The Impact of Varying Levels of Blended Teaching Readiness on

Student Achievement Outcomes

by

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Dedication

I dedicate this thesis to my family: Joseph, Madison, and Jackson Akers and John and Marian Hemmenway. Without each of you, I could not have accomplished this goal. Joseph, without your encouragement I would have never begun my doctoral journey. Thank you for providing me with the time needed to read, write, and study by taking on the bulk the responsibility around our home. Madison and Jackson, thank you for your patience as I have spent countless hours locked away in our guest room working. You have been understanding beyond your years of the time commitment and have encouraged me to keep working hard. I pray that through this process you have seen me model the importance of education, hard work, and dedication to your goals. Mom and Dad, you have always modeled hard work and dedication to me in all that you do. Thank you for your support and for stepping in to help with the children on numerous occasions to enable me to pursue my goals. I love you all more than I could express and I could not have achieved this goal without each of your cheerleading, encouragement, and support.

I also dedicate this thesis to my students, colleagues, and the community I serve. Over the past three years of my doctoral journey, my overarching goal has been to learn and grow in order to improve my practice to be a better principal and leader for the teachers, students, and community I serve.

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Abstract

Background: Blended learning combines online and face-to-face instruction and can result in significant gains for students. While many state and federal policies require the use of technology within face-to-face classrooms, teachers are left to discover the best way to incorporate technology on their own. High-quality professional development can help prepare teachers for new instructional practices and improve students' learning. **Purpose:** This study aimed to examine the relationships between blended learning professional development, teachers' self-assessed readiness to teach in a blended learning environment, and student achievement outcomes. **Methodology:** In this quantitative study, I surveyed 73 third-fifth grade teachers in a large suburban school district in southeast Texas to determine their level of readiness and participation in blended learning professional development. I matched 1771 students' 2022-23 Math scores and 1120 students' Reading scores to their teachers and used mediation analysis to test the relationships of interest. **Results:** I found that readiness to teach in a blended learning environment was less important for student achievement in Math and Reading than teacher participation in blended learning professional development. Math teachers with two or more years of blended learning professional development had students with scores that on average were five points higher than students who had teachers with no exposure to blended learning professional development. Furthermore, there was no mediation effect for Math achievement; however, blended learning readiness negatively mediated the relationship between Reading achievement and teacher professional development, which was contrary to my hypothesis. **Conclusion:** The results of this thesis suggest that any amount of blended learning professional development has a significant, positive impact on student achievement outcomes for

Math. District and campus leaders should provide educators with professional development specific to blended learning as a key step toward making gains in student learning.

Keywords: education technology, blended learning, blended teaching, technology in education, online and face-to-face instruction, hybrid learning, elementary, K-12, professional development

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Chapter I Introduction to the Study

Many educators across the globe are trying out a relatively new set of pedagogical practices known as blended learning, which combines online and face-to-face instruction (Anthony, 2019; Archibald, et al., 2021; Fazal et al., 2020; Prescott et al., 2018). While many state and federal policies require the use of technology within face-to-face classrooms, teachers are left to discover the best way to incorporate technology on their own. As far back as the Reagan administration's *A Nation at Risk* report in 1983, there have been calls from the government to include technology instruction in our public schools to benefit our students and our future as a country. *A Nation at Risk* recommended that Computer Science courses be included in schools as one of the five basic subjects needed for graduation. Almost 20 years later, the No Child Left Behind legislation mandated that a new National Education Technology Plan be developed to "inform and guide policymakers in their efforts to ensure that schools will be able to use technology effectively to support high-quality teaching and learning for all students" (McMillan Culp et al., 2003). Yet, Archibald et al. (2021) point out that "although schools across the world are moving forward with the implementation of BL (Blended Learning) at an accelerated rate, teacher preparation lags far behind" (p. 537). This lack of teacher preparation was exacerbated further when lawmakers and school administrators pushed technology into students' hands as well as students and teachers back into school buildings following COVID-19. Educators are now left guessing what strategies to utilize in their classrooms to best incorporate technology and traditional face-to-face teaching strategies, such as lecture or pencil-and-paper-based teaching methods. This study aimed to examine the relationships between blended learning professional development, teachers' self-assessed readiness to teach in a blended learning environment, and student achievement outcomes on standardized tests. This chapter introduces the study by first discussing the background and context, followed by the research problem, the research purpose and question, the significance of the study, an overview of the methodology, and finally, the limitations.

Background

There are numerous definitions of blended learning and many different practices educators categorize as blended learning. The earliest seminal report on blended learning is the US Department of Education's 2009 meta-analysis which used the terms blended and hybrid learning synonymously to describe any classroom that used both online and face-to-face instruction (Fazal et al., 2020; Means et al., 2013). Fazal et al. (2020) assert that "blended learning is not a singular phenomenon but rather a combination of methods using technology and effective face-to-face teaching and learning strategies" (p. 71), while Prescott et al. (2018) claim that "blended learning incorporates face-to-face, teacher-led instruction along with digital technology using actionable data to provide students with a personalized educational path" (p. 497). These definitions are vastly different as the first describes ambiguous strategies that combine online and face-to-face instruction, but the latter notes the importance of using the data acquired from technology in order to provide greater personalization for each student. With such variability in how blended learning is defined, it is hard to compare studies on the implementation and effects of blended learning practices. According to Pulham and Graham (2018), Christensen et al. (2013) provide the most widely accepted definition of blended learning:

> Blended learning is a formal education program in which a student learns at least in part through online learning with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from

home (p. 7).

The authors elaborate that "the modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience" (Christensen et al., 2013, p. 7). This means that students are not completing tasks having to do with different learning objectives, but all learning activities, whether completed online, in small group instruction, collaboratively, or independently, are helping students to construct meaning on one given learning objective.

Another concept vital to this definition of blended learning is personalization. Prescott et al. (2018) state that "blended learning incorporates face-to-face, teacher-led instruction along with digital technology using actionable data to provide students with a personalized educational path" (p. 497). Students typically receive personalized instruction through blended learning in three ways: adaptive software, differentiated small-group instruction, and one-on-one instruction from a face-to-face teacher. Adaptive software personalizes instruction by assessing student knowledge and skills within a subject when students first use the program (Prescott et al., 2018). The program then provides instruction and practice questions based on each student's skill level (Prescott et al., 2018). Adaptive software provides teachers with detailed data describing what specific skills and objectives students have mastered and areas of need (Prescott et al., 2018). Armed with the data from the adaptive digital software, teachers can differentiate instruction to remediate for students who are struggling as well as support gifted and talented students by extending their learning beyond the current grade level (Prescott et al., 2018).

Fazal et al. (2020) support the importance of teachers utilizing the data from adaptive software to personalize small-group and individualized instruction within the classroom. Based on their analysis of the degree to which teachers utilized blended learning practices and student achievement outcomes, “it was not the integration of adaptive digital content that led to a significant difference, but rather the use of data and teacher strategies for differentiating instruction that led to a statistically significant impact on the math scores” (p. 74). Fazal et al.’s (2020) findings prove that differentiated small-group instruction driven by the data acquired from adaptive software is vital to the success of blended learning pedagogical practices. Thus, blended learning cannot be categorized as simply any combination of face-to-face instruction and technology, but educators must uncover the specific teacher and student practices that make blended learning effective and provide teacher training on these practices.

Problem Statement

Following the widespread school closures caused by the COVID-19 pandemic, when face-to-face classes began to resume in the 2020-21 school year, students returned to brick-and-mortar school buildings, but each with their own school-assigned technology device in hand. While schools’ and districts’ top priority was ensuring students received devices so they could connect to class and continue learning from home during school closures, little thought was put into how students and teachers would use these devices in the context of the school building. Thus, and according to Archibald et al. (2021), there is now widespread adoption of blended learning with little to no teacher preparation for managing students online and face-to-face simultaneously (Archibald et al., 2021). Although many teachers received training in different software programs, online programs, and learning management software programs, there is currently no commonly agreed-upon method for best implementing and balancing learning activities between online and more traditional paper-and-pencil methods (Archibald et al., 2021). While the literature shows that the addition of technology increases engagement and achievement for students (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei

& Zhao, 2008), educators must look more deeply to uncover the impact of teacher preparation, readiness, and practice has on student achievement outcomes.

A large suburban school district in southeast Texas, Sunnyside Independent School District (SISD, Sunnyside ISD), found itself in the same situation described above when they provided Chromebooks one-to-one for every student from Pre-K through 12th grade. Sunnyside ISD provided training for teachers on software programs they could use with students on the devices; however, there was no training for teachers on how to change their pedagogy or instructional practices within their face-to-face classrooms while incorporating this abundance of new technology. Many individual school principals within SISD sought out professional development from a blended learning consultant to train and prepare teachers to include the elements of blended learning in their classrooms. Although all teachers throughout SISD utilize the one-to-one devices in their classrooms, not all have had the same level of preparation to incorporate blended learning practices. Given varied levels of teacher preparation to incorporate technology and online learning into their classrooms and the fact that blended learning is not going away, it is important to assess teachers' readiness and evaluate the relationship between their readiness and student achievement.

Purpose Statement

The purpose of this study was to examine the effect that differing levels of teacher preparation in blended learning practices had on teachers' self-assessed blended teaching readiness and student achievement outcomes in Sunnyside ISD elementary schools. The study evaluated if there was any correlation between elementary school teachers' perceived readiness to teach in a blended learning environment and their students' achievement outcomes in a large suburban school district.

Research Questions

In order to explore the effect of blended teacher preparation on student outcomes, I sought to answer the following questions in my research:

1. To what extent are there differences in teacher readiness depending on whether a teacher participated in BL professional development?
2. To what extent does student achievement vary depending on whether a teacher participated in BL professional development?
3. To what extent is a teacher's blended learning readiness related to student achievement outcomes?
4. To what extent does teacher readiness to use BL mediate (help explain) the relationship between teacher participation in BL professional development and student achievement?

Through this quantitative study, I tested whether elementary teachers' readiness to implement blended learning as measured by the Blended Teaching Readiness Instrument (see Appendix A) was correlated with student academic outcomes on Texas' state standardized assessments, the STAAR tests.

Significance

While there is abundant research available on the implementation of one-to-one device initiatives in schools (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Harris et al., 2016; Heath, 2017; Lei & Zhao, 2008), there is little research on the relationship between teacher readiness to teach in a blended learning environment and student achievement (Archibald et al., 2021). Short et al. note in their 2021 literature review that they were unable to locate any systematic studies focusing primarily on preparing K-12 teachers for blended teaching. This gap is problematic given the overwhelming evidence of the exponential rise of K–12 blended teaching practices brought on by emergency remote teaching during the Covid–19 pandemic. Short et al. (2021) predict that blended teaching practices will likely continue to gain momentum in growth due in large part to the investments made in technological infrastructures of schools as well as the experience and knowledge teachers gained through the necessity of emergency remote teaching during the COVID-19 pandemic. While districts ensured schools had the infrastructures needed to support large amounts of technology use and teachers gained technology knowledge and skills out of necessity, there is still a gap in skills and training in how best to combine online and face-to-face instruction in the K-12 setting (Short et al., 2021). Therefore, Short et al. (2021) conclude that the lack of peer-reviewed articles on blended teaching paired with the call for blended teacher training from the U.S. Department of Education shows that this topic deserves more attention. Investigating this problem further benefits countless districts, schools, classrooms, teachers, and students. As Fazal et al. (2020) attest, "Schools need high-impact strategies that demonstrate strong evidence of effectiveness and student achievement" (p. 71). This is true now more than ever following the gaps in learning created by learning from home due to the coronavirus pandemic. The data collected in this study have the potential to impact countless teachers' understanding and implementation of blended learning.

Overview of Methodology

I utilized quantitative methods to uncover any correlation between teacher readiness to provide blended learning instruction and student achievement outcomes. Participants included teachers from Sunnyside ISD from a wide selection of schools across the district. This variety in the selection of participants served my research questions by providing survey participants with differing levels of blended teaching preparation. To determine the effect of teacher preparation to teach with a blended learning pedagogy on student achievement, I used the Blended Teacher Readiness Instrument (BTRI), developed and validated by Archibald et al. (2021). I sent this survey to a sample of elementary-level teachers at multiple elementary schools within SISD.

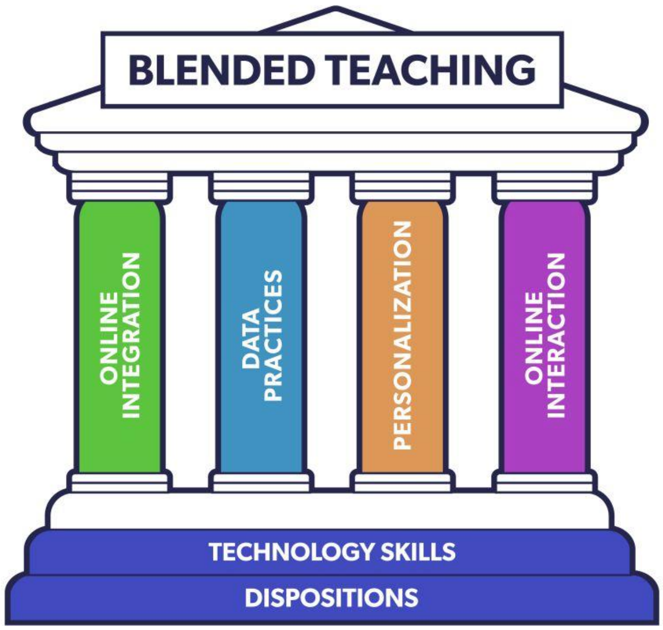
I then obtained the state of Texas' standardized testing STAAR assessment results for students that had each participating teacher for the school year in which the teachers self-reported their readiness to teach with a blended learning pedagogy. This data comparison allowed me to gain more insight into the effectiveness of blended learning teacher preparation in regard to teaching practice and, ultimately, student achievement.

Conceptual Framework

My research is grounded in the Blended Teaching framework outlined in Graham et al.'s (2019) K-12 Blended Teaching: A Guide to Personalized Learning and Online Integration. Graham et al.'s (2019a) framework is displayed in Figure 1:

Figure 1

Blended Teaching Framework



Note. Source: Graham et al., 2019a.

This framework builds upon the previous work done by Graham et al. (2019a). During the validation process, Graham et al. (2019a) purposefully paired down the length and number of competencies to make the framework accessible and easy to understand. They focused their framework on key dispositions and pedagogically oriented competencies (Archibald et al., 2021). Graham et al. (2019a) utilized a comprehensive literature review of blended teaching competencies that coded and ranked all existing blended teaching standards to determine the most essential competencies to include in their framework (Archibald et al., 2021; Graham et al., 2019a; Pulham & Graham, 2018). The framework resulting from this work consists of "*Dispositions* and four key competencies: *Online Integration*, *Data Practices*, *Personalization*, and *Online Interaction"* (Archibald et al., 2021, p. 541). Refer to Table 1 below for descriptions and related organizing themes and ranks.

Table 1

Descriptions of the Top-Level Constructs in the K-12 BTR Model

Construct	**Related organizing theme & rank (from Pulham & Graham, 2018)**
Dispositions – focus on the teacher's attitudes and beliefs toward blended learning and teaching.	Student-centered learning (#8)
Online Integration and Management - focuses on the teacher's ability to make and implement decisions related to selecting when and how to effectively combine online and in-person learning as part of core instruction.	Expectations established (#4) Classroom management (#6) Integration of online and face-to-face elements (#8) General assessment (#11) Software management (#12)
Data Practices – focus on the teacher's ability to use digital tools to monitor student activity and performance in order to make informed choices about interventions to help students progress.	Mastery-based learning (#2) Data usage and interpretation (#3) Learning Management System (#7) Formative assessment (#15)
Personalization – focuses on the teacher's ability to implement a learning environment that allows for student customization of learning goals, time, place, pacing and/or path.	Flexibility & personalization (#1) Student progress review (#5) Student grouping (#10) Instructional intervention (#15)
Online Interaction – focuses on the teacher's ability to facilitate online interactions with and between students.	Community development (#12) Online discussion facilitation (#14)

(Archibald et al., 2021, p. 542)

The competencies outlined in this framework by Graham et al. (2019a) and further defined by Archibald et al. (2021) align with the definition for blended learning outlined by Christensen et al. (2013) as an education program in which a student learns "at least in part through online learning, with some element of student control over time, place, path, and/or pace" (p. 8). Archibald et al.'s (2021) addition of "data practices" and "personalization" echo

Fazal et al.'s (2020) findings that teachers' use of data to inform their teaching practices had the greatest impact on increased student performance. This framework will be the lens through which I evaluate teacher readiness to implement blended learning in their classrooms.

