overall research means that even less research in blended learning focuses specifically on K-12 charter schools. Significant similarities between traditional public schools and charter public schools do exist, but there are often also significant differences, and conclusions drawn from research which derives from and applies to one may not always apply to the other.

Both traditional and charter schools have been examined using the social development theory of Lev Vygotsky. This theory has become quite influential in recent decades and maintains that students learn when one or more human teachers who are more knowledgeable interact with the less knowledgeable and developing students (Kozulin, 2005). Proponents of blended learning embrace this model and suggest that in addition to the face-to-face interaction of the student that occurs within the classroom with a more knowledgeable teacher and with more knowledgeable peers, additional components are added. First, online computer learning systems and software provide additional more knowledgeable mentors (Cicconi, 2014). Second, the online system also effectively enables self and peer review/assessment for students, which greatly magnifies the number of more knowledgeable mentors (Holmes & Gardner, 2006). Between the human and computerized mentors and the developing students, social connections are made where instruction is individualized such that the students are more effectively located in their personal zone of proximal development. In this way, learning is both mediated and maximized by both human and computerized mentors (Bratitsis & Demetriadis, 2013; Smith, 1998; Stahl, 2011).

Within a few years of the beginning of the new millennium, many dozens of virtual schools existed, operating in many states and serving hundreds of thousands of students (Carpenter & Finn, 2005; Setzer & Lewls, 2005). The use of online learning systems increased with the growth of the Internet and by 2002, over one-third—nearly 600,000—of the students who took any courses online took all of their courses online, and online graduate students composed the largest single group (Allen & Seaman, 2003). Such online systems recently reached a penetration rate in North America of 78.6% (Internet World Stats, 2014). Many postsecondary education programs include online learning components or programs. However, while popular and widely used, questions remain regarding the effectiveness of the fully online learning approach. Research suggests that fully online learning is not more effective than traditional learning; at best, it may be equally effective, but it is no better (Bowen, Chingos, Lack, & Nygren, 2013; Means, Toyama, Murphy, Bakia, & Jones, 2010). Still, the online learning phenomenon has not been slowed by challenges about whether or how it should be done (Perry & Pilati, 2011; Weston, 2009), and it is expected to grow from a market of just over $27 billion in 2009 (Interactive Ontario's eLearning Committee ONeLearning, 2011) to an anticipated market of nearly $169 billion by 2018 (Companies and Markets, 2012).

The idea of blending online learning with the learning already happening in the classroom was a natural next step once online learning came to be widely available and favorably perceived. While it is now part of common educational jargon, the "blended learning" designation did not began to appear in research literature until 2000, but quickly became ubiquitous thereafter (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014; Bliuc, Goodyear, & Ellis, 2007). The meaning of the term has evolved, and it has been applied to various pedagogical approaches. Some definitions have been so broad as to include nearly all forms of learning (Koohang, 2009; Singh & Reed, 2001; Verkroost, Meijerink, Linsten, & Veen, 2008). Others are more narrow and more helpful, but easily misconstrued, as when Staker and Horn (2012) focused on any blend of online and traditional learning without regard to whether the two components are each a significant part of the blend. They claimed that blended learning is "any time a student learns at least in part in a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path and/or pace" (p. 3). The consensus today is that while blended learning does indeed refer to a combination of online and traditional classroom learning, it requires a regular combination of each and seeks to employ the best components of face-to-face learning in the classroom and those of online or otherwise electronically delivered learning experiences. As a result, the use of blended learning allows the best of both online and traditional learning (Torrisi-Steele, 2015). The use of blended learning designs the face-to-face and online learning experiences in ways that vary depending on the objectives and in ways that complement one another to better achieve those specific objectives (Rose & Ray, 2011).

The appeal of blended learning is evident by its rapid growth. 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). 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. Three-quarters of those consisted of high school students pursuing credit recovery, dual enrollment, and/or Advanced Placement courses (International Association for K-12 Online Learning, 2013). 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).

One report highlighted the fact that by 2013, there were 24 states with blended schools in addition to Washington, DC (Watson et al., 2013). It also pointed out that many charter schools were numbered in that group. In the face of economic and academic pressures, these charter schools chose to invest their scarce funds in technological tools that allowed them to blend traditional classroom learning with that available online (LaFrance & Beck, 2014). They presume with their traditional public school counterparts that this will be an effective route to higher student achievement (Clark, 2012). Nearly all teachers in a recent survey agreed that there is a significant role for technology in their classrooms (TES Global, 2015). Blending the learning in classrooms has become one of the key trends in educational technology anticipated in the next few years (Johnson, Adams-Becker, Estrada, & Freeman, 2015).

However, while Oliver & Stallings (2014) spoke of “many studies” (p. 58) that compared blended learning to traditional classroom learning and found blended learning to be equivalent or even more effective, few of those studies directly involved the K-12 context (Bowen et al., 2013). This dearth of research led Corry and Stella (2012) to draw attention to the significant need for additional research on blended learning, specifically within K-12 schools. Unfortunately, the undone research on blended learning in the K-12 context means that growing numbers of schools and students are investing heavily in a learning system the effectiveness of which has not yet been well established (DiRienzo & Lilly, 2014; Halverson, Graham, Spring, & Drysdale, 2012; Murphy et al., 2014).

Staker and Horn (2012) noted that blended learning varies in structure and detail from one implementation to another and even from one day to the next in the same location. The blended learning students in this study used the drills, lessons, and games provided by Edmentum’s Study Island as the online component through a variety of approaches that focused primarily on station rotation, lab rotation, and individual rotation (Edmentum, 2014). Those whose learning was fully online used the system provided by K-12, Inc.

Problem Statement

In the rush to embrace and implement blended learning, decision-makers have often overlooked several important considerations. Having reviewed the most influential scholarship on the topic prior to 2012, Halverson et al. (2012) concluded that “most of the seminal work in blended learning to this point has not been empirical in nature” (p. 397). In a more recent follow up review of high-impact scholarship on blended learning, the same authors noted that just over half of the highly cited articles were empirical (Halverson, Graham, Spring, Drysdale, & Henrie, 2014). Clearly, the work of producing the research necessary for a basic understanding of the complexities of blended learning has only begun. Bernard et al. (2014) stated bluntly, “Enthusiasm for blended learning has not been matched by a large literature of primary research studies” (p. 90).

In addition, decision-makers often overlook the fact that the best scientific studies to date that support the efficacy of blended learning come from within the context of higher education; even if research confirms that blended learning produces higher levels of student achievement in postsecondary education when compared to traditional classroom learning or fully online learning models, it is not at all clear and must not be assumed that it will produce the same levels of achievement elsewhere. This is particularly true within K-12 education “where adolescent learners have very different needs from adult learners” (Halverson et al., 2012). As a result, it is unwise to generalize that simply because something works for young adults in college, it will also work for K-12 students (Cavanaugh, Barbour, & Clark, 2009; Headden, 2013). Unfortunately, the dearth of research in the K-12 setting means that decision-makers have little to help them decide whether the investment in blended learning can be expected to pay off in terms of greater achievement.

Although blended learning has been widely embraced in the K-12 education context, it is not yet clear that it improves math and reading achievement when compared to fully online or traditional classroom learning. There is little research and therefore, little evidence to substantiate that conclusion. Compounding the problem, although charter schools are some of the most ambitious users and enthusiastic proponents of blended learning, it is even less clear that blended learning improves math and reading achievement more effectively than the other options since there is even less research focused on the charter school context. Unfortunately, it is often merely assumed as a matter of fact that blended learning works, works well, works less expensively, and works wherever it is tried—including in charter schools with characteristics that can sometimes make them very different from traditional public schools. Yet, the research that exists lacks the narrow focus necessary to substantiate these assumptions. Therefore, the problem is whether blended learning provides greater improvement in the math and reading achievement of students in a charter school context than fully online or traditional classroom learning.

Purpose Statement

This study sought to determine whether blended learning improved the math and reading achievement of students in a K-12 charter school context. The purpose of this quantitative, causal-comparative research study was to determine whether significant differences exist when comparing the achievement on the State of Texas Assessments of Academic Readiness (STAAR) test of charter school students who participated in a blended learning approach to reading and math with that of students who studied the two subjects in fully online learning classes and with that of students who studied them in traditional classrooms. The design was causal-comparative with nonrandomized control groups and both pretest (2013 STAAR tests) and posttest (2014 STAAR tests) for all students in the sample. The sample consisted of students from elementary, middle, and high schools and included only students enrolled in the same charter school management organization system. No manipulation of the variables occurred as the entire blended learning system was already in place at the beginning of the 2013-2014 school year and operated without intervention. The independent variable was the type of learning environment: fully online learning, traditional classroom learning, and blended learning. Fully online learning is a method of course delivery where nearly all learning activities are facilitated or delivered through the Internet (Staker & Horn, 2012). Traditional classroom learning is characterized by face-to-face and direct teaching by a teacher with no significant online learning (Staker & Horn, 2012). Blended learning incorporates elements of traditional classroom learning but combines them with online teaching and learning activities (Staker, 2011). The dependent variable was 2014 STAAR test scores and the covariate was 2013 STAAR test scores.

Significance of the Study

In spite of the enthusiastic reception of blended learning, published research on the practice betrays a paucity of empirical studies in general (Drysdale, Graham, Spring, & Halverson, 2013; Halverson et al., 2012; Vanderkam, 2013), and most of the research that exists focuses on postsecondary education rather than K-12 education (Headden, 2013) or only on student satisfaction (Cherry, 2010), leaving a gap in the literature with regard to the effectiveness of blended learning when used with charter school students at the K-12 level (Headden, 2013). This study is designed to address that gap.

While a research base exists indicating that when compared with traditional classroom learning, the addition of online learning in higher education has a modest yet significant impact (Bernard et al., 2014), research studies on elementary, middle, and high school students are neither numerous nor conclusive. Headden (2013) noted that not only has there been little research focused on the effectiveness of blended learning in schools below the postsecondary level, but that it also may not be possible at all to generalize from that which has been done. Headden (2013) notes the positive conclusions of a Department of Education review of research on blended learning, but notes its limitations, including that it reviewed only 45 studies and focused on postsecondary students simply because so little work has been done in K-12 education. Unfortunately, this means that significant research on the impact of blended learning on K-12 education is meager and the research used to support the current widespread practice of blended learning in public schools is mostly research on college students. Moreover, the research used to support the practice in K-12 charter schools is even more notably anemic and distant. The result is that it remains entirely unclear whether blended learning is an effective pedagogy for K-12 students, whether it is as effective when used with elementary students as with those in middle school and high school, and whether it is as effective with charter school students as with traditional public school students.

In terms of Vygotsky's social constructivism, it remains unclear whether blended learning provides an effective context in which to construct new understanding from previous knowledge and experience (Kolb & Kolb, 2005). Vygotsky firmly places this construction of understanding within the context of social and cultural interaction to the extent that knowledge comes to be seen as the result of co-construction of individuals and their social context (Williams, 1989). Vygotsky's social learning emphasis comes into play in that the blended learning context normally includes additional students in a classroom setting providing necessary social interaction and construction. Blended learning assumes that instruction and learning experiences delivered through a computer and Internet connection can serve as the more knowledgeable mentor that is central to Vygotsky's theory rather than as a mere artifact or tool such as a book, but it remains to be established that a non-human can fill such a social role. Yet, even if that turns out to be possible, blended learning suggests that the combination of a human teacher with computerized learning that is found in blended learning is a more effective way for students to socially construct learning than either alone. Of course, charter school advocates assume that what is true of the effectiveness of online learning in helping students to socially construct new understanding within traditional public schools will also be true for them despite the varying characteristics both between and among the two. This too deserves attention.

Current educational practice in traditional K-12 schools as well as charter schools widely encourages the use of online educational learning experiences. Sometimes a student's learning is fully online, but far more often it is combined with traditional classroom learning to create a blended learning experience. These online opportunities often utilize sophisticated software that can be quite expensive. As a result, much time and significant money is invested in online learning in modern educational practice today in both traditional and charter public schools and in most grades. This is done under the assumption that online learning provides a cost-effective pathway to enhance student achievement overall. Thus, current practice is predicated on assumptions that have not yet been substantiated. This study sought to examine the effectiveness of online learning to inform decisions about its implementation in various charter school grade levels.

Thus, the significance of this study lies first in the fact that it sought to help fill the considerable gap in the research concerning the effectiveness of blended and fully online learning in a charter school context when compared to traditional classroom learning. It also sought to analyze the components of blended and fully online learning systems as they relate to Vygotsky's theory of socially constructed learning. Finally, the results of this research provide charter school leadership with additional information for consideration as they seek to determine whether blended learning is an effective pathway to increased achievement of students in public charter schools.

Research Questions

RQ1: Is there a difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading portion of the State of Texas Assessments of Academic Readiness test?

RQ2: Is there a difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the math portion of the State of Texas Assessments of Academic Readiness test?

Null Hypotheses

$H_0$1: There is no difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading portion of the State of Texas Assessments of Academic Readiness test.

$H_0$2: There is no difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the math portion of the State of Texas Assessments of Academic Readiness test.

Definitions

1. *Blended Learning* - Staker (2011) defined blended learning as “any time a student learns at least in part in a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path and/or pace” (p. 5). Blended learning has also been called hybrid learning (GeÇEr & DaĞ, 2012; Koehler et al., 2013), but the popularity of that term may be waning.

2. *Charter School* - Beginning in 1992, in an effort to create competition and improve education, states began to authorize a new kind of public school that operated outside of the control of the traditional school district to allow them greater freedom to innovate in the pursuit of student achievement. They are characterized by open enrollment to all students, by public funding with no right to charge tuition, and by no special entrance requirements that would discourage enrollments (Lawton, 2009; National Alliance for Public Charter Schools, 2014b; Stetson, 2013).
3. *Fully Online Learning* - Where blended learning combines traditional classroom learning with online learning, fully online learning occurs almost completely online in association with a virtual school that allows students great latitude in determining the time and place of access to the learning systems. Nearly all their learning takes place through accessing and interacting with the content, instruction, and learning activities provided by a single virtual school provider. Students do not attend a traditional school away from home except perhaps for occasional testing, labs, or social gatherings (Staker & Horn, 2012). The fully online learning experience is also sometimes called cyberschool or virtual school (Morse, 2010).
4. *State of Texas Assessments of Academic Readiness (STAAR)* - Texas replaced its previous state test, the Texas Assessment of Knowledge and Skills, with the STAAR in 2012. During the time relevant to this study, the STAAR test was given to all students in grades 3-8 in reading and math, grades four and eight in writing, grade five in science, and also to high school students in Algebra I, English I and II, US History, and Biology (Cadena, 2014). This study only included STAAR scores for reading and math in grades three through eight.

5. *Traditional Classroom Learning* - This category includes the familiar face-to-face and teacher-led instructional environment found in brick and mortar schools that require student attendance, structure student education, categorize students usually by age, and employ the use of textbooks as well as individual and group assignments (Staker & Horn, 2012). In addition, to avoid ambiguity and to ensure a strong representative sample, this study restricted the group designated traditional classroom learning to students with no online learning.

CHAPTER TWO: LITERATURE REVIEW

Futuresource Consulting (2015) highlighted that schools all over the world are introducing computing technology to students at an unprecedented rate. The research suggests the number of tablets, computers, and other computing devices provided to students worldwide will grow by 12% in 2015 compared with the previous year. In the United States, the researchers expect the number of devices to grow 10% in the same period of time (Futuresource Consulting, 2015). However, educational research has not yet established the effectiveness of using such technology to access online learning in K-12 classes (Halverson et al., 2012). Researchers have investigated the efficacy of blended learning for some time, but they have tended to focus on its application in higher education (Bernard et al., 2014; Halverson et al., 2014). This review of the literature will identify the chosen theoretical framework, examine the nature and advantages of blended learning, and discuss the costs and the technology involved.

Theoretical Framework

Decades ago, Lewin (1951) declared the practicality of good theory. Perraton (2000) argued that research without firm grounding in theory is not so much research as it is the mere gathering of data. This study proceeds based on the social development theory of the Russian psychologist and educator, Vygotsky. As Elhammoumi (1997) outlined the life of Vygotsky, he showed that Vygotsky enjoyed significant notoriety during the 1920s, but his ideas were almost totally eclipsed after his untimely death of tuberculosis on June 11, 1934, at the age of 37. However, in the 1950s educators rediscovered his thinking, in the 1980s they rehabilitated it, and by the 1990s they celebrated a renewed Vygotskyism (Elhammoumi, 1997).

In their 1992 essay, Wertsch and Tulviste noted that interest in Vygotsky flourished in the 1980s. To be sure, in the years since, rather than abating, this interest has only increased. Within the span of a few decades, Vygotsky's virtually dormant ideas came to be counted among the most significant influences on educational research (Daniels, 1996b). What are now influential concepts were nearly lost in the dustbins of history due to suppression by Russian leaders until the 1960s. While Vygotsky accepted the dialectical materialism of Marx and was an epistemological realist and an ontological materialist (Duncan, 1995), nonetheless, Soviet political leaders suppressed his work, finding the ideas out of step with their thinking. Seeking to play down Vygotsky's views that Christian scholars have found objectionable, Estep (2002) argues that Soviet opposition arose because while he was certainly influenced by Marxism, he did not accept the move in Soviet psychology to embrace a deterministic view of the human psyche; nor did Vygotsky agree with the idea of Stalin that man's nature can be completely shaped by external influences (Estep, 2002). As a Jew, while he could pursue an academic career, the Soviets forced him to work under their pressures and censorship. In addition, they confronted him daily with the threat of repercussions for any disapproved ideas (van der Veer, 2007) and even eventually for any independent thought (Kozulin, 1986). Yet, one must remember that his historical context heavily influenced Vygotsky. Many of the basic philosophical ideas that composed his worldview—objectionably evolutionary and naturalistic as they may be to the theist—heavily impacted his theory and his conclusions about learning (Duncan, 1995; Sawyer, 2014). It would be a mistake to conclude from this that his ideas have no value for the Christian educator. It does mean that one who is rational and Christian must exercise a healthy incredulity here as elsewhere and carefully critique the concepts to determine whether they are true (Loughlin & Pritchard, 1997).

Unfortunately, once rediscovered, because of problems and inaccuracies as publishers translated and edited Vygotsky's writings (Daniels, 1996b), he was not always well understood.

Early mistranslation (van der Veer & Yasnitsky, 2011), popular misunderstanding, and a tendency to reduce his ideas to nothing more than the zone of proximal development (Gredler, 2009, 2012; Prestes & Tunes, 2012) contributed to misunderstanding. What people believed about Vygotsky's theory was not always true but reflected instead their own cultural contexts (Daniels, 1996a).

Vygotsky's social development or social constructivism theory lends itself to an investigation of blended learning. As a cognitive constructionist, Vygotsky believed that learning occurs when one constructs new understanding from previous knowledge and experience (Kolb & Kolb, 2005). However, for Vygotsky, this occurs surrounded by social and cultural exchange such that knowledge comes to be the result of co-construction of individuals and their social context. At the heart of Vygotsky's theory is the essential idea that through social interactions with the environment, learners create psychological structures. Those structures do not preexist the learner, nor does the learner pass them on (Williams, 1989). While Miller (2011) rightly warns that Vygotskian theory "does not lend itself to pithy summaries of the nutshell variety" (p. 1), several key components of the theory deserve consideration. First, Vygotsky maintained the higher-level learning of which humans are capable is the result of a developmental process. Indeed, learning is all about motion, change, and process. Given his presuppositions, both Darwinian and otherwise, a theory of learning must be a process of development or evolution from the lesser to the greater (Williams, 1989). Learning is the process of developing; indeed, alluding to what occurs in Vygotsky's Zone of Proximal Development, Holzman said, "Development, in this understanding, is the activity of creating who you are by performing who you are not" (Holzman, 2008, p. 19).

Wertsch (1985) argued that it is possible to summarize the outline of Vygotsky's theory in terms of three major components. To begin with, before one can comprehend any psychological observation, one must first understand its origin and acquisition—that is, where it came from and how it was acquired (Aukrust, 2011). Vygotsky spoke of this investigation as genetic or developmental analysis. The theory of biological evolution and the tendency in his day to apply an evolutionary theory of development to nearly everything, including culture, heavily influenced his thinking (Wertsch & Tulviste, 1992). Vygotsky held as an essential part of this analysis "the general genetic law of cultural development" (Daniels, 1996a, p. 6). It constituted a firm conclusion or law regarding uniquely human (Silverman & Clay, 2010) higher mental functions that a function always appears twice and on two planes in the cultural development of a child (Wertsch, 1981).

The second major component of Vygotsky's system enters into the discussion to shed light on these two planes: the human mind is by nature social and it is constituted through linguistic social interaction with others (Aukrust, 2011). Vygotsky maintained that "mental functioning in the individual can be understood only by examining the social and cultural processes from which it derives" (Wertsch & Tulviste, 2005, p. 58). Close examination of those processes shows that learning can only occur on the internal (intrapersonal) level after a teacher who already understands what the student is learning uses language to lead the student to an external (interpersonal) understanding. The teacher may also use other mediate tools in leading or helping the student, but language is the most important. In this way, "interpersonal processes are transformed into intrapersonal ones" (Kozulin, 2005, p. 266).

It is significant for Vygotsky's theory that learning precedes development, and interpersonal understanding always precedes intrapersonal understanding. Thus, a function appears first in a social context of interaction with other people who lead one to deeper and further understanding. Then, the function occurs on the psychological plane as the student internalizes new developments (Minick, 1987). The latter changes become "nothing other than the organization and means of actual social behavior that has been taken over by the individual and internalized" (Minick, 1987, p. 36).

The very closely related third primary component of Vygotsky's theory is mediation. Learning begins in a socio-cultural context, according to the theory, and only later does the learner come to internalize it; however, something more is necessary to understand the mental processes involved (Wertsch, 1985). Only if one understands the tools and signs that mediate the processes can one understand the processes themselves. Here again, while not alone, the primary tool of mediation is language (Wertsch, 1985). The two planes in which human higher mental functions appear relate to one another by nature and whatever boundaries exist between them are very permeable (Wertsch, 2000). Primarily, it is language that ties the two levels together; it shapes, mediates, and links both planes (Wertsch, 2000). In the end, that which a person internalizes is a system of signs (semiotic system) that comes from society and culture (Dockrell, Smith, & Tomlinson, 2003). Because of this internalization process, the learner can afterward do independently what he or she could once only do with the help of people (society) around (Dockrell et al., 2003).

Of central importance in Vygotsky's theory was the conviction that social interaction with others plays the primary role in the construction of learning. The most significant of these social actions he considered to be those that occur with adults as they lead the child to understanding and knowledge—yet, interaction of the child with peers also plays a large role (Blatchford, Kutnick, Baines, & Galton, 2003). Within the context of such social interaction, the theory famously posits that the greatest amount of learning occurs when learners stretch or are stretched beyond what they can do by themselves into an area where they are only successful with the help of someone(s) more knowledgeable and capable than themselves (Vygotsky, 1978). This area, space, or zone where one requires interpersonal assistance has become known as the zone of proximal development; the lesson of which is that students can achieve more and at higher levels through the strategic help of others than they can on their own (Miller, 2011). While Vygotsky himself did not dwell on this point at length, educators consider it a significant part of his theory. Vygotsky suggested that the most effective instruction is that which occurs in the space between what the student can do without assistance and what the student can do with help from a more skilled tutor (Brown, Sorrell, McClaren, & Creswell, 2006; Morrow & Woo, 2001). This interplay enables the learner to move to ever higher levels of understanding and achievement.

Vygotsky and Online Learning

As a result of Vygotsky's central belief that social interaction with others plays the primary role in the construction of learning, learning outside of a social context—such as that which occurs in fully online learning done by a lone student—was initially greeted with some skepticism and expected to be less effective at developing higher cognitive thinking processes than traditional classroom learning (Cicconi, 2014). In the context of social constructive theory, it would be expected to be more difficult overall for the fully online learning student to construct higher order understanding due to the diminished social interaction with more knowledgeable adults and peers that is so central to the learning process as understood by Vygotsky. On the other hand, blended learning incorporates the social aspect more fully through the presence of one or more teachers and peers in the classroom; therefore, Vygotsky's theory would lead one to expect blended learning students to construct higher order understanding than students who are learning in a fully online learning program of study.

This line of inquiry raises the question of whether online learning coheres with Vygotsky's concepts of a more knowledgeable other and the zone of proximal development. It may not be immediately obvious that it does or can. However, proponents have suggested that it not only fits, but it fits quite well despite challenges that arise (Allen, 2005; Cicconi, 2014; Deulen, 2013; Hrastinski, 2009; Lear, 2009; Marsh & Ketterer, 2005; Smith, 1998). For example, for a single teacher to customize the learning experience and keep each of the students in an entire class within their own unique zone of proximal development is quite difficult and perhaps impossible. A recent controversy over a related idea, one of the standard doctrines of modern education as practiced in the past several years, reinforces this point. Differentiated instruction is the enormously popular idea that instructors can and ought to tailor the learning experience to account for individual student background, ability, preference, needs, and learning style to place all students within their zones of proximal development (Scalise, 2007). The controversy arose when an article in *Education Week* by Delisle (2015), entitled "Differentiation Doesn't Work," appeared. The author agreed that it is difficult—and perhaps impossible—for a teacher to perform such magic. He argued that it cannot work because in most modern classrooms too much variation among students confronts the teacher for differentiation to be possible. The variations include such categories as struggling learners, gifted learners, English language learners, and average learners (Delisle, 2015). No matter how sincere a teacher's efforts, one finds it impossible to be everything that each student needs when each student needs it—there are simply too many different levels of learning or zones of proximal development represented.

Proponents of online learning suggest that it has the potential to change this by providing customized online learning experiences which continuously adjust to maintain each student within his or her zone of proximal development (Glick, 2006; Kleber, 2015; Scalise, 2007).

Sometimes computer engineers design the software behind online learning to be adaptive; it then adapts individually to the level, needs, and pacing requirements of each student based on input and interaction. The sophistication of this adaptation varies from platform to platform and product to product (Shea, 2015). In other instances, schools load achievement test results for each student into the online system to inform the system and locate a student in his or her zone of proximal development in the learning continuum (Edmentum, 2013). In still other instances, in what may be a more linear, less ideal, and the least sophisticated and personalized option, the online experience may simply allow students to proceed through the same learning experiences, but at their own pace working as quickly as they are able and without waiting for other students in the class who occupy different zones of development (Bridges, Chang, Chu, & Gardner, 2014; Edmentum, 2013; Horn, 2013; Murphy et al., 2014; Sofia Balula & José Alves, 2014). Researchers and developers continue to explore variations on these approaches including an option that allows an adaptive computer system to provide custom-printed material locally as needed for each student based on their pen and paper responses that are scanned into the system to inform its adaptive recommendations (Gerth, 2015; Wilson, 2015). Each option allows for some level of differentiation in the learning experience that helps keep the student in the appropriate zone of proximal development, each is available in both blended learning and fully online pedagogies, and each presents a level of differentiation that a classroom teacher working without these tools would find difficult or impossible to match (Scalise, 2007). In this context, the online learning system or the software behind it becomes one of the more knowledgeable others that Vygotsky identified as a mediator, able to step in and assist the student in times of need while struggling in the zone of proximal development (Attwell, 2010; Hsu, 2005; Smith, 1996, 1998; Westby & Atencio, 2002).