Limitations

Limitations of my study include that the design of the study sought correlation and not causation. The results of the study are unable to point to any variable as the cause of student performance outcomes, only identify a correlation between teacher self-reported readiness to teach BL and student outcomes. Additionally, I measured teacher readiness not at the beginning of the pandemic, when teachers were likely at their lowest point of readiness, but rather after two-plus years of teachers practicing some form of blended learning in their classrooms with or without training. Since I asked teachers to complete the BTRI, a self-report measure, it must be noted that self-reported measures are limited because respondents tend to provide the responses they think researchers want to hear. Additionally, teacher readiness is not a measure of implementation, so the teachers that participated and took the survey could show that they are ready to implement BL but did not actually implement BL well in their classrooms. All of these limitations were taken into account throughout the study.

Outline of Remaining Chapters

In the remaining chapters, I explore the concept of blended learning further and provide more specific plans outlining my research. In Chapter Two, I explore the literature regarding blended learning as well as technology implementation and teacher preparation to implement technology into their classrooms. This chapter also delves more deeply into the Blended Teacher Readiness Framework and the concepts within it being used to define quality blended teaching. Chapter Three describes the specific methods utilized to select survey participants within

Sunnyside ISD and how the data was collected and analyzed. I then discuss the results in my fourth chapter and conclude my study in my fifth chapter.

Chapter II Literature Review

Introduction

For technology to have the most significant impact possible on learning, educators must do more than simply distribute devices to students. In their 2015 literature review of technology in K-12 classrooms, Delgado et al. reviewed 90 articles selected from 1986 to 2014 to answer the question, “How effective is educational technology?” (p. 399). The authors presented an overview of the rapid transition of technology implementation over the years covered. Delgado et al. (2015) noted numerous studies that reported one-to-one computing environments lead to significantly higher scores on both Reading and Math achievement tests as well as higher overall grade point averages. Additionally, the authors' synthesis of the data revealed that students in one-to-one computing environments exhibited improved engagement, research skills, and collaboration skills (Delgado et al., 2015). Although the authors found that the nationwide average of students to device was 1.7 to 1 at the time of their study, teachers reported that only 40% of their students used computers “often” during instructional time (Delgado et al., 2015, p. 409). This means that 60% of students did not use computers very often or at all for learning in schools. While the literature shows that the addition of technology increases engagement and achievement for students, educators must look more deeply to uncover what specific teacher and student actions utilizing technology make the most significant impact on learning (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008). The purpose of this study was to examine the effect that differing levels of teacher preparation in blended learning practices had on student achievement outcomes. The study evaluated if there was any correlation between elementary school teachers’ perceived readiness to teach in a blended learning (BL) environment and their students' achievement outcomes in a large suburban school district. Specifically, my research questions were:

1. To what extent are there differences in teacher readiness depending on whether a teacher participated in BL professional development?
2. To what extent does student achievement vary depending on whether a teacher participated in BL professional development?
3. To what extent is a teachers' blended learning readiness related to student achievement outcomes?
4. To what extent does teacher readiness to use BL mediate (help explain) the relationship between teacher participation in BL professional development and student achievement?

When reviewing the literature on technology implementation in K-12 schools, several themes emerged: one-to-one device implementation, specific technology practices, and blended learning as a pedagogical practice to incorporate face-to-face and digital learning.

One-to-One Device Implementation and Effects

There have been numerous studies on the implementation of one-to-one device initiatives in schools. From the earliest one-to-one device implementation initiative in the late 1980s to more recent distributions of devices in schools, researchers have shown that adding more technology into schools has a positive correlation with student achievement outcomes (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Harris et al., 2016; Lei & Zhao, 2008). Additionally, studies have found that student motivation also increases when student technology use increases in schools (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008). A shortcoming of much of this research is that the studies do not permit the authors to make causal claims—these relationships are correlations only. Yet, the purchase and distribution of devices in schools continues with the hope that adding these devices will increase student engagement and achievement. At the same time, many studies point to the importance of teacher readiness and preparation to implement technology in their classrooms (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008), yet few describe what types of preparation teachers need (Heath, 2017). That said, findings suggest that even without consistent teacher preparation, one-to-one device implementation in schools is followed by increased student engagement, motivation, and learning outcomes (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008).

Numerous studies demonstrate the correlation between the addition of technology and positive student outcomes (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008). For example, Bebell and Kay (2010) set out to investigate the effects of one-to-one device implementation with a mixed methods study across five Massachusetts middle schools over the three-year pilot of the Berkshire Wireless Learning Initiative. Results of Bebel and Kay's (2010) study indicated that teacher and student technology use dramatically increased following the one-to-one device initiative, with student technology use increasing nearly four times in the first six months of the one-to-one device deployment (Bebell & Kay, 2010). Similarly, 76% of teachers agreed that student motivation increased and 83% felt that student engagement improved due to the one-to-one device implementation (Bebell & Kay, 2010). While school leaders and teachers overwhelmingly agreed that one-to-one device implementation had a positive effect on student achievement, the standardized testing data showed that after two years with individual student computers, English Language Arts (ELA) scores had a statistically significant increase, but Math scores did not (Bebell & Kay, 2010). Since no specific teaching practices or expectations for technology use were required of teachers, it is not clear what teaching practices, if any, were different between ELA and Math teachers that might have affected these outcomes.

Similar to Bebel and Kay's (2010) study, Cavanaugh et al. (2011) sought to determine the effects of one-to-one device implementation on student achievement and teacher practices. Researchers collected data following a one-to-one technology device pilot program in 440 Florida K-12 classrooms (Cavanaugh et al., 2011). Cavanaugh et al. (2011) concluded that all districts saw positive academic outcomes as a result of implementing one-to-one technology. Specifically, results showed significant increases in student attention, interest, and engagement, as well as decreased independent seatwork (Cavanaugh et al., 2011). Another key result showed a significant increase in the frequency with which teachers implemented meaningful computer activities (Cavanaugh et al., 2011). Seventy-eight percent of the participating teachers documented positive changes in student achievement based on test scores, retention, and transfer of learning (Cavanaugh et al., 2011). In one elementary and two middle school classrooms, teachers reported negative effects such as lower writing achievement and frustration (Cavanaugh et al., 2011). The authors attributed these adverse to inexperience with technology, which forced students to learn the new technology alongside the course content (Cavanaugh et al., 2011). Sixty percent of teachers reported increases in conditions that support learning, such as student enjoyment, motivation, on-task behavior, and a positive school experience (Cavanaugh et al., 2011). Though the authors state that professional development was provided to the teachers involved in this pilot program, the authors do not describe what that professional development entailed (Cavanaugh et al., 2011). Therefore, it is difficult to determine what specific teacher practices made the one-to-one technology implementation effective.

In contrast to the large-scale study conducted by Cavanaugh et al. (2011), Harris et al. (2016) studied the effects of one-to-one technology implementation on a much smaller scale - studying just two classrooms in the same school. The purpose of this smaller study was very similar to Bebell and Kay's (2010) and Cavanaugh et al.'s (2011) research goals: to determine whether one-to-one technology affects student academic achievement and motivation. The participants in this study were fourth-grade students from two different classrooms in the same Title 1 school located in central Illinois (Harris et al., 2016). Students in one class were provided with one-to-one technology, while a separate class in the same grade level was taught with traditional methods (Harris et al., 2016). Researchers collected the results from two Math assessments given at varying intervals throughout the year as well as student attendance rates to determine the impact of technology on student motivation and achievement (Harris et al., 2016). Harris et al. (2016) found that while students in the one-to-one technology classroom achieved higher scores on the first three of one of the Math assessments administered, students in the traditional classroom scored higher on the final three tests in the series. The study also looked at student motivation, as measured by attendance. When comparing the two classes by month, the traditional classroom had lower absences for four of the months and the one-to-one implementation classroom had lower absences for three of the months; however, when looking at the overall number of absences throughout the year, the one-to-one implementation classroom had fewer absences total (Harris et al., 2016). From these results, Harris et al. (2016) concluded, "The results show that one-to-one technology could be a factor in student academic achievement and motivation to be at school" (p. 368).

The article had several limitations. First, the authors did not report all the data they collected. While Harris et al. (2016) state themselves that one of the Math assessments was administered seven times, they do not list the second of the seven assessments in their results, nor is it mentioned why this test is omitted. Similarly, while the researchers reported that four tests would be administered for the second Math assessment, results for only the first three were reported. These omissions may have been tantamount in proving or disproving the authors' theory that one-to-one device implementation has a significant impact on student achievement outcomes and motivation; however, without these assessment results or any explanation as to why they were excluded, further research is warranted.

In their 2008 study, Lei and Zhao found that with simply the addition of one-to-one devices for all students, "teachers and students believed that the laptops were very important, and that the one-to-one laptop project greatly helped teaching." (p. 118) Lei and Zhao (2008) conducted their study at a northwestern middle school in a middle- and upper-class neighborhood with about 1% of students receiving free or reduced lunch. The school implemented a one-to-one device implementation program at the beginning of the 2003-2004 academic year, providing every teacher and student with an Apple iBook that they could take home every day (Lei & Zhao, 2008). While no specific expectations for student or teacher use of the new one-to-one devices were documented, simply by making the devices available, students and teachers began utilizing them. In fact, Lei and Zhao (2008) found that 47% of students spent more than two hours a day on their laptops following the implementation. Although time spent using their newly acquired devices does provide one data point for the success of the one-to-one implementation, Lei and Zhao (2008) assert that "what is more important than the quantity of technology use is the quality of technology use, or how technology is used and for what purposes" (p. 106).

Despite Lei and Zhao's claim that "how technology is used and for what purpose" (p. 106) is more important than how much technology is available, it seems that the school did not put any training or expectations in place for how students and teachers were to use the devices for learning inside or outside of school. Even without training or expectations for students or teachers, students showed significant gains in technology proficiency from the test administered prior to the one-to-one device implementation as compared to the end of the academic school year after having one-to-one devices all school year (Lei & Zhao, 2008). Students' overall academic performance also increased when looking at their cumulative GPAs from 3.27 at the end of the year prior to the one-to-one device implementation to 3.32 at the end of the following year in which one-to-one devices were distributed (Lei & Zhao, 2008).

Results from Lei and Zhao's 2008 study further confirm the findings of Cavanaugh et al. (2011) and Harris et al. (2016) in showing that one-to-one device implementation has a positive correlation with increased student academic performance. Lei and Zhao report that "interviews with teachers and students suggested that one-to-one computers and related technologies have enriched students' learning experiences, expanded their horizons, and opened more opportunities and possibilities" (p. 117). Additionally, Lei and Zhao found that "results from this study suggest that having one-to-one computers can significantly help increase student technology proficiency because of the increased opportunities of learning technology knowledge and skills while using the laptops to work on various tasks for learning, communication, expression, and exploration" (p 117).

While the majority of the literature concerning one-to-one technology implementation in K-12 schools focuses on top-down approaches in which district or campus administrators initiate a one-to-one device implementation plan, Heath's 2017 study examines "the lived experiences of two middle school social studies teachers who self-initiated a one-to-one technology program in their classrooms" (p. 89). In reviewing the qualitative data gathered through numerous interviews with the two participants, Heath (2017) reported that several themes emerged: positive beliefs about technology, the teachers' belief in themselves as change agents, and bureaucratic and technological barriers to implementation. Heath (2017) claimed that the teachers in this case study were able to overcome the barriers described due to "the teachers' belief in the value of technology and the teachers' belief in themselves as agentic professionals" (p. 101). Further, Heath (2017) recommended that "policymakers and school leaders empower teachers by building capacity and supporting development of positive teacher beliefs well in advance of technology initiatives" (p. 103). Heath's recommendation that building teacher capacity through professional development and support should come prior to any device implementation program further supports my view that one-to-one device implementation initiatives that districts across the country rushed to implement due to the need for students to be able to connect to class from home during the pandemic has created numerous problems that must be remedied with professional development, support from administrators, and, as Heath puts it, "opportunities to take risks with technology" (p. 103).

Researchers have demonstrated that one-to-one device implementation, even with no specific professional development plan or expectation for student use of the devices, has a positive impact on student engagement and achievement (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008). Although Lei & Zhao (2008) note that "the school district provided teachers with convenient and sufficient professional development opportunities" in their study (pp. 103-104), they do not detail what the professional development specifically entailed nor how they concluded that it was *sufficient*. This is especially important to note because Lei and Zhao (2008) themselves stated the importance of determining "how technology is used and for what purposes" (p. 106), yet they fail to provide information on the extent to which teachers received training on this principle. In the small-scale study completed by Harris et al. (2016) involving only two classrooms, I am left wondering how the one-to-one technology implementation results may have been moderated by the quality of each of the teachers selected. Harris et al. (2016) agree that teacher quality plays an important role in the success of any one-to-one technology implementation initiative:

> Teachers must continue to be learners themselves to produce the best teaching methods and introduce technology that works for their classroom and the specific needs of their students. What teachers decide to bring into the classroom, must "hook" students and make them excited to learn, thus, the programs, materials, and projects done should be meaningful to the students. When this is done correctly, school districts will see the product of higher engagement levels, higher achieving students, and the desire to be at school to learn (p. 380).

The literature is clear that professional development is needed for teachers prior to one-to-one device implementation to provide teachers with "a voice in initiatives from conception through implementation in order to minimize negative perceptions" (Heath, 2017, p. 102). While some would argue that teachers must have devices in the classroom before they can begin to implement them, the research shows that teacher knowledge, skills, and beliefs about technology implementation are of extreme importance to successful implementation and, therefore, should be cultivated prior to device implementation (Heath, 2017). Lei and Zhao (2018) agree, imploring "Further research is needed to provide a deep understanding of learning practices in classrooms with one-to-one laptops" (p. 101). Bebell and Kay (2010) echo this point when they point out that educational leaders have spent billions of dollars on education technology, "believing that increased use of computers will lead to improved teaching and learning, greater efficiency, and the development of important skills in students," yet little is known about the specific practices and learning activities that make the greatest impact on student learning (p. 5).

Specific Technology Practices

While the literature overwhelmingly supports that the implementation of one-to-one technology devices increases student engagement and academic performance (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008), educators must consider what specific learning activities have the greatest impact. Educators should look to current research to determine which learning tasks should be completed using traditional paper and pencil methods and when it is most appropriate and beneficial to utilize electronic media for learning tasks (de Koster et al., 2017; Sage et al., 2020). Additionally, the research shows that the specific teacher practice of planning for technology implementation is much more effective if teachers begin with their pedagogical beliefs and select technology activities that fit into their overarching goals rather than starting with technology as the basis for a lesson (de Koster et al., 2017). The emerging practices of gamification and virtual reality (VR) are gaining momentum in K-12 education despite associated costs (Bai et al., 2020; Luo et al., 2021). This is due in large part to the high levels of motivation that these practices bring to a classroom as well as the immersive experience they can bring beyond that of traditional paper and pencil methods (Bai et al., 2020; Luo et al., 2021). In this section I will examine the specific technology practices of reading from print compared to electronic devices, the teacher practices involved in planning lessons that incorporate student technology use, gamification in the classroom, and utilizing virtual reality for learning.