Vygotsky, however, emphasized that learning is inherently social (Smagorinsky, 1995) to the extent that "it is through others that we develop into ourselves" (Vygotsky, 1981, p. 181). His entire theory bends on "the critical importance of interaction with people, including other learners and teachers, in cognitive development" (Huang, 2002, p. 29)—thus the designation by which educators know the theory, "social constructivism" (Huang, 2002). The clear disadvantage of fully online learning is that depending on the design of the system, and despite the fact that solutions to the problem do exist, it may involve very little social interaction thus hampering the learning process (Lear, 2009). This has proven to be a significant challenge to fully online programs for adults (Richardson & Swan, 2003). Indeed, designers can create online learning experiences that include or that minimize the need for human oversight and interaction. They may provide for collaboration and communication of student to student and student to teacher, or they may limit interaction to that which occurs between the student and the online software program. The latter can result in a form of dehumanization and isolation that strip motivation and make learning more difficult (Huang, 2002; Kim & Frick, 2011). Thus, depending on the design of the system, while actually engaged in the learning process, fully online students may have little social interaction. Even where they do exist, the social connections built into the system may be very different than those which take place in face-to-face interaction—perhaps categorically so (Anderson, 2008). Indeed, the social interactions may be so radically different that they do not even qualify as social in the sense in which Vygotsky expressed when he advocated learning as a social process. After all, his theory was that all learning occurs in the context of social interaction (Vygotsky, 1981), not that all social interactions produce learning. Not all social relations include a more knowledgeable other leading a student into a zone of proximal development where learning occurs (Vygotsky, 1978). In the case of online learning, the kind of social interactions that take place may well be so limited that this impacts the very learning experience itself.

Blended learning, on the other hand, by definition involves a classroom with a teacher and other students (Staker, 2011). In such a setting, indisputably social relations of the kind that Vygotsky considered necessary for constructing understanding can and do exist in addition to any social components built into the online learning system. Both the teacher and other students can serve as the essential Vygotskian, more-knowledgeable other who can provide assistance in the process of traversing the zone of proximal development.

Related Literature

While traditional classroom learning continues to reign supreme in schools all over the world, more and more schools are contributing to the burgeoning growth of alternatives that utilize online learning (Vaughan, 2010). Schools from kindergarten to graduate level are investing unprecedented funding in educational technology. Institutions use much of this to provide access to online learning delivered over the Internet. They justify this substantial investment on the basis that it will lead to increased student achievement and reduce overall costs in an era of financial strictures; however, they may take much of this on faith without much regard for what research might say.

Published research literature, while not extensive, informs the issues related to blended and online learning. The critical review in this section will discuss the growth of blended learning, the nature of blended learning, the advantages of online and blended learning, blended learning and achievement, the costs of online and blended learning, and the personalization of online and blended learning.

Recent research focused on K-12 education and drawing from interviews with more than 50 experts in the field suggests that the fully online learning model is approximately equal in effectiveness, but far less costly than traditional classroom learning (Battaglino, Haldeman, & Laurans, 2012). A number of published research studies using a variety of statistical methodologies—as well as several meta-studies—indicate that blended learning, which combines the advantages of online learning (engagement, self-adjusting differentiation, etc.) with the benefits of classroom instruction (social impact on learning, access to proximate help, etc.), tends to produce significantly greater achievement than traditional learning (Bernard et al., 2014; Castaño-Muñoz, Duart, & Sancho-Vinuesa, 2014; Means et al., 2009; Spanjers et al., 2015; Tamim et al., 2011; Wai & Seng, 2015; Zhonggen, 2015a), but at a cost that tends to fall between that of fully online learning and traditional classroom learning (Battaglino et al., 2012; Clark, 2012). As a result, interest in blended learning that is financially feasible is high particularly among schools with fewer financial resources such as charter schools.

Charter schools, challenged by the fact that they receive much less funding than traditional public schools (Vanderkam, 2013), face the significant problem of creating a blended learning system that produces increased achievement outcomes at the same or lower cost as current systems and which is also sustainable (Chamberlin & Powers, 2010). Gronberg, Jansen, and Taylor (2012) pointed out that non-charter public schools in Texas receive funding from a number of additional sources including cost-of-education index (CEI) adjustments for schools located in high-cost areas, small and midsized district adjustments for districts without the benefits that accompany greater numbers of students, higher enrichment tax rates if they choose, and a number of programs that assist with the costs of facilities. Most of this, however, is not available to charter schools, which do not receive CEI adjustments, enrichment tax rates, district size adjustments, nor aid for facilities. Thus, financial stability is a constant concern, and charter schools must maintain a high degree of cost-consciousness at every level.

The Growth of Online Learning

The potential for a cost-effective path toward higher levels of student achievement combined with the greater degree of crucial operational flexibility granted to charter schools may largely explain why so many early adopters of blended learning have been charter schools (Horn & Maas, 2013; Vanderkam, 2013). Precise numbers are difficult to obtain due to the fact that no single repository for such data exists; however, in 2005, Carpenter published survey results from 2001-2002 identifying more than 70 virtual charter schools operating in five states including Texas during that time (Carpenter & Finn, 2005). Setzer and Lewls (2005) published survey results for 2002-2003, indicating that 36% of school districts throughout the nation had enrolled 330,000 students in distance learning courses, though they were delivered through a variety of media and not all were online. The lack of precision is evident when the report indicated that in the group was "at least 1 charter school" (Setzer & Lewls, 2005, p. 2).

By 2005, it was estimated that one percent of all public school students had taken at least a single online course (Smith, Clark, & Blomeyer, 2005), and a private company, K12 Inc., reported that in the last year its sales of distance learning products and services had dramatically increased from 11 states and 12,000 students to 13 states and 50,000 students (Shin, 2005; Smith et al., 2005). In 2008, the Sloan Consortium estimated that since the previous year when they also collected data, the number of students who were participating in some kind of virtual school had increased almost 50% to over one million, representing 2% of all students (Picciano & Seaman, 2008). High school level students composed 70% of these virtual school students (Picciano, Seaman, Shea, & Swan, 2012). From the 2007-2008 school year to the 2008-2009 school year, the Florida Virtual School student course completion rate rose from more than 116,000 courses to over 150,000—most of which consisted of students who were supplementing their education with blended learning.

By 2009-2010, K12 Inc. enrollment grew to 67,000 (Watson et al., 2010), one or more virtual schools were operating in perhaps as many as 27 states, and over 150,000 students were learning full-time through various virtual schools (Watson et al., 2010). Glass and Welner (2011) noted that during the 2009-2010 school year, Arizona, Ohio, and Pennsylvania had multi-district and full-time virtual schools operating with more than 24,000 students enrolled in each state. They also pointed out that almost all of the virtual schools through these years were charter schools. By 2011, nearly a third of high school students and a fifth of middle school students reported that they had completed either a blended or fully online course (Glass & Welner, 2011).

The Nature of Blended Learning

Not many years ago the term “blended learning” might have been used to refer to any educational approach that combined or blended separate components into one (Clement, 2010). However, in the present educational context, the words carry only one meaning for the vast majority of those who hear or use them. Contrary to those who have argued that no definition is possible (Dalsgaard & Godsk, 2007) and recognizing occasional exceptions to the rule do exist (Thiele, 2013), most understand blended learning to refer to the blending of traditional classroom learning with “computer-mediated” (Bonk & Graham, 2006, p. i) and usually online instruction delivered via computer (Moskal, Dziuban, & Hartman, 2013).

Examples of this understanding are easily multiplied. In 2007, Tittenberger affirmed to teachers in a weblog entry no longer available, “Blended learning is the integration of face-to-face and online learning to help you enhance the classroom experience and extend learning through innovative use of information and communications technology" (Clark, 2012, p. 8). Garrison and Kanuka (2004) said it is the "thoughtful integration of classroom face-to-face learning experiences with online experiences" (p. 96). Osguthorpe and Graham (2003) described blended learning as finding "a harmonious balance between online access to knowledge and face-to-face human interaction" (p. 228). Staker (2011) said simply, blended learning is "any time a student learns at least in part in a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path and/or pace" (p. 3).

Previously, as blended learning developed, some suggested that the definition includes other components. Chou and Chou (2011) argued that the concept of blended learning cannot be separated from the component of change which is inherent in it: "It adopts multiple learning methods and combines both traditional and online learning activities," and its "blended learning method continuously changes the ways of learning method and technological infrastructure" (p. 463). Dziuban et al. (2004) suggested that for it to be true blended learning it must also use the online component to reduce the amount of time spent face-to-face or in traditional classroom learning—that is, to reduce the overall amount of time in the classroom seat. Some have gone so far as to specify the ratio of traditional classroom learning time to online learning necessary to qualify as blended learning; Clark (2012) mentioned as an example, a ratio of two hours of in-class work to one hour online, whereas the Sloan Corporation definition called for 30% to 79% of online course delivery with the rest made up of traditional face-to-face learning (Allen, Seaman, & Garrett, 2007). Others have specified that blended learning requires "a fundamental redesign that transforms the structure of, and approach to, teaching and learning" (Hu, Kuh, & Li, 2008, p. 5). Yet, in common usage, the educational community has accepted none of these aspects or additions as widely as it has embraced the understanding that blended learning requires a combination of a face-to-face or traditional classroom learning component and an online learning experience.

Contrary to this common acceptance and widespread usage, Oliver and Trigwel (2005) found little redeeming value in the designation “blended learning.” They not only rejected as nebulous or unhelpful the definition that sees it as a combination of face-to-face and online learning, but they also dismissed other permeations of the definition as well as the idea that there is a single definition of online learning or traditional learning. They argued that assigning the term its popular meaning is arbitrary and fundamentally problematic, that “any current definition…is either incoherent or redundant,” (p. 24) and that the term can only be salvaged by redefining it entirely so that if focuses on learner rather than teacher experience. Nonetheless, in the several years since the publication of their opposition piece, they have failed to persuade many, and the popularity of the common definition has only increased.

Advantages of Online and Blended Learning

As the practice of blended learning has spread, research has identified several benefits. Indeed, what Oliver and Trigwell saw as uncertainty and incoherence in the concept of blended learning, others consider to be a valuable flexibility inherent in the very concept itself (Dalsgaard & Godsk, 2007). While fully online learning courses receive high ratings for their flexibility due in part to the fact that one is free to work whenever one wishes, Moskal et al. (2013) noted the paradoxical fact that the same students also decry the lack of face-to-face communication. Blended learning resolves this problem and much more by providing a framework which Vasileiou (2009) suggested affords students the very best of the many possible delivery options whatever their current stage of development may be. This certainly includes face-to-face instruction, but as educators understand and practice it today, blended learning amplifies or extends that approach in which people primarily engage one another face-to-face in synchronous interchange to exchange ideas (Ting & Chao, 2013).

In blended learning, the normal learning experience is freed from the constraints of primarily face-to-face and synchronous exchange; it is then expanded using online learning that can take place asynchronously. Further freedom exists in the flexibility that blended learning allows regarding the amount of time devoted to the synchronous and face-to-face communication as opposed to asynchronous learning experiences and regarding the precise nature of the learning experience in each (Massoud, Iqbal, Stockley, & Noureldin, 2011). Thus, a blended learning system allows the decision-makers involved, whether they be teachers, administrators, schools, or districts, the flexibility to decide how much of the learning experience will be face-to-face, to decide how much will be online, and to determine freely what they will include in both components. They may choose to focus the direct instruction time on nearly any of the varieties of learning experience found in classrooms everywhere; yet, as Moskal et al. (2013) observed, by the addition of blended learning, leaders can add to the resources already in the classroom many more assets that are as good or better. At the same time, leaders are also free to determine what online instruction systems to use and what learning paths students will follow within the systems. Through such decisions, the decision-makers can customize learning experiences continuously so that maximum benefits are derived for each new group of students (Dalsgaard & Godsk, 2007).

As significant as flexibility is, much more is required to create an effective learning context. Rhodes (2011) has argued that an effective system focuses first on knowledge by emphasizing true understanding as opposed to memorization, then on the learner by appreciating his or her personal experience and preferred learning style, next on the learning community by including learner collaboration and opportunities to participate initially outside of the focus of attention, and finally on assessment by incorporating formative evaluations that provide students an opportunity to reflect on and envision their own metacognitive processes. If one accepts this understanding of effective learning environments, then like all other models, a blended learning system must include all components. However, while there is a learning environment in a fully online learning model, it is rarely a classroom as such and often represents a less constrained environment.

In a blended learning system, the learning environment does not have to be a classroom as it is so often in traditional schools; it can be a library, computer lab, or any number of other options, as well as a traditional classroom. However, by definition, it does include the significant face-to-face interaction Vygotsky considered so important. It therefore provides all of the benefits of the social aspects of learning (Ting & Chao, 2013). Moe and Rye (2011) focused on this point when they reminded, “Even if the Internet can facilitate increased flexibility and reduce the friction of time and space, some of the old needs for communication remain present” (p. 165).

Vasileiou (2009) argued that the classroom provides advantages that can only be simulated in the online context including an organizational framework, a context for learning from peer experiences, additional incentive and motivation for learning, a place to reinforce learning, as well as the best place to learn any exceptions to normal rules. Indeed, blended learning fully recognizes that there are learning stages that require peer interaction and practical application to bring learning to maturity and achieve functional expertise (Blatchford et al., 2003). However, despite a ubiquitous emphasis in recent years on differentiating instruction to meet the personal and unique needs of every child, most teachers realize that one teacher cannot provide ideal differentiation for each of 20 to 30 children in each subject. While recognizing and welcoming the emotional and cognitive diversity that is found throughout classrooms around the world, the fact is, “the traditional classroom training model wasn’t designed to handle these factors and can’t meet all of the learning needs of every individual” (Wilson & Smilanich, 2005, p. 3). Something far more personalized—something akin to a tutor for each student—is needed for true individualization.

On the other hand, online learning is said to hold the potential to compress learning by individualizing the learning process for each unique student and by providing ready remote access to that truly differentiated instruction from any location with an Internet connection (Vasileiou, 2009). By integrating online learning into the system, blended learning expands Rhodes’ effective learning environment into the virtual world where traditional limitations—teacher and otherwise—are removed. In the end, the differentiation that is possible through the online component and the social aspect of learning associated with the classroom combine synergistically in blended learning to create a formidable learning system. The result has been called “the best of both worlds” (Anderson & Skrzypchak, 2011; Herrmann-Nehdi, 2009; Lapuh Bele & Rugelj, 2007; Oakes & Green, 2003) and appears to be well-suited to address each of Rhodes’ components of an effective learning environment.

Staker (2011) suggested that blended learning offers each of the students involved a more personalized approach to teaching where they control their own pacing and where they are enabled to see themselves as successful students. Staker explained that it allows students a higher quality learning experience in accord with their own preferred learning modalities while receiving more frequent and effective feedback and providing better, less labor-intensive data to teachers. Alonso, Manrique, Martinez, and Vines (2011) agreed that that much of the success of the experiment was because the Internet portion of a blended learning course individualized the course at the same time that it freed the student from the confines of specific class time and place. Indeed, some argue that students are capable of choosing their own learning pathways. They "are able to select learning formats to fit their changing needs…It is not the role of the teacher to prescribe the nature of the blend" (George-Walker & Keeffe, 2010, p. 12). Whether one agrees with this understanding of the role of the teacher or not, at least the options from which students may choose are increased through blending student learning.

Garrison and Kanuka (2004) attributed the significant growth in the number of blended learning courses at least in part to the popular demand of students who are well acquainted with electronic communication for courses that integrate "connectivity" (p. 95). They suggested that these tools have the potential to move students to "higher levels of thinking" (p. 95). Similarly, Harnisch and Taylor-Murison (2012) highlighted "the pedagogic benefits of utilizing technology" (pp. 400-401) and Dalsgaard and Godsk (2007) suggested that blended learning can produce students who are both more reflective and capable of learning without regard to traditional classroom limitations. In this context, researchers believe that the use of technology may well function to transform the processes and roles of education (Banados, 2006; Draffan & Rainger, 2006; Garrison & Kanuka, 2004; Harnisch & Taylor-Murison, 2012). Halverson et al. (2012) analyzed the published research and revealed that the thing that intrigues most researchers about blended learning and which therefore, drives the focus of their research is its potential for transformation as opposed to mere enhancement or enablement: converting education into a learning centered and higher learning experience, reconceptualizing and reorganizing teaching/learning and their interplay, improving quantity/quality of interaction, increasing engagement in the learning community, and moving education from a mentality associated with the 1800s to one appropriate to the 2000s.

Blended Learning and Achievement

Among the chief claims of blended learning enthusiasts is that it leads to greater achievement than traditional classroom learning. This goes beyond the significant claims made for the equal effectiveness of online learning in general by Cavanaugh et al. (2004) in the first published meta-analysis of available studies of online learning in the K-12 context. The effort sought to identify all published research for studies of scientific rigor from the early years of online learning, 1999 to 2004. Only 14 studies qualified for inclusion with a total of 116 effect sizes. The most significant and surprising conclusion of the meta-analysis for the education world was that online learning "can have the same effect on measures of student academic achievement when compared to traditional instruction" (p. 4), and "a student’s education online can be as effective as it is in a classroom" (p. 21). This meta-analysis study found a weighted mean effect size for all identified outcomes to be -0.028, with a 95% CI [0.060, -0.116]. Not only did this study raise questions about the inherent superiority of conventional face-to-face classroom instruction, but considering the widespread perception that online education can dramatically reduce costs, the implication was that equivalent educational results could be obtained through less costly, online learning.

The U.S. Department of Education funded a study of 463 students in 21 schools that stretched from October 2003 to October 2006 and compared the seventh and eighth grade Spanish language program of the West Virginia Virtual School with the traditional classroom program while controlling for prior year achievement (Rockman et al., 2007). It is noteworthy that the virtual program used a blended delivery model derived from a partnership with the

Florida Virtual School that included extensive face-to-face contact with instructors as well as the online components. Results of the quasi-experimental study and associated surveys showed that online students performed as well as their conventional classroom counterparts, developed a positive attitude toward language study, and learned helpful technological skills in the process, but also that they were better prepared when moving from Spanish I to II. The study also found that the greatest variations were between the different participant sites due to the variations in practice from one site to another (Rockman et al., 2007). After considering all of the metrics of the study together, Kumi-Yeboah (2013) suggested that the performance of the blended learning students in the study was significantly better than that of their traditional counterparts.

Some studies have focused on the effectiveness of online math programs. (O'Dwyer, Carey, & Kleiman, 2007) used a quasi-experimental study with a pretest and posttest to analyze the impact on high school student achievement and attitude of the online Louisiana Algebra I course when compared to traditional classroom versions of the class. The sample included 33 classrooms in multiple districts and schools with a total of 463 students in school year 2004-2005, and results showed that while more of the online students reported both an unsatisfactory experience and less confidence in their algebra skills, they demonstrated higher performance overall with higher scores on 18 of the 25 items in the posttest with a medium effect size of +0.37. The study also included an analysis of group membership that confirmed no statistically significant relation existed between group membership and posttest scores. Hughes, McLeod, Brown, Maeda, and Choi (2007) studied 192 high school algebra students to compare those enrolled in an online version with those in traditional classrooms. The researchers found that while traditional students had higher levels of perception of student cohesiveness, involvement, and cooperation, both algebra posttest scores and perceptions of teacher support were higher for the online students with 16% of the variance in posttest scores explained by school type.

Heppen et al. (2011) used a randomized control trial to investigate a blended Algebra I course for eighth grade students who were determined to be ready for algebra but were located in schools where Algebra I was not offered to eighth graders. The study of over 1,800 students in Maine and Vermont during the 2008-2009 school year included two analytic sample groups: the first numbered 440, and the second 1,445. The study did not focus exclusively on achievement. It evaluated the program in terms of technological capabilities of the schools, teacher ability to provide content support, student achievement scores on an end-of-year algebra exam, and later student enrollment in high school math courses. Student posttest scores were compared with those of students who did not take the algebra course but continued in the normal eighth grade math class which included substantial exposure to algebraic concepts. The course was judged to be effective in each area of inquiry. In regards to achievement, in spite of the fact that less than half of the students who started the blended course completed it, those students with any time in the blended course outperformed their peers with model-adjusted mean scores of 447 to 442 (out of a 500 scale) and an effect size of 0.39 ($p = 0.001$). Moreover, the students in the blended course were more than twice as likely to enroll in advanced math courses in high school as their peers from the control group.

Similar advantages for online learning arose in a quasi-experimental, nonequivalent-control group study of 113 Taiwanese fifth graders from four classrooms and two schools by Sun et al. (2008). The study focused on a science laboratory class conducted virtually for 56 students and traditionally for 57 students. One of several factors considered was achievement, where the online learners had a significantly higher posttest score ($F = 3.812$, $p < .05$) and an effect size of

+0.26 in favor of the virtual lab (Means et al., 2010). Another factor was the number of students in the online group who would like to continue working online; nearly 75% affirmed that they would.

In their significant meta-analysis of empirical studies focused on the effectiveness of online learning, Means et al. (2010) conducted an extensive search of published research on behalf of the U.S. Department of Education. It is both surprising and telling that the "most unexpected finding" (p. xii) of the researchers was that there was not a single published study from 1996 to 2006 that met their criteria and compared the effectiveness of online and traditional classroom learning through experimental or controlled quasi-experimental research focused on K-12 education and that also provided enough data to be included in a meta-analysis. When the search was expanded to include research through July 2008, a total of nine studies were found that dealt with K-12 education; however, inadequacies in four of them meant that they had to be excluded, leaving only five qualifying studies for meta-analysis.

As a result of these factors, most of the studies included in the analysis involved older subjects outside of K-12 education. Results of the meta-analysis included 51 study effects; however, only seven of the effects were drawn from K-12 research. Analysis of all 51 effects found that when comparing fully online and blended learners together with those in traditional, face-to-face learning contexts, students who took all or part of their class online performed better than the traditional classroom learners (with a somewhat small average effect size of +0.20, $p < .001$). However, it is noteworthy that when students in blended learning contexts were compared to traditional students and fully online students were excluded, the blended learning students demonstrated significantly better performance (with a larger effect size of +0.35, $p < .001$). By comparison, when fully online students were compared to traditional classroom students while excluding blended learning students, the effect size was greatly reduced (+.0.05, $p = .46$) indicating that the two groups were "statistically equivalent" (Means et al., 2010).

The meta-analysis also drew conclusions about other effects. It found that the type of online course impacted effects ($Q = 6.19$, $p < .05$). Courses where the students worked independently were less effective (+0.05) than those where the instruction was collaborative (+0.25) or instructor-directed (+0.39). Also worthy of notice, the analysis showed that variations in online learning other than blending it with classroom experiences and altering the type of online instruction (independent, collaborative, or instructor-directed) had an insignificant impact on student achievement. However, the analysis identified a small but significantly larger advantage to online learning where the curriculum and instruction offered online differed from that in the conventional classroom (+0.40) as opposed to being identical (+0.13), suggesting that customization of the online experience impacted results. Important for the purpose of this study, Means et al. (2010) suggested that while the effectiveness of online learning appeared to be quite broad across age ranges (undergraduates, graduates, and professionals), while the type of learner was not a significant moderator and while subject matter of the learning experience did not impact the results, little of this can be applied with confidence to the K-12 context due to insufficient number of studies for that group.

Little research had been done in the K-12 context in the period considered by the Means et al. (2010) meta-analysis that made it impossible for the researchers to achieve their stated goal: "The goal of the study as a whole is to provide policy-makers, administrators and educators with research-based guidance about how to implement online learning for K–12 education and teacher preparation" (p. xi). Regarding K-12 learners specifically, the authors noted that the absence of scientific evidence means that one cannot know whether the same level of effectiveness exists with this group. Moreover, even for older students, the authors warned that their analysis showed greater effects not just for online learning, but for online learning in combination with other variables including additional time, materials, and collaboration.

Responding to the need for additional research studies of blended learning, in 2012 Project RED (derived from the phrase, "Revolutionizing Education") approached the complexities of online learning and education using a standard survey statistical methodology that focused on educators—"a self-selected sample of public- and private-school professionals" (Greaves, Hayes, Wilson, Gielniak, & Peterson, 2012, p. 97). The large study was funded by several companies with significant interests in technology and learning and included nearly 1000 schools in 49 states and the District of Columbia, 11 success measures, 22 groups of independent variables, many subcategories, a comparison based on student-to-computer ratios, and correlated demographic data in addition to interviews and more. While the published results do not include all analytical survey data, among the many findings and conclusions, Project RED identified classes that integrate technology in the learning process to transform intervention classes as especially effective. For students in such classes who struggled with English, had low reading skills, were identified as Title I, or were special education students, such technology-transformed classrooms were the best predictor for four important measures of educational success: improved state test scores, reduced dropout rates, improved discipline, and increased course completions. Although not all subsequent studies have confirmed it (Pace & Mellard, 2016), this is a significant relationship. Regarding the relation between the technology-transformed classroom among all of the variables the survey investigated on the one hand and the 11 measures of educational success they identified on the other, Greaves, Hayes, Wilson, Gielniak, and Peterson

(2010) emphasized, "No other independent variable is the top-model predictor for more than one" (p. 16) measure of educational success.

Werth et al. (2013) conducted a more limited survey study in May of 2013 in the state of Idaho. It focused only on the perceptions and practices of blended learning held by 145 teachers (representing a 23% response rate from 627 teachers contacted). At least 85% of those surveyed indicated that for each of the areas of inquiry, blended learning provided equal or better outcomes. Among respondents who used blended learning, responses indicated that academic ability was better or much better regarding student-led location of resources (67.7% of respondents agreed), student responsibility for learning (67.5%), development of higher-level thinking skills (56.4%), improvement in homework and test scores (53.8%), and student perseverance (52.5%). Furthermore, responses indicated that overall work quality and engagement was better or much better regarding student time on task (57.5%), student motivation to participate in class (65.4%), interest level of students during instruction (55%), student behavior issues (52.5%), and student excitement during class (42.5%). With regard to communication, 61% of teachers with blended classes believed that communication between teachers was better or much better and 87% believed that communication between teachers, between teachers and parents, and between students was the same or better. In addition, 77.5% believed that they could monitor student learning better or much better, 64.1% indicated that they could manage the class better or much better, and 62.5% affirmed that self-efficacy and confidence of teachers was better.

The state of Florida, with the largest state virtual school in the nation, has a great deal of experience and data related to online learning. The initiative began in school year 1996-1997 with only 77 successful semester course completions, but by 2011-2012 the total had risen to

1,291,849 (Florida Virtual School, 2013b). During school year 2013-2014, the number of successful course completions passed the 2 million mark with 433,994 completions in that year alone (Florida Virtual School, 2014). The school offers a number of options for students both by way of fully online learning and blended learning (Florida Virtual School, 2013a). In addition, in 2015-2016, courses located at local high schools that also included a blend of online learning with face-to-face teachers were launched (Postal, 2015). In promotional materials, Florida Virtual School (2014) highlighted an eight percent advantage over state averages on 2014 Advanced Placement (AP) exams as well as higher performance than the state average on Florida state end-of-course benchmarks in Algebra 1, Geometry, Biology 1, and U.S. History. In fact, the difference was significant: full-time students in the virtual school averaged over six percent higher in benchmark performance in the four subjects, and part time students averaged more than nine percent higher.

In 2007, the Florida TaxWatch Center for Educational Performance and Accountability (2007) launched a comprehensive evaluation of the Florida Virtual School in an effort to determine its viability and credibility when compared to traditional schools. The study looked at both student achievement and cost effectiveness and found that regarding the former, in both reading and math virtual students consistently outperformed their traditional peers by large margins. In addition, in all but one instance, virtual student scores increased from one year to the next unlike students enrolled in traditional courses. Similarly, when Advanced Placement test results were analyzed, they showed in aggregate that the virtual students did better with an average of 2.89 compared to 2.54 in 2004-2005 and an average of 3.05 compared to 2.49 in 2005-2006.