Reading Practices

Although there are more and more electronic devices available and being used by students in the K-12 setting, many educators wonder if student learning outcomes are supported or hindered by these devices. Sage et al. (2020) sought to uncover if student learning outcomes differed across three different reading platforms: print, laptop, and e-reader. To investigate this, the researchers engaged 144 undergraduate students as participants in a mixed-methods study (Sage et al., 2020). Sage et al. (2020) found that students performed significantly higher on comprehension quizzes after reading a passage from paper, then computers, and finally, e-readers. While students read the leisure readings faster and reported enjoying those readings more, they performed better on the multiple-choice and open-ended comprehension quizzes after engaging with the academic readings (Sage et al., 2020). Interestingly, researchers found that students who scored higher on the multiple-choice comprehension quizzes also reported enjoying the readings (Sage et al., 2020). Sage et al. (2020) concluded that, at the time of this study, college students continue to prefer paper and perform better academically when utilizing paper to read passages. The authors caution that this research must continue to be conducted and re-analyzed as technology advances and continues to increase in use over time (Sage et al., 2020).

Despite the numerous studies that show academic increases when students utilize technology (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008), for the specific practice of reading for comprehension, paper is not only preferred but correlates to increased comprehension scores (Sage et al., 2020). Sage et al. (2020) hypothesize that e-readers and computers will continue to gain momentum in preference and performance of students over time with increased exposure and technological advancements. While the authors point out this may change over time as students begin to use technology to read at younger ages and, therefore, have more experience and comfort with reading from a screen instead of paper, it is important to note that at this time, for the specific practice of reading comprehension, reading from paper is preferred and correlates to higher achievement (Sage et al., 2020).

Planning for Technology in the Classroom

In contrast to Sage et al.'s (2020) research into the specific student practice of reading with technology at the college level, de Koster et al. (2017) examined the specific teacher practice of planning for technology use at the K-12 level. de Koster et al. (2017) claim that technology can only be considered truly integrated when it supports a specific type of teaching and learning. Therefore, the authors focused their research on teachers planning lessons that integrate technology into their school's current educational concept. Specifically, de Koster et al. (2017) argue that when teachers design learning activities that align with their school's overall pedagogy and practices, they are much more successful in executing the technology integration. Although some people believe that simply adding more technology devices into the classroom or counting the frequency with which technology is used in the classroom accounts for technology integration, de Koster et al. (2017) insist that authentic technology integration occurs when the technology supports the pedagogy and practices already in place in a school community and teacher's belief system. In sum, their view is that teachers must be an integral part of planning any successful technology integration, and the planning should begin with the learning pedagogy teachers are already familiar with rather than the technology (de Koster et al., 2017).

de Koster et al.'s (2017) claims align with current planning practices and beliefs in education that lesson planning should always begin with learning outcomes in mind, not the technology to be integrated. Some might object, of course, and point to one-to-one technology integration research that simply adding technology increases student achievement (Bebell &

Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008). However, research supports that only after learning outcomes are determined should an educator select appropriate technologies to support or enhance the learning (de Koster et al., 2017).

Gamification

Another technology implementation practice gaining momentum in K-12 education is gamification (Bai et al., 2020). Games for entertainment were created primarily for amusement and recreation. In contrast, the major goals of games for learning, also known as games-based learning or serious games, are information acquisition and behavior change (Bai et al., 2020). Digital games called "serious games" are made to teach players academic material or train them in a specific ability. Gamification, in contrast, is a technique that incorporates video-game-like characteristics into a non-game context to influence learner behavior (Bai et al., 2020). In their meta-analysis, Bai et al. (2020) only reported on the game components explicitly stated in the initial investigations, including badges, challenges, leaderboards/ranks, levels/unlocks, storylines, points, progress bars, and teams. Although Bai et al. (2020) found that most of the studies they examined looked at the impact of multiple game elements combined rather than single game elements, the research indicated that no matter the combination of game elements, gamification had an overall significant positive effect on student learning outcomes.

To uncover why gamification had a positive effect on student learning outcomes, Bai et al. (2020) also examined qualitative data and found that gamification promoted personal goal-setting among learners. Learners in a badge-oriented gamification program might work to earn the “early bird” badge by finishing all work first or the “active participation” badge by staying engaged and answering questions during the lesson. The study's findings indicate that learners who receive a badge for their efforts in class are more likely to finish the course-related assignments than those who are only instructed to do their best or who are not given a clear goal such as a badge to be earned (Bai et al., 2020). Consequently, students who are motivated to finish their assignments and participate in class perform better than students who are not given a clear goal (Bai et al., 2020). Gamification can also satisfy a learner's desire for acknowledgment. Motivation theorists generally concur that students enjoy having their efforts noticed by others (Bai et al., 2020). While gamification is not directly a technology practice, it is derived from technology and is most often used to promote the completion of technology-based and offline tasks to improve learning outcomes.

Virtual Reality

A cutting-edge technology rapidly gaining attention in K-12 and higher education learning environments is Virtual Reality (VR) (Luo et al., 2021). As its name suggests, VR is defined as a collection of software and hardware tools used to create computer simulations (Luo et al., 2021). VR is drawing attention as a prospective technology for use in K–12 and higher education settings due to its potential to create immersive learning experiences through simulated reality (Luo et al., 2021). Luo et al. (2021) conducted a systematic review of the literature on K-12 and higher education research from 2000-2019 based on 149 selected articles. Their research indicated that higher education incorporates VR technology considerably more extensively than K-12, particularly in the disciplines of health and medicine (Luo et al., 2021). Inquiry-based learning and direct instruction were discovered to be the two most popular pedagogies for VR interventions (Luo et al., 2021). The findings of the meta-analysis showed that VR interventions had a moderate impact on learning; however, the authors assert that the addition of offline learning activities is essential to the success of any VR intervention (Luo et al., 2021). The researchers posit that student involvement with the VR intervention can only constitute a portion of the learning process in VR-based instruction (Luo et al., 2021). The authors report that individual or group debriefing between instructors and students following VR practice can significantly improve the results of VR-based instruction (Luo et al., 2021).

VR-based learning experiences were found to have several limitations. Despite the fact that VR is typically regarded as an immersive medium, only a few VR programs were able to provide a completely immersive learning experience using cutting-edge technology (Luo et al., 2021). Additionally, it was discovered that VR interventions lacked embedded learning features, including assessments, collaboration, and data collection (Luo et al., 2021). The usage of VR for education faces consistent challenges, such as induced physical discomfort, safety risks, technical difficulties, and excessive expense (Luo et al., 2021). At this time, these limitations make it difficult to integrate VR into more standard curriculums (Luo et al., 2021).

Summary of Specific Technology Practices

This section has covered only a few topics that make up the broad range of specific technology practices utilized in K-12 and higher education, yet they showcase the disconnect between solid research findings and classroom implementation. While Sage et al. (2020) found that at the time of their study, students preferred to read from paper over electronic devices and performed better on comprehension quizzes after reading from paper, the same year of the study, the COVID-19 pandemic swept across the world forcing devices into the hands of teachers and students despite these findings. Similarly, while de Koster et al. (2017) posit that the most effective technology integration occurs when the technology supports the pedagogy and practices already in place in a school community and teacher's belief system, throughout the pandemic, teachers were forced to utilize technology in order to communicate with students and this practice has endured because of the amount of money spent on these devices. On the other hand, Bai et al. (2020) found that students who experienced the specific technology practice of gamification had much higher levels of motivation and were more likely to complete tasks than students who would not receive a badge or game-like acknowledgment after reaching a goal. Additionally, while VR simulations have the potential to provide students with hands-on, immersive learning experiences they would not have otherwise, the cost and limitations make it difficult to incorporate into a standard curriculum at this time (Luo et al., 2021).

Whether looking at student practices using technology as Sage et al. (2017) did with their study on reading comprehension using print, laptops, or e-readers, the impact of teacher practices as de Koster et al. (2017) did with their study on teacher planning for technology integration, the impact of classroom practices such as gamification as a method for motivating students using technology elements as explored by Bai et al. (2021), or the impact of VR on student outcomes as examined by Luo et al. (2021), all of these studies conclude that more research is needed to determine best practices for implementing technology to have the greatest impact on student learning. There is an abundance of technology available to students and teachers. The question educators face is selecting not only the technology to be used but the practices they should select in order to best incorporate that technology into their face-to-face classrooms.

Blended Learning

While a review of the literature shows that the addition of one-to-one technology has a positive impact on student achievement (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008), and that there are specific practices using technology that can impact implementation and learning (Bai et al., 2020; de Koster et al., 2017; Luo et al., 2021; Sage et al., 2020), there are no widely agreed upon pedagogical practices for face-to-face instruction utilizing one-to-one devices; however, one such approach that is gaining attention is blended learning (Horn & Staker, 2011; Li & Wang, 2022). In their 2005 book, Bonk and Graham described blended learning systems as "the combination of face-to-face instruction with computer-mediated instruction" (p. 5). Researchers now agree that blended learning is more than just technology-rich instruction (Archibald et al., 2021; Fazal et al., 2020; Graham et al., 2019b; Li & Wang, 2022; Pulham & Graham, 2018; Staker & Horn, 2012). A critical addition to the definition of blended learning includes more student control over their learning. Christensen et al. (2013) later added the idea of student personalization to the definition of blended learning by including that students have some degree of "control over time, place, path, and/or pace." (p. 8).

But why are educators and researchers so interested in blended learning? This interest is primarily driven by the belief that blended learning provides greater flexibility, interactivity, collaboration, and reflection (Poirier et al., 2019). No matter the implementation model a teacher selects, blended learning has been found to support more student-centered activities as well as offer more individualized differentiation for students (Li & Wang, 2022). This is partly because students spend time learning online, which enables teachers to access online learning data and adjust their instructional practices to meet the individual learning needs of their students (Li & Wang, 2022). Additionally, the success of blended learning is attributed to the models' ability to offer students control over time, pace, path, and/or pace, providing a more student-centered learning environment as well as greater participation and engagement (Poirier et al., 2019). In the following sections, I explore the research on blended learning implementation models (Christensen et al., 2013; Horn & Staker, 2011; Li & Wang, 2022; Staker & Horn, 2012), discuss the effectiveness of blended learning in K-12 environments (Li & Wang, 2022; Poirier et al., 2019; Prescott et al., 2018), and discuss the practices associated with blended teaching (Anthony, 2019; Archibald et al.,2021; Graham et al., 2019b).

Blended Learning Implementation

While researchers agree that blended learning includes some elements of face-to-face instruction and some elements of online or digital instruction (Bonk & Graham, 2015; Li & Wang, 2022; Staker & Horn, 2012), there is still much debate about what specific implementation practices should be included as integral to blended learning (Christensen et al., 2013; Horn & Staker, 2011; Li & Wang, 2022; Staker & Horn, 2012). Staker and Horn (2012) claim there are four primary blended learning models: the rotation model, the flex model, the self-blend model, and the enriched-virtual model. Christensen et al. (2013) agree that these four distinct models of blended learning are inclusive of current practices in K-12 environments. These blended learning implementation models are summarized in Table 2.

Table 2

Four Primary Models of Blended Learning as Described by Staker and Horn (2012)

Rotation Model	A program in which students rotate between different learning modalities, at least one of which is online learning. Other stations may include whole-group instruction, small group instruction, group or partner work, or independent paper-and-pencil based assignments. There are four variations: the station rotation model, the lab rotation model, the flipped classroom, and the individual rotation models
Flex Model	Although students attend school face-to-face, in this model, instruction is primarily delivered online. The teacher provides face-to-face support to the students as needed with individual tutoring, small group support, and possible group projects while the students move at their own pace.
Self-Blend Model	In this model, students choose to take one or more courses entirely online and other courses entirely at school with face-to-face teachers.
Enriched-Virtual Model	This program encompasses a whole-school experience which is partly face-to-face in the physical school building and partly online learning from a remote location.

Staker and Horn (2012) define the rotation model as a program in which students rotate "on a fixed schedule or at the teacher's discretion between learning modalities, at least one of which is online learning" (p. 8). Other stations may include whole-group instruction, small-group instruction, group or partner work, or independent paper-and-pencil-based assignments (Staker & Horn, 2012). Within the rotation model, Staker and Horn (2012) define four variations: the station rotation model, the lab rotation model, the flipped classroom, and the individual rotation models. A teacher that incorporates all of the stations within the walls of the classroom is using the station rotation model. If the entire class rotates to a computer lab for the online learning portion of their instruction but receives the other portions of instruction within their classroom, they are utilizing the lab rotation model. Another variation of the rotation model is the flipped classroom model in which students complete the online portion of their learning from home and "rotate" to school for their face-to-face, offline instruction. In the flipped classroom model, Staker and Horn (2012) describe that the primary delivery of instruction occurs online and away from the school building. In this model, students have control over time, place, path, and/or pace because they are able to choose where they receive instruction as well as the pace at which they move through the online instruction. As part of the flipped classroom model, students receive offline learning, practice, and direct instruction from their teacher during the school day in their brick-and-mortar classroom. The fourth and final variation Staker and Horn (2012) categorize as a rotation model is the individual rotation model. In this model, a teacher may utilize individual rotation schedules in which each student's schedule is customized and they may not complete every station or the same stations as other classmates daily (Staker & Horn, 2012).

The second implementation model described by Staker and Horn (2012) is the flex model. In this model, instruction is primarily delivered online, and "students move on an individually customized, fluid schedule… and the teacher-of-record is on-site" (Staker & Horn, 2012, p. 12). The teacher provides face-to-face support to the students as needed with individual tutoring, small group support, and possible group projects (Staker & Horn, 2012). Staker and Horn (2012) note numerous variations in the amount of support provided using this model. Some schools utilize certified teachers and structured support within the flex model, while others provide minimal face-to-face support (Staker & Horn, 2012).

The third implementation model presented by Staker and Horn (2012) is the self-blend model. Christensen et al. (2013) later renamed this model the "a la carte model" because in this model, students take one or more courses entirely online and others entirely at school with face-to-face teachers. This differs from the fourth model, the enriched-virtual model, because students who self-blend (Staker & Horn, 2012), or choose courses "a la carte" (Christensen et al., 2013), take entire courses either fully online or fully face-to-face. In the enriched-virtual model, on the other hand, the whole-school experience is partly face-to-face in the physical school building and partly online learning from a remote location. Staker and Horn (2012) note that most enriched-virtual programs have only a few meetings with students face-to-face and provide most instruction online.

Christensen et al. (2013) note that the most widely used model is the rotation model with its four variations. This blended learning implementation design combines the old and the new while preserving the role of the traditional classroom, which requires students to be in classroom seats for a prescribed number of minutes. Nevertheless, which implementation model is most effective? Li and Wang (2022) conducted a meta-analysis of K-12 studies from 2000-2020 to determine the effectiveness of each of the implementation models described by Staker and Horn (2012). The authors claim that until this study, there has been no empirical evidence as to which blended learning model is the most effective (Li & Wang, 2022). The station rotation, flipped classroom, and flex models all had statistically significant impacts on student learning, with the flipped classroom having the greatest impact (Li & Wang, 2022). The lab rotation had the smallest effect size without being statistically significant from the other models (Li & Wang, 2022). These findings mirror the findings of Means et al. (2009) in their first meta-analysis of K-12 blended learning practices, which found that the variations in blended learning implementation did not have a significant effect on learning outcomes.

Li and Wang (2022) not only examined the effectiveness of Staker and Horn's (2012) implementation models, but they also uncovered the specific practices of utilizing a learning management system and including group work as having positive effects on student learning outcomes. In looking at the types of technology used within the blended learning environment, Li and Wang (2022) found that classrooms that utilized a Learning Management System (LMS) had a larger effect on student learning outcomes than those that only used video in their online learning. In comparing if asynchronous or synchronous online assignments affected learning outcomes in a blended learning environment, Li and Wang (2022) reported that the difference in practice was not significant. Finally, Li and Wang (2022) examined the effect of group work on blended learning environments. They found that group activities had a statistically significant impact on student achievement outcomes in blended learning environments as compared to blended learning models without group activities (Li & Wang, 2022).