Chingos and Schwerdt (2014) evaluated the academic performance of the Florida Virtual School using the data from 2005-2006 to 2008-2009. Although the data were unfortunately dated, it is worth noting that during that time the school had been in existence for years giving it sufficient time to establish an educational philosophy and many policies and practices that continue to the present. Also, during that span the virtual school had over 410,000 successful course completions and was already making a significant impact in Florida (Florida Virtual School, 2013b). Thus, while dated, the analysis is still valuable. The investigators compared students taking one or more courses through the virtual school with those taking no virtual courses and found that virtual school students had modestly higher scores. However, when the performance of the virtual school students was compared to how the same students had done before they had enrolled in the virtual school (i.e., the within-student relationship), no significant correlation was found in performance. When the attendance rates of those same students were analyzed, they were found to have had slightly higher attendance rates while taking virtual school courses than before they started; yet, the difference amounted to less than a day. When Algebra 1 and English 1 students were compared using scores on the Florida Comprehensive Assessment Test, the virtual school students performed better, but when the researchers introduced controls for past test performance, the difference between the two groups became statistically insignificant. Thus, the authors concluded that students in virtual courses did at least as well as those who were in traditional settings and perhaps a bit better. Moreover, they draw attention to the point that the virtual school appeared to be able to do this with greater cost efficiency.

Because of its correlation with student achievement, among the most important benefits attributed to blended learning is increased student engagement and satisfaction (Kavadella, Tsiklakis, Vougiouklakis, & Lionarakis, 2012). Researchers at New York City's much publicized School of One identified significant student achievement and student approval as well as high levels of teacher satisfaction with their blended approach (New York City Department of Education's Research and Policy Support Group, 2010). Yapiciy and Akbayin (2012) investigated student satisfaction in a blended high school biology class; students were highly satisfied particularly with the freedom to direct their own learning. The approach received high marks for giving students the chance to prepare in advance for lessons, review and repeat them as needed, asynchronously access related subject content, assess one's own understanding, and communicate with the rest of the class regardless of time or place. Thus, much of what students appreciated and highlighted took place far beyond the classroom because learning and classroom culture were no longer confined to its walls. Blended learning students respond positively to "interaction and communication opportunities, increased motivation, increased opportunities to voice their opinions" (Gedik & Yaşar Özden, 2012, p. 114). Students appreciate the social and inspirational aspects of blended learning. In short, the fact that blended learning provides so many additional options adds to its appeal, engagement, and ability to increase learning. Part of the rationale on the part of those designing blended learning is the systems will more highly engage students and motivate them to learn. Blended learning provides students with rapid and convenient access to extended scope and greater depth as they pursue their learning experiences in an individual zone of proximal development. As a result, designers expect students will be more likely to reach their learning goals (Ting & Chao, 2013). The combination of high student achievement and satisfaction on the one hand with teacher contentment on the other gives all the appearance of a system that qualifies as the kind of effective learning system described by Rhodes (2011).

Student interest and satisfaction impact a variety of factors, which in turn impact achievement. One early study noted correlations between the use of technology by students and better attendance and graduation rates, greater independence, and heightened responsibility for one's learning (Coley, 1997). Holley and Oliver (2010) suggested that among the reasons why blended learning engages students is because it offers them an opportunity to develop their own voices, think through new ideas in conversation with other students online, and try out their own ideas on others in an environment where they feel safe—thanks in large part to the relative anonymity afforded by the online context. Garrison and Kanuka (2004) suggested that in online academic discussion, "there is a greater focus on the substantive issues and less distraction or noise" (p. 99). The very fact that these development opportunities exist tends to encourage greater student engagement as they invest themselves in a safe variety of academic pursuit (Holley & Oliver, 2010). This would seem to be consistent with a Department of Education study (Means et al., 2010), which noted some empirical indication of "an advantage for giving learners an element of control over the online resources with which they engage" (p. 41). Evidence continues to mount that a student's attitude and perception of his or her academic self tend to grow in conjunction with the use of computer-aided instruction (Hannafin & Vermillion, 2008; Kulik, 1994; Mann, Shakeshaft, Becker, & Kottkamp, 1999).

Delialioğlu (2012) compared student experience and performance in a course taught with a blend of lecture and online instruction with the same course taught with a blend of problem-based instruction and online learning. The study showed that students judged both blends to be highly satisfactory; however, greater engagement occurred in the context of the problem-based learning blend. However, the study did not include for comparison either an unblended group taught only by lecture or one taught only by problem-based learning. Thus, when compared, engagement was higher for the problem-based learning blend; however, this should not be understood to mean that the lecture blend itself failed to engage the students.

Researchers have also identified other advantages of blended learning that associate it with effective learning environments and higher achievement. Striking a note that Vygotsky would appreciate, Hyo-Jeong and Bonk (2010) suggested an international and social advantage: properly implemented, blended learning enhances collaboration within classes and between classes and students throughout the world. After all, electronic communication and exchange means that the world of today is not nearly as big as the world of only a couple decades ago. Adding international friendships and collaboration to the learning process can magnify student interest and engagement.

Napier, Dekhane, and Smith (2011) suggested first that the blended model recognizes that at least some learning material can be delivered to learners as well or even better online as in the traditional classroom setting, and second that blended learning provides a flexible, asynchronous framework in which students can pursue learning at times when they are most ready to learn and according to their own schedule, as they are no longer bound by the synchronous timetable of the teacher. On the other hand, the circumstances and constraints of a specific blended learning implementation may or may not utilize this potential flexibility since models often specify the time and place when students are online. Nonetheless, the potential is there for students to schedule their own online learning activity.

An advantage that brings to mind Vygotsky's "more knowledgeable other" (Saxe, Gearhart, Note, & Paduano, 2002) and that has great potential impact for the crowded classroom as well as the ability of students to receive help from their teacher and/or peers (Blatchford et al., 2003) was offered by Francis (2012). In an era where many classes are large, he suggested that blended learning offers the best real-world solution for increasing engagement and therefore achievement in over-sized classes. Blended learning brings with it a variety of tools to increase engagement. Francis (2012) emphasized that even in the bloated classrooms that are common today, good teachers maintain student engagement in order to do their job of enhancing achievement. While the topic has generated innumerable studies and strategies, Francis argues the case for infusing into the classroom a combination of the right technology, appropriate large group instruction and management strategies, and effective blended learning strategies. Indeed, a careful comparison shows that some of the same concepts Francis advocated are practices at the heart of the highly regarded School of One operating philosophy.

The Costs of Online and Blended Learning

The history of free public education in America makes it impossible to overlook on the one hand the value and importance Americans place on education (Bankston & Caldas, 2009; Fife, 2013; Pulliam & Van Patten, 2007; Urban & Wagoner, 2013) and on the other the dramatic expense of offering education to every child for free (Bernardo, 2015; Federal Education Budget Project, 2015; Kena et al., 2014). The costs of providing this opportunity to all eligible citizens is the single greatest expense of local and state governments--$869.2 billion in 2012, according to the U.S. Census Bureau (Barnett, Sheckells, Peterson, & Tydings, 2014). Indeed, the expense is nearly double that of the second biggest expense faced by cities and states, public welfare ($485.6 billion) (U. S. Census Bureau, 2014). While one may somewhat rarely encounter an opposing viewpoint in academic circles (Kenny, 2015), one is far more likely to see references to the advantages, economic and otherwise, that education brings with it (Pew Research Center, 2014; Prothero, 2015; Rothwell, 2015). Yet, offering so much for free remains an expensive enterprise, and the pressure of that expense has a significant impact on classroom issues such as the pedagogic models at the heart of this study.

Not only is public education expensive, it is increasingly so. Hanushek and Rivkin (1996) demonstrated some years ago that in the 100 years from 1890 to 1990, the real per capita spending rose three percent each year. Scafidi (2012) highlighted the U.S. Department of Education statistics that show that after adjusting for inflation to maintain constant 2013 dollar values, the cost of sending a student from kindergarten through grade twelve rose over 185% since 1970 when the cost was $57,602 to 2010 when the cost had risen to $164,426. Actual cost for educating each student in 2010 (adjusted for inflation to 2013 dollar values) was $13,871, which represented a drop from the high in 2009 of $14,090. Thus, for a class of 30 students—admittedly not the average class size, but also not at all uncommon in public schools—the total cost represented in 2010 would have been over $416,000 while a much more manageable class of 22 students would represent a cost of over $305,000 (Coulson, 2013). In Texas, the costs in terms of real 2007 dollars increased 107% from 1969 to 1989. In 1994, the average cost per student nationally was $7,504 and $6,486 in Texas; by 2004, it had risen to $9,266 per student nationally and $7,716 in Texas—a rise of 19% and 23.5% respectively (Lips, Watkins, & Fleming, 2008). Thus, average per pupil expenditures were less in Texas than those across the nation and the rate of expansion, while still significant, was 4.5% less than that nationally.

Such growing cost increases, likely as they are to continue into the future, certainly impact matters of classroom pedagogy in Texas and beyond. One government projection suggested that between 2009 and 2023, one can expect to see an increase in expenditures of 27% (Hussar & Bailey, 2014). This financial pressure means that anticipated cost increase or savings must always be carefully weighed, including those associated with the blending of online educational components with the traditional classroom model, which is at the heart of this study.

Without question, one of the factors involved in the growth observed in the rate of educational spending over time has been the increase in the number of school employees. Scafidi (2012) highlighted information from the U.S. Department of Education Statistics that revealed that while United States public school students increased by 96% from 1950 to 2009, the number of school employees grew 386%—four times as fast—during the same time.

Similarly, Burke (2012) noted that since 1970 there had been an eight percent growth in the number of students; however, the number of school employees rose at a rate 2.3 times that. The number of teachers had risen by 60% and that of non-teaching personnel by 138%. She also pointed out that the number of teachers rose by 32% and that of other staff and administrators grew 46%—a rate 2.7 times that of the student growth rate (Burke, 2012). Whether such a large increase is justified is beyond the scope of this study; however, what is clear is that in a system where human capital composes such a large share of the budget, the swelling of the ranks of school employees makes a heavy contribution to the financial pressure felt by schools. Moreover, any reduction in the number of employees is likely to provide benefits and relief that will quickly impact school budgets.

While providing education to all eligible students represents a very large and rapidly growing expense for the United States—due in part at least to the fact that staffing has increased at a much higher rate than student enrollment—no parents or students pay tuition as such. This is the essence of what it means to offer a free public education to all students. Nonetheless, the great and growing expense of educational services increasingly leads schools to pass a variety of costs and fees on to parents (Gellman, 2013). As a result, parents whose students attend school tuition free still find themselves covering the costs for such things as calculators, computers, extracurricular activities, college preparation services, transportation, and special occasion activities including trips, proms, and even graduation (Hopkins, 2012). These costs and fees mean that even though local, state, and federal government spending on public education has increased dramatically, it does not represent all spending on public education. In some places, this has raised questions about whether public education should still be considered free at all (Gellman, 2013); specifically, how much incidental cost do parents have to pay for their children to attend public school before it is no longer considered free?

Another factor that deserves notice is public school cost variance. Using somewhat different metrics than the Census Bureau, the National Center for Education Statistics said that in school year 2010-2011, America spent $632 billion to fund public elementary and secondary education in the United States. Using the Consumer Price index to adjust for the change in the value of the dollar, school districts across the nation spent an average of $12,608 for each individual student; however a great variation of per pupil expenditures exists among states, school districts, and individual schools (Kena et al., 2014). In addition, spending among school districts in the same state and even among schools within the same district differs considerably (Federal Education Budget Project, 2015). Such variations have been among the factors leading to lawsuits over public school financing for decades.

While charter schools also offer a tuition-free education and are as much public schools as traditional public schools, they spend considerably less per student with an average of just $7,658 per year (The Center for Education Reform, 2014). However, there is great variation here, as well. It is worth noting that per capita charter school spending can range from less than $4,500 to more than $9,501, the average of $7,658 is actually $527 less than the average cost, and the difference is made up primarily through fundraising (The Center for Education Reform, 2014). Thus, charter schools that invest heavily in raising funds through private contributions—which is common in some charter management organizations such as KIPP—may spend substantially more per student than those that do little or no fundraising. Schools struggling with rising costs on the one hand and accountability regulations on the other find methods and pedagogies that offer the possibility of higher achievement at a reduced expense to be very attractive.

While the high cost of education is obviously problematic for all schools, it should be equally obvious that schools which receive relatively less funding face an even greater challenge. This is certainly true for charter schools. Historically and on average, charter schools operate with substantially less funding than traditional public schools; in 2006-2007 the average disparity was $3,727 or 27.8% (Batdorff, Maloney, & May, 2010). In 2011, a Bellwether Education Partners report revealed that charter schools were receiving 19% less funding than other public schools, and that the variation ranged from 41% in Washington, DC, on the high side to 5% in Indiana on the low (Lozier & Rotherham, 2011). A more recent analysis of 2011 data by the Department of Education Reform at the University of Arkansas, revealed that the disparity stood at $3,509 (Batdorff et al., 2014). Methodological differences between these studies account for some of the differences in the conclusions presented, but the results indicated that substantial disparity exists between the funding that charter schools receive and that which other public schools receive. Thus, while all public schools must face the challenges presented by high and increasing costs, charter schools find that they are expected to produce at least equal results—though preferably better—while operating at a distinct funding disadvantage.

The average funding for charter schools in Texas, the state where this study is focused, falls short of that for other Texas public schools. Specifically, charter schools receive funding that is $1,017 or 10% less per student per year than other public schools; not to be overlooked is the fact that this is in a state already near the bottom in state rankings based on expenditure (McGaughy, 2015). Such funding disparity increases the challenges charters face to complete their educational mission and successfully achieve accountability standards (Colorado League of Charter Schools, Texas Charter Schools Association, & National Alliance for Public Charter Schools, 2011). Again, charter schools are expected to do at least as well as other public schools on state achievement tests although the state provides them with far less funding. This means they must be both financially and educationally astute to survive. Anything that can lower costs while maintaining or increasing achievement will always capture the interest of charters whether they be in Texas or elsewhere.

While traditional classroom learning continues to reign supreme in schools all over the world, growing numbers of schools have embraced alternative models that utilize online learning in some fashion (Vaughan, 2010). Educational opportunities from the graduate level and beyond (UMassOnline, 2007) down even to the preschool level (Strauss, 2015), and including all levels in-between (Kwan, Fong, & Wang, 2010) are choosing to utilize online learning; in the process, schools have invested unprecedented funding in educational technology assuming that it will produce positive results (Barrow, Markman, & Rouse, 2009; Li, Atkins, & Stanton, 2006; Machin, McNally, & Silva, 2007; Silva, Milkman, & Badasyan, 2016) in spite of occasional warnings that it may not (Belo, Ferreira, & Telang, 2014; Goolsbee & Guryan, 2006; Hazlett, Schwall, & Wallsten, 2016; Leuven, Lindahl, Oosterbeek, & Webbink, 2007). In 2008, Nagel predicted that the spending on education technology in 2012 would top 56 billion dollars (Nagel, 2008). However, another study estimated the total expenditure on such educational endeavors in 2011 to be just under 74 billion dollars and predicted that between 2012 and 2017, spending would increase to 220 billion dollars—a compound growth rate of over 20% per year (Song, 2014). A survey found school districts were demonstrating a marked optimism regarding upcoming expenditure on technological resources: almost 90% anticipated expenditures in the 2014-2015 school year to be as much or more for hardware, software, teacher training, and technical support as in the previous year ("K-12 market research finds strong ed-tech budgets and optimistic outlook for 2015," 2015). Nearly half of all high schools represented in the survey indicated that they already had rolled out substantial implementation of a 1:1 computer to student program. Over a third of middle schools and fully a fifth of elementary schools indicated the same ("K-12 market research finds strong ed-tech budgets and optimistic outlook for 2015," 2015).

Institutions use much of their online expenditures to provide access to a variety of online learning options that are delivered over the Internet. Costs can be substantial, but schools justify the investment on the basis that it will lead to increased student achievement and reduce overall costs in an era of financial strictures; however, they may take much of this on faith without much regard for what research might say.

Blended learning has been quickly embraced and widely believed to be a successful and cost-effective avenue to increased student achievement since the term came into use in 2000 (Bernard et al., 2014). Oliver & Stallings (2014) drew attention to “many studies” (p. 58) that compared blended learning to traditional classroom learning and found blended learning to be equivalent or even more effective. The Sloan Consortium reports (Allen & Seaman, 2008; Picciano & Seaman, 2007) estimated that between the 2005–2006 school year and that of 2007–2008, the number of public school students who enrolled in online courses grew 43%, from 700,000 to over one million. As a result, blended learning has grown such 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, 78% of those that did also incorporated some blend of online learning with traditional classroom learning experiences for the students involved, and an estimated total of 1.8 million students enrolled in blended learning courses (Queen & Lewis, 2011). By 2013, an annual report highlighted the fact that "at least 24 states and Washington DC have blended schools" (Watson et al., 2013, p. 5). They also pointed out that many charter schools are numbered in that group.

While charter schools share much in common with traditional public schools including the need to increase achievement to meet state accountability measures, the state and federal funding of charters falls significantly short of that provided to traditional schools (Maloney, Batdorff, May, & Terrell, 2013). Forced to operate with less funding while still required to produce equally high levels of student achievement, they must be creative yet judicious as they choose where to invest their funds to best overcome challenges. In the face of economic and academic pressures, these charter schools have chosen to invest their scarce funds in technological tools that allow them to blend traditional classroom learning with that available online (LaFrance & Beck, 2014)—presuming with their non-charter public school counterparts that this is an effective route to higher student achievement (Clark, 2012).

Recent research suggests that purely online learning is nearly equal in effectiveness, but is far less costly than traditional classroom learning (Battaglino et al., 2012). Research also indicates that blended learning, which combines the advantages of online learning (engagement, self-adjusting differentiation, etc.) with the benefits of classroom instruction (social impact on learning, access to proximate help, etc.), tends to produce significantly greater achievement, but at a higher cost (Clark, 2012). Thus, interest in blended learning that is financially feasible is high, particularly among schools with fewer financial resources such as charter schools. Charter schools, challenged typically with lower funding than traditional public schools, face the significant problem of creating a blended learning system that produces increased achievement outcomes at the same or lower cost as current systems and which is also sustainable (Chamberlin & Powers, 2010). Gronberg et al. (2012) pointed out that non-charter public schools in Texas receive funding from a number of additional sources including cost-of-education index (CEI) adjustments for schools located in high-cost areas, small and midsized district adjustments for districts without the benefits that accompany greater numbers of students, higher enrichment tax rates if they choose, and a number of programs that assist with the costs of facilities. Charter schools, however, "have neither a CEI nor an enrichment tax rate and are not eligible for the district size adjustments or the facilities aid programs" (Gronberg et al., 2012, p. 306). Thus, they must maintain a high degree of cost-consciousness at every level.

The available research does not provide an unambiguous answer to the question of whether blended learning costs more or less than the traditional classroom model. Harnisch and Taylor-Murison (2012) suggested that one of the reasons why blended learning is on the rise seems to be the perception that blended learning is an effective way to manage costs and resources. At least in some contexts, blended learning has provided cost savings (Lothridge, Fox, & Fynan, 2013). Perhaps a bit unrealistically, Dalsgaard and Godsk (2007) suggested that it is necessary to expand the number of students and schools who use blended learning, whatever it costs, simply because the academic gains and increased growth that occur in blended learning far outweigh the investment. Unfortunately, the current and anticipated educational economic scene requires a more careful consideration of return on investment.

While they do not report the total costs per student, Barbour (2012) noted that in Florida, the Florida TaxWatch Center examined the finances of the Florida Virtual School and determined that in the school year 2003-2004, the cost effectiveness of the virtual school over the traditional model was $284; in 2006-2007, it grew to $1,048. Had capital outlay expenses been included in the formula used to determine cost effectiveness, the authors suggested that the virtual school cost effectiveness would have been even higher. Thus, at that time it cost over $1,000 less for a student to attend the virtual school than a traditional school in Florida. However, in a report to the joint budget committee of the Colorado state legislature in 2004, Hausner, representing the virtual schools in Colorado, clearly indicated that while Colorado had found it more expensive to educate through the virtual school, over time the costs were expected to drop substantially (Hausner, 2004).

In 2005, the Ohio legislature determined that the cost per student for those attending the five virtual schools in the state was $5,382 compared to $7,452 in their five charter schools and $8,437 in traditional schools (Barbour, 2012); thus, virtual school cost per student was far more cost-effective at more than $3,000 or 36% less. However, in 2006, the BellSouth Foundation released a report (Anderson, Augenblick, DeCesare, & Conrad, 2006) they commissioned through Augenblick, Palaich, and Associates on the cost and funding of setting up and maintaining a virtual school. The study took a primarily professional judgment approach that gathered data from experienced professional educators as the basis for their conclusions, though they also had other experts review the findings before publication. They concluded that the costs did not differ much between a virtual school and a traditional school, that startup costs were about $1.6 million, and that cost per student thereafter ranged from $3,650 to $8,300 per student. However, they went on to affirm that the study did not account for the costs of capital expenses or transportation and that if it had, "the costs of operating virtual schools would have been less per pupil than brick-and-mortar schools" (Anderson et al., 2006, p. 5).

Yet, according to one fully online charter school representative, Lisa Gillis of Insight Schools (a subsidiary of the Apollo Group), during school year 2008 to 2009 when one unidentified state was spending $9,760 per student for traditional school children, the cost to educate a child in their virtual school was only $6,480 (Barbour, 2012). Again, this represents a huge cost differential, a difference of over $3,200 and 34%. The results of a survey of directors for 20 virtual schools in 14 states in 2008 indicated that the average cost per student was $4,310 at a time when the U.S. average was $10,259; in addition, only one virtual school had costs that exceeded its state average (Cavanaugh, 2009).

Barbour (2012) drew attention to the fact that identifying and breaking down the costs to educate a student in a virtual school has been complicated by the fact that often a private company provided the services and the funding details regarding the profit margin were not made public. However, when K12 Inc. opened a charter for Michigan in 2010, state regulations requiring the publication of cost data indicated that the endeavor cost $7,205 for each student compared to the far higher cost of educating a traditional student that same year, over $10,643 (“Education spending per student by state,” 2015). Another Michigan charter school characterized as an in-district charter and focused on serving at-risk students took a somewhat different approach to virtual education by requiring the students to spend five hours each day in the distance education lab. In the 2009-2010 school year, it cost 16% less per student than it did to educate traditional students (Barbour, 2012).

The Commonwealth Foundation published a report in 2011 representing a clearly positive perspective on fully online and blended learning schools that saw them as institutions that transform student lives (Abraham & Benefield, 2011). The report argued that during the 2009-2010 school year, virtual schools in Pennsylvania recorded an average expenditure of $10,935 per student, while traditional school districts in the state expended $14,315; thus, virtual schools cost about 76% of what traditional schools cost. However, in 2012, The Center for Public Education in conjunction with the National School Boards Association, expressing a less favorable view of virtual schools, argued based on state auditor reports that the difference in terms of actual cost to educate a student was only about $2,000 less for virtual schools (The Center for Public Education, 2012). Still, the difference is substantial.

Researchers found similar differences in a Fordham report from the same year (Battaglino et al., 2012), which concluded that both fully online and blended learning cost less on average per student than the traditional counterpart: from $5,100 to $7,700 in fully online schools, from $7,600 to $10,200 in blended learning schools, and $10,000 for traditional schools. One critic of the report, Rice (2012) found problems with "lack of clarity surrounding the models being studied and its methodological shortcomings limit its utility" (p. 5). Rice objected to the report's failure to use research literature, its confusing use of terms, and its methodological problems including "the data sources, the models studied, the shortcomings in the cost analysis, and the grounds for cost comparisons" (p. 4).

However, the approach of the Fordham report researchers appears to be straightforward enough: they offer it as a report on the descriptive research conducted and not a comprehensive record of that research, nor—at only 14 pages—is it given in full study form. Descriptive research is a type of research in which one seeks to understand and report characteristics of something that exists now or has existed in the past, and descriptive studies may differ in complexity as well as methods of data collection and analysis (Lauer, 2006). The descriptive researcher investigates what, how, and/or why something is happening or has happened (Lauer, 2006) and is free to use a variety of research methods as appropriate to collect quantitative and/or qualitative data (Boudah, 2010). The authors of the Fordham report clearly stated that the conclusions of the report were drawn "from interviews with more than fifty entrepreneurs, policy experts, and school leaders" (Lauer, 2006, p. 2). It is clear that these interviews produced quantitative data when the researchers explained that the interviews "informed the set of estimates regarding the cost of virtual and blended schools across a number of categories" (Lauer, 2006, p. 2). They go on to emphasize that the report does not provide a definitive answer on costs, but are intended to provide a helpful starting point for further inquiry in an area characterized by a paucity of quality data and research.

Both the Fordham report and a point-counterpoint exchange by Barbour and Powell (2012) helped to make sense of the variety found in the data regarding the per capita cost of educating a student in a virtual school as opposed to a traditional, brick and mortar school. The Fordham report explained the variation in the literature regarding cost by noting that like cars, blended learning programs can come in a variety of levels and quality (Battaglino et al., 2012). Indeed, in this regard, the variations in cost for virtual education parallel those observed throughout K-12 education where between and within states and even districts significant cost variations can be observed (Federal Education Budget Project, 2015).

In their exchange over the cost effectiveness of virtual schools when compared to traditional schools, Barbour and Powell (2012) argued their cases from the same list of sources and agree that the data is incomplete. Yet, in the final analysis, even allowing for the fact that the data is not as complete as one might wish, Barbour (2012) was able to substantiate through the data that does exist that virtual schools, in many instances, operate at a far lower cost than their traditional counterparts, or-profit organizations, in many instances, are able to operate virtual schools for less, and the substantial variation in costs from one virtual school to another is simply due to the fact that different schools include different levels, elements, approaches, and quality. On the other hand, even if Powell (2012) was found correct in concluding that the costs are basically the same for both virtual and traditional schools, if the academic results of virtual education could be shown to be greater, then there would still be impetus to embrace online learning.

Published research has more often focused on pedagogy and student learning outcomes than matters such as cost effectiveness and access to the blended learning system (Halverson et al., 2012). This is unfortunate since cost effectiveness in the current educational economy is such a serious systemic consideration, and initial technology setup costs can be an insuperable barrier to launching a blended learning system. Access is also impacted by this fact since a classroom with only a few computers cannot support a functional blended learning system. In addition, students who are limited to computer usage only in the classroom are unable to derive the benefits that come with a fully operational blended learning system which allows access nearly anytime and anywhere. As it is, many researchers seem to assume the availability of technology on a scale impossible for many impoverished school systems.

Some suggest that a solution to this problem may soon be found in the rise of blended learning systems that integrate mobile phones and other mobile devices into a larger blended learning system. The indisputable fact is that cell phones are far more common among students than computers or tablet devices. This is even true among many very poor students from households living below the poverty level. For them, as for their peers, a cell phone represents their primary means of communication and entertainment. The rise of smartphones that are capable to connecting to and browsing the Internet has made it possible to use these myriad devices for learning. Yet, it remains an unanswered question whether such devices with their small screens, fonts, and keyboards can perform well enough to sustain an effective blended learning system. The fact that the small size of these components does not currently discourage use for various activities by students today may be telling (Kalinic, Arsovski, Stefanovic, Arsovski, & Rankovic, 2011).

The Personalization of Online and Blended Learning

One of the reasons blended learning has become such a prevalent educational phenomenon today and one of the means by which it contributes to an effective learning environment is through the availability of adaptive software learning programs. Rather than a linear presentation of content and concepts that is the same for each student, adaptive instruction responds to student input by adapting the content, concepts, and even the presentation to give the student a custom-tailored learning experience. Certainly, blended learning—like every other learning model—brings its own instructional challenges, but a carefully constructed blended system carries several advantages. It allows a student’s choices to determine what content and concepts come next and adjusts the material to make it more challenging when student input evidences understanding and more supportive when student choices indicate a lack of understanding. This means that a student can be kept in a customized zone of proximal development—the appropriately challenging level of learning identified by Vygotsky. In the process, student and teacher are provided both a conceptual and practical delivery method for learning and teaching (Abdelaziz, 2012). Teachers have for many years sought to differentiate their instruction to meet each of the students at their own level of understanding and development. Sometimes teachers have even claimed to differentiate their content and classes

(Tomlinson, 2015); however, every teacher knows that it is simply not possible to be all things to all students (Delisle, 2015). In an ideal world with a tutor for every student, perhaps differentiation would be possible. However, in the modern classroom, computers and adaptive learning instruction become personal tutors and make it possible to provide truly customized differentiation. The computerized instruction becomes the one-on-one tutor that every student needs to push, reward, and review concepts and content. In a blended context, where the software fall short and the help of a human teacher is needed, one is available.

Summary

Despite the internecine disputes discussed above regarding such things as definitions, advantages, costs, and technologies associated with blended learning, the topic has captured the popular attention. Because blended learning has been in the spotlight, but perhaps more importantly because it is so readily implemented in one form or another due to the widespread accessibility of computer technology in the classroom, its popularity has quickly grown throughout the educational systems of the world. As a result, it has attracted a great deal of attention among researchers who have begun the lengthy process of empirical investigation necessary for thorough analysis. Proponents argue that initial studies indicate that blending student learning produces higher achievement and carries numerous advantages in addition to the cost efficiency that is so important for schools today. Studies document successful results for blended learning in contexts as varied as Turkish business courses, Serbian mobile learning projects, and perhaps even KIPP kindergarten classes (Dzakiria, Wahab, & Rahman, 2012; Kalinic et al., 2011; Roth, 2012). Yet, while initial studies look promising, a significant body of literature focused on the impact of blended learning on achievement in K-12 schools and charter schools sufficient to inform decisions about its value in that context does not exist. Indeed, some studies fail to sustain the hypothesis that blended learning produces superior results (Pace & Mellard, 2016).

CHAPTER THREE: METHODS

Design

This quantitative study was conducted with a causal-comparative design as it investigated whether blended learning improves the State of Texas Assessments of Academic Readiness (STAAR) math and reading achievement of students in a charter school context while using a covariate to control for pretest score. Such a design was justified because this was a non-experimental research study to compare multiple groups with a view toward identifying potential correlation between the variables (Creswell, 2013). Furthermore, this design was justified by the fact that no manipulation of the independent variable was possible (Gall, Gall, & Borg, 2009). The independent variable was the type of learning environment: fully online learning, traditional classroom learning, and blended learning. Fully online learning is a method of course delivery where nearly all learning activities are facilitated or delivered through the Internet (Staker & Horn, 2012). Traditional classroom learning is characterized by face-to-face and direct teaching by a teacher with no significant online learning (Staker & Horn, 2012). Blended learning incorporates elements of traditional classroom learning but combines them with online teaching and learning activities (Staker, 2011). The dependent variable was 2014 STAAR test scores and the covariate was 2013 test scores. Neither the independent variable, the course delivery system, nor the dependent variable, STAAR test scores, was or could be manipulated because in each case the variables represent decisions and events in the past and beyond influence by the researcher.

Research Questions

RQ1: Is there a difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading portion of the State of Texas Assessments of Academic Readiness test?

RQ2: Is there a difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the math portion of the State of Texas Assessments of Academic Readiness test?

Null Hypotheses

$H_0$1: There is no difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading portion of the State of Texas Assessments of Academic Readiness test while controlling for pre-test scores.

$H_0$2: There is no difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the math portion of the State of Texas Assessments of Academic Readiness test while controlling for pre-test scores.

Participants and Setting

Population

The population for the study consisted of charter school students located in Texas who took State of Texas Assessment of Academic Readiness tests in reading, math, or both in 2013 and 2014. All students in the study were in a single charter school district located in the State of Texas and managed by the same non-profit charter management organization. Students included in the study were selected if they matched the criteria for the groups described below. All traditional learning students and blended learning students came from brick and mortar schools; all fully online students came from a virtual school. The brick and mortar schools included in the study were located in a variety of contexts. Some were urban, others suburban, and some were located in small towns. Demographic information for the brick and mortar school population is provided in Table 1. Likewise, the virtual school also includes students from various settings scattered throughout the State of Texas. Demographic information for the virtual school population is provided in Table 2.

Table 1

Brick and Mortar School Student Information

Student Information	Brick and Mortar Schools		State	
	Count	Percent	Count	Percent
Total Students	6,523	100.0	5,135,880	100.0
Students by Grade				
Early Childhood Ed.	7	0.1	12,304	0.2
Pre-Kindergarten	7	0.1	225,664	4.4
Kindergarten	910	14.0	391,421	7.6
Grade 1	940	14.4	409,208	8.0
Grade 2	832	12.8	394,217	7.7
Grade 3	762	11.7	389,813	7.6
Grade 4	649	9.9	383,388	7.5
Grade 5	540	8.3	382,742	7.5
Grade 6	435	8.2	376,456	7.3
Grade 7	336	5.2	385,387	7.5
Grade 8	302	4.6	379,597	7.4
Grade 9	353	5.4	408,020	7.9
Grade 10	142	2.2	362,356	7.1
Grade 11	167	2.6	330,064	6.4
Grade 12	79	1.2	305,243	5.9
Ethnic Distribution				
African American	1,003	15.4	650,919	12.7
Hispanic	1,877	28.8	2,660,463	51.8
White	3,012	46.2	1,511,700	29.4
American Indian	27	0.4	20,142	0.4
Asian	331	5.1	189,483	3.7
Pacific Islander	11	0.2	6,778	0.1
Two or More Races	262	4.0	96,395	1.9
Economically Dis.	2,407	36.9	3,092,125	60.2
Non-Econ. Dis.	4,116	63.1	2,043,755	39.8
ELL	456	7.0	899,780	17.5

Discip. Placements	0	0.0	82,653	1.6
At-Risk	1,460	22.4	2,562,457	49.9

Notes. Economically Dis. = Economically Disadvantaged, Non-Econ Dis. = Non-Economically Disadvantaged, ELL = English Language Learner, = Discip. Placements = Disciplinary Placements.

Table 2

Virtual School Student Information

	Virtual School		State	
Student Info	Count	Percent	Count	Percent
Total Students	5,999	100.0	5,135,880	100.0
St. by Grade				
Grade 3	235	3.9	389,813	7.6
Grade 4	301	5.0	383,388	7.5
Grade 5	516	8.6	382,742	7.5
Grade 6	573	9.6	376,456	7.3
Grade 7	873	14.6	385,387	7.5
Grade 8	982	16.4	379,597	7.4
Grade 9	1,070	17.8	408,020	7.9
Grade 10	669	11.2	362,356	7.1
Grade 11	524	8.7	330,064	6.4
Grade 12	256	4.3	305,243	5.9
Ethnic Distr.				
African Am.	694	11.6%	650,919	12.7
Hispanic	1,585	26.4%	2,660,463	51.8
White	3,278	54.6%	1,511,700	29.4
Am. Indian	28	0.5%	20,142	0.4
Asian	132	2.2%	189,483	3.7
Pacific Isl.	8	0.1%	6,778	0.1
2/More Race	274	4.6%	96,395	1.9
Econ. Dis.	2,834	47.2%	3,092,125	60.2
NonEcon. Dis.	3,165	52.8%	2,043,755	39.8
ELL	82	1.4%	899,780	17.5
Discip. Place.	0	0.0%	82,653	1.6
At-Risk	1,981	33.0%	2,562,457	49.9

Notes. St. = Students, Ethnic Distr. = Ethnic Distribution, African Am. = African American, Am. Indian = American Indian, Pacific Isl.= Pacific Islander, 2/More Race = Two or More Races, Econ. Dis. = Economically Disadvantaged, NonEcon Dis. = Non-Economically Disadvantaged, ELL = English Language Learner, = Discip. Place. = Disciplinary Placement.

Sample

In this causal-comparative design, a reading sample of 1797 students and math sample of 2298 students for the study was drawn from a sample of charter school students located in Texas during 2013 and 2014. According to Gall et al. (2007), this sample size far exceeds the required minimum of 375 for a small effect size with statistical power of .5 at the .05 alpha level.

The sample included students from a traditional learning context, a fully online context, and a blended learning context. All students in the study had taken either the STAAR reading test in 2013 and 2014, the STAAR math test in both years, or both tests in both years. The 2013 tests serve as pretests and the covariant while the 2014 tests serve as posttests. Demographic information, STAAR test records, and student online participation records for the time period were accessible to this researcher through access rights granted by the charter management organization. The organization served as site for this study and as a part of the research process. This access made it possible to access information about the students and their scores for analysis and to place them in the designated groups.

Data to verify the amount of blended learning participation, if any, and to assign students to groups, was drawn from the records of the online provider. Data from the STAAR tests was accessed after all necessary approvals were received and the data was released by the Texas Education Agency. Results were statistically analyzed to identify differences between the groups in achievement after treatment.

Groups

Traditional

This group consisted of 239 students in reading and 298 students in math who attended a brick and mortar classroom at a school classified by the State of Texas as standard accountability and whose learning was by traditional classroom instruction. They did not participate in online learning. Demographic information for this group is provided in Table 3.

Table 3

Traditional Learning Students

	Math		Reading	
Student Info	Count	Percent	Count	Percent
Total Students	298	100	239	100
St. by Grade				
Grade 3	2	0.7	1	0.4
Grade 4	103	34.6	95	39.7
Grade 5	89	29.9	65	27.2
Grade 6	29	9.7	17	7.1
Grade 7	41	13.8	41	17.2
Grade 8	34	11.4	20	8.4
Ethnic Distr.				
African Am.	32	10.7	26	10.9
Hispanic	65	21.8	56	23.4
White	173	58.1	130	54.4
American Indian	1	0.3	1	0.4
Asian	13	4.4	14	5.9
Pacific Islander	1	0.3	1	0.4
2/More Race	13	4.4	11	4.6
Econ. Dis.	108	36.2	82	34.3
ELL	14	4.7	13	5.4
Discip Placements	00	00	00	00
At-Risk	51	17.1	38	15.9

Notes. St. = Students, Ethnic Distr. = Ethnic Distribution, African Am. = African American, 2/More Race = Two or More Races, Econ. Dis. = Economically Disadvantaged, ELL = English Language Learner, = Discip. Placements = Disciplinary Placements.

Fully Online

This group consisted of 637 students in reading and 1046 students in math whose learning was primarily online and who were enrolled in a virtual charter school. While these students may have had supplementary materials provided that were not online, the majority of their learning took place through accessing and interacting with the learning activities provided by a single virtual charter school provider. There was no alternative accountability counterpart to this group. Demographic information for the fully online students is provided in Table 4.

Table 4

Fully Online Learning Student Information

	Math		Reading	
Student Info	Count	Percent	Count	Percent
Total Students	1046	100	637	100
St. by Grade				
Grade 3	00	00	2	0.3
Grade 4	78	7.5	12	1.9
Grade 5	177	16.9	54	8.5
Grade 6	159	15.2	106	16.6
Grade 7	298	28.5	205	32.2
Grade 8	334	31.9	258	40.5
Ethnic Distr.				
African Am.	122	11.7	53	8.3
Hispanic	284	27.2	154	24.2
White	535	51.1	356	55.9
American Indian	7	0.7	5	0.8
Asian	47	4.5	40	6.3
Pacific Islander	3	0.3	2	0.3
2/More Races	48	4.6	27	4.2
Econ. Dis.	553	52.9	312	49.0
ELL	21	2.0	9	1.4
Discip. Place.	00	00	00	00
At-Risk	212	20.3	83	13.0

Notes. St. = Students, Ethnic Distr. = Ethnic Distribution, African Am. = African American, 2/More Races = Two or More Races, Econ. Dis. = Economically Disadvantaged, ELL = English Language Learner, = Discip. Place. = Disciplinary Placement.

Blended

This group consisted of 921 students in reading and 954 students in math attending a brick and mortar charter school classified by the State of Texas as a standard accountability institution whose reading and math instruction was blended. This study defines blended learning students as those attending brick and mortar schools where they receive traditional face-to-face instruction as well as online learning. Study Island, a product of Edmentum, Inc., provided the online learning for blended learning students in both math and reading. Demographic information for the blended learning standard and alternative accountability students is provided in Table 5.

Table 5

Blended Learning Student Information

	Math		Reading	
Student Info	Count	Percent	Count	Percent
Total Students	954	100	921	100
St. by Grade				
Grade 3	1	0.1	2	0.2
Grade 4	294	30.8	274	29.8
Grade 5	263	27.6	227	24.6
Grade 6	165	17.3	164	17.8
Grade 7	145	15.2	137	14.9
Grade 8	86	9.0	117	12.7
Ethnic Distr.				
African Am.	139	14.6	114	12.4
Hispanic	271	28.4	235	25.5
White	478	50.1	498	54.1
American Indian	3	0.3	2	0.2
Asian	27	2.8	31	3.4
Pacific Islander	00	00	00	00
2/More Races	36	3.8	41	4.5
Econ. Dis.	372	39.0	323	35.1
ELL	54	5.6	44	4.8
Discip. Place.	00	00	00	00
At-Risk	261	27.4	239	26.0

Notes. St. = Students, Ethnic Distr. = Ethnic Distribution, African Am. = African American, 2/More Race = Two or More Races, Econ. Dis. = Economically Disadvantaged, NonEcon Dis. = Non-Economically Disadvantaged, ELL = English Language Learner, = Discip. Place. = Disciplinary Placements.

Instrumentation

The independent variable in this study was course delivery method, of which there were three types: traditional classroom learning by face-to-face and direct teaching by a teacher with no blended learning, blended learning through a combination of face-to-face teaching and learning through online courses, and fully online learning where all coursework is delivered through the Internet. The dependent variables were achievement measured by scores on the State of Texas Assessments of Academic Readiness (STAAR) tests in reading and math. The two test instruments were used as a pretest and posttest.

The assessment tool used in this study, the STAAR test, is the Texas state-mandated, timed (four hours), criterion-referenced, and vertically scaled subject test developed by the Pearson Corporation. It is given to public school students in grades three through ten in the State of Texas during the spring with specific retest dates scheduled later for those who fail (Cadena, 2014). It is the instrument currently used for Texas state testing. It was first used in the spring of 2012 and was designed to provide a more rigorous replacement for the previous state test focusing on student content mastery rather than on minimum competency (Cadena, 2014). Notar, Herring, and Restauri (2008) pointed out that criterion-referenced tests are designed “to determine whether each student has achieved specific skills or concepts” (p. 121). As such, the purpose of the STAAR test instruments is to measure whether students have learned what is expected at each grade level for the subject tested. More specifically, the purpose of the STAAR test is to assess each student’s level of understanding of the state standards, the Texas’s Essential Knowledge and Skills.

The various STAAR tests utilized in 2013 and 2014 were paper and pencil tests for grades three through eight. They included from 40 to 56 questions depending on the subject and grade level and utilized multiple-choice questions with four answer options, short-answer questions, gridded questions, and thematically linked selections. Only reading and math scores were used in this study. Grades three through eight are all tested in both subjects.

Scores were scaled for the 2013 STAAR reading test in grades three through eight from a low of 729 in third grade (Texas Education Agency, 2013b) to a high of 2186 in eighth grade (Texas Education Agency, 2013d). The scores for the 2014 reading test were scaled from a low of 744 in third grade (Texas Education Agency, 2014b) to a high of 2177 in eighth grade (Texas Education Agency, 2014c).

In math, scores were scaled for the 2013 STAAR test in grades 3–8 from a low of 755 in third grade (Texas Education Agency, 2013a) to a high of 2233 in eighth grade (Texas Education Agency, 2013c). The 2014 math test for grades three through eight was scaled from a low of 754 for third grade (Texas Education Agency, 2014a) to a high of 2231 for eighth grade (Texas Education Agency, 2013c).

In accordance with the Texas Education Code, the Texas Education Agency utilized standard setting to determine cut scores and designate performance levels for STAAR exams (Texas Education Agency, 2013e). Three performance levels were established with Level I being the lowest and Level III the highest. Level I represents Unsatisfactory Academic Performance and students whose scores fall into this category have not passed or demonstrated adequate preparation for academic success. Level II represents Satisfactory Academic Performance, a passing score and a reasonable likelihood of academic success. Level III represents Advanced Academic Performance and includes students whose scores indicate they are well prepared and have a high likelihood of success (Texas Education Agency, 2013e). Precise cut scores for these performance levels at each grade level and in each subject of STAAR testing varies (Texas

Education Agency, 2013e); however, these designations are not a consideration in this study where the focus is on comparing scaled score means rather than categories.

Data collection for this causal-comparative study was completed by accessing the charter management organization records of the STAAR test scores for each student. Scores were gathered by identification number and assigned anonymous identifiers before they were entered into a statistical data shell. Neither teachers nor students needed to be contacted for these test scores.

The State of Texas takes careful measures to ensure the validity and reliability of all state-developed testing instruments, which are frequently reviewed by the TEA in addition to the federal government. A series of linking, comparison, correlation, vertical scale, and external validity studies was employed to establish STAAR test validity (Texas Education Agency, 2013e). Internal consistency was analyzed using Kuder–Richardson Formula 20 for the multiple-choice and gridded response tests and the stratified coefficient alpha for those tests that combined multiple-choice and gridded response items with extended constructed response items (Texas Education Agency, 2011-2012). Official Texas Education Agency (TEA) estimates for internal consistency of the STAAR range from 0.81 to 0.93 placing it in the very good to excellent range (Texas Education Agency, 2011-2012). Analysis of the validity of the STAAR, that is, the extent to which it measures what it is intended to measure, is a complex and continuous process that gathers information from "test content, response processes, internal structure, relationships with other variables, and analysis of the consequences of testing" in order to monitor and improve validity (Texas Education Agency, 2011-2012, p. 111).

While still relatively new, the STAAR has been used in several published studies (Anderman, Gimbert, O'Connell, & Riegel, 2015; Davis & Willson, 2015; Kuyatt, Holland, &

Jones, 2015; Montemayor, Kupczynski, & Mundy, 2015) as well as two unpublished studies (Green, 2013; Osuch, 2014).

Procedures

As soon as approval from Liberty University (LU) was received, an institutional review board (IRB) packet was submitted for approval from the LU IRB, and formal permission was requested of the participating charter school organization. IRB approval was routine and a copy of the approval letter is found in Appendix A. After all approvals were received, research began with the gathering of existing data from the STAAR reading and math tests. The STAAR test results data file was downloaded and distributed to authorized charter school management organization personnel (including the researcher) by the company's testing coordinator. The coordinator obtained the file from the test provider, Pearson ®, as soon as grading was complete for each of the subjects and grades tested. The data file was then processed by the researcher or others in the data department using a Microsoft Excel macro tool provided by the charter school Director of Standard Accountability which transformed the database file into a standard Excel file with one row per student and hundreds of columns. The columns identified details of student performance on all STAAR tests to date as well as enrollment and full demographic information on each student. Thus, the data file downloads from Pearson provided all of the STAAR information necessary for the proposed study including the identification of which students were in the same charter school system for both the 2013 and 2014 STAAR exams—a prerequisite for inclusion in this study—and identification of the specific charter school that the student attends. The latter is important in that it identified which students were fully online learners enrolled in the charter school organization's online school and which attended classes at one of the company's physical locations.

The latter category, students attending physical charter school locations, included both students who were taught using blended learning and students who were taught traditionally. These students cannot be distinguished based on the Pearson data file alone but must be identified using the records available in the online blended learning system. All the student usage data was downloaded in Microsoft Excel format after logging in at the provider website. Since different providers use different identification systems, once the data was downloaded in Excel format, students had to be identified either by identification number or by a combination of campus location and student name.

Once all data was downloaded and converted where necessary to Microsoft Excel format, it was combined and integrated into a single Excel file that contained all 2013 and 2014 scores from the State of Texas Assessments of Academic Readiness tests in reading and math for every student in the charter school management organization as well as the amount of time (if any) that each student spent in the online learning system focused on math and/or reading. At that time, student records of online learning could be analyzed to identify the students whose learning was blended and those whose learning was traditional in nature and distinguished them from those students whose learning was completely on-line.

No additional special training was necessary to gather or analyze the data except for that required to use Microsoft Excel and IBM SPSS. No additional contacts were made to obtain the student data as they were readily accessible to the researcher by the administrative position held. No additional consent or permissions were required to access the data; however, a formal request for permission to use the data for doctoral research was submitted and is found in Appendix B.

Data Analysis

Using SPSS Statistics Version 24, a one-way between-subjects analysis of covariance (ANCOVA) was used to test each null hypothesis (Johnson & Christensen, 2013). A level of significance at $p < .05$ was used for all analyses in the study to test the null hypothesis. The partial eta squared statistic was used to calculate effect size (Cohen, 1988). Since random selection of students was not possible, it is impossible to know whether the groups were equivalent prior to the treatment. This selection bias seriously threatens the internal validity of the study design. Including the covariate, the 2013 STAAR pretest, in the analysis increases both statistical power and control so long as the covariate used clearly influences the dependent variable (Cohen, 1988; Gall et al., 2009; Johnson & Christensen, 2013).

Since ANCOVA can be very sensitive to outliers (Gall et al., 2009; Mertler & Vannatta, 2009), data was screened using a box and whisker plot for each variable. If a *z*-score was greater than +3.00 or less than -3.00, it was treated as an outlier (Mertler & Vannatta, 2009). Each of the assumptions for ANCOVA was investigated. Since the sample size exceeded 300, while the assumption of normality was tested using Kolmogorov-Smirnov (Burdenski, 2000; Rovai, Baker, & Ponton, 2013), it was followed by histograms and Q-Q charts as appropriate for the sample size (Kim, 2013). The assumption of linearity was tested by a series of scatterplots between the pretest and posttest variables for each group (Gall et al., 2009; Rovai et al., 2013). For homogeneity of equal variance, Levene's test was used to determine whether there were differences in the variance of pretest and posttest scores (Rovai et al., 2013). The assumption of homogeneity of slopes required that the regression slopes be checked for significant interaction (Rovai et al., 2013). In instances where the data failed the assumptions for ANCOVA, a variety of options exist depending on the assumptions at stake (Lomax & Hahs-Vaughn, 2013) and appropriate action may be taken guided by the literature.

Microsoft Excel 2016 was used to collect data and strip it of all personally identifiable information to ensure confidentiality and to determine the appropriate course delivery classification for each student: blended learning, face-to-face traditional classroom learning with no participation in blended learning, or fully online learning.

CHAPTER FOUR: FINDINGS

This chapter provides the statistical information, analysis of the data, and results. It includes the steps taken to screen the data and evaluate it considering the assumptions of analysis of covariance (ANCOVA). It also provides a rationale for changing from an analysis of the data using ANCOVA to that using analysis of variance (ANOVA) instead.

Research Questions

The research questions for this study were:

RQ1: Is there a difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading portion of the State of Texas Assessments of Academic Readiness test?

RQ2: Is there a difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the math portion of the State of Texas Assessments of Academic Readiness test?

Null Hypotheses

The null hypotheses for this study were:

$H_0$1: There is no difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading portion of the State of Texas Assessments of Academic Readiness test while controlling for pre-test scores.

$H_0$2: There is no difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the math portion of the State of Texas Assessments of Academic Readiness test while controlling for pre-test scores.

Descriptive Statistics

The data used for this study came from two primary sources: State of Texas Assessments of Academic Readiness (STAAR) test results for 2013 and 2014 and the record of student activity for the 2013-2014 school year downloaded from the online learning provider. The covariate *2013 STAAR scale scores*, dependent variable *2014 STAAR scale scores*, and adjusted means for *2014 STAAR scale scores* for math can be found in Table 6 and for reading can be found in Table 7. Based on the descriptive statistics, mean *STAAR scale scores* for each of the three groups, the traditional classroom, fully online classroom, and blended learning classroom groups, increased from the pretest to the posttest.

Table 6
Descriptive Statistics for Dependent Variable and Covariate: Math

Variables	Group	Mean	S.D.	*N*
Traditional Learning	2013 STAAR Scale Score	1534	152.6	310
	2014 STAAR Scale Score	1589	141.9	313
Fully Online Learning	2013 STAAR Scale Score	1539	140.2	1070
	2014 STAAR Scale Score	1590	132.0	1076
Blended Learning	2013 STAAR Scale Score	1527	144.2	982
	2014 STAAR Scale Score	1599	134.6	986

Table 7
Descriptive Statistics for Dependent Variable and Covariate: Reading

Variables	Group	Mean	S.D.	*N*
Traditional Learning	2013 STAAR Scale Score	1601	152.7	240
	2014 STAAR Scale Score	1540	144.1	239
Fully Online Learning	2013 STAAR Scale Score	1677	102.7	639
	2014 STAAR Scale Score	1710	99.5	638
Blended Learning	2013 STAAR Scale Score	1610	132.2	922
	2014 STAAR Scale Score	1554	143.4	922

Results

Data Screening

Before further analysis began, the data was screened to check for missing information, outliers, and data inconsistencies using the procedures recommended by Green and Salkind (2013). Data screening was conducted on the independent variable (traditional learning, fully online learning, and blended learning), the covariate (2013 STAAR scale scores), and the dependent variable (2014 STAAR scale scores). No data errors or inconsistencies were identified. However, the box and whisker plots revealed several outliers in both the covariate and the dependent variable for both math and reading.

For the covariate for math, 2013 STAAR scale scores, the box and whisker plot displayed outliers in each treatment group. Visible in the box and whisker plot, the blended learning group had eight mild outliers on the high side, the traditional learning group had four mild outliers on the high side in addition to one mild and two extreme outliers on the low side, and the fully online learning group had eight mild outliers on the high side in addition to two mild and one extreme on the low side. No clear explanation for these outliers could be identified from the data set. To further investigate them, the researcher produced standardized *z*-scores for this variable and found that all but 13 fell within normal range (between -3.00 and +3.00) (Mertler & Vannatta, 2009). The outliers were excluded due to the sensitivity of ANCOVA and ANOVA to outliers (Gall et al., 2009; Mertler & Vannatta, 2009). The lowest *z*-score was -4.72 and the highest *z*-score was 3.45. Figure 1 includes the box and whisker plots for the 2013 scores by group.