From the rotation model in which students receive all instruction within the walls of their classroom, to the enriched-virtual model in which students receive the majority of their instruction online away from the school building, it is clear that there is a wide variation in implementation within the bounds of blended learning. Christensen et al. (2013) admit that "the taxonomy is still imperfect and will continue to evolve along with the field" (p. 26). For the time being, these models at least offer a starting point for differentiating between different models for blended learning implementation (Christensen et al., 2013; Staker & Horn, 2012). While Means et al. (2009) found that variations within blended learning models did not have a significant impact on student learning outcomes, Li & Wang (2022) found that the station rotation, flipped classroom, and flex models all had statistically significant impacts on student learning with the flipped classroom having the greatest impact. Additionally, Li and Wang (2022) found that using an LMS and including group work in blended learning models both provided statistically significant learning outcomes for students. While blended learning models have been defined and researched (Christensen et al., 2013; Li & Wang, 2022; Staker & Horn, 2012), more research is warranted, especially at the K-12 level. Li & Wang (2022) claim their study to be the first to analyze the effectiveness of the various models of blended learning, showing a true need for additional research in this area. Further research is needed to determine the knowledge, skills, and beliefs that a teacher needs in order to be ready to implement blended learning as well as the exact practices that have the greatest impact on learning in a K-12 blended environment.

Effectiveness of Blended Learning

There is minimal research, especially at the elementary level, about the academic effect of blended learning on K-12 classrooms (Li & Wang, 2022; Poirier et al., 2019; Prescott et al., 2018). In their 2009 seminal meta-analysis of K-12 blended learning commissioned by the U.S. Department of Education, Means et al. found only five studies that met their criteria from 1996 to 2008 comparing the learning effects of online versus face-to-face instruction. Even with this small pool of studies, Means et al. (2009) found that instruction combining online and face-to-face methods had a higher effect size than purely online or face-to-face instruction on their own.

Means et al. (2009) claimed that providing students with greater control and autonomy over their online learning environment as well as providing for self-monitoring of understanding enhanced learning, while technology used for video or online quizzes did not. Interestingly, effect sizes were even more significant for those blended learning environments that included collaborative activities than those that only included independent activities for students (Means et al., 2009).

Poirier et al. (2019) sought to extend the work of Means et al. (2009), picking up where the previous meta-analysis ended. Poirier et al. (2019) investigated the empirical research on K-12 blended learning published between 2009 and 2017, finding eleven articles that met their inclusion standards. Of the included studies, mixed results were reported on the effect of blended learning on student achievement outcomes (Poirier et al., 2019). Four studies demonstrated significantly higher academic achievement in the blended learning environment; however, one study reported mixed results, and three reported higher, but not statistically significant, achievement results (Poirier et al., 2019). Poirier et al. (2019) also found positive outcomes of blended learning other than academic achievement in their meta-analysis, including increased self-directed learning skills, increased attitude toward the content, increased engagement with the content, less boredom, and less confusion. Poirier et al. (2019) do note the limitation that the studies reviewed did not detail the features of the blended learning environments studied which could have been responsible for variations within the results. Of the studies that had significant positive academic achievement gains, each included the use of peer-to-peer interaction or collaboration in their blended learning implementation model (Poirier et al., 2019).

Prescott et al. (2018) found that even when teachers did not meet the time recommendations for a blended learning program, students still made significant gains academically. Prescott et al. (2018) sought to look specifically at the effects of blended learning on literacy achievement for K-12 students from an urban elementary school with over 70% of participants qualifying for free or reduced-price meals. A total of 641 students participated in both the pre- and post-tests to be included in the final sample (Prescott et al., 2018). Participants ranged from Kindergarten through fifth-grade students with between four and six classes per grade level participating (Prescott et al., 2018, p. 499). Teachers in this district were encouraged to use the Daily 5 framework, "a classroom management program in which students rotate between five literacy activities while teachers work one-to-one or in small groups with students" (p. 500). The Daily 5 activities are consistent with a station rotation form of blended learning and include reading to self, writing, reading to someone else, listening to reading, and independent work (Prescott et al., 2018). In order to incorporate blended learning into the Daily 5 station rotation already in place, teachers were asked to utilize the Core5 digital technology (Prescott et al., 2018). The Core5 software begins with an assessment to determine each student's level of knowledge and skills (Prescott et al., 2018). "Students are required to show content mastery for each unit of an activity, which is 90%-100% accuracy, before progressing to subsequent units" (p. 500). Teachers were instructed to ensure students received online instruction and practice using the Core5 software for 20-80 minutes per week, as recommended for each student by the program (Prescott et al., 2018). While Prescott et al. (2018) included all students in their analysis regardless of usage, they reported that just under three-quarters of students met the usage recommendation set by the program (Prescott et al., 2018, p. 500).

Prescott et al. (2018) found significant gains for students in five of the six participating grade levels. The authors concluded that "gains were generally greater for students in early grades compared with later grades" (Prescott et al., 2018, p. 503). The authors explained further, "Overall, kindergarten through second-grade students showed the greatest gains in reading, with kindergarten and first-grade students averaging double-digit gains on a standardized reading test" (Prescott et al., 2018, p. 503). This may be due to the fact that younger grades had much higher usage of the software than the upper grades (Prescott et al., 2018). The authors note that "this discrepancy highlights the importance of a strong implementation to achieve the anticipated benefits of a blended learning program" (Prescott et al., 2018, p. 503). As schools across the United States work to close gaps in learning between English Learners (ELs) and non-English Learners (non-ELs), it is significant to note that in all but one grade level, gains in learning were as strong or stronger for ELs as compared to non-ELs (Prescott et al., 2018, p. 503). Thus, these findings indicate that a "blended learning program for students who were ELs could help mitigate some achievement gaps commonly found in the literature" (Prescott et al., 2018, p. 503).

Fazal et al. (2020) continued the research on the effects of blended learning on student achievement with their mixed-methods study, which found that increases in blended learning practices lead to increases in student achievement and provided teachers with more time to focus on their most struggling students. Although the authors did not provide a formal definition for blended learning, the district in which the research was collected ascribed informally to the four elements of blended learning described by Education Elements: "(a) adaptive online digital content integration, (b) differentiation practices by teacher, (c) use of data by teachers to inform their teaching practices and (d) student agency and self-directed learning opportunities provided by teachers in blended learning classrooms" (Fazal et al., 2020, p. 72). Researchers utilized a five-point scale in which school principals provided feedback on the degree to which teachers implemented blended learning practices in their classrooms. This measure was defined by Fazal et al. (2020) as the independent variable in their research. Principals were asked to provide the information retrospectively based on the last two years of their observations of teaching and planning discussions. The dependent variable was the student growth scores on the MAP Reading and Math assessments (Fazal et al., 2020). Additionally, qualitative data were collected through classroom observations, teacher interviews, and student focus groups to understand which aspects of blended learning teachers and students found most effective (Fazal et al., 2020). Fazal et al. (2020) utilized a difference-in-difference (DID) regression analysis at the classroom level to measure the impact of a change in the degree of blended learning implementation on students' scores over a two-year period.

Fazal et al. (2020) found that increases in blended learning practices led to positive increases in student growth on Math assessments. Additionally, and even more significant, “data shows that boys, African American students, students with a 504 plan, and those in the second quartile on MAP benefited the most from being in a blended learning environment” (Fazal et al., 2020, p. 74). “A 1-point increase in the average level of blended learning was estimated to increase math growth by .10 standard deviations for boys, .20 standard deviations for African American students, and .23 standard deviations for students with 504 plans” (Fazal et al., 2020, p.74). Fazal et al. (2020) go on to explain:

> Using data from seven nationally normed standardized tests, these authors estimate that one year of schooling accounts for a .42 standard deviation increase on math achievement tests average across grades 3-8. Using this benchmark, and assuming students are in school ten months in one year, standard deviation value for one month was calculated. (pp.74-75).

Since the researchers found that a 1-point increase in blended learning practices led to an average .05 standard deviation increase in students’ Math growth scores on the MAP assessment, this standard deviation can be considered equivalent "to an additional one month of schooling in math" (Fazal et al., 2020, p. 75).

Many current practitioners question the use of blended learning strategies in classrooms and ask why they should change their traditional research-based methods of instruction. Fazal et al. (2020) have demonstrated that utilizing blended learning strategies over the course of a year has the potential to be tantamount to an additional month of instruction. An equivalent to an additional month of instruction each year could potentially close gaps in learning and extend learning for countless students. The goal and purpose of education is to grow and add value to all learners and Fazal et al. (2020) claim to have a strategy that will accomplish the goal - adding a month more growth without the addition of more time inside a school building by simply incorporating blended learning.

Fazal et al. (2020) concluded that using blended learning strategies in the Math classroom allowed teachers and students to generate data much more quickly than traditional grading and those teachers that used this data to guide their instructional practices saw the most gains in student achievement. Qualitative data indicated that "blended learning allows teachers to concentrate on their lower performing students. Teachers have more time for individual, face-to-face instruction for those who are not on target, while having the confidence that their higher performing students are still being challenged with digital content" (Fazal et al., 2020, p. 76). It is important to note that Fazal et al. (2020) assert that the data shows "it was not the integration of adaptive digital content that led to a significant difference, but rather the use of data and teacher strategies for differentiating instruction that led to a statistically significant impact on the math scores" (Fazal et al., 2020, p. 74). Therefore, it is not the technology that made the ultimate difference for students, but the way educators used the data generated from the technology to differentiate their instruction (Fazal et al., 2020). This research supports the need to train teachers and define expectations for teaching with technology to make the greatest impact on student achievement.

Although there is limited research at the K-12 level on the effectiveness of blended learning practices, in their 2009 meta-analysis, Means et al. (2009) found that instruction combining online and face-to-face methods had a larger effect size than purely online or face-to-face instruction on their own. Means et al. (2009), Li and Wang (2022), and Poirier et al. (2019) each separately found that effect sizes were even larger for those blended learning environments that included collaborative activities as compared to those that only included independent activities for students. Blended learning has been shown to significantly impact specific learning groups (Fazal et al., 2020; Prescott et al., 2018). Prescott et al. (2018) found that when participating in a blended learning program, learning gains for ELs were as strong or stronger as compared to non-ELs. Similarly, Fazal et al. (2020) found that increases in blended learning practices lead to increases in learning gains on Math assessments and even more significant gains for African American students and students on a 504 plan. Poirier et al. (2019) found additional positive outcomes of blended learning including increased self-directed learning skills, increased attitude toward the content, increased engagement with the content, less boredom, and less confusion. Although Fazal et al. (2020) found that increases in blended learning practices lead directly to increased student performance, the research did not define what those blended learning practices were, how a teacher or student could increase their use, or if a teacher needed certain knowledge or skills to be ready to teach in a blended learning format. Poirier et al. (2019) also note the limitation that the studies they reviewed did not detail the features of the blended learning environments studied. With such positive benefits linked to blended learning practices in K-12 environments (Fazal et al., 2020; Li & Wang, 2022; Means et al., 2009; Poirier et al., 2019; Prescott et al., 2018), it is crucial that teachers be trained in what these practices entail, how to best incorporate them in their classrooms, and assess their readiness to teach in blended learning format for the benefit of their students.

Blended Teaching

While Christensen et al. (2013) describe blended learning as an innovation that will disrupt traditional models of education and call for a major transformation to how teachers teach and students learn, Anthony (2019) demonstrated that there are distinct research-based teaching practices that are common to both successful traditional classrooms and successful blended learning classrooms. Anthony (2019) posits that "the field should recognize that many of the best teaching practices in blended learning elementary classrooms are the same practices that decades of research have shown are the most impactful on student learning, simply applied in a new context" (p. 45). To provide evidence for this argument, Anthony (2019) conducted case studies of six blended learning classrooms across five different elementary schools to determine which classrooms promoted the highest growth in student academic performance. Anthony evaluated each blended learning teacher using part of a traditional teaching rubric to determine whether there was any correlation between research-proven traditional teaching practices and student success in a blended learning environment. Anthony (2019) found that the high-growth classrooms all had teachers who scored very high on the traditional teaching practices rubric and three specific strategies stood out as most important: "demonstrating flexibility and responsiveness, using assessment in instruction, and engaging students in learning" (p. 42).

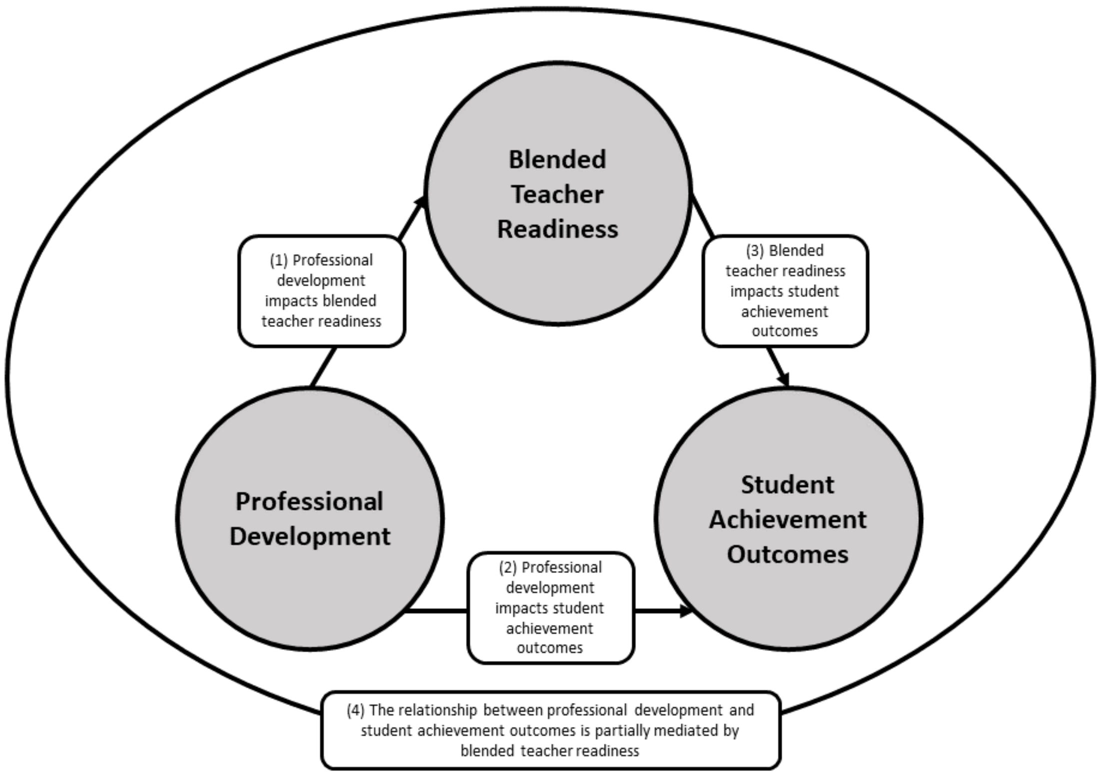
Anthony (2019) goes on to describe how "demonstrating flexibility and responsiveness goes hand-in-hand with using assessment in instruction, as effective teachers not only integrate multiple forms of assessment throughout the lesson but also adjust instruction in response to evidence of student understanding (or lack thereof) in real time" (p. 42-43). Flexibility and data-driven instruction are among the pillars that Archibald et al. (2021) and Graham et al. (2019a) have established as essential for blended teaching success.

Conceptual Framework

The conceptual framework that guided this study is based on an exploration of the relationships between professional development, blended teacher readiness, and student outcomes. I postulated that the Blended Teacher Readiness competencies established by Graham et al. (2019a) and validated by Archibald et al. (2019) were valuable standards for quality teaching with technology in the K-12 setting. I also argued that (1) the professional development provided, not just on technology or software, but on the specific teacher and student practices that improve teaching and learning when using technology increase a teacher's blended teacher readiness, (2) quality professional development targeting technology instruction for teachers improves student achievement outcomes, (3) a teacher's readiness to teach in a blended learning environment impacts student achievement outcomes, and (4) blended teacher readiness partially mediates the relationship between professional development and student achievement outcomes. This argument is summarized in Figure 2 below.