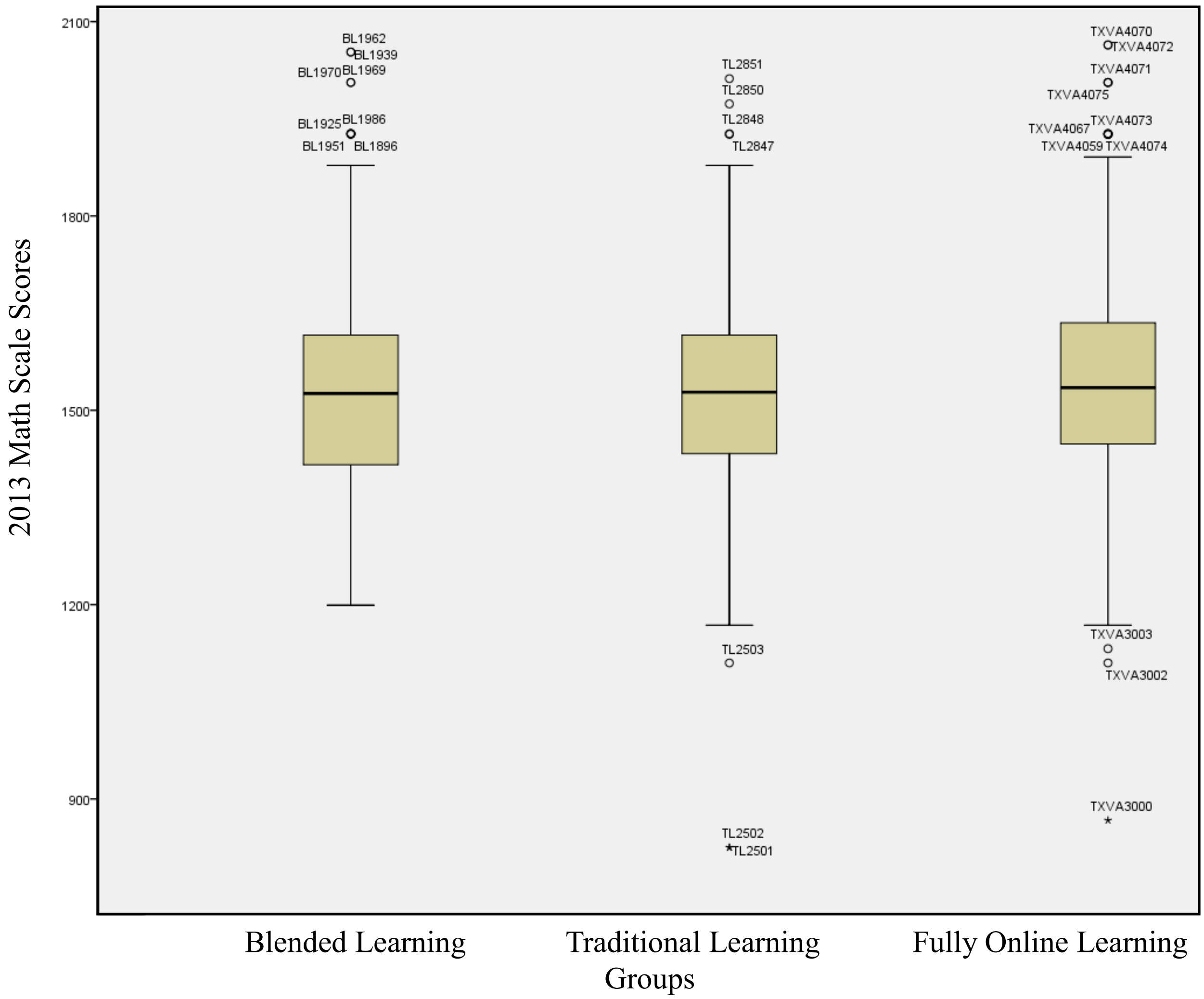

Figure 1. Box and whisker plots of 2013 STAAR math scale score by treatment group.

For the dependent variable for math, 2014 STAAR scale scores, the box and whisker plot displayed outliers in each treatment group. Visible in the box and whisker plot, the blended learning group had nine mild outliers on the high side in addition to five on the low side, the traditional learning group had five mild outliers on the high side in addition to one mild and two extreme outliers on the low side, and the fully online learning group had eight mild outliers on the high side in addition to four mild outliers on the low side. No clear explanation for these outliers could be identified from the data set. To further investigate them, the researcher produced standardized *z*-scores for this variable and found that all fell within normal range (between -3.00 and +3.00) (Mertler & Vannatta, 2009). The lowest *z*-score was -1.32 and the highest z-score was .96. The outliers were excluded due to the sensitivity of both ANCOVA and ANOVA to outliers (Gall et al., 2009; Mertler & Vannatta, 2009). Figure 2 includes the box and whisker plots for the 2013 scores by group.

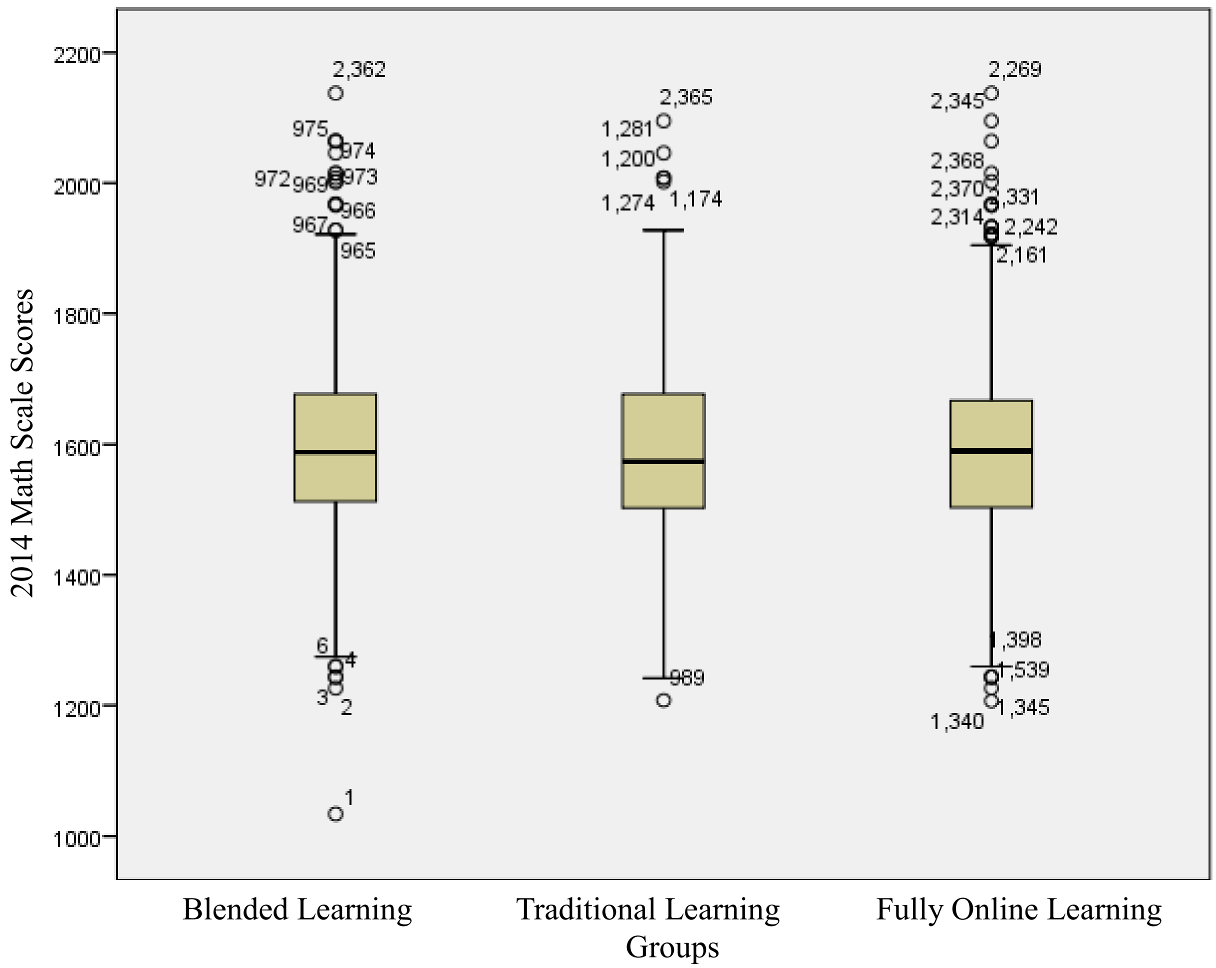

Figure 2. Box and whisker plots of 2014 STAAR math scale score by treatment group.

For the covariate for reading, 2013 STAAR scale scores, the box and whisker plot manifested outliers in each treatment group. Visible in the box and whisker plot, the blended learning group had eight mild outliers on the high side, the traditional learning group had three mild outliers on the high side, and the fully online learning group had six mild outliers on the high side. No clear explanation for these outliers could be identified from the data set. To further investigate them, the researcher produced standardized *z*-scores for this variable and found that all but two fell within normal range (between -3.00 and +3.00) (Mertler & Vannatta, 2009). The outliers were excluded due to the sensitivity of ANCOVA and ANOVA to outliers (Gall et al., 2009; Mertler & Vannatta, 2009). The lowest *z*-score was -2.82 and the highest *z*-score was 3.34. Figure 3 includes the box and whisker plots for the 2013 scores by group.

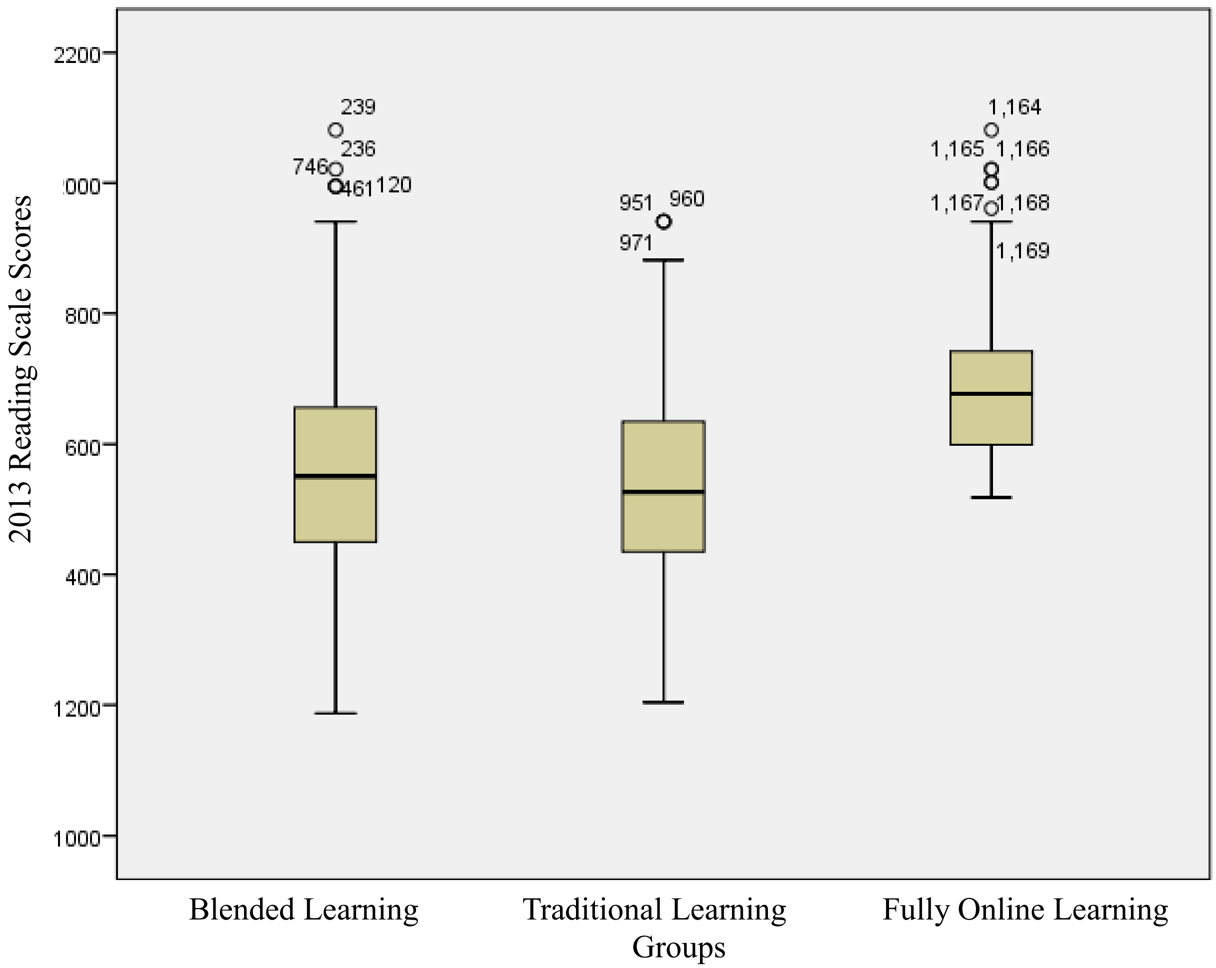

Figure 3. Box and whisker plots of 2013 STAAR reading scale score by treatment group.

The dependent variable for reading, 2014 STAAR scale scores, was examined by box and whisker plot and manifested outliers in each treatment group. Visible in the box and whisker plot, the blended learning group had five mild outliers on the high side, the traditional learning group had no outliers, and the fully online learning group had five mild outliers on the high side in addition to four mild and one extreme outlier on the low side. No clear explanation for these outliers could be identified from the data set. To further investigate them, the researcher produced standardized *z*-scores for this variable and found that all but four fell within normal range (between -3.00 and +3.00) (Mertler & Vannatta, 2009). The outliers were excluded due to the sensitivity of ANCOVA and ANOVA to outliers (Gall et al., 2009; Mertler & Vannatta, 2009). The lowest *z*-score was -3.65 and the highest *z*-score was 3.94. Figure 4 includes the box and whisker plots for the 2013 scores by group.

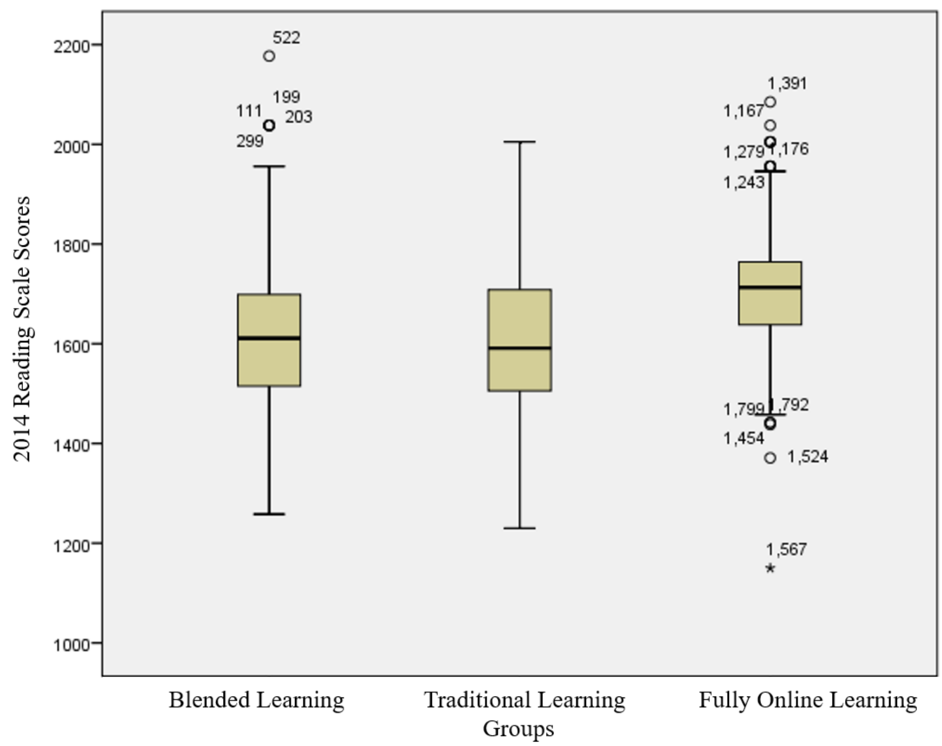

Figure 4. Box and whisker plots of 2014 STAAR reading scale score by treatment group.

Tests for Null Hypothesis One: (Reading)

The Kolmogorov-Smirnov statistic was used to assess the normality of each group’s data because the sample size was large. In reading, the assumption of normality was only met by the traditional learning group for both 2013 and 2014 scores. According to the Kolmogorov-Smirnov statistic, the other two groups failed the test for normality for both years. Table 8 includes the results of the Kolmogorov-Smirnov test.

Table 8

Kolmogorov-Smirnov Test of Normality for STAAR Reading Score

		Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
2013	Traditional Learning	.057	240	.054
	Fully Online Learning	.059	639	.000
	Blended Learning	.036	922	.006
2014	Traditional Learning	.055	239	.080
	Fully Online Learning	.053	638	.000
	Blended Learning	.038	922	.003

a. Lilliefors Significance Correction

To explore normality further, the researcher checked a series of histograms for both the covariate, 2013 STAAR reading scores, and the dependent variable, 2014 STAAR reading scores, for normality of distribution. The histograms suggested that there could be a lack of a normal distribution, in accord with the results of the Kolmogorov-Smirnov analysis. This appears particularly true for the 2013 fully online student group. However, evaluating histograms is notoriously difficult as such an eyeball test is often unreliable (Ghasemi & Zahediasl, 2012), and “the criteria for determination are not clear” (Kim, 2012, p. 247). Figure 3 includes the 2013 STAAR reading scores histograms and Figure 4 includes the 2014 STAAR reading scores histograms.

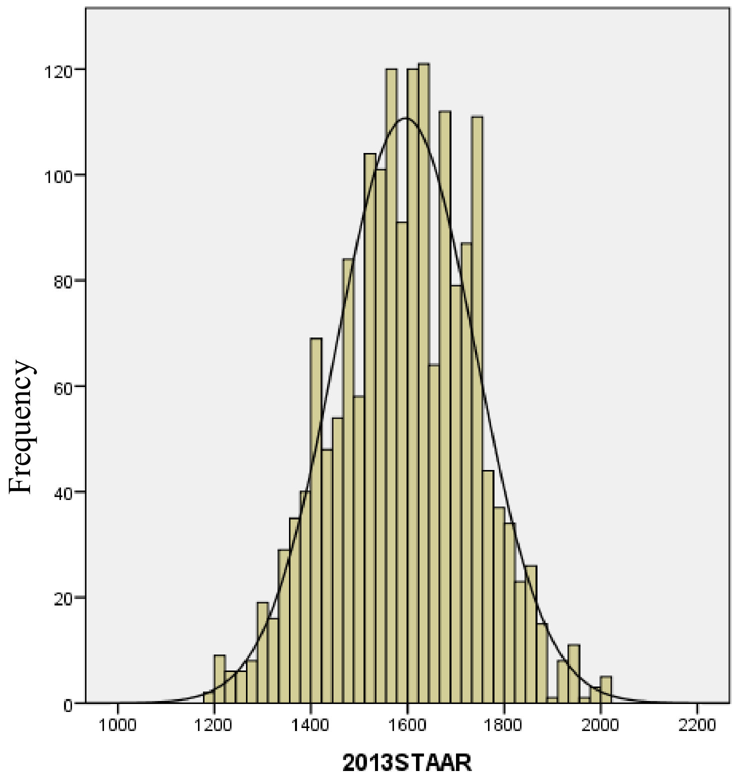

Figure 5. Histogram of all 2013 STAAR reading scores.

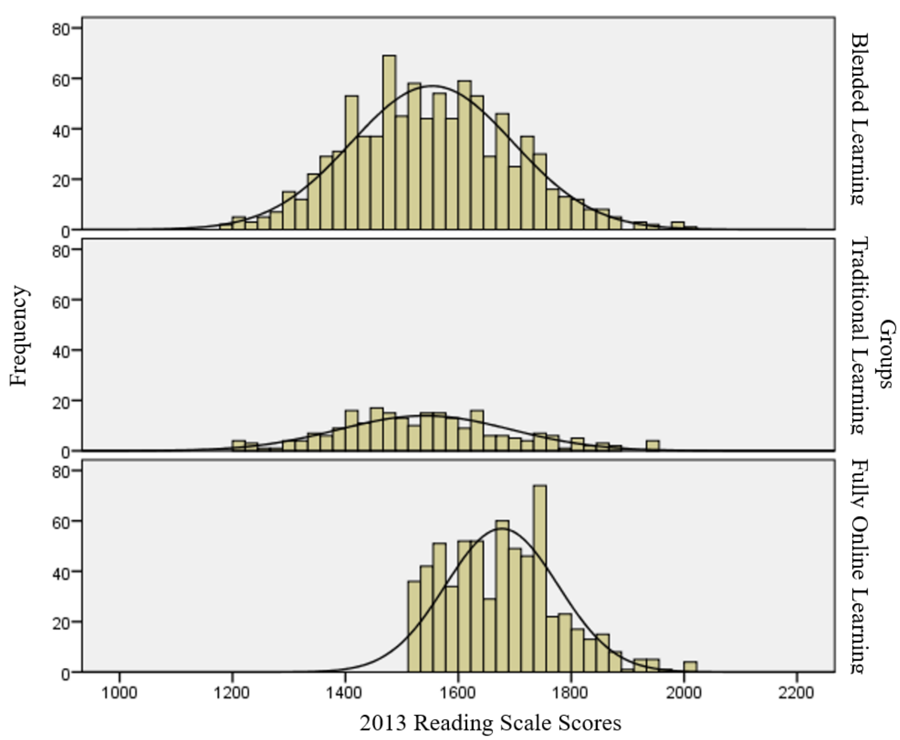

Figure 6. Histogram of 2013 STAAR reading scores by group.

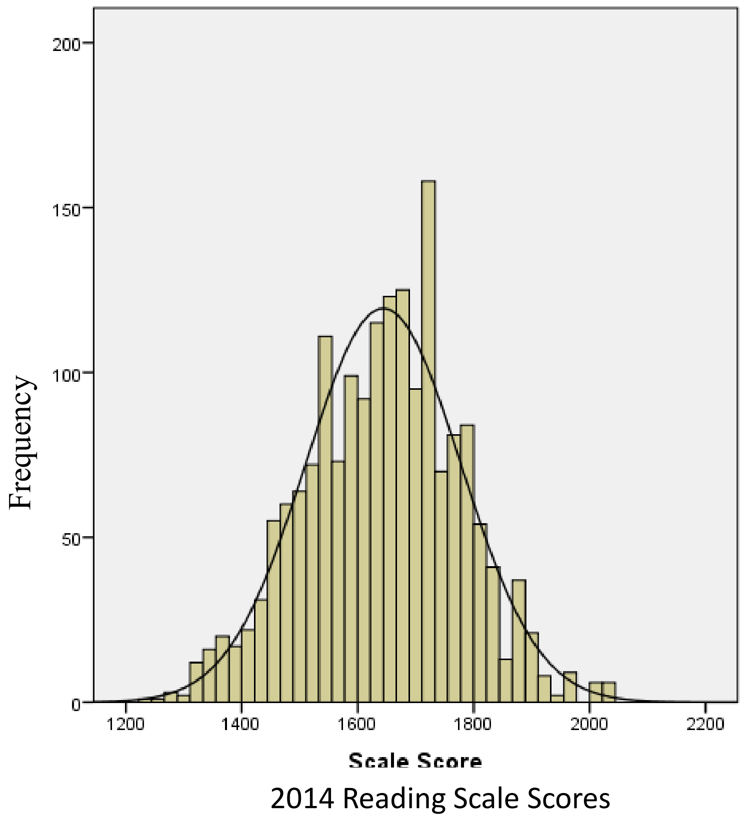

Figure 7. Histogram of all 2014 STAAR reading scores.

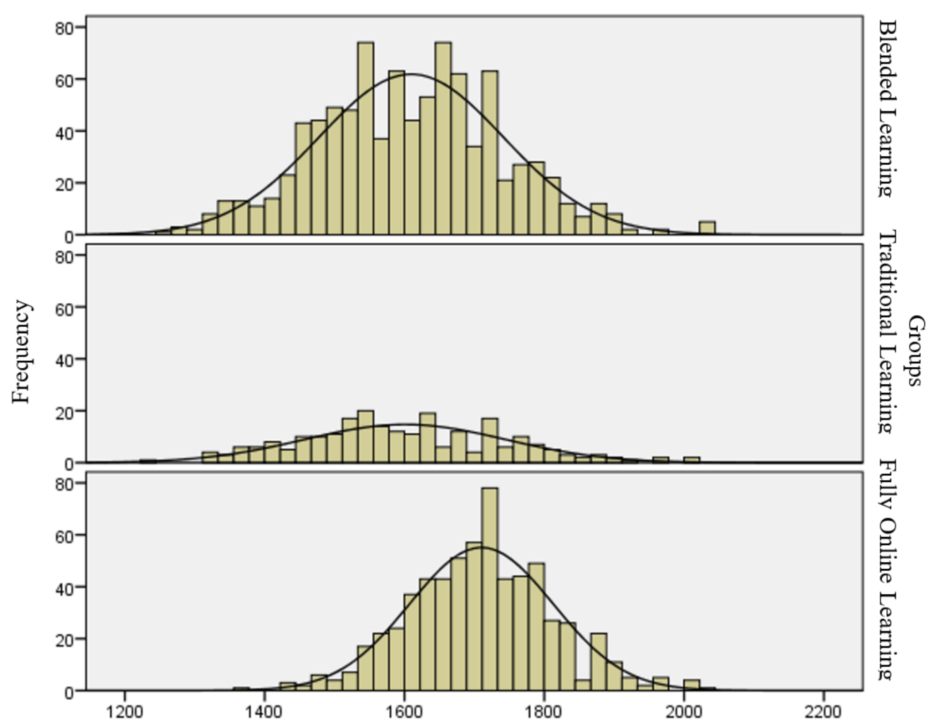

Figure 8. Histogram of 2014 STAAR reading scores by group.

Because of the possible ambiguity of the Kolmogorov-Smirnov results and the histograms, the researcher also produced Q-Q charts to assess normality of distribution for all scores (see Figure 9 for 2013 and Figure 13 for 2014) and for each group of scores (For 2013 scores, see Figure 10 for blended learning, Figure 11 for traditional learning, and Figure 12 for fully online learning scores; for 2014 scores, see Figure 14 for blended learning, Figure 15 for traditional learning, and Figure 16 for fully online learning scores). Contrary to the Kolmogorov-Smirnov results, these visual representations appear to suggest that the data is normally distributed.

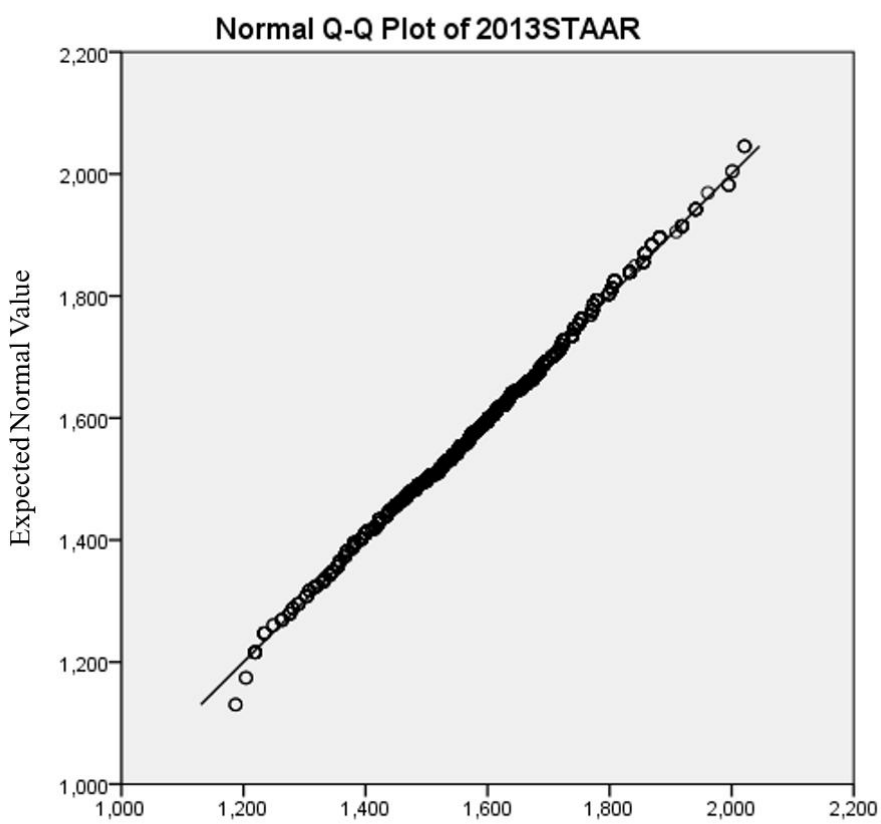

Figure 9. Q-Q chart of all 2013 STAAR reading scores.