Figure 2

Blended Teacher Readiness Conceptual Framework



Blended Teacher Readiness Competencies

To better understand the extent to which teachers feel ready to practice blended learning strategies within their classrooms, I drew upon Archibald et al.'s (2019) Blended Teaching Readiness competencies framework. Because K-12 teachers already receive training and certification for face-to-face teaching practices, the idea of adding an online component may seem like it would be simple for teachers; however, it instead "appears to require all the expertise of the traditional model plus new expertise in managing digital devices and in integrating data across all the supplemental online experiences in the teacher-directed rotation" (Staker & Horn, 2012, p. 28). Further, Li and Wang (2022) described how many K-12 teachers reported they struggled to manage the many different technology platforms they were required to use in a blended learning environment and that they were not adequately trained to do so. Archibald et al. (2021) agree that explicit expectations for teaching in a blended learning environment are needed. As the authors themselves put it, “research and training in blended learning are far outpaced by its usage” (Archibald et al., 2021, p. 536).

The authors propose a framework for measuring a teacher’s readiness to provide blended learning (Archibald et al., 2021). Specifically, Archibald et al. (2021) argue that the framework they have developed, the Blended Teacher Readiness (BTR) competencies and accompanying survey can help determine a teacher’s self-efficacy, skill level, and readiness to begin teaching in a blended learning environment. The authors focused their framework on key dispositions and pedagogically oriented competencies (Archibald et al., 2021). Although many state and district leaders believe that adding technology and software training is all that is needed for teachers to be successful in implementing a blended learning model, Archibald et al. (2021) insist that there are specific skills and teaching techniques that should be taught and mastered before teachers begin teaching in blended environments including:

> **Online Integration and Management**-focuses on the teacher’s ability to make and implement decisions related to selecting when and how to effectively combine online and in-person learning as part of core instruction
>
> **Data Practices**-focus on the teacher’s ability to use digital tools to monitor student activity and performance in order to make informed choices about interventions to help student progress.

Personalization-focuses on the teacher's ability to implement a learning environment that allows for student customization of learning goals, time, place, pacing and/or path.

Online Interaction-focuses on the teacher's ability to facilitate online interactions with and between students. (Archibald et al., 2021, p. 542).

The competencies laid out by Archibald et al. (2021) align with the definition for blended learning outlined previously as well as Christensen et al.'s (2013) definition of blended learning as an education program in which a student learns "at least in part through online learning, with some element of student control over time, place, path, and/or pace" (p. 8). Archibald et al.'s (2021) addition of "data practices" and "personalization" echo Fazal et al.'s (2020) findings that teachers' use of data to inform their teaching practices had the greatest impact on increased student performance. The addition of "online interaction" is reflective of the findings Poirier et al. (2019) and Means et al. (2009) in their meta-analyses which both found that community interaction and discourse about the content among the learners is vital to the success of blended learning. Thus, although there is still not a total consensus on the definition or components of quality blended teaching and learning, the Blended Teacher Readiness competencies have brought together the findings of many BL researchers and will be used as the standard for quality blended teaching in this conceptual framework.

The Impact of Professional Development on Blended Teaching Readiness

High-quality professional development has been found to have a profound impact on teachers' self-efficacy (Watson, 2006). Watson (2006) defines self-efficacy as "a belief in one's own abilities to perform an action or activity necessary to achieve a goal or task" (p 152). Studies show a link between a high level of teacher self-efficacy and increased student achievement (Watson, 2006). Additionally, low teacher self-efficacy has been shown to negatively impact student performance (Watson, 2006). Watson (2006) found that elementary students assigned a teacher with high technology self-efficacy followed by a teacher with low technology self-efficacy did not improve their own skills as much as students who went from having a teacher with low technology self-efficacy to a teacher with high technology self-efficacy. Thus, a teacher's technology self-efficacy, or belief in their own abilities with technology, correlates to higher student performance (Watson, 2006). I posit that self-efficacy is no different than what Archibald et al. (2021) have deemed "readiness" in their Blended Teacher Readiness framework.

There is an incredible lack of research surrounding professional development practices associated specifically with teaching in a blended environment. In response to the rapid increase in the use of blended teaching practices in the United States, the 2017 National Education Technology Plan recommended "develop[ing] a teaching force skilled in online and blended instruction" (U.S. Department of Education, p. 40). Despite this national mandate, there is limited peer-reviewed research on how to best train teachers for this new learning environment (Short et al., 2021).

Although there is limited research in the area of blended teaching professional development, one instrument for measuring Blended Teaching Readiness has been validated. Archibald et al. (2021) created a Blended Teaching Readiness Instrument (BTRI) to measure pre-service teacher perceptions of their own skill level in the four competencies of the Blended Teaching Readiness (BTR) framework established by Graham et al. (2019a). The BTRI was a survey administered via Qualtrics on which participants rated the accuracy of statements on a scale of one to six from very limited competence or agreement to high competence or agreement (Archibald et al., 2021). BTRI surveys were distributed to preservice teachers enrolled in a one-hour blended teaching college course through an anonymous link before course content began and at the conclusion of the course (Archibald et al., 2021). The data showed that the BTRI was a valid measurement and it also showed that the preservice teachers grew their skills and self-efficacy due to taking the blended teaching course (Archibald et al, 2021). Thus, this research supports that training teachers prior to blended learning implementation is paramount to a blended learning initiative's success.

The majority of articles on the topic of blended teaching professional development focus mainly on university coursework, which highlights the need for additional research specifically focused on K-12 practicing educators (Short et al., 2021). Short et al. (2021) note in their review of the literature surrounding blended teacher preparation that only 19 of the 183 authors in their literature review wrote more than one article on the subject of blended teacher preparation. Short et al. (2021) posit that this reveals that most research on blended teacher preparation has been completed by researchers whose primary interests lay elsewhere. The majority of the articles reviewed by Short et al. (2021) were found to have a broader focus and touched on blended teacher preparation. There is a dire need for research focused on the direct impact that professional development in blended teaching has on teacher practices as well student outcomes (Short et al., 2021).

The Impact of Professional Development on Student Achievement Outcomes

Professional development (PD) for teachers has increasingly become perceived as an urgent need in schools as well as an essential step for school improvement (Borko et al., 2010). Borko et al. (2010) state, "If we want schools to offer more powerful learning opportunities for students, we must offer more powerful learning opportunities for teachers" (p. 548). These authors call for professional development that not only increases teacher knowledge but improves their practices to ultimately result in student achievement gains (Borko et al., 2010).

There is a myriad of different formal and information learning opportunities that could be categorized as professional development including observations, hallway conversations with a colleague, educator groups on social media, and school-provided or self-selected professional development courses or workshops (Desimone, 2009). With such great variation in when and where teachers can receive professional development, Desimone (2009) suggests focusing on the critical features of the teachers' learning experience rather than the structure of the professional development to determine the effectiveness and impact results. Kennedy (2016) agreed, stating, "we need to replace our current conception of good PD as comprising a collection of particular design features with a conception that is based on more nuanced understanding of what teachers do, what motivates them, and how they learn and grow" (p. 974).

In her review of 28 different studies on the effectiveness of professional development, Kennedy (2016) found that almost all PD programs in her study had what is considered only a small effect size on student learning no matter the number of hours, ideas offered in the course, or how the PD was facilitated. However, it was interesting to note that for studies that included a follow-up year after the initial PD, researchers found that student achievement was higher at the end of the follow-up year rather than at the end of the year when the teacher was in the PD program. This suggests that teachers grow incrementally over time and the full effects of PD cannot be fully evidenced at the end of the year the PD was taken (Kennedy, 2016).

While Kennedy (2016) found that professional development had a relatively small effect size on student achievement outcomes, Yoon et al. (2007) found that substantial professional development had a moderate effective size across the studies they analyzed. After reviewing over 1,300 studies Yoon et al. (2007) selected nine research studies that fit their standards for professional development. All nine studies were based on elementary students and teachers

(Yoon et al., 2007). The results of those studies demonstrated that providing professional development to teachers had a moderate impact on student achievement across the nine studies, with the average control group students increasing their achievement by 21 percentile points if their teacher had received significant professional development (Yoon et al., 2007).

Can we be sure that professional development truly improves student achievement outcome in different settings, contexts, and subject areas? This is one of the questions that Wallace (2009) set out to examine. She found that the impacts of professional development on teacher practice and student achievement endured and were similar across analyses, despite variations in populations, academic disciplines, and assessments (Wallace, 2009). The author created a model that measured the effects of professional development and teaching practices on student achievement in Mathematics and Reading on a large scale while controlling for teacher preparation program and teacher characteristics (Wallace, 2009). The study utilized existing multi-level state and national data collected from 1996 to 2000 including six different national data sets (Wallace, 2009). The results of the study indicate that the effects of professional development can be linked to teacher practice and subsequent student achievement outcomes (Wallace, 2009).

Lawless and Pellegrino (2007) found in their review of technology professional development studies that in all studies that utilized a method for evaluating teacher change, teacher skill levels increased as a result of participating in the technology professional development. Data also indicated that following technology professional development, teachers not only felt more comfortable using technology, but were also more confident in their abilities to integrate technology into their classrooms (Lawless & Pellegrino, 2007). Of the 28 technology PD studies Lawless and Pellegrino (2007) included in their report, only one included student learning outcomes. That study found that students of teachers who participated in technology professional development outscored other students on a technology project on performance measures including content, design, and overall quality (Lawless & Pellegrino, 2007). Wallace (2009) posits that it is crucial for educators to understand the relationship between effective professional development that produces successful teaching practices and improved K–12 student achievement results (Wallace, 2009).

Further Impacts of Professional Development and Blended Teaching Readiness

It was my hypothesis that professional development would have a positive impact on a teacher's blended readiness score on the BTRI and, therefore, student achievement outcomes. Using the lens of the Blended Teacher Readiness competencies (Archibald et al., 2021) paired with the BTRI to measure a teacher's self-perceived readiness to teach in a blended learning environment, I sought to uncover the relationship between professional development, teacher readiness, and student achievement outcomes.

Conclusion

Numerous studies conclude that even without providing professional development for teachers on how to incorporate technology into their classroom or setting expectations for specific technology practices within the classroom, simply adding technology into classrooms has numerous positive effects on student learning and engagement at school (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Lei & Zhao, 2008). However, providing training and implementation expectations for blended learning that includes adaptive software and teachers utilizing the data from the adaptive software to differentiate instruction for students has an even greater impact on student learning (Fazal et al., 2020). Additionally, the practice of involving teachers in the planning of which learning activities should be completed with technology with a focus on pedagogy over technology integration has a positive impact on student achievement and teacher perceptions (de Koster et al., 2017). While the available literature shows that blended learning can have a positive impact on student learning, "there is limited research examining the effectiveness of blended learning, especially at the elementary school level" (Prescott et al., 2018, p. 497).

While the literature reviewed in this chapter has shed light on the potential that one-to-one technology implementation has for increases in student achievement and motivation, educators must do more than simply add computers into classrooms. The literature clearly outlines the even greater potential that the specific blended teaching strategies outlined in the BTR framework can have on student achievement (Archibald et al., 2021; Fazal et al., 2020; Graham et al., 2019a; Graham et al., 2019b; Prescott et al., 2018; Pulham & Graham, 2018), yet more research is needed to determine if teacher readiness to teach blended learning has an impact on student achievement scores, especially at the elementary level. Of technology practices in face-to-face classrooms, Lei and Zhao (2008) implored that "further research is needed to provide a deep understanding of learning practices in classrooms" (p.101). With student learning and growth at stake, educators must not choose programs and learning activities to complete with technology at random. Instead, research-proven pedagogical practices for incorporating technology alongside face-to-face instruction are desperately needed to be validated in K-12 classrooms (Poirier et al., 2019).

Teachers at the elementary level are beginning to try different blended learning practices in an effort to update their teaching practices for the benefit of their students (Christensen et al., 2013; Horn & Staker, 2011); however, these practitioners are still unsure how to most effectively utilize blended learning practices to enact positive learning outcomes (Poirier et al., 2019)

Prescott et al. (2018) state that, “Blended learning is growing as a pedagogical approach to instruction in elementary school, despite little research on its effectiveness at that age level” (p. 504). Prescott et al. (2018) point out the need for additional research when they state, “Research regarding the potential benefits of blended learning is limited, especially in elementary school settings” (p. 498). Poirier et al. (2019) even state that “a gap in the knowledge of the effectiveness of blended learning in the K-12 educational setting has become evident” (p. 4).

This research was conducted through the lens of the BTR framework established by Graham et al. (2019a) as the specific pedagogical practices for incorporating technology alongside face-to-face instruction. The BTRI (Archibald et al., 2021), which measures a teacher’s readiness to teach in a blended learning environment as described in Graham et al.’s (2019a) framework, was utilized to determine if a teacher’s self-perceived readiness to teach BL had an effect on student achievement outcomes. This study adds value to the field by looking specifically at elementary students, by looking at best practices for blended learning, and by utilizing the BTRI with practicing K-12 educators for further academic research. While much research has shown the positive impact that one-to-one device implementation can have on student learning, there is a gap in the research at the elementary level in determining if a teacher’s readiness to implement the specific blended learning practices laid out in the BTR framework as well as if professional development on blended teaching practices was provided to teachers have an even greater impact on student achievement.

Chapter III Methodology

In this chapter, I present the methodology and research design for this study. I begin by presenting the research questions and research design followed by an overview of the research setting, participants, and the dataset. Finally, I outline the variables, instrumentation, and procedures used in the study. Considered together, these elements enabled me to explore the relationships between teacher preparation, teacher readiness to teach in a blended learning (BL) format, and student achievement outcomes.

Research Questions

As stated in Chapter One, the research questions for this study are as follows:

1. To what extent are there differences in teacher readiness depending on whether a teacher participated in BL professional development?
2. To what extent does student achievement vary depending on whether a teacher participated in BL professional development?
3. To what extent is a teacher's blended learning readiness related to student achievement outcomes?
4. To what extent does teacher readiness to use BL mediate (help explain) the relationship between teacher participation in BL professional development and student achievement?