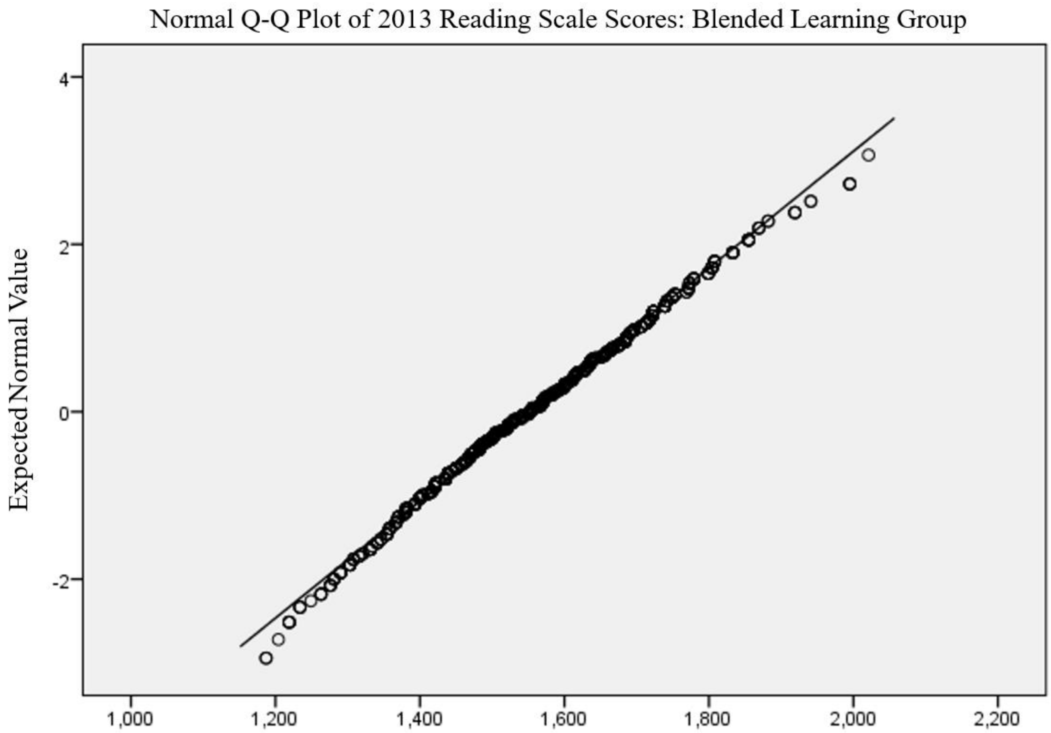

Figure 10. Q-Q chart of 2013 STAAR reading scores for the blended learning group.

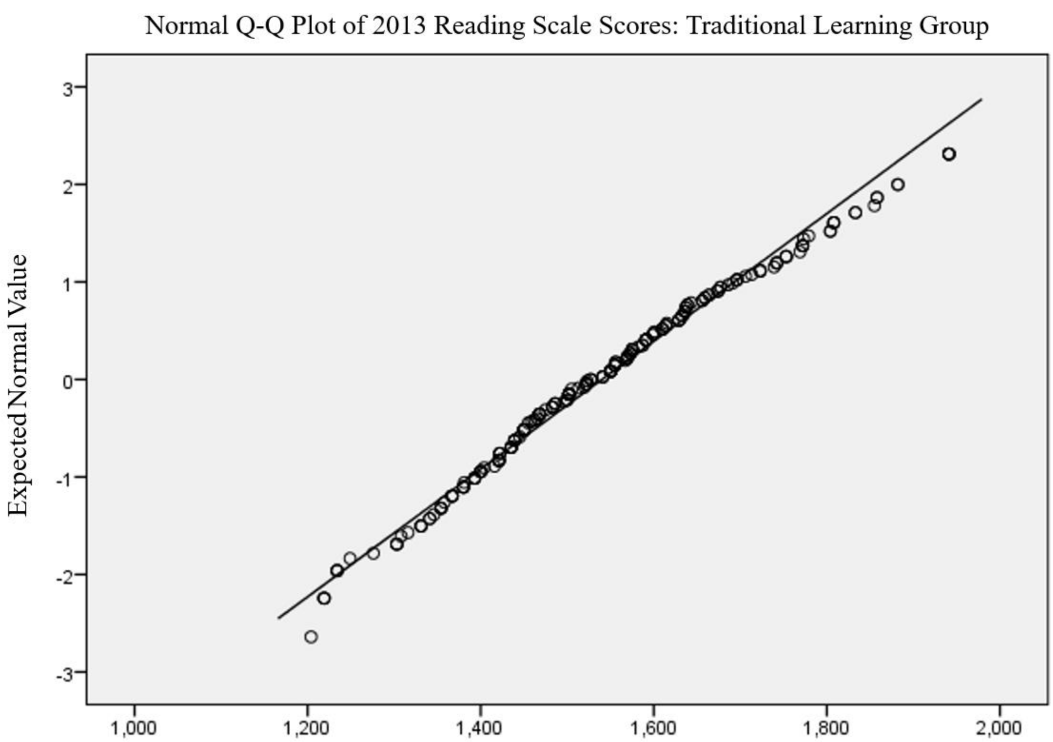

Figure 11. Q-Q chart of 2013 STAAR reading scores for the traditional learning group.

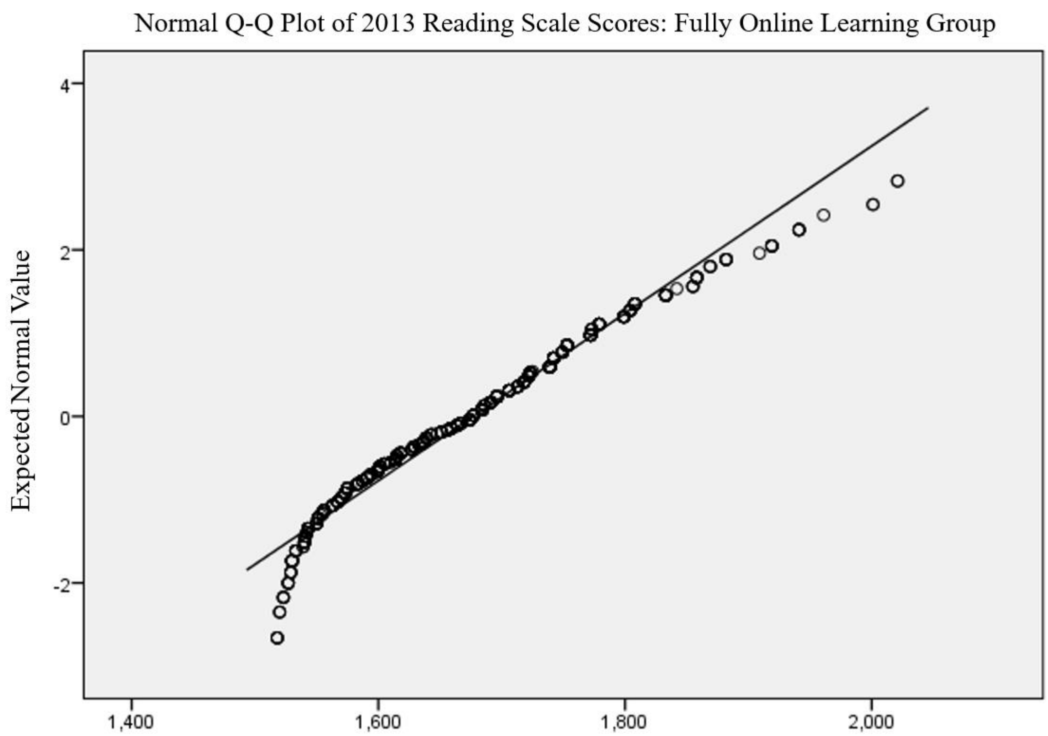

Figure 12. Q-Q chart of 2013 STAAR reading scores for the fully online learning group.

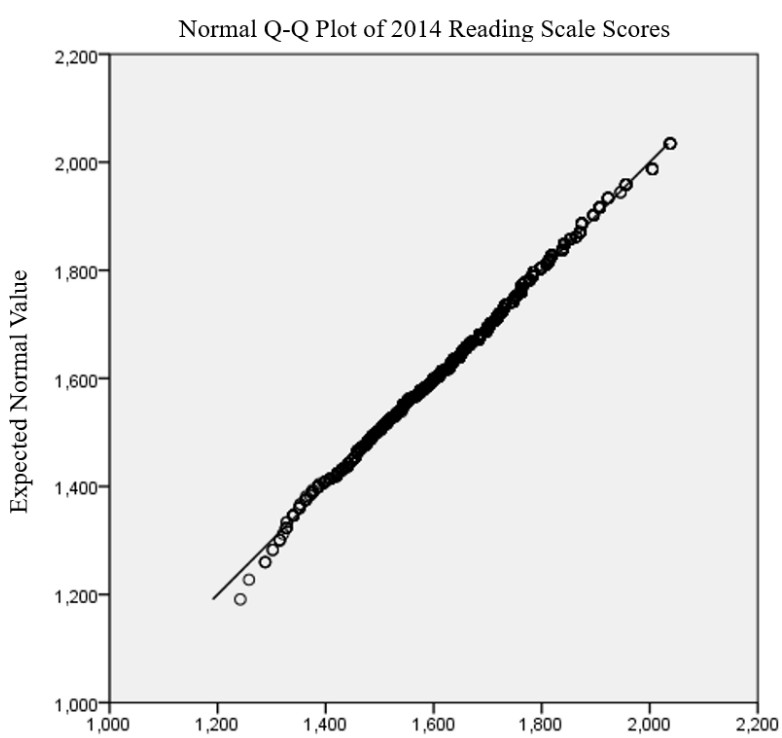

Figure 13. Q-Q chart of all 2014 STAAR reading scores.

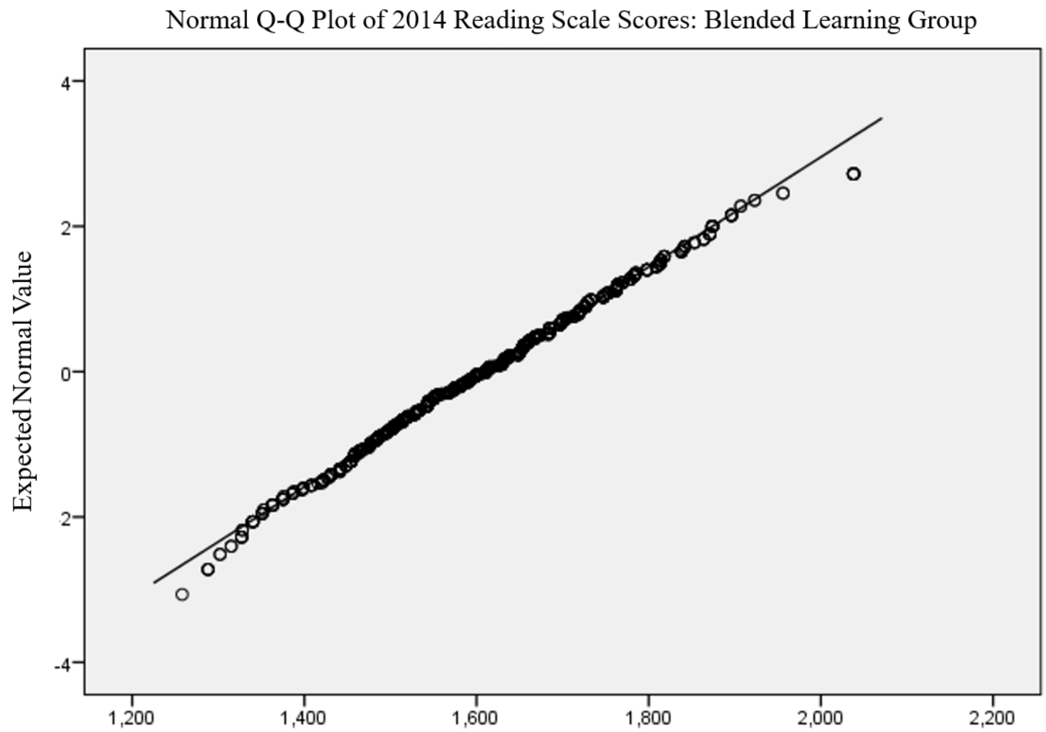

Figure 14. Q-Q chart of 2014 STAAR reading scores for the blended learning group.

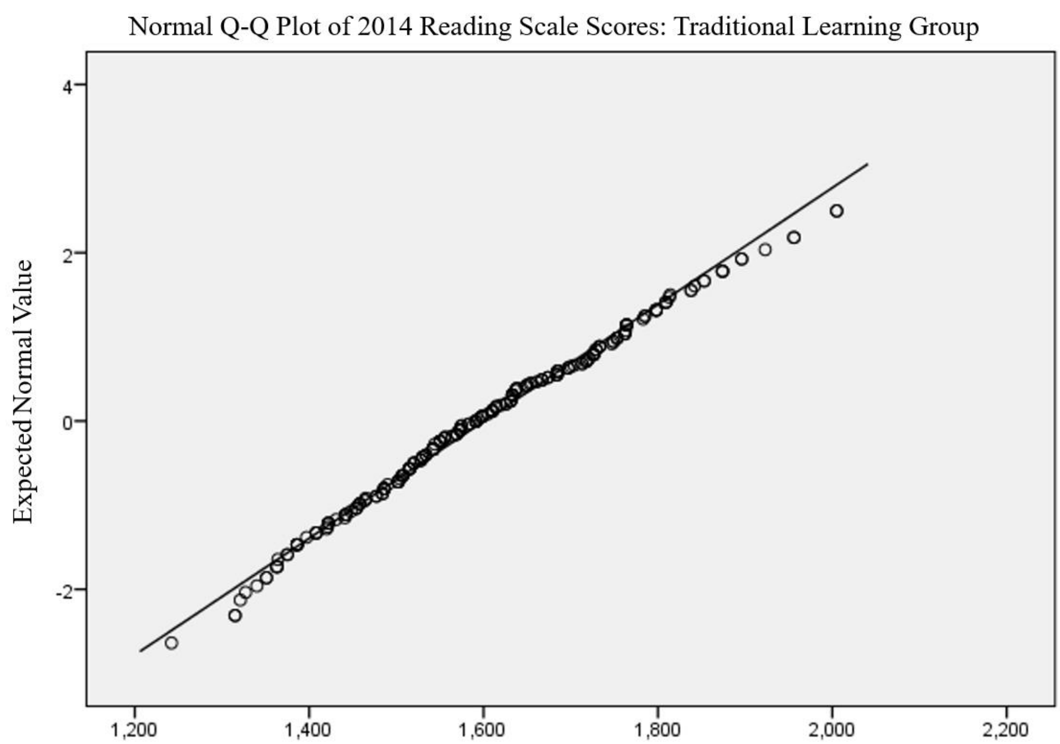

Figure 15. Q-Q chart of 2014 STAAR reading scores for the traditional learning group.

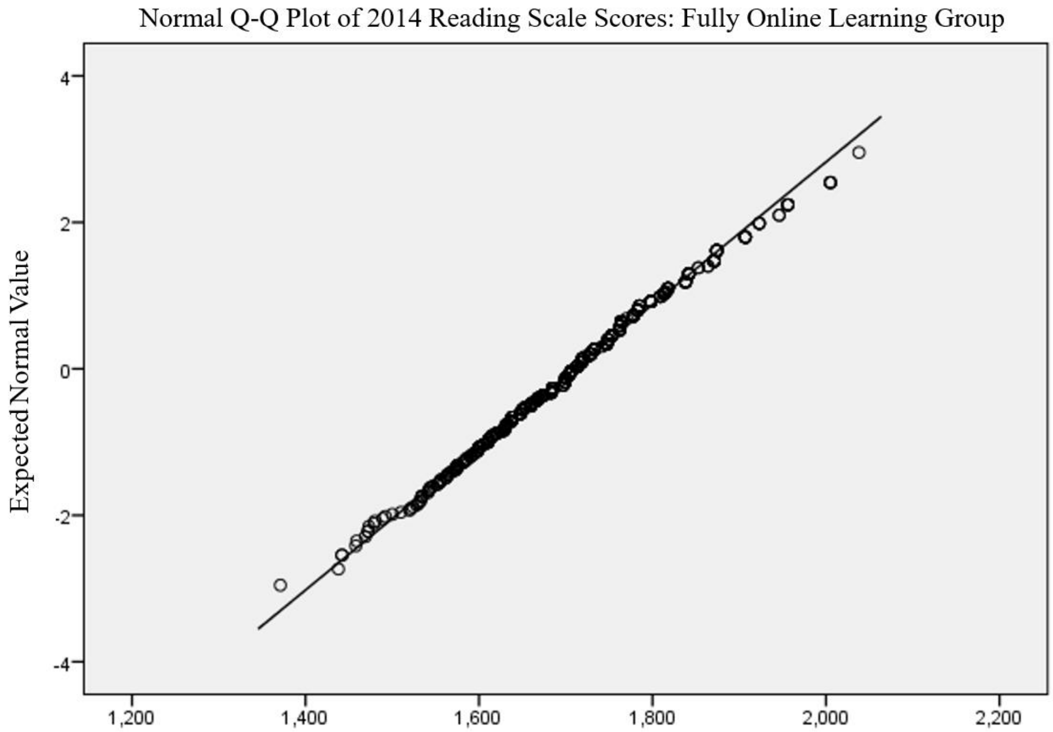

Figure 16. Q-Q chart of 2014 STAAR reading scores for the fully online learning group.

Due to the potential conflict between normality as seen in the Kolmogorov-Smirnov test, histograms, and Q-Q charts, the researcher investigated normality further. Kim (2013) discussed the problem of apparent incompatibility between formal normality tests and visual exams of histograms. She argued that formal normality tests including Shapiro-Wilk and Kolmogorov-Smirnov may only be appropriate for small to medium sample sizes because with samples of 300 or more, they become unreliable. A better solution for large sample sizes is to assess normality using skewness and kurtosis, and this same approach also works for small and medium sample sizes (Kim, 2013).

As a result, the researcher used absolute values of skew and kurtosis to evaluate whether the data was normally distributed for mode of instruction (Kim, 2013). In each case, skew and kurtosis fell well within the range of normality established by Kim: less than two for skew and less than seven for kurtosis. In the case of the traditional learning group, the sample sizes were less than 300, but more than 50. In such cases, Kim argued that normality is best evaluated by dividing the skew or kurtosis by the standard of error for the measurement to derive a z-score. When analyzed in this way, the traditional learning group *z*-scores for reading in both 2013 and 2014 fell well below the standard of 3.29. Thus, the assumption of normality was upheld when evaluated by skew and kurtosis. Table 9 includes the results of the test for normality.

Table 9

Results for Tests of Normality for Reading

Variables	Group	Skew	Kurtosis	*N*
All Subgroups	2013 STAAR Scores	-.078	-.152	1797
	2014 STAAR Scores	-.061	-.119	1797
Traditional Learning	2013 STAAR Scores	.354	-.063	239
	2014 STAAR Scores	.263	-.187	239
Fully Online Learning	2013 STAAR Scores	.539	.066	637
	2014 STAAR Scores	.088	.254	637
Blended Learning	2013 STAAR Scores	.169	-.190	921
	2014 STAAR Scores	.162	-.023	921

Scatterplots comparing the covariate, 2013 STAAR reading score, and dependent variable, 2014 STAAR reading score, were examined to test the assumption of linearity (Gall et al., 2009; Rovai et al., 2013). The assumption of linearity was met. Figures 17 includes the scatterplots.

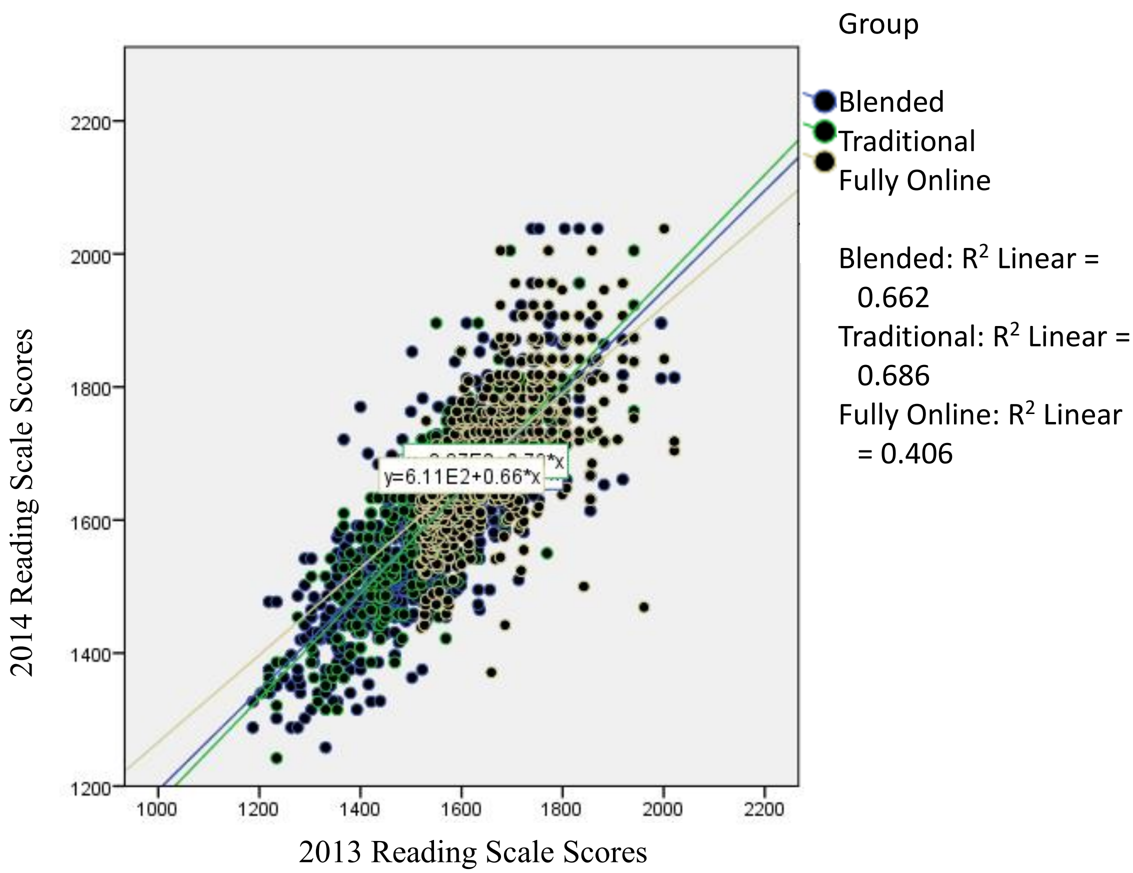

Figure 17. Scatterplot of 2013 STAAR reading scores vs. 2014 STAAR reading scores.

The homogeneity of variance was checked using Levene's test. The results were not significant (p = .591), indicating that the assumption of equal variances was met for reading. Table 10 includes the results of Levene's test.

Table 10

Test of Homogeneity of Variance for 2014 STAAR reading scale score

Dependent Variable: 2014 STAAR Reading Scale Score

F	df1	df2	Sig.
.526	2	1794	.591

Finally, the assumption of homogeneity of slopes was tested. For reading, the interaction was statistically significant: $F(2, 1791) = 4.85$, $p = .01$; therefore, the assumption of homogeneity of slopes was violated. Table 11 includes the homogeneity of slopes test.

Table 11

Tests of Homogeneity of Slopes for 2014 STAAR Scale Score: Reading

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	21041403.520[a]	5	4208280.705	688.098	.000	.658
Intercept	2045929.368	1	2045929.368	334.531	.000	.157
Group	64923.255	2	32461.628	5.308	.005	.006
@2013Scale	12202368.660	1	12202368.660	1995.214	.000	.527
Group * @2013Scale	59337.215	2	29668.607	4.851	.008	.005
Error	10953431.730	1791	6115.819			
Total	4887828365.000	1797				
Corrected Total	31994835.250	1796				

Notes. R Squared = .658, Adjusted R Squared = .657

This study originally proposed that an ANCOVA be used to determine the effect of course delivery (traditional, fully online, or blended learning) on student State of Texas Assessment of Academic Readiness test scores in reading for 2014 after controlling for 2013 scores. Previous investigation revealed several outliers in the data, as assessed by standardized *z*-scores greater than ±3. Two were identified and removed from the 2013 reading scores, and four were identified and removed from the 2014 reading scores. A linear relationship between 2013 and 2014 scores for each intervention type was confirmed by visual inspection of a scatterplot. In addition, analysis of skewness and kurtosis confirmed the assumption of normality. The assumption of homogeneity of variances, as assessed by Levene's test of homogeneity of variance, was met for reading (p = .591). However, the test for homogeneity of slopes found that the interaction term was statistically significant, F(2, 1791) = 4.85, p = .01; thus indicating that an ANCOVA was not an appropriate statistical approach for this study.

In instances where the data fails the assumptions for ANCOVA, a variety of options exist depending on the assumptions at stake (Lomax & Hahs-Vaughn, 2013). In the case of a failure to uphold the assumption of homogeneity of slopes, Warner (2012) suggested that one legitimate approach is to discard the covariate and perform an ANOVA instead to evaluate the dependent variable by group.

In preparation for ANOVA analysis, the data for 2014 STAAR reading scores was examined without the covariate. Homogeneity of variance was violated as assessed by Levene's Test of Homogeneity of Variance ($p < .0005$). In instances where the assumption of homogeneity of variances fails, the Welch ANOVA is the most widely recommended approach (Jan & Shieh, 2014; Liu, 2015; Lix, Keselman, & Keselman, 1996; Moder, 2010). The Welch ANOVA is more robust than a standard ANOVA.

Thus, a one-way Welch ANOVA was performed. It confirmed a statistically significant difference in means for the levels of 2014 STAAR reading score, Welch's $F(2, 628.886) = 162.354$, $p < .0005$. The 2014 STAAR reading scores mean increased from the traditional learning group ($M = 1600.7$, $SD = 144.1$) to the blended learning group ($M = 1609.6$, $SD = 132.2$) and fully online learning group ($M = 1710.0$, $SD = 102.7$), in that order. The Games-Howell post hoc analysis revealed that the mean increase from the traditional learning group to the fully online learning group, 109.3, 95% CI (85.4, 133.3) was statistically significant ($p < .0005$), as well as the increase from the blended learning group to the fully online group, 100.4, 95% CI (86.4, 114.4), $p < .0005$. However, for the increase from the traditional learning group to the blended learning group there was no statistically significant difference, 8.9, 95% CI (-15.3, 33.2), $p = .660$.

As a result, a statistically significant difference in the group means of 2014 STAAR reading scores was observed ($p < .05$) and, therefore, the first null hypothesis was rejected. The online group significantly differed from both the traditional and blended groups on reading scores. The online group scored higher than the other two groups.

Tests for Null Hypothesis Two: (Math)

The Kolmogorov-Smirnov statistic was used to assess the normality of each group's data because the sample size was large. In math, the assumption of normality was only met by the traditional learning group in 2013 and the fully online learning group in 2014. Thus, according to the Kolmogorov-Smirnov, the other groups failed the assumption. Table 12 includes the results of the Kolmogorov-Smirnov test.

Table 12

Kolmogorov-Smirnov Test of Normality for STAAR Math Score

		Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
2013	Traditional Learning	.040	298	.200*
	Fully Online Learning	.028	1046	.055
	Blended Learning	.037	954	.003
2014	Traditional Learning	.049	298	.075
	Fully Online Learning	.025	1046	.112
	Blended Learning	.044	954	.000

* This is a lower bound of the true significance

To explore normality of the data for math further, the researcher checked a series of histograms for both the covariate 2013 STAAR math score and the dependent variable 2014 STAAR math score for normality of distribution. The histograms did not appear to confirm the lack of a normal distribution, challenging the results of the Kolmogorov-Smirnov analysis; however, again the disadvantage of such an eyeball test is that it is often unreliable (Ghasemi &

Zahediasl, 2012), and “the criteria for determination are not clear” (Kim, 2012, p. 247). See Figure 18 for the 2013 STAAR math score histogram for all scores regardless of group and Figure 19 for the individual group histograms. See Figure 20 for the 2014 STAAR math score histogram for all scores regardless of group and Figure 21 for the individual group histograms.