Research Design

A research design should be selected based on the research questions and the purpose of the research (Creswell, 2014). For this study, I selected a quantitative, non-experimental research design to measure the potential relationships outlined in the research questions. Moreover, a quantitative correlational study determines the strength of relationships within the data if a correlation is present (Bernard, 2006). This study will not determine a cause for the relationships;

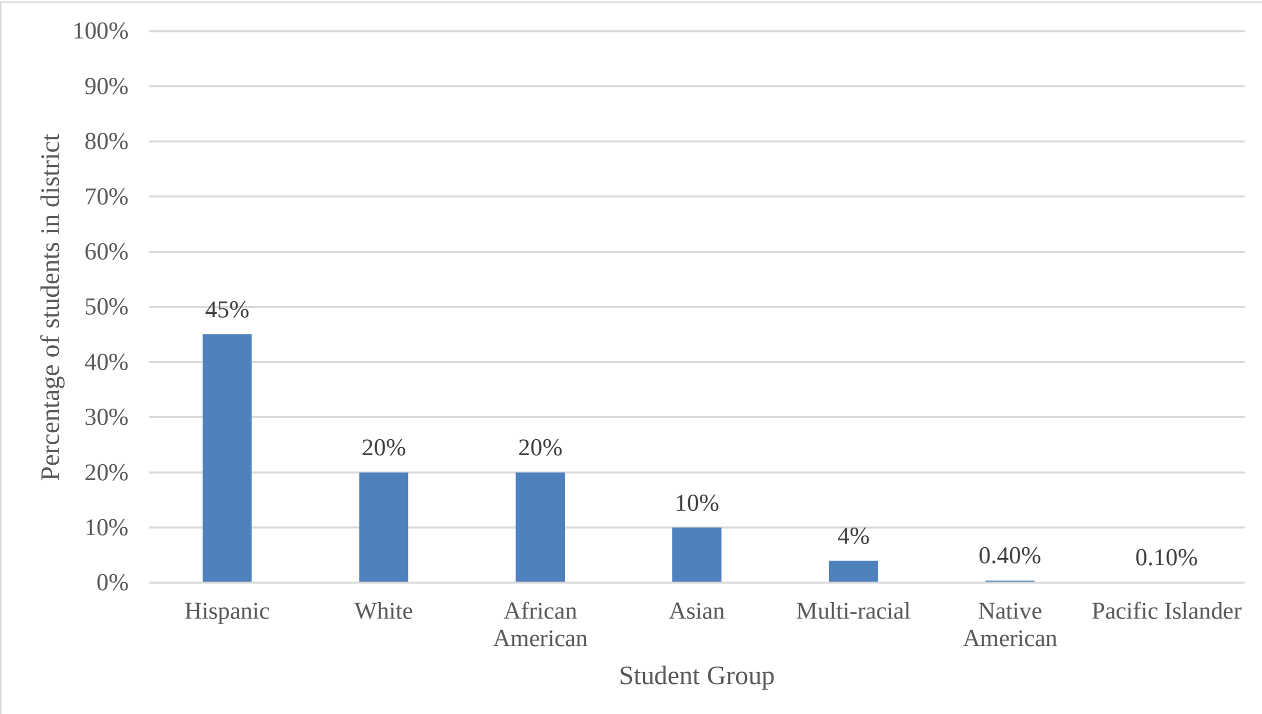
instead, it will show if relationships are present between the variables and the strength of those relationships. This study required the collection of data measuring teachers' perceptions of their own level of blended teaching readiness. In quantitative studies, the systematic collection of data often utilizes tools such as surveys or questionnaires in order to quantify data for numerical analysis (Queirós, Faria, & Almeida, 2017). The validated BTRI (see Appendix A) instrument gathers numeric data on teachers' perceptions of their own blended teaching readiness. The dataset measuring teacher participation in blended learning training is also needed to answer three of the research questions. Additionally, student achievement results are classically numerical values or measured with a pass or fail. Thus, the three datasets needed to answer the questions posed for this study are comprised of numeric values or dichotomous (pass/fail or yes/no) responses ideal for quantitative analyses.

Setting

I conducted my research in Sunnyside ISD (a pseudonym), a large suburban school district in southeast Texas. Schools within the district vary from being less than 10% economically disadvantaged to 99% economically disadvantaged. Sunnyside ISD provided student demographic data in its 2022-23 State of the District Fact Sheet which is posted to the district's website:

Figure 3

Demographic Breakdown of Sunnyside ISD



(Sunnyside ISD, 2022b)

In the 2021-22 State of the District brochure published by Sunnyside ISD, the district reported that more than $238 million from its 2019 bond package was devoted to technology to support the district's 1:1 device initiative. The expenditure of more than 238 million dollars shows that the district places a high value on these technology devices and the 1:1 device initiative.

Prior to the onset of the coronavirus pandemic, Sunnyside ISD provided teachers with seven Chromebooks per classroom. They were not assigned to individual students, but to each classroom to share while at school. Because students were no longer taught in their classrooms in the Spring of 2020 due to stay-at-home mandates, the district quickly surveyed all families in the community to find out and address technology and internet needs. All Chromebooks were collected from school buildings and distributed to students whose families indicated they did not have access to a device they could use to access classroom materials online. The district made a plan to purchase and distribute new Chromebooks for all 110,000 students as soon as possible.

While all students district-wide now each have their own school technology device, and teachers have been trained in a learning management system that enables them to distribute classwork online, the district did not provide any training for how face-to-face instruction should change based on the one-to-one device implementation. While some campuses within Sunnyside ISD have contracted consultants to train staff on implementing the principles of blended learning in their classrooms, the vast majority of campuses across the district have made no strides to address how teaching needs to change due to the one-to-one device implementation. Because the onset of the coronavirus came so suddenly and caused virtually all face-to-face schools across the globe to change their mode of instruction to allow for teaching and learning at home in the Spring of 2020, this problem of quickly distributed student devices with little to no teacher training is widespread and not unique to Sunnyside ISD.

Participants

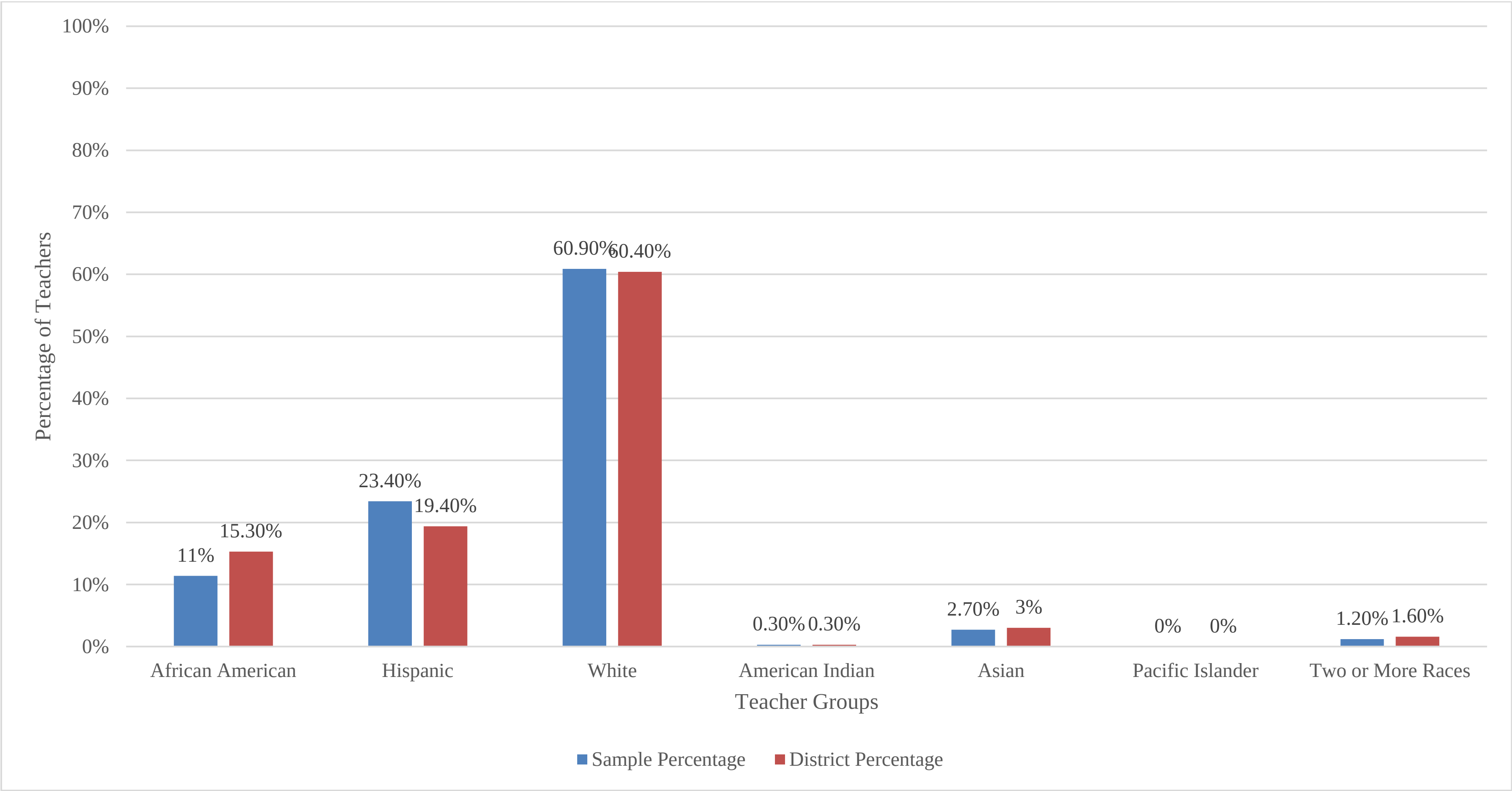
Participants include elementary teachers from Sunnyside ISD who teach grade levels assessed by the STAAR test (third through fifth grades). According to the National Center for Education Statistics, there were 2,943 elementary teachers in Sunnyside ISD in the 2021-22 school year (2022). Since elementary schools in Sunnyside ISD include Pre-Kindergarten through fifth grade, it can be estimated that the population for this study is approximately half of all elementary teachers in the district or about 1,500 third- through fifth-grade teachers. These 1,500 third- through fifth-grade teachers work across the 57 different elementary campuses within the district which have varying geographic locations, socioeconomic statuses, and student achievement scores. Sunnyside ISD groups these 57 elementary schools by “clusters” of six to seven schools with similar socio-economic statuses, geographic locations, and student achievement scores.

For the purposes of this study, I utilized the cluster groupings already created by Sunnyside ISD to select a little over 70% of the elementary schools as participants. I selected four to five schools from each of Sunnyside ISD’s nine cluster groups resulting in forty-one selected schools which equates to 70% of the schools in the district. Because quantitative studies aim to quantify and generalize data from a sample to a population (Park & Park, 2016), I sought to select participants representative of the wide variety of socio-economic statuses, geographic locations, and academic achievement found in district schools. Therefore, I selected four to five schools from each cluster (totaling forty-one schools) for participation knowing that not all teachers on each campus would choose to participate. By utilizing the district-provided cluster grouping of schools by socio-economic status as well as plotting the schools on a map, I worked to maximize the variety of locations and socio-economic statuses among the schools.

Using the Texas Academic Performance Report (TAPR) for the 2022 school year for each of the forty-one participating schools, I gathered and analyzed the data within the reports to compare the sample data to Sunnyside ISD’s district data. I added the number of teachers in each demographic group listed in Figure 3 for each of the selected schools in my sample and divided by the total number of teachers in the sample schools to determine the percentage of each teacher demographic group within the sample. Figure 4, below, provides the demographics of teachers for the sample schools selected as well as Sunnyside ISD as a whole.

Figure 4

Demographic Data of Teachers from Sample Schools

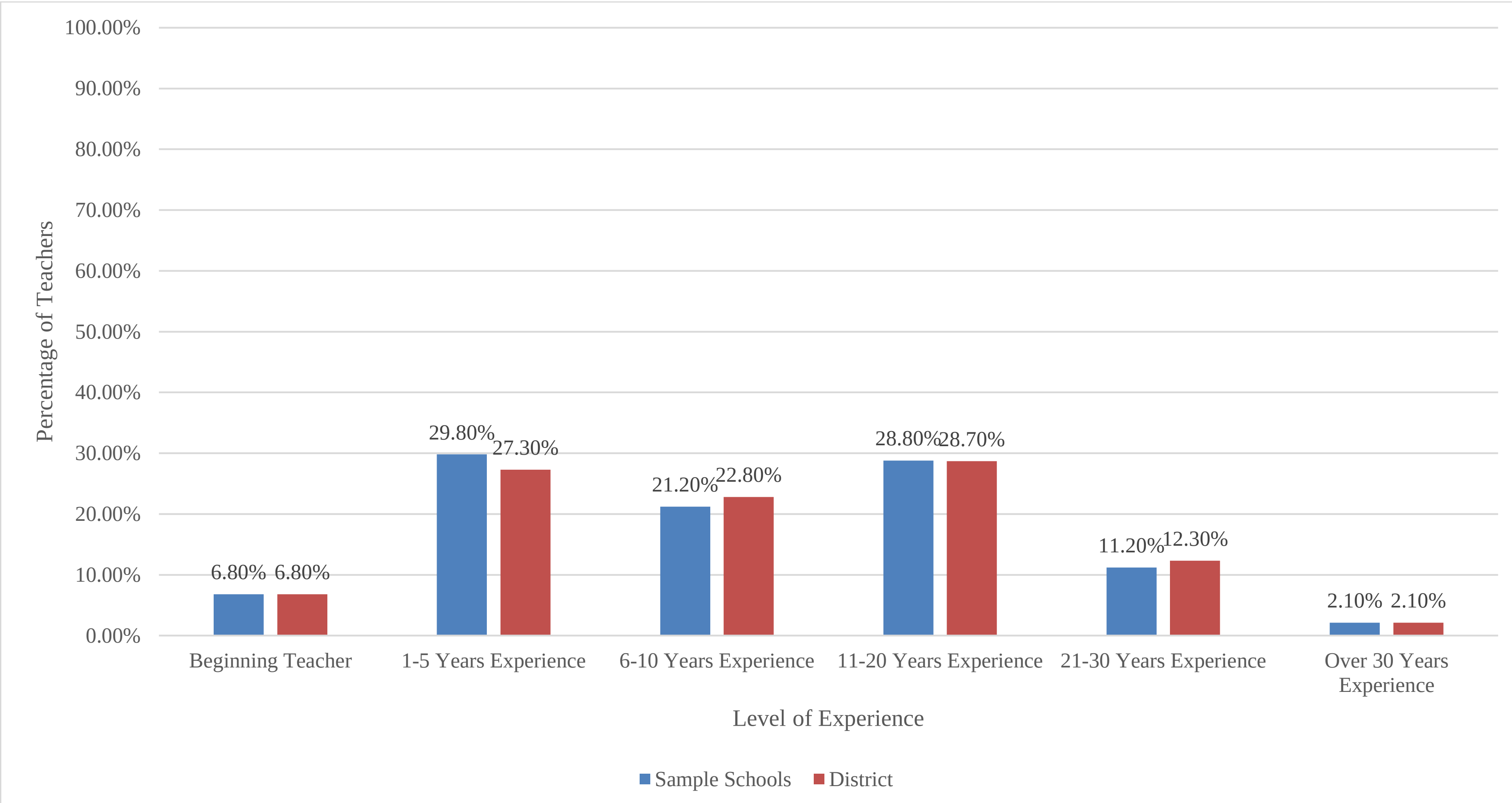


Source: Texas Academic Performance Reports, 2022

The 2022 TAPR reports also provided teacher experience information for each of the selected schools in my sample as well as for the district. I collected the data for the number of teachers for each experience category listed below in Figure 5 for each of the sample schools to get a sum and then divided by the total number of teachers in the sample in order to find the percent of teachers within the sample for each experience level.