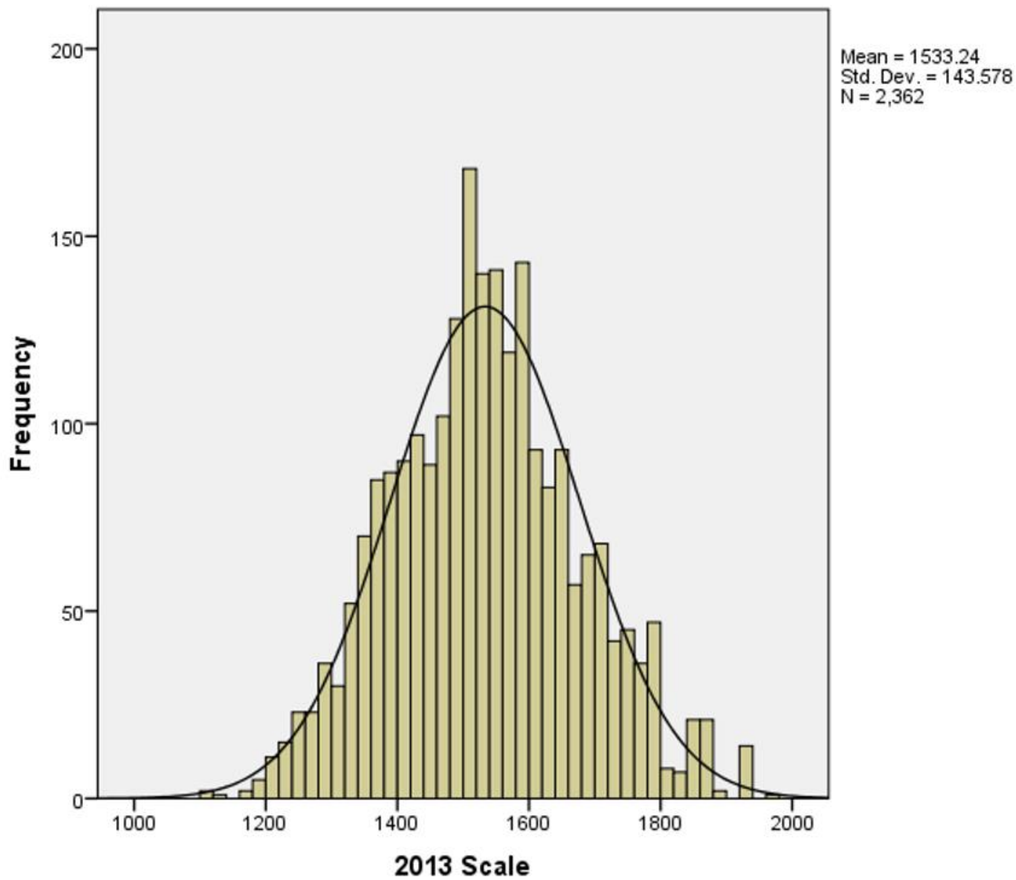

Figure 18. Histogram of all 2013 STAAR math scores.

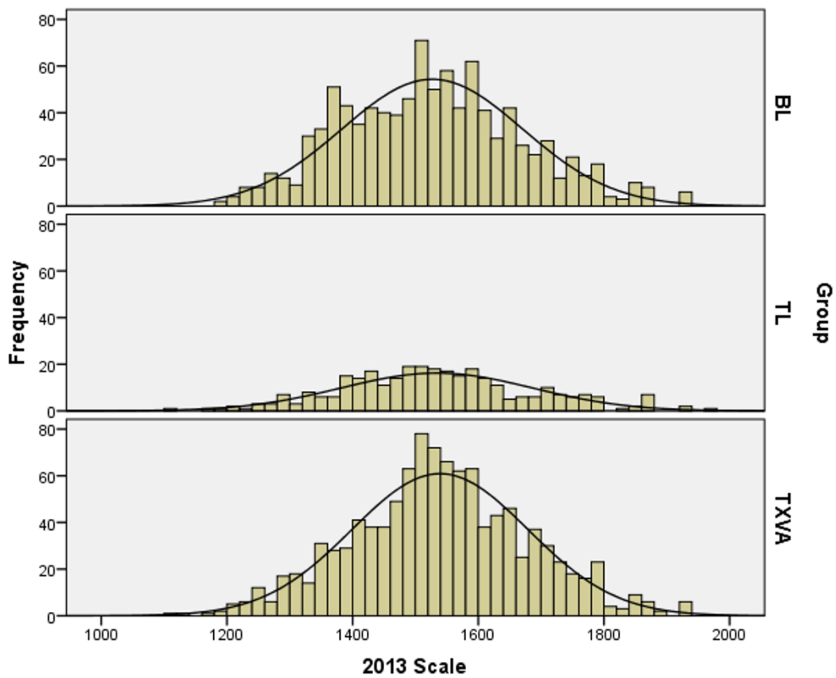

Figure 19. Histogram of 2013 STAAR math scores by group.

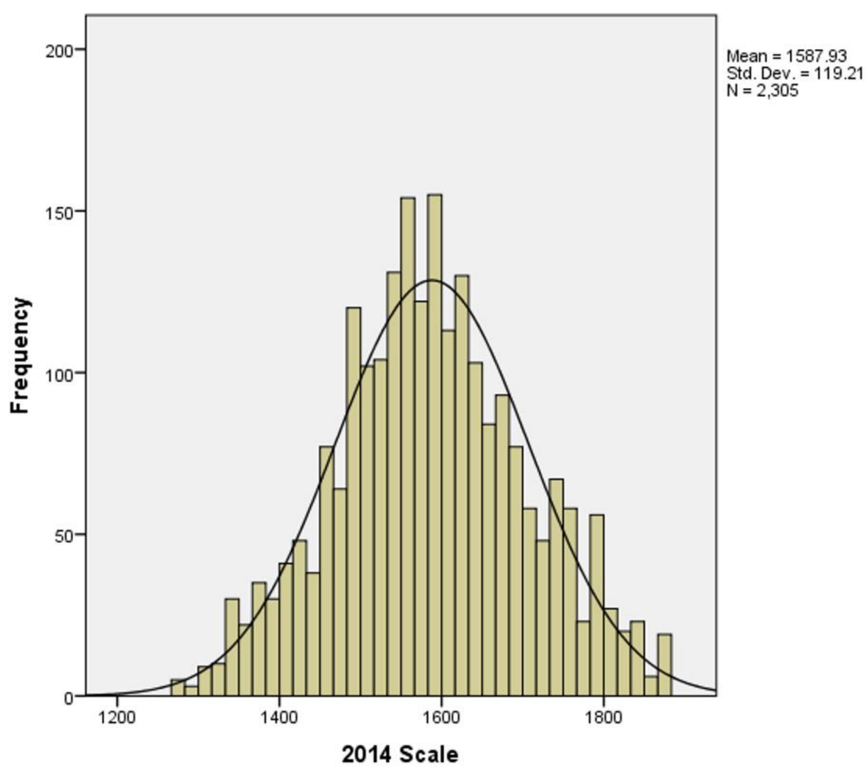

Figure 20. Histogram of all 2014 STAAR math scores.

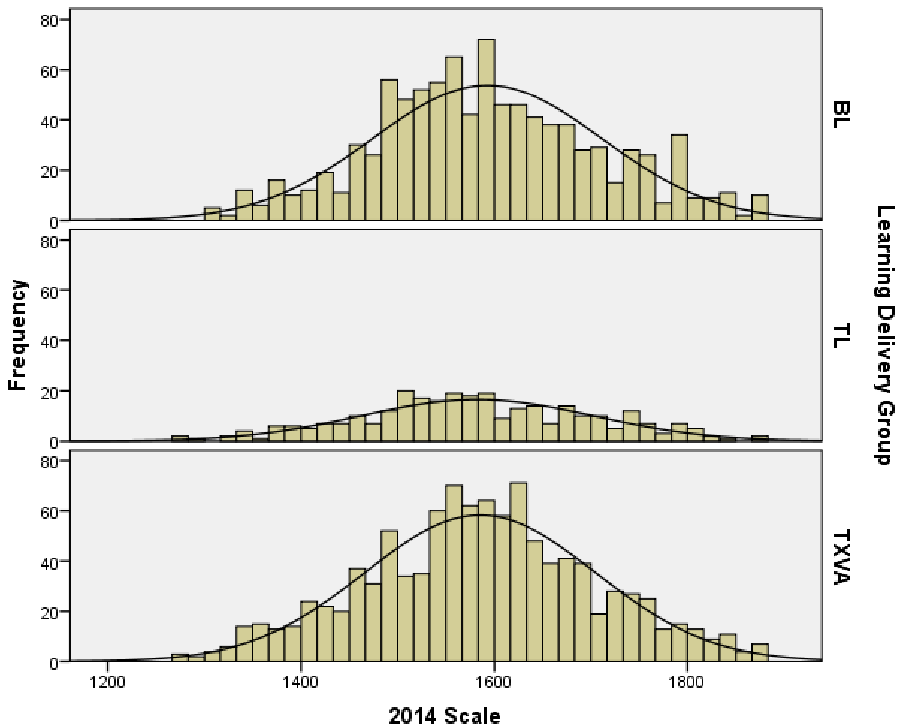

Figure 21. Histogram of 2014 STAAR math scores by group.

Because of the possible conflict between the Kolmogorov-Smirnov results and the histograms, the researcher also produced Q-Q charts to assess normality of distribution for all scores (see Figure 22 for 2013 and Figure 26 for 2014) and for each group of scores (For 2013 scores, see Figure 23 for blended learning, Figure 24 for traditional learning, and Figure 25 for fully online learning scores. For 2014 scores, see Figure 27 for blended learning, Figure 28 for traditional learning, and Figure 29 for fully online learning scores). Contrary to the Kolmogorov-Smirnov results, these visual representations confirm the suggestion from the histograms that the data is normally distributed.

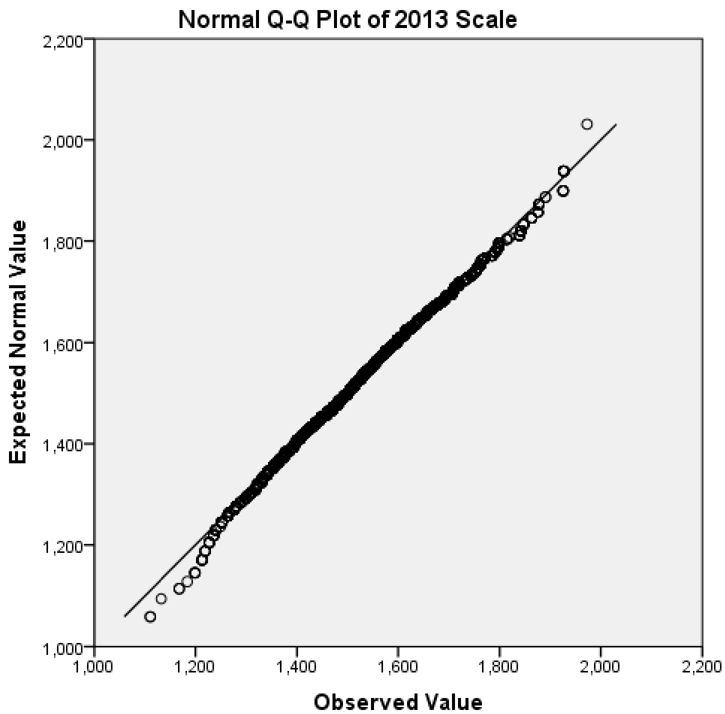

Figure 22. Q-Q chart of all 2013 STAAR math scores.

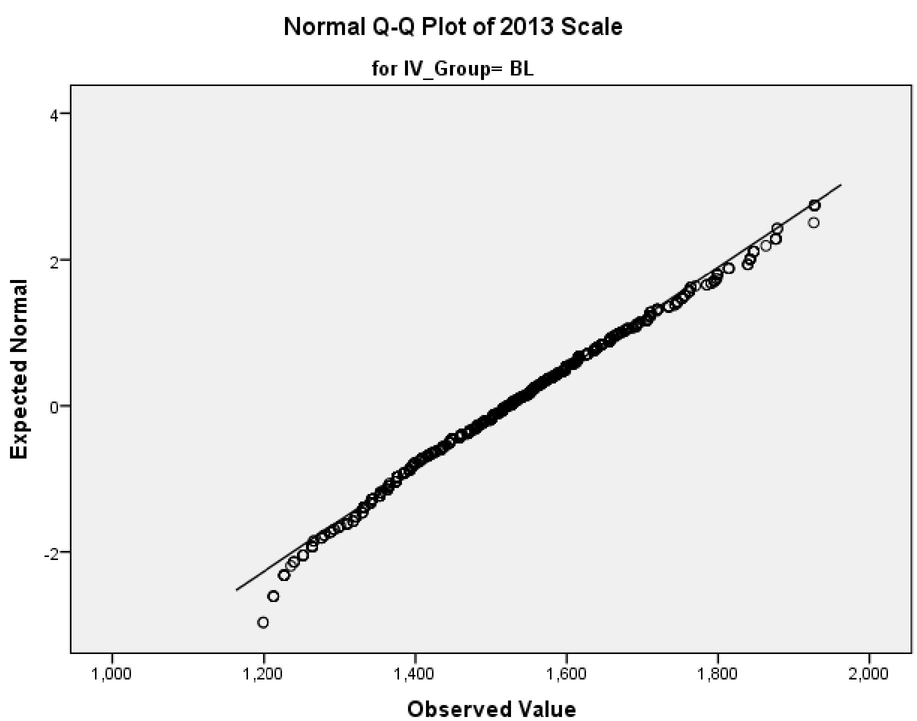

Figure 23. Q-Q chart of 2013 STAAR math scores for the blended learning group.

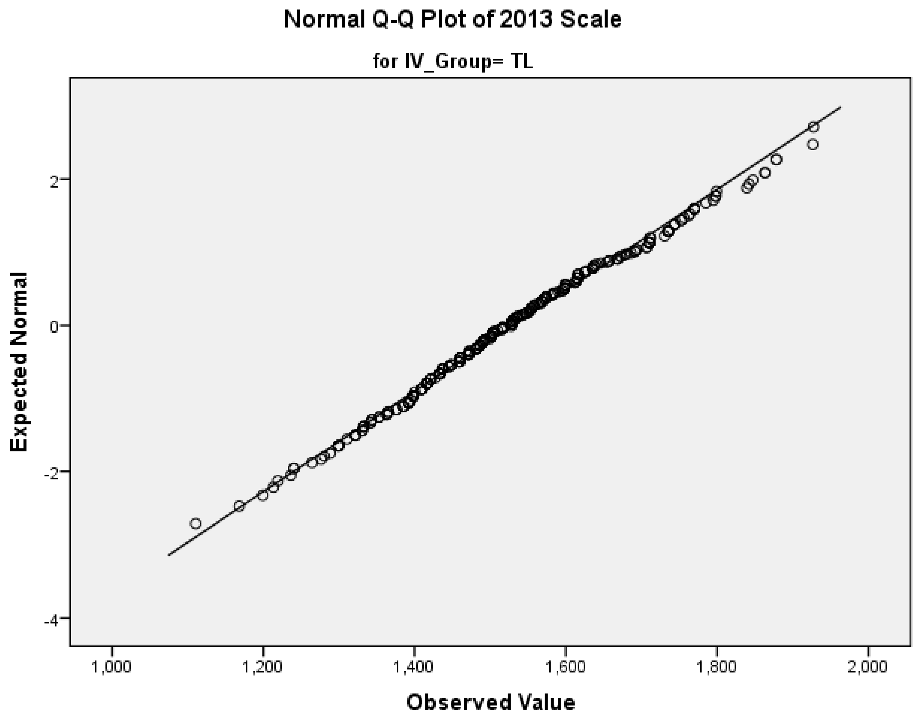

Figure 24. Q-Q chart of 2013 STAAR math scores for the traditional learning group.

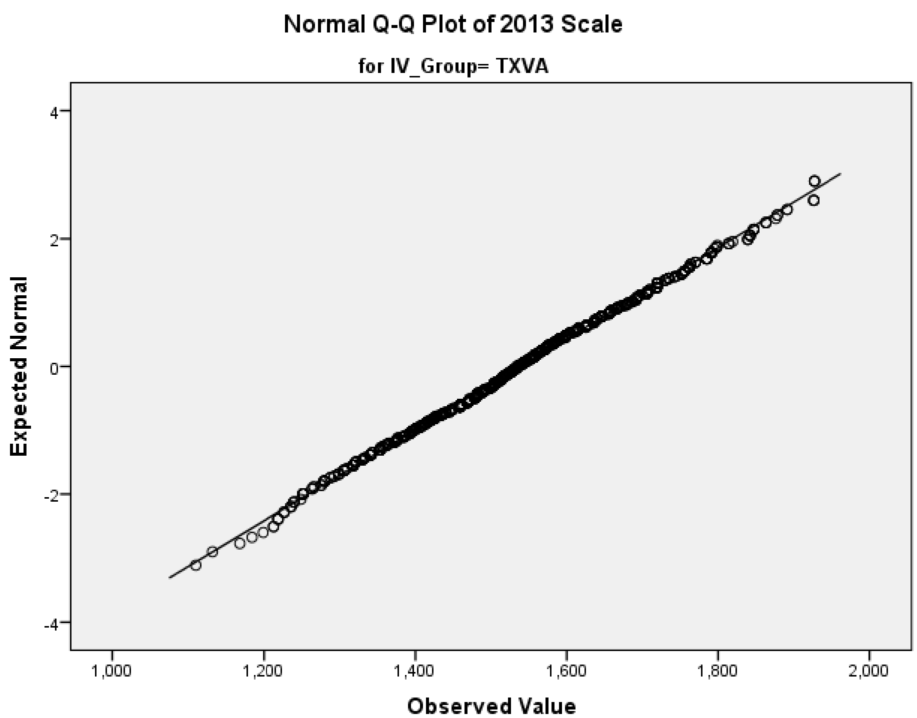

Figure 25. Q-Q chart of 2013 STAAR math scores for the fully online learning group.

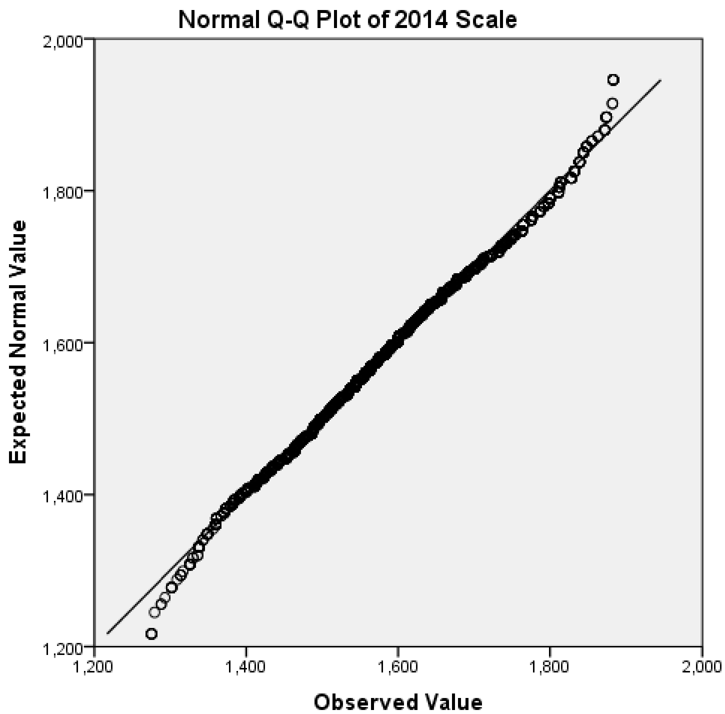

Figure 26. Q-Q chart of all 2014 STAAR math scores.

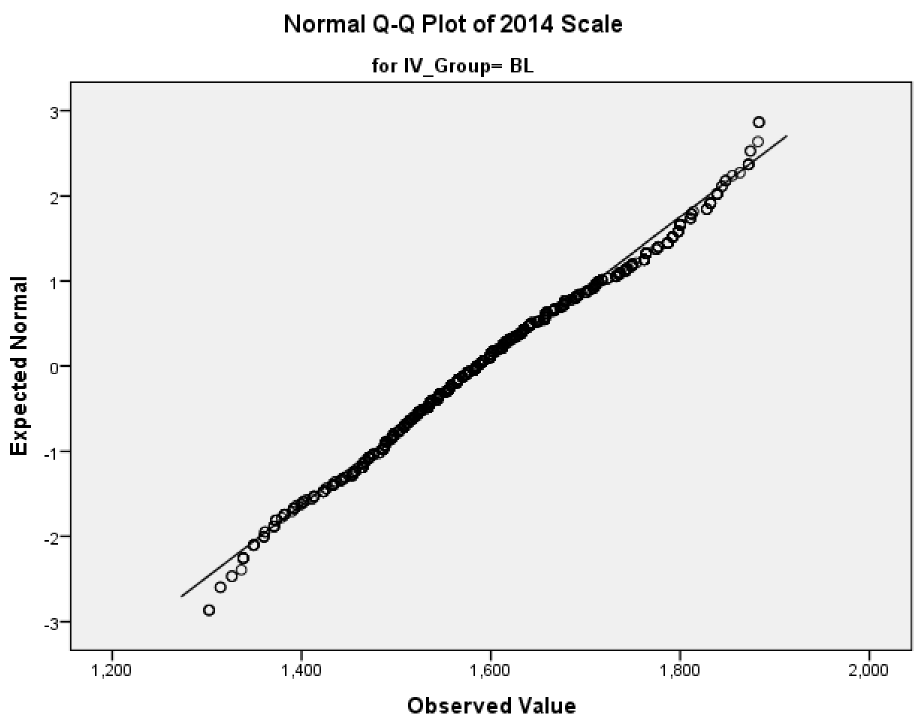

Figure 27. Q-Q chart of 2014 STAAR math scores for the blended learning group.

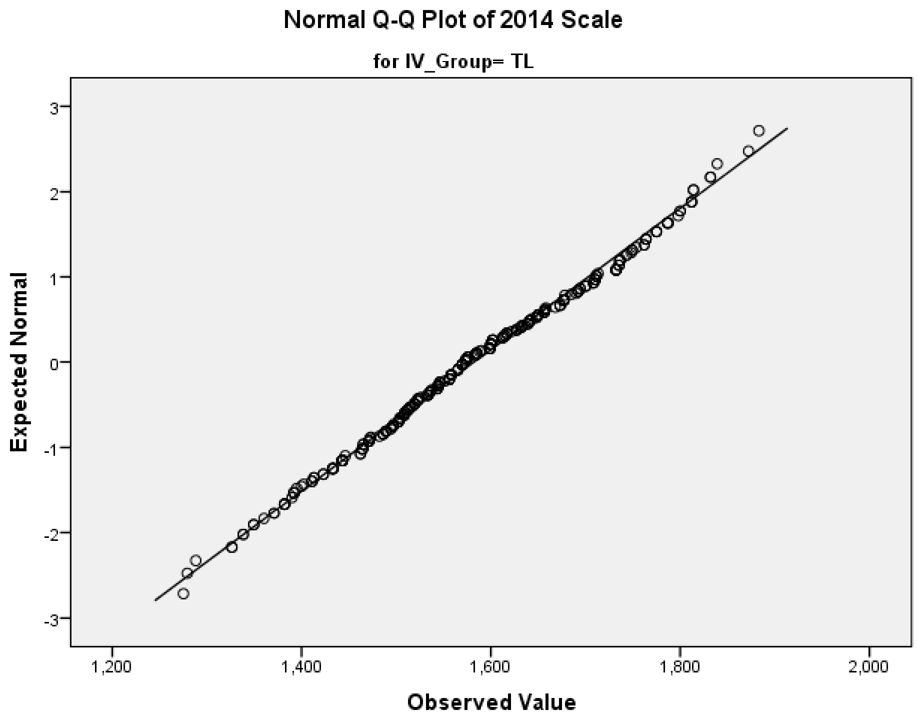

Figure 28. Q-Q chart of 2014 STAAR math scores for the fully blended learning group.

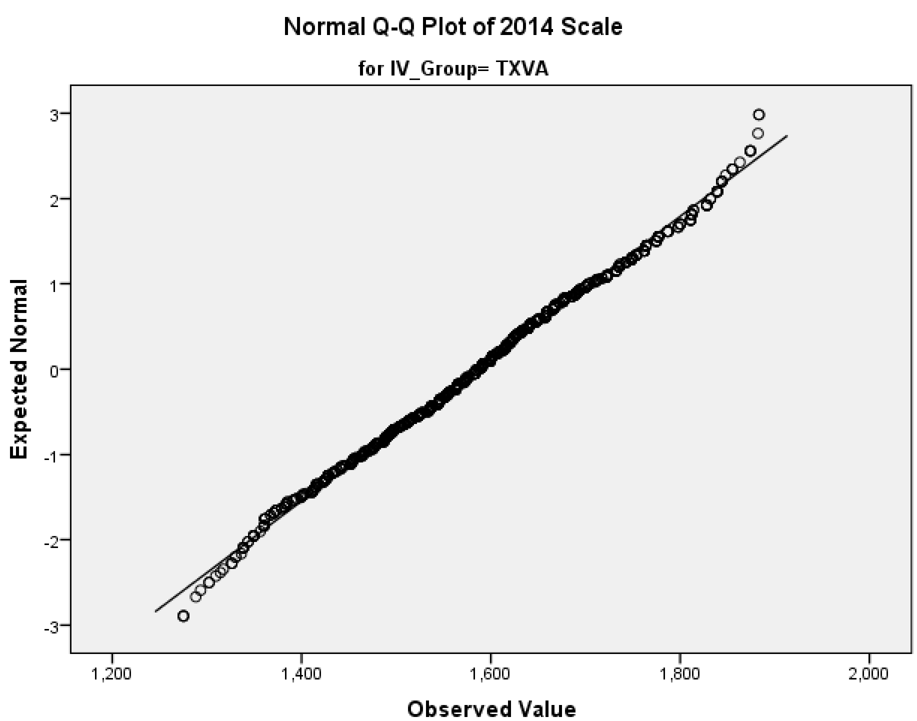

Figure 29. Q-Q chart of 2014 STAAR math scores for the fully online learning group.

Since the histograms and Q-Q charts appear to demonstrate normality despite the contrary results of the Kolmogorov-Smirnov test, the researcher investigated normality further. As indicated with regard to the first null hypothesis above, Kim (2013) discussed the problem of apparent incompatibility between formal normality tests and visual exams of histograms. She argued that formal normality tests including Shapiro-Wilk and Kolmogorov-Smirnov may only be appropriate for small to medium sample sizes because with samples of 300 or more they become unreliable. A better solution for large sample sizes is to assess normality using skewness and kurtosis, and this same approach also works for small and medium sample sizes (Kim, 2013).

As a result, the researcher used absolute values of skew and kurtosis to evaluate whether the data is normally distributed for mode of instruction (Kim, 2013). The sample sizes for all groups and for both subjects in 2013 and 2014 was 300 or more except for 2014 STAAR scores for the traditional learning group in math, which was 298. All groups of larger than 300 participants had skew and kurtosis numbers between negative one and positive one, placing them well within Kim's suggested parameters of an absolute skew value of two and an absolute kurtosis value of seven. The only group with a sample size less than 300, 2014 STAAR scores for traditional learning in math, included no *z*-scores above 3.00. Again, this placed all scores well within the parameter of 3.29 advocated by Kim. Thus, the assumption of normality was upheld as evaluated by skew and kurtosis.