Figure 5

Level of Experience for Teachers from Sample Schools as Compared to District

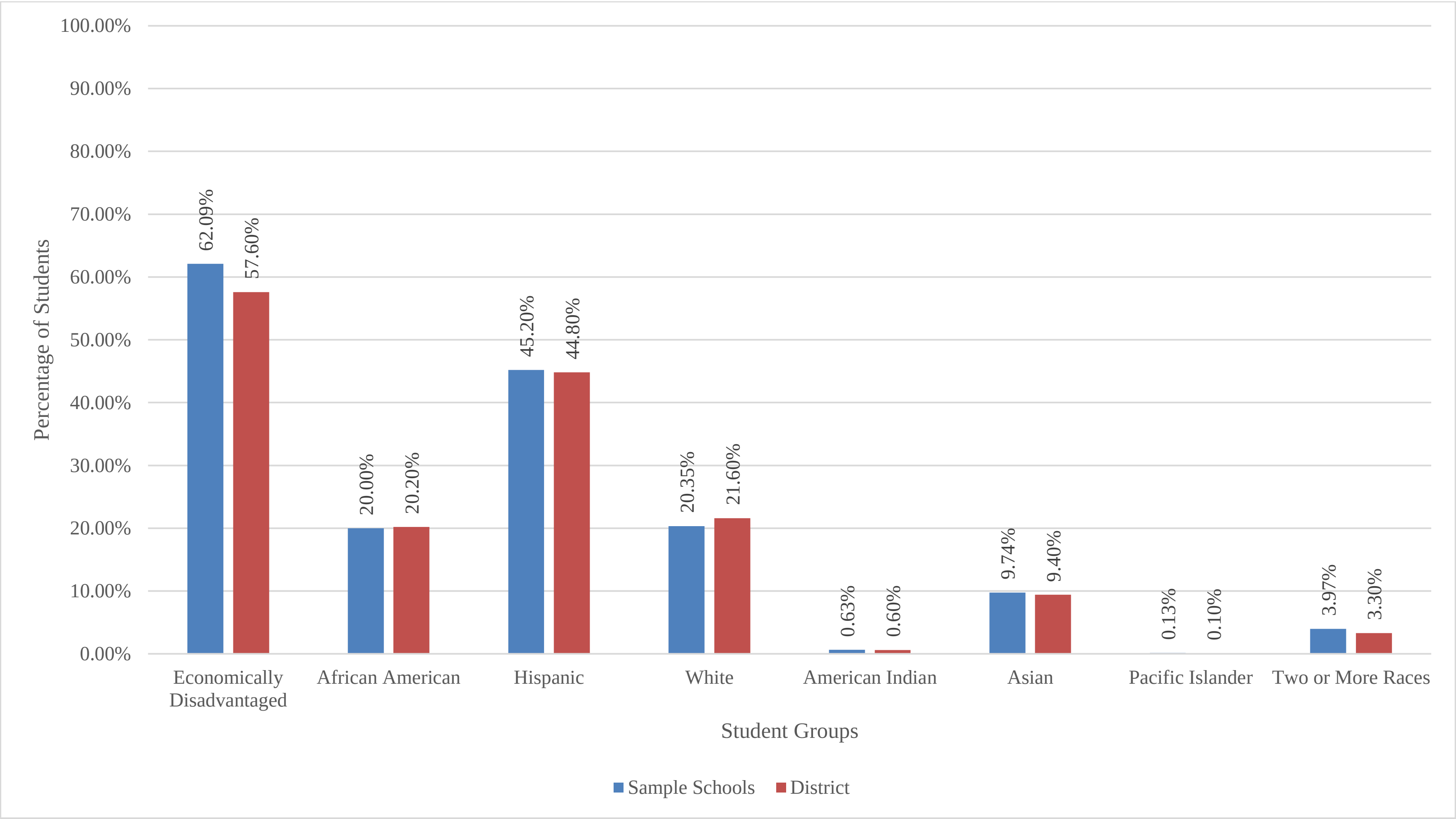


Source: Texas Academic Performance Reports, 2022

Because this study will also look at student achievement outcomes, it is also important to analyze student demographic and achievement data of the selected sample schools. In order to find the percentage of students in my sample group for each of the demographic groups listed below in Figure 6, I added the total number of students for each of the sample schools to find the total number of students who attend my sample schools. I also added the number of students in each demographic group for each of the selected schools in my sample to find the total number of students in each demographic group for my sample schools. For each demographic group, I divided the number of students in the sub-populations by the total number of students in my sample to find the percentage of students for the schools in my sample.

Figure 6

Demographic Data of Students Attending Sample Schools as Compared to District



Source: Texas Academic Performance Reports, 2022

It should be noted that data provided by the TAPR reports do not differentiate grade levels and are representative of the entire school and not just grades three through five. In looking at achievement data, 82% of all Sunnyside ISD students passed the STAAR test at the Approaches level or higher on all tests. In comparison, when averaged together, 78% of students attending the selected schools in my sample group in 2022 passed the STAAR test at the approaches level or higher on all tests. While I was not able to look specifically at grades three through five, and the academic achievement data is slightly lower than the district, when looking at the figures above, it is clear that the sample schools chosen for participation in the study are a good representation of the district as a whole.

Instrumentation

The instrumentation used for this study included the Blended Teacher Readiness Instrument (BTRI), which was validated by Archibald et al. (2021), an additional survey question to determine teacher participation in BL training, and the STAAR test.

Blended Teaching Readiness Instrument

In order to determine a teacher's level of blended teaching readiness, the BTRI was utilized as a survey sent to participants electronically. Archibald et al. (2021) claim that the BTRI can help to determine a teacher's self-efficacy, skill level, and readiness to begin teaching in a blended learning environment. Throughout the development and validation of the BTRI, the instrument was purposefully paired down in length and number of competencies to make the framework and accompanying survey (BTRI) accessible, easy to understand for teachers, and a reasonable length to complete (Archibald et al., 2021; Graham et al., 2019a; Pulham & Graham, 2018). The authors focused their framework on key dispositions and pedagogically-oriented competencies outlined in detail in Chapter 2 (Archibald et al., 2021). The BTRI utilizes a Likerttype scale of 1 (very low) to 6 (very high) for teachers to rate their perception of 43 statements within the BTRI. There are eight questions related to dispositions, 11 questions related to online integration, eight questions for data practices, eight questions for personalized instruction, and eight questions under online interactions (see Appendix A) (Archibald et al., 2021; Graham et al., 2019b).

To test the validity and reliability of the BTRI, Archibald et al. (2021) ran a confirmatory factor analysis (CFA) using structural equation modeling (SEM) on the results of the BTRI for pre-service teachers before taking a blended teaching course and then again on the results of the BTRI for those same pre-service teachers after taking a blended teaching course. Archibald et al. (2021) tested the pre-course survey data for the assumptions of normality (linearity, independence, normality, no extreme multicollinearity, and no outliers), and found that these assumptions held true. After running CFA for the pre-course BTRI survey results, the authors found that the model met the cutoffs for all the fit statistics (RMSEA = 0.045, CFI = 0.933, TLI = 0.929 and SRMR = 0.043) (Archibald et al., 2021, p. 544). In the same way, when Archibald et al. (2021) tested the post-course survey data for the assumptions of normality, they found that the assumptions for normality held for all the competency areas and results of the CFA found good fit across all four statistics cutoffs (RMSEA = 0.044, CFI = 0.911, TLI = 0.905 and SRMR = 0.051) (Archibald et al., 2021, p. 544). These data analyses indicate the validity and reliability of the BTRI.

Participation in BL Professional Development

When teachers were surveyed using the BTRI, an additional question was also asked to determine any correlation related to teacher participation in blended learning professional development. This question was:

Have you participated in any form of professional development (PD) that focused primarily on how to teach in a blended learning environment whether provided by your district, campus, local service center, or sought out elsewhere over the following school years? (You may select more than one answer choice). Answer choices included:

- I participated in PD that focused primarily on blended learning in the 2022-23 school year (this year);
- I participated in PD that focused primarily on blended learning in the 2021-22 school year (last school year);
- I participated in PD that focused primarily on blended learning in the 2020-21 school year (two school years ago);
- I participated in PD that focused primarily on blended learning prior to the 2020-21 school year; or
- I have never participated in a PD that focused primarily on blended learning.

After reviewing the responses to this question, I created three categories to better interpret teacher responses. The first category was for teachers who had never participated in any PD that focused primarily on blended learning. The second category included teachers who participated in PD that focused primarily on blended learning during one school year, regardless of when that year was. The final category included responses that indicated the teacher completed professional development that focused primarily on blended learning during two or more school years. In SPSS, I created two dummy variables that indicated if a teacher had one year of PD or zero years of PD. Two or more years of PD served as my reference category.

The STAAR Test

Student academic achievement was measured by the State of Texas Assessment of Academic Readiness (STAAR) tests. Students in third through fifth grade take the STAAR test for Reading Language Arts and Mathematics annually. Fifth-grade students also take a STAAR test in Science. The STAAR test measures student achievement with a raw score as well as three levels of achievement: “Approaches,” “Meets,” and “Masters.” For the purposes of this study, I used student raw scores for the Reading and Math tests for each third through fifth-grade student in Sunnyside ISD whose teacher participated in the survey.

Procedures

Sunnyside ISD requires that research on any campus within the district must first be approved by the school principal. Potential participants in Sunnyside ISD may only be informed of the opportunity to participate one time and must volunteer to participate. Knowing that not all principals may approve research on their campus and that many busy educators may potentially choose not to participate, I requested that Sunnyside ISD allow me to send the survey to the third- through fifth-grade teachers at approximately 70% of the elementary schools in the district. Sunnyside ISD currently has 57 elementary schools, so I requested to send the information to 41 elementary schools. On average, Sunnyside ISD has approximately seven teachers per grade level. Since participants consist of third- through fifth-grade teachers, each participating school had the potential to provide 21 participants, resulting in approximately 861 potential participants out of the approximately 1,200 total third- through fifth-grade teachers in Sunnyside ISD.

After receiving approval from Sunnyside ISD, I contacted the principal of each of the 41 selected schools to approve or deny this research on their campus. After receiving approval from all 41 principals, the principal, or principal’s designee, sent a recruitment email I composed on my behalf to all third- through fifth-grade teachers on their campus that included the purpose of the study, that teacher participation is voluntary, and the anticipated time (approximately 15 minutes) that participation would take. A link to the informed consent notice as well as the BTRI and blended learning training question was included in the email. As the researcher, I was not permitted by Sunnyside ISD to have direct contact with the participants. The participants and their responses were kept anonymous and not shared with their administrators or reported in my results; however, I did request that teachers provide their name, grade level taught during the 2022-23 school year, and subjects taught during the 2022-23 school year. I needed this information so that I could request student STAAR scores from Sunnyside ISD for each of the teachers who responded to and fully completed my survey. After distribution of the survey to teachers at the approved campuses within Sunnyside ISD, one additional reminder was emailed to potential participants. After reviewing responses and removing incomplete surveys, I collected 76 completed surveys. Data included responses from 43 math teachers and 30 Reading teachers; some teachers taught both Math and Reading. Next, I sent the data collected from these 76 participants to Sunnyside ISD in password protected files and requested that student STAAR test results for each of the participating teachers be provided. Sunnyside ISD assigned random identification numbers to the teachers, students, and campuses before providing the requested student STAAR raw score results. Sunnyside ISD notified me that it is their practice to mask data sets with five or fewer responses. Sunnyside ISD matched teachers' responses to their students' STAAR scores, which resulted in 39 math teachers and 27 Reading teachers as the district removed four Math teachers and three Reading teachers because these teachers had five or fewer students. Furthermore, the district identified two teachers who had taken the survey twice and removed their first responses. There were three teachers within my remaining data set who taught both Math and Reading. This resulted in a total of 73 teachers who completed the BTRI and professional development survey question from 28 of the selected campuses. Sunnyside ISD provided STAAR raw score results for 2,891 students who had one of the 73 participating teachers for Math or Reading in the 2022-23 school year. For Reading, the district matched 1,120 student raw scores on the STAAR test with teachers who completed the survey. For Math, 1,171 student raw scores on the STAAR test were matched with teachers who completed the survey.

Data Analysis

Data needed to answer the research questions included teacher survey results on the BTRI from third- through fifth-grade teachers at selected campuses, their answers to one additional question about their participation in blended learning professional development, and STAAR assessment results for students that had each participating teacher for the school year in which the teachers self-reported their readiness to teach with a blended learning pedagogy and their level of teacher preparation in blended learning. I conducted my analyses using two different units of analysis: teacher, with student scores aggregated by teacher, and student, with student scores not aggregated to the teacher level. At the teacher level, my sample sizes were n=39 for Math and n=27 for Reading, and at the student level, my sample sizes were n=1771 for Mathematics and n=1120 for Reading.

Dependent Variable

The dependent variable in this study consists of student achievement results as measured by the State of Texas Assessment of Academic Readiness (STAAR) tests in Math and Reading Language Arts. The STAAR test is administered annually to elementary students in grades three through five. Results of the STAAR test for students of teachers who participated in the study from the 41 selected schools that make up my sample group were obtained from Sunnyside ISD as the dependent variable.

For the purposes of this study, student achievement was defined as the average student scores for each teacher. The vast majority of teachers in Sunnyside ISD teach either two sections of Math (40-60 students) or two sections of Reading Language Arts (40-60 students), but only vary rarely do third- through fifth-grade students in Sunnyside ISD teacher both Math and Reading Language Arts. For this reason, I determined average Math scores and average Reading scores separately for each teacher based on the subject(s) they taught in the 2022-23 school year and not combined for a composite.

Independent Variables

There were two key independent variables in this study: teacher participation in BL training and a teachers' self-reported level of blended teaching readiness as measured by the BTRI (Archibald et al., 2021). A teacher's participation in BL training was measured by one survey question:

1. Have you participated in any form of professional development (PD) that focused primarily on how to teach in a blended learning environment whether provided by your district, campus, local service center, or sought out elsewhere over the following school years?

This question sought to uncover if a teacher participated in any sort of professional development to learn more about how to teach using a blended learning pedagogy during the 2022-23 school year or the two school years prior. Blended learning was defined for survey participants using the definition widely used from Christensen et al. (2013):

Blended learning is a formal education program in which a student learns at least in part

> through online learning with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from home (p. 7).

Additionally, it was clarified for participants in the survey that any form of professional development, whether from a campus leader, colleague, consultant, book study, etc. that they either sought out or were required to attend that addressed the definition provided by Christensen et al (2013) above would be considered BL training. This data was analyzed to determine if a relationship exists between teacher participation in blended learning professional development and student achievement outcomes. Additionally, this data was used to determine if teacher participation in BL training has any correlation to a teacher's level of readiness to teach in a BL environment as measured by the BTRI.

The second independent variable in this study was a teacher's self-perceived level of readiness to implement blended learning in their classroom. This variable was measured through an electronic survey of teachers from the forty-one selected schools in my sample group. A single score was created for each teacher by adding the sum of each domain score within the BTRI and dividing by the total number of domains to create an average score for each teacher.

Data Analysis

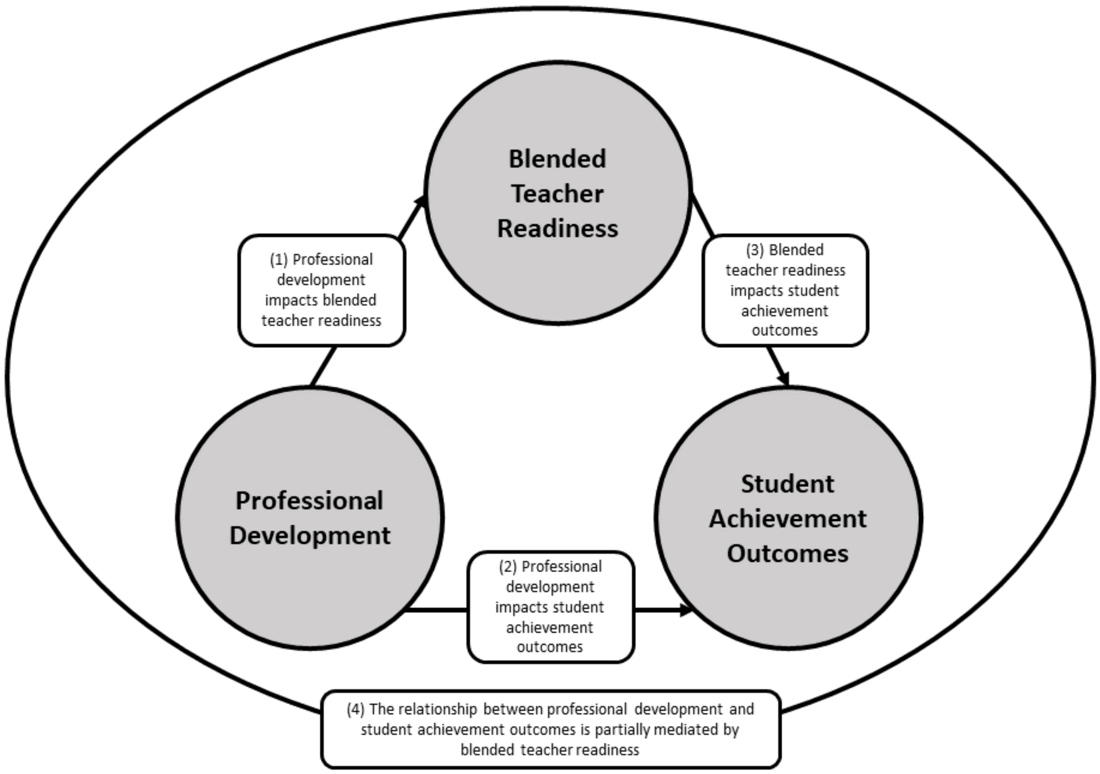
Without claiming cause-and-effect, correlational designs aim to determine if a relationship exists between two or more variables (Bloomfield & Fischer, 2019; Spector, 1981). Studies that explore relationships using linear regression analysis classify the strength of the relationship as positive, negative, or irrelevant (Seermam, 2019). I determined and reported the strength of each relationship posed in my research questions in chapter 4.

Testing Assumptions

I utilized linear regression analyses to test assumptions for each of the paths laid out in my research questions and displayed in the visual model below: 1) the relationship between teacher participation in BL professional development and teacher readiness as measured by the BTRI, 2) the relationship between teacher participation in BL professional development and student achievement outcomes, and 3) the relationship between teacher readiness as measured by the BTRI and student achievement outcomes. I also utilized the PROCESS macro in SPSS (Hayes, 2018) to determine if teacher blended learning readiness, as measured by the BTRI, significantly mediated the relationship between campus-provided professional development and student achievement outcomes.

Figure 2

Blended Teacher Readiness Conceptual Framework



For paths 1-3 displayed in the Figure 2, the assumption of normality was tested visually by reviewing the P-P Plots. The assumption of homoscedasticity was tested with a visual inspection of the scatterplots. I reviewed Cook's distance for each of the first three relationships to determine if there were potential outliers. The independence of observation assumption was tested with a Durbin-Watson statistic. By reviewing the R-square value for each of the relationships, the assumption of multicollinearity was tested.

Testing Hypotheses

In order to answer research question 1, "Are there differences in teacher readiness depending on whether a teacher participated in BL professional development?" I utilized a simple regression analysis to compare teachers' overall, combined BTRI scores to the BL training they received. Before running the regression analysis in SPSS, I created two dummy variables to delineate different levels of BL training for teachers: zero years of BL professional development and one year of BL professional development. The reference group was two or more years of BL professional development. I tested the hypothesis:

H1: Teachers who participated in BL training have higher levels of readiness to teach in a BL format as measured by the BTRI.

It is important to note that I violated the assumption of independence because students are clustered together within teachers and schools and my analysis did not account for the clustering. I also calculated Cohen's *d* effect size.

In order to answer research question 2, "Does student achievement vary depending on whether a teacher participated in BL professional development?", I tested the hypothesis:

H2: Student achievement increases when a teacher participates in BL professional development.

I again used a simple regression model to compare student achievement to training received by participating teachers using the dummy variables created to answer question 1.

To answer research question 3 "Does a teacher's blended learning readiness have an effect on student achievement outcomes?", I conducted a simple regression model to determine if there is a relationship between a teachers' overall BTRI score and student achievement outcomes on the STAAR test. I tested the hypothesis:

H3: A teacher's BL readiness as measured by the BTRI has a positive effect on student achievement outcomes as measured by the STAAR test in Reading Language Arts and Math.

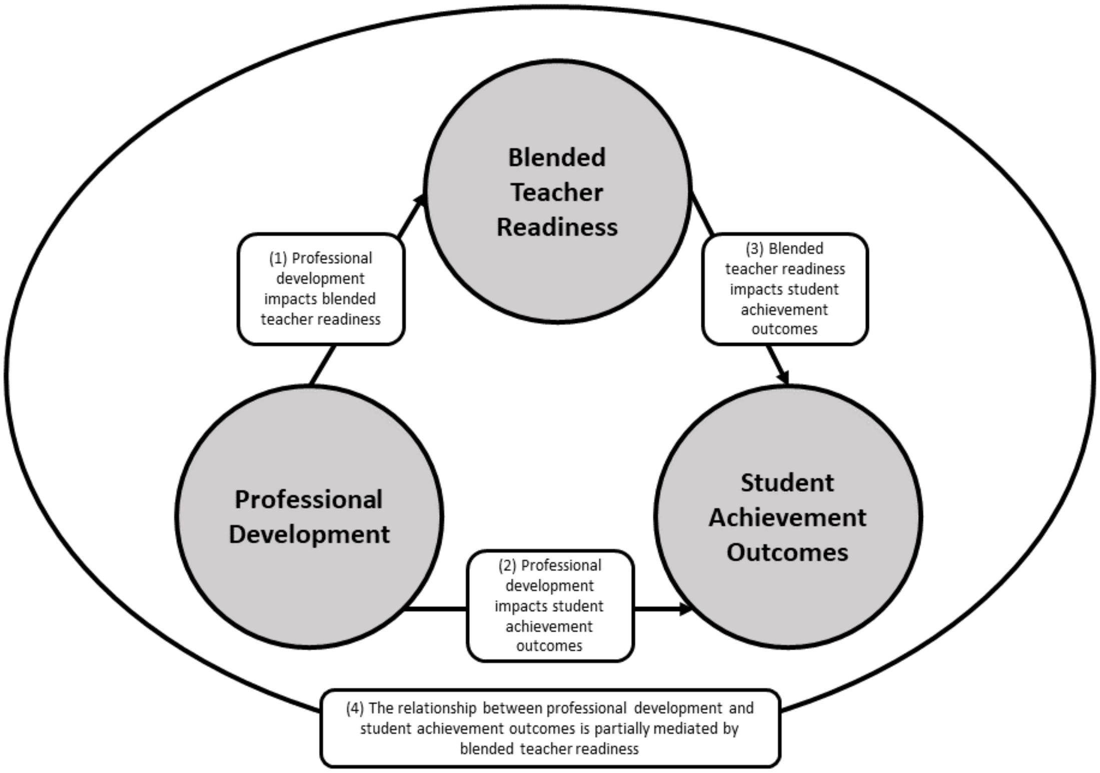
To answer research question 4, “Does teacher readiness to use BL mediate the relationship between teacher participation in BL professional development and student achievement?”, I utilized a partial mediation model. In a partial mediation model, it is hypothesized that one variable affects another variable (the mediator), which then affects another variable. In this study, I hypothesize:

H4: The relationship between professional development and student achievement outcomes is partially mediated by blended teacher readiness.

A visual model for partial mediation in this study is below denoted in pathway 4 where BL Professional Development is the predictor (independent variable), blended teacher readiness is the mediator, and student achievement is the outcome (dependent variable).

Figure 2

Blended Teacher Readiness Conceptual Framework



The process for determining if a partial mediation relationship existed utilized the PROCESS regression path analysis modeling tool in SPSS (Hayes, 2018; Hayes, n.d.). The PROCESS macro is widely used to calculate direct and indirect effects in models with one or more mediators (Hayes, 2018; Hayes, n.d.). Hayes (2018) describes that the effect of X (in this study, Professional Development) on Y (Student Achievement Outcomes) is moderated by W Blended Teacher Readiness) if “its size, sign, or strength depends on or can be predicted by W” (p.220). PROCESS provides an output which determines the proportion of variance in Y that can be uniquely attributed to W’s effect on X (Hayes, 2018). I predicted that professional development would have a direct effect on student achievement outcomes as well as an indirect effect on student achievement through blended teacher readiness.

To test for a partial mediation relationship, the mediator (in this study, blended teacher readiness) is regressed on the independent variable (BL professional development), the dependent variable (student achievement) must be regressed on the independent variable (BL professional development), and the dependent variable (student achievement) must be regressed on both the independent variable (BL professional development) and on the mediator (blended teacher readiness) (Baron & Kenny, 1986). While I already completed each of these steps in the process of answering my first three questions, the PROCESS macro tests all of these relationships together.

Baron and Kenny (1986) state that the following conditions must be true in order to establish mediation: first, it must be demonstrated that the independent variable affects the mediator in the first equation (BL professional development must impact blended teacher readiness); second, it must be demonstrated that the independent variable affects the dependent variable in the second equation (BL professional development must impact student achievement); and third, the mediator must affect the dependent variable in the third equation (blended teacher readiness must impact student achievement). If these three conditions are met, and in the predicted direction, then the effect of the independent variable (BL professional development) on the dependent variable (student achievement) must be less in the third equation than in the second (Baron & Kenny, 1986). The PROCESS macro in SPSS not only tests all of these relationships, but also provides a statistic for the significance of the partial mediation.

Summary

In this chapter, I focused on the methodology and research design for this study. I utilized quantitative methods to explore the relationships between different levels of teacher preparation in blended learning practices, teachers' perceived readiness to teach in a blended learning pedagogy as measured by the BTRI, and student achievement outcomes as measured by the STAAR. I gained consent from a large, suburban school district to survey third- through fifth-grade teachers from across forty-one varying campuses. Participants completed the BTRI and provided information on blended learning professional development received. Results of this survey as well as STAAR results from participating teachers' students, were analyzed for correlations. The results of these analyses are discussed in Chapter 4 and further discussion is provided in Chapter 5.

Chapter IV Results

In this chapter, I present the results of the statistical analyses outlined in Chapter Three. I utilized simple regression analyses to address three of my research questions to test the hypothesized relationships between participation in blended learning (BL) professional development, teachers' self-perceived readiness to implement BL in their classrooms as measured on the BTRI, and student achievement outcomes. I utilized the PROCESS macro in SPSS to further explore if a mediation relationship existed between the variables (Hayes, n.d.). Before reporting my findings, I contextualize my analyses through relevant descriptive statistics. After that, I describe the assumptions I tested prior to running my analysis. Finally, I present the results of the regression models for each of the first three research questions and the PROCESS analysis, which answers the fourth research question, and conclude with a summary of the significant findings.

Descriptive Statistics

To provide important context to the subsequent regression and PROCESS results, in this section, I offer descriptive statistics regarding key variables in the analysis. This information describes relevant characteristics of the data collected by the BL professional development question, the BTRI survey, and student raw scores on the STAAR test. Reading student raw scores ranged from a low raw score of three to a maximum high score of 51. The mean Reading raw score for the sample was 29.7 with a standard deviation of 10.8. Math student raw scores ranged from a low raw score of zero to a maximum high score of 42. The mean math raw score for the sample population was 23.2 with a standard deviation of 9.2. For each teacher who participated, I created a teacher average, which was the average student STAAR score for mathematics and for Reading. The Reading raw score mean variable had a minimum of 22.3, a maximum of 39.7, and a mean of 29.5 with a standard deviation of 4.9. The math raw score mean variable had a minimum of 14.8, a maximum of 32.7 and a mean of 22.9 with a standard deviation of 4.9.

For Reading teachers, the minimum BTRI score was 2.7 and the maximum score was a 5.8. The mean BTRI Score for Reading teachers was 4.7 with a standard deviation of 0.7. For Math teachers, the minimum BTRI score was much higher at 3.2 with a maximum score of 6.0. The mean BTRI score for Math teachers was 4.7 with a standard deviation of 0.7. In response to the survey question about participation in BL professional development, teachers could select more than one response based on which years they participated in BL professional development. Table 3, below, represents all the different combinations of responses that teachers reported and the frequencies and percentages of each of the combinations:

Table 3

Responses to BL Professional Development Survey Question

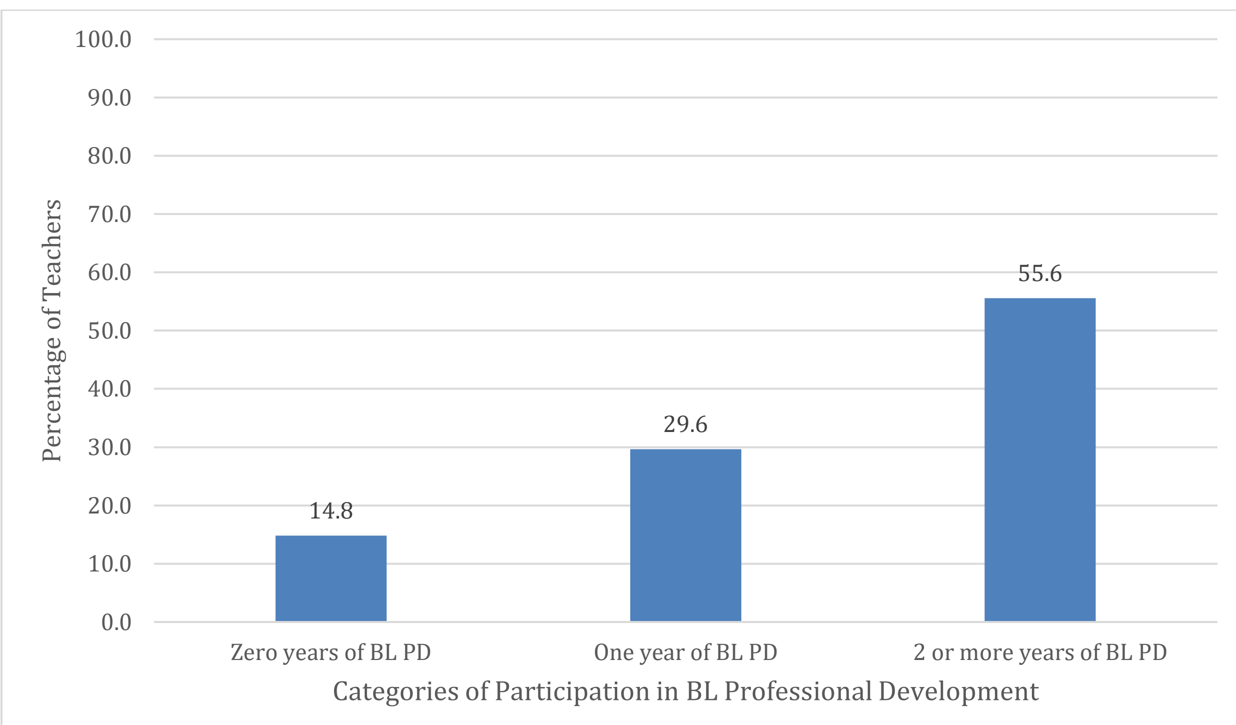
Possible survey response combinations	**Responses from Reading Teachers**	Percentage of Reading teachers who selected this combination of responses	Responses from Math Teachers	Percentage of Math teachers who selected this combination of responses
I have never participated in a PD that focused primarily on blended learning.	4	14.8%	3	7.7%
I participated in PD that focused primarily on blended learning in the 2020-21 school year (two school years ago)	4	14.8%	2	5.1%
I participated in PD that focused primarily on blended learning in the 2020-21 school year (two school years ago), I participated in PD that focused primarily on blended learning prior to the 2020-21 school year	1	3.7%	1	2.6%
I participated in PD that focused primarily on blended learning in the 2022-23 school year (this year)	1	3.7%	6	15.4%
I participated in PD that focused primarily on blended learning in the 2022-23 school year (this year), I participated in PD that' focused primarily on blended learning in the 2021-22 school year (last school year)	1	3.7%	7	17.9%
I participated in PD that focused primarily on blended learning in the 2022-23 school year (this year), I participated in PD that' focused primarily on blended learning in the 2021-22 school year (last school year), I participated in PD that focused primarily on blended learning in the 2020-21 school year (two school years ago)	1	3.7%	3	7.7%

I participated in PD that focused primarily on blended learning in the 2022-23 school year (this year),I participated in PD that' focused primarily on blended learning in the 2021-22 school year (last school year),I participated in PD that focused primarily on blended learning in the 2020-21 school year (two school years ago),I participated in PD that focused primarily on blended learning prior to the 2020-21 school year	6	22.2%	4	10.3%
I participated in PD that focused primarily on blended learning prior to the 2020-21 school year	2	7.4%	4	10.3%
I participated in PD that' focused primarily on blended learning in the 2021-22 school year (last school year)	1	3.7%	4	10.3%
I participated in PD that' focused primarily on blended learning in the 2021-22 school year (last school year), I participated in PD that focused primarily on blended learning in the 2020-21 school year (two school years ago)	3	11.1%	2	5.1%
I participated in PD that' focused primarily on blended learning in the 2021-22 school year (last school year), I participated in PD that focused primarily on blended learning in the 2020-21 school year (two school years ago), I participated in PD that focused primarily on blended learning prior to the 2020-21 school year	3	11.1%	3	7.7%
Total	27	100.0%	39	100.0%

After reviewing the responses and noting that there were 11 different combinations selected by participating teachers, I saw the need to create variables that help to better explain these data. I created three categories of BL professional development in order to disaggregate the data: zero years of BL professional development, one year of BL professional development, and 2 or more years of BL professional development. In looking at Reading