Table 13

Results for Tests of Normality for Math

Variables	Group	Skew	Kurtosis	*N*
All Subgroups	2013 STAAR Scores	.147	-.171	2362
	2014 STAAR Scores	.072	-.282	2349
Traditional Learning	2013 STAAR Scores	.169	-.003	298
	2014 STAAR Scores	.039	-.373	298
Fully Online Learning	2013 STAAR Scores	.026	-.044	1046
	2014 STAAR Scores	.007	-.243	1046
Blended Learning	2013 STAAR Scores	.207	-.254	954
	2014 STAAR Scores	.154	-.305	954

Scatterplots comparing the covariate, 2013 STAAR math scores, and the dependent variable, 2014 STAAR math scores, were examined to test the assumption of linearity (Gall et al., 2009; Rovai et al., 2013). There was a linear relationship between the covariate and dependent variable for each intervention type, as assessed by visual inspection of the scatterplot. The assumption of linearity was met. Figure 30 includes the scatterplots.

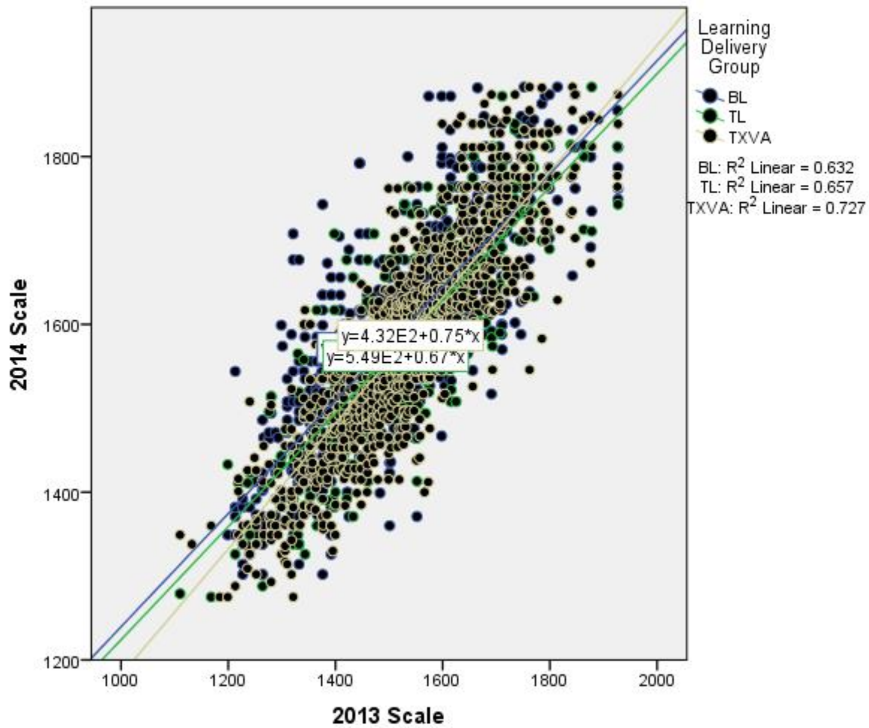

Figure 30. Scatterplot of 2013 and 2014 STAAR math scores by Independent Variable group.

The homogeneity of variance was checked using Levene's test. The results were significant (p = .001), indicating that the assumption of equal variances has not been met for math. Table 14 includes the results of Levene's test.

Table 14

Test of Homogeneity of Variance for 2014 STAAR math scale scores

F	df1	df2	Sig.
6.920	2	2295	.001

Finally, the assumption of homogeneity of slopes was tested. For math, the interaction was statistically significant: $F(2, 2292) = 6.77$, $p = .001$; therefore, the assumption of homogeneity of slopes was violated. Table 15 includes the homogeneity of slopes test.

Table 15

Tests of Homogeneity of Slopes for 2014 STAAR Scale Score: Math

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	22087693.910[a]	5	4417538.782	970.730	.000
Intercept	3802952.653	1	3802952.653	835.678	.000
IV_Group	76538.348	2	38269.174	8.409	.000
COV_Mth13SCL	16561627.830	1	16561627.830	3639.325	.000
IV_Group * COV_Mth13SCL	61646.905	2	30823.453	6.773	.001
Error	10430298.760	2292	4550.741		
Total	5824548277.000	2298			
Corrected Total	32517992.670	2297			

Notes. a. R Squared = .679 (Adjusted R Squared = .679)

The proposed study called for an ANCOVA to be run to determine the effect of course delivery (traditional, fully online, or blended learning) on student State of Texas Assessment of Academic Readiness test scores in math and reading for 2014 after controlling for 2013 scores. Previous investigation revealed several outliers in the data, as assessed by standardized *z*-scores greater than ±3. Thirteen outliers were identified and removed from the 2013 math scores, but none were identified from the 2014 math scores. Visual inspection of a scatterplot confirmed that there was a linear relationship between 2013 and 2014 scores for each intervention type. In addition, analysis of skewness and kurtosis confirmed the assumption of normality. However, the test for homogeneity of slopes found that the interaction term was statistically significant, $F(2, 2292) = 6.77$, $p = .001$; thus indicating that an ANCOVA was not an appropriate statistical approach for this study. In addition, the assumption of homogeneity of variances, as assessed by Levene's test of homogeneity of variance, was rejected for math ($p = .001$).

In accordance with Warner (2012), after testing the relevant assumptions and finding that the data for math failed the assumptions of homogeneity of slopes, normality, and homogeneity of variance, the researcher rejected the propriety of ANCOVA to analyze the data for math. Also in accordance with Warner (2012), after testing the relevant assumptions and finding that the data for reading failed the assumptions of homogeneity of slopes and normality, the researcher rejected the propriety of ANCOVA to analyze the data for math.

In instances where the data fails the assumptions for ANCOVA, a variety of options exist depending on the assumptions at stake (Lomax & Hahs-Vaughn, 2013). In the case of a failure to uphold the assumption of homogeneity of slopes, Warner (2012) suggested that one legitimate approach is to discard the covariate and perform an ANOVA instead to evaluate the dependent variable by group.

In preparation for one-way ANOVA analysis, the data for 2014 STAAR math scores was examined without the covariate. Homogeneity of variance was upheld as assessed by Levene's Test of Homogeneity of Variance ($p = .832$). Participants were classified into three groups: traditional learning ($n = 300$), fully online learning ($n = 956$), and blended learning ($n = 1049$). The 2014 STAAR math scores increased from the traditional learning group ($M = 1582.1$, $SD = 120.6$), to the fully online learning group ($M = 1585.4$, $SD = 119.7$), to the blended learning group ($M = 1592.6$, $SD = 118.2$), in that order, but the differences between these learning groups was not statistically significant, $F(2, 2302) = 1.347$, $p = .260$.

As a result, a statistically significant difference in the group means of 2014 STAAR math scores was not observed ($p = .260$) and, therefore, the second null hypothesis was not rejected.

This chapter provided the statistical information, analysis of the data, and results. It explains the steps taken to screen the data and evaluate it considering the assumptions of

Analysis of Covariance (ANCOVA). It also provided a rationale for changing from an analysis of the data using ANCOVA to that using Analysis of Variance (ANOVA) instead due to assumption violations.

CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

The purpose of this causal-comparative research study was to determine if there were any significant differences when comparing the achievement on the State of Texas Assessments of Academic Readiness (STAAR) test of charter school students who participated in a blended learning approach to reading and math with students who studied the two subjects in fully online classes and with students who studied them in traditional classrooms with no online learning. For both subjects, the independent variable was the three learning delivery systems, the dependent variable was 2014 scores, and the covariate was 2013 scores. Math results for 2013 included 310 traditional learning students, 1070 fully online students, and 982 blended learning students for a total of 2362. Math results for 2014 included 313 traditional learning students, 1076 fully online students, and 986 blended learning students for a total of 2375. Reading results for 2013 included 240 traditional learning students, 639 fully online students, and 922 blended learning students for a total of 1801. Reading results for 2014 included 239 traditional learning students, 638 fully online students, and 922 blended learning students for a total of 1799.

The data for the covariate, 2013 scores, and the dependent variable, 2014 scores, in both math and reading were evaluated in preparation for an analysis of covariance (ANCOVA) to identify differences between the 2014 scores for each of the three groups. In both math and reading, the assumption of homogeneity of slopes was violated. In math, the assumption of homogeneity of variance was also violated. Thus, the researcher performed an analysis of variance (ANOVA) on 2014 scores to identify any differences without regard to 2013 scores.

Because of the removal of the covariate, a high degree of caution is required when interpreting the results of this study. Using ANOVA instead of ANCOVA means that the study did not include in the analysis the fact that the different groups began the school year already at different levels (see Tables 6 and 7). Two important considerations must be noted. First, in reading the fully online learning group began the school year already showing a significantly higher level of achievement (see Table 7). Second, somewhat astoundingly, the fully online learning group is the only one of the three groups to show a positive increase in the 2014 reading scores mean over the 2013 reading scores mean.

Enthusiasm for online learning runs high, but primary research remains scant (Bernard et al., 2014). In addition, much of the research that exists has been done in postsecondary contexts (Headden, 2013) and may well not apply to traditional or charter school K-12 students (Cavanaugh et al., 2009; Halverson et al., 2012; Means et al., 2010). Thus, there is a gap in research regarding the effectiveness of online learning whether it is fully online or blended when compared to traditional learning particularly in the charter school context. This study sought to add to the literature by investigating whether there is a difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading and math portions of the State of Texas Assessments of Academic Readiness test.

Null Hypothesis One: (Reading)

The first null hypothesis stated there is no difference in the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading portion of the State of Texas Assessments of Academic Readiness test while controlling for pre-test scores. Inability to use ANCOVA due to assumption violations meant that it was not possible to control for the pre-test scores. However, one-way Welch ANOVA results indicated a significant difference in the group means of 2014 reading scores ($p < .05$), leading the researcher to reject the first null hypothesis in favor of the alternative hypothesis.

Specifically, Games-Howell post hoc analysis indicated that the 2014 mean increase from the traditional learning group to the fully online learning group, 109.3, 95% CI (85.4, 133.3), was statistically significant ($p < .0005$). The mean of 2014 scores also increased significantly from the blended learning group to the fully online group, $F = 100.4$, 95% CI (86.4, 114.4), $p < .0005$. However, while the mean of 2014 scores increased from the traditional learning group to the blended learning group, it was not a statistically significant increase, $F = 8.9$, 95% CI (-15.3, 33.2), $p = .660$. Thus, the fully online group performed significantly higher on reading test scores than the other two groups.

These results for reading do not support the belief that blended learning is more effective than either traditional or fully online learning (cf. Alijani et al., 2014). Like this study, several others (Cavanaugh et al., 2004; Chingos & Schwerdt, 2014; Heppen et al., 2011; Hughes et al., 2007; Means et al., 2010; O'Dwyer et al., 2007; Sun et al., 2008) have found that students in online learning environments do as well or better than those in a traditional classroom. This study supports these claims.

In contrast with this study, a long and growing list of others have shown that blended learning students also do better than those in a traditional classroom (Almasaeid, 2014; Bernard et al., 2014; Castaño-Muñoz et al., 2014; Eryilmaz, 2015; Ibrahim Yasar & Demirkol, 2014; Kumi-Yeboah, 2013; Means et al., 2009; Rockman et al., 2007; Saritepeci & Çakir, 2015; Spanjers et al., 2015; Stockwell et al., 2015; Tamim et al., 2011; Wai & Seng, 2015;

Zhonggen, 2015a, 2015b). However, this study did not support these claims. In addition, when the focus is narrowed to reading, blended learning students have demonstrated greater learning growth when compared to traditional students (Petrone, 2014; Rosen & Beck-Hill, 2012; Schechter, Macaruso, Kazakoff, & Brooke, 2015; Szymanska & Kaczmarek, 2011). However, while this study found a significant elevation in mean scores of students in fully online contexts when compared to those in traditional classrooms, it did not find a significant difference in mean reading scores of students in blended learning contexts when compared to those in traditional classrooms (cf. Pace & Mellard, 2016).

Vygotsky's social development theory suggests that students learn when one or more teachers who are more knowledgeable interact with the less knowledgeable and developing students (Kozulin, 2005; Saxe et al., 2002; Vygotsky, 1978). The results of this study raise interesting issues. Specifically, the results suggest that Vygotsky's requirement for the presence of a more knowledgeable teacher and peers was met more effectively in the fully online learning context than it was in either the traditional or the blended environments. This contrasts with previous, stated expectations of blended learning enthusiasts based on Vygotsky's social development theory. They suggest that blended learning could better provide the necessary more knowledgeable teacher through adaptive technology capable of more effectively individualizing instruction (Allen, 2005; Attwell, 2010; Cicconi, 2014; Deulen, 2013; Hrastinski, 2009; Hsu, 2005; Lear, 2009; Marsh II & Ketterer, 2005; Smith, 1996, 1998; Westby & Atencio, 2002). Thus, students would be kept closer to their zone of proximal development. At the same time, the blended learning environment, providing as it does interaction with a human teacher and students (Holmes & Gardner, 2006; Staker, 2011; Ting & Chao, 2013), might be expected to better meet student social needs than the fully online learning context which lacks the personal presence of a teacher and peers (Bratitsis & Demetriadis, 2013; Smith, 1998; Stahl, 2011). However, this study did not confirm these expectations.

Null Hypothesis Two: (Math)

The second null hypothesis stated there is no statistically significant difference between the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the math portion of the State of Texas Assessments of Academic Readiness test while controlling for pre-test score. Inability to use ANCOVA due to assumption violations meant that it was not possible to control for the pre-test score. However, one-way ANOVA results indicated a nonsignificant difference in the group means of 2014 math scores (p = .260), making it not possible for the researcher to reject the second null hypothesis at the 95% confidence level.

These results for math do not support the understanding that blended learning is more effective than either traditional or fully online learning (cf. Alijani et al., 2014). Unlike this study, several others (Cavanaugh et al., 2004; Chingos & Schwerdt, 2014; Heppen et al., 2011; Hughes et al., 2007; Means et al., 2010; O'Dwyer et al., 2007; Sun et al., 2008) found that students in online learning environments do as well or better than those in a traditional classroom. Also unlike this study, a long and growing list of others have shown that blended learning students also do better than those in a traditional classroom (Almasaeid, 2014; Bernard et al., 2014; Castaño-Muñoz et al., 2014; Eryilmaz, 2015; Ibrahim Yasar & Demirkol, 2014; Kumi-Yeboah, 2013; Means et al., 2009; Rockman et al., 2007; Saritepeci & Çakir, 2015; Spanjers et al., 2015; Stockwell et al., 2015; Tamim et al., 2011; Wai & Seng, 2015; Zhonggen, 2015a, 2015b). In addition, when the focus is narrowed to math, blended learning students have demonstrated greater learning growth when compared to traditional students (Bottge et al., 2014; Kronholz, 2012; Mulqueeny, Kostyuk, Baker, & Ocumpaugh, 2015; Nusir et al., 2012; Pane et al., 2014; Rosen & Beck-Hill, 2012; Smith & Suzuki, 2015; Swan et al., 2015). However, this study did not find a significant difference in mean math scores of students in blended learning contexts when compared to those in traditional classrooms and fully online contexts (cf. Pace & Mellard, 2016; Pane et al., 2014).

Vygotsky's social development theory suggests that students learn when one or more teachers who are more knowledgeable interact with the less knowledgeable and developing students (Kozulin, 2005; Saxe et al., 2002; Vygotsky, 1978). The results of the math portion of this study suggest that Vygotsky's requirement for the presence of a more knowledgeable teacher and peers was met with no significant difference in effectiveness by fully online learning, traditional learning, and blended learning. As was the case with the reading portion of this study, the results for math contrast with previous, stated expectations based on Vygotsky's social development theory. Blended learning supporters suggest that it provides the best of both the traditional and fully online learning worlds. First, blended learning provides the more knowledgeable teacher through adaptive technology capable of more effectively individualizing instruction (Allen, 2005; Attwell, 2010; Cicconi, 2014; Deulen, 2013; Hrastinski, 2009; Hsu, 2005; Lear, 2009; Marsh II & Ketterer, 2005; Smith, 1996, 1998; Westby & Atencio, 2002). Through the technological, more knowledgeable teacher, students are kept centered in their zone of proximal development. At the same time, the blended learning environment, which includes by definition significant interaction with a human teacher and other students (Holmes & Gardner, 2006; Staker, 2011; Ting & Chao, 2013), is expected to better meet student social needs than the fully online learning context which lacks the personal presence of a teacher and peers (Bratitsis & Demetriadis, 2013; Smith, 1998; Stahl, 2011). This study did not support such expectations.

Conclusions

After the data failed the assumptions for Analysis of Covariance (ANCOVA), this causal-comparative research study used Analysis of Variance (ANOVA) to examine the differences between 2014 STAAR scores in the subjects of reading and math for three learning models: traditional learning, fully online learning, and blended learning. It employed sampling of students in grades two through eight from multiple locations of a single charter school management organization in Texas. ANOVA was used to examine whether there was a significant difference in the mean scores of students in each of the three groups.

This study produced mixed results. The second null hypothesis focused on math and stated that there is no statistically significant difference between the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the math portion of the State of Texas Assessments of Academic Readiness test. This null was confirmed by the study when differences were determined to be statistically insignificant.

However, the first null hypothesis of the study focused on reading stating that there is no statistically significant difference between the mean scores of blended learning charter school students, traditional classroom charter school students, and online only charter school students on the reading portion of the State of Texas Assessments of Academic Readiness test. This null was rejected by the researcher. Thus, the only significant differences identified by the study were in the subject of reading; however, there was no significant difference even between the traditional learning group and the blended learning group (p = .660). A significant difference was observed between the traditional and fully online groups, $F = 109.3$, 95% CI (85.4, 133.3), $p < .0005$, and the blended and fully online groups, $F = 100.4$, 95% CI (86.4, 114.4), $p < .0005$. In each instance, the fully online group had a significantly higher mean score.

The results of this study contribute to educational researchers' search for effective avenues to increase student achievement. Fully online schools remain popular for a variety of reasons; somewhere between 200,000 (Aldis & O'Leary, 2015) and 300,000 (Bausell, 2016) students throughout the United States either cannot attend school in a traditional or blended classroom context or choose not to do so, preferring instead to enroll in one of 200 online charter schools (Bausell, 2016; Fernandez, Ferdig, Thompson, Schottke, & Black, 2016). This study suggests that at least in the subject of reading, the fully online model may well provide an effective means for increasing achievement. Research has long affirmed literacy as a key component of student academic success (Boivin & Bierman, 2014; Cain & Oakhill, 2011; Heller & Greenleaf, 2007; Rubin, 1974; Sparks et al., 2013). Thus, the fully online learning model may well serve to improve overall academic success.

These findings may conflict with expectations considering current events. Of the variables explored in this study, the one that may be most suspect at the present time is the fully online course delivery model due to a series of high-profile problems that include unsatisfactory learning gains (Herold, 2015; Mandak, 2016; Prothero, 2016; Smyth, 2016; Woodworth et al., 2015). Yet, in this study, reading students in the fully online learning category are the only ones to have demonstrated significant learning gains over the alternative models. The results of this study are important because they show that contrary to some high-profile failures, it is possible in some circumstances for fully online learning students to demonstrate superior academic achievement. Such achievement contributes to student success and graduation rates. In addition, while research indicates that blended learning has sometimes been a more effective route to student achievement than traditional or fully online learning, this study suggests that this is not always the case. The results indicate that not all blended learning is any more effective than all traditional or fully online learning. In addition, even if fully online learning has often not proved more effective than traditional learning, especially when implemented on a large scale, in this study it produced significantly better results. Investigating why that was the case in this study is one area worthy of future research. However, because pre-test scores were removed as a control, these results must be interpreted with caution.

Implications

Studies have shown that learning delivery method, whether fully online, blended, or traditional, can impact the learner (Rivera, 2016; Tseng & Eamonn Joseph, 2016; Van Doorn & Van Doorn, 2014). This is true in reading (Petrone, 2014; Rosen & Beck-Hill, 2012; Schechter et al., 2015; Szymanska & Kaczmarek, 2011). It is also true for math (Bottge et al., 2014; Kronholz, 2012; Mulqueeny et al., 2015; Nusir et al., 2012; Pane et al., 2014; Rosen & Beck-Hill, 2012; Smith & Suzuki, 2015; Swan et al., 2015). Most studies comparing traditional, blended, and fully online learning have been conducted in the higher education context (Bernard et al., 2014; Halverson et al., 2014; Headden, 2013), and relatively few have been conducted that specifically focus on the K-12 learning context (Halverson et al., 2012). As one might expect, even fewer have focused on K-12 charter schools. This study added to the body of knowledge by examining the impact of traditional, blended, and fully online learning delivery methods on reading and math achievement.

The fact that no covariate could be included in this study due to Analysis of Covariance (ANCOVA) assumption violations means that a high degree of caution is required when drawing conclusions. The lack of the covariate means that it is not possible to know the level at which each of the three groups actually began. This means that one cannot know how much change in scores occurred; therefore, one cannot know which group scores actually increased most. Comparing end scores without knowing where groups began in order to compare the effectiveness of traditional, blended, and fully online learning introduces a significant level of uncertainty for any conclusions.

Keeping this significant caution in mind and left only with the 2014 scores and ANOVA results, one notes that this study did not support the literature regarding the effect of blended and online learning on student achievement when compared to traditional classroom learning. In this study, the fully online learning group in reading was the only one with a statistically significant relationship to test scores. Thus, fully online learning demonstrated a greater impact on achievement than either traditional or blended learning, but only in reading. The finding suggests that there may be times when fully online learning is the best choice for increasing achievement. On the other hand, the fact that there were no significant differences between any of the groups in math at all and no significant difference between traditional and blended learning for reading may suggest that additional variables are heavily involved, and they may be more important than which of the three course delivery options is used.

Because assumption violations made it impossible to use Analysis of Covariance, there is no way to know how the level of learning with which each group began the study impacted the 2014 scores. It is entirely possible that the group differences are due to the fact that they began at different levels. In reading, the fully online group may well have begun at a higher level as the 2013 means might suggest.

Limitations

There were several limitations to this study. First, the study includes data from only one year. Research including additional years of data would likely add additional clarity to the results. Another limitation of this study is that it is difficult to generalize beyond the actual participants. This is because the students were not randomly chosen or assigned to the groups, and all were charter school students. Thus, subgroups in the study (i.e., gender groups, ethnic groups, socio-economic groups) may or may not compare well with those outside the study. The very fact that the parents of the students involved have chosen to place them in a charter school may well involve confounding variables that hinder generalization from the results.

This study is also limited by variations in the practices, participation, and frequency of blended learning. The online learning component which was blended with the traditional classroom experience was encouraged, but not guided by procedural instructions resulting in variations in practice from campus to campus and even from classroom to classroom. Technology limitations meant that not all students could pursue blended learning at the same time. Students were generally rotated on and off the available computers. In some instances, teachers had great freedom to choose which students would work online, what subject they would work on, and how long they would work; in other instances, the campus principal made the choices or provided guidance and specifications to teachers by which they were to make these determinations. Thus, there was great variety in the blended learning implementation. This variation adds to the difficulty in generalizing from the findings because practices in other contexts may be very different. Even if other schools were to use the same online learning provider, Edmentum's Study Island, their practices might well differ significantly.

In addition, this study focused only on math and reading learning. Thus, the results of this study cannot be applied to other academic subjects. This study is further limited by the focus on Texas educational standards, the Texas Essential Knowledge and Skills. Both standards and curricula in other states may well differ such that the results of this study cannot be applied.

Another limitation of this study derives from the fact that apart from the students enrolled in a fully online school, all students with any online participation at all were included in the blended learning group without regard to the amount of participation. Thus, students who participated in very little online learning were included as well as those with significant time investment.

Finally, because pre-test scores were removed as a control due to the violation of Analysis of Covariance (ANCOVA) assumptions, these results must be interpreted with a high degree of caution since Analysis of Variance (ANOVA) does not account for the fact that the three groups did not all begin the school year at the same level; therefore, performance scores at the end of the year are not likely to be due to the independent variable alone.

Recommendations for Future Research

The continuing lack of extensive research comparing the effectiveness of traditional learning, blended learning, and fully online learning in the K-12 context (Barbour & Reeves, 2009; International Association for K-12 Online Learning, 2012; Means et al., 2010; O'Dwyer et al., 2007), and especially among charter schools, provides many opportunities for future research. Many facets of the learning process comparing these learning delivery systems remain unexplored. Yet, the fact that both online and blended learning continue to grow rapidly in K-12 and charter school contexts accentuates the need for additional research and examination of the questions at the heart of this study as well as others. Schools presume that these approaches to learning will improve achievement, but it is unknown if they actually improve achievement. Only through careful research can the question be answered and best practices identified. This study draws attention to the need for qualitative analysis to understand and explain the observed data. Specifically, it highlights the need for qualitative research that focuses on understanding why two of the three groups showed negative progress from their 2013 reading scores mean to their 2014 reading scores mean. Clearly, this would provide significant insight that is not discoverable through the Analysis of Variance (ANOVA) and other analyses included in this study.

K-12 populations, groups, and subgroups would also benefit from additional research comparing their results in traditional, blended, or fully online learning. Gender, socio-economic status, English learner status, special education status, gifted and talented status, and many other student groups often show differences in study results. Practices that are not effective with one population may be effective with another.

Research that focuses on the effectiveness of online learning component and practice variations would also be beneficial. Online learning can include a host of different activities as well as providers, and online learning can be blended into a classroom in several very different ways. These variables may impact student achievement and learning growth and produce different results.

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Appendix A: Institutional Review Board Approval

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

6/1/2016

Terry A. Chaney
IRB Exemption 2542.060116: The Effect of Blended Learning on Math and Reading Achievement in a Charter School Context

Dear Terry A. Chaney,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under exemption category 46.101(b)(4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

> (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
The Graduate School
LIBERTY
UNIVERSITY.
Liberty University | Training Champions for Christ since 1971

Appendix B: Local Consent Form

REQUEST FOR PERMISSION TO USE DATA FROM WITHIN THE RESPONSIVE EDUCATION SOLUTIONS SYSTEM FOR ACADEMIC RESEARCH

Name_______Terry A. Chaney__________________

RES Employee: Yes _X__ No ____ If NO, list employer: _____________________

College/University Supervising Activities___Liberty University___________________

Degree in Progress (Level/Area)_Doctor of Education, Educational Leadership_______

Date of Request_Oct 18, 2015__ Requested Dates for Data Collection: Nov 2015 to Dec 2015

Professor's Name _Dr. Daniel Baer_____

Phone #/Email _dnbaer@liberty.edu

Phone/email for Terry A. Chaney: (940) 222-9616 (cell)

terrychaney@gmail.com/tachaney@liberty.edu

Include with this request:

A copy of the research prospectus or plan.

I,__Terry A. Chaney___ do hereby submit to not hold Responsive Education Solutions liable for any findings, or commentary involved in this research. I understand that without the express written permission of Responsive Education Solutions, I am not authorized to utilize any data involving system employees or students and/or any other information that is protected by Federal or State Law. Furthermore, a copy of all findings and data collection instruments will be made available to the Responsive Education Solutions leadership. All research is to be sent to the Executive Director of Research upon completion of the project.

Signature____ Date October, 2015

Terry Chaney

From: Steve Bourgeois
Sent: Tuesday, October 20, 2015 1:02 PM
To: Terry Chaney
Subject: Permission to Conduct Research

Dear Mr. Chaney,

As Executive Director of Research, Evaluation, and Instruction at Responsive Education Solutions, I grant you permission to access requested 2013 and 2014 STAAR/EOC data along with online supplemental usage data from the same time period for your doctoral dissertation.

Please feel free to have representatives of Liberty University contact me if they require additional clarification of this permission.

Sincerely,

Steven J. Bourgeois, PhD
Executive Director of Research, Evaluation, and Instruction
Division of Learning and Leadership Development
Responsive Education Solutions

Office Phone: 972-316-3663, Ext. 430
Corporate Cell: 940-231-9617
Personal Cell: 817-773-0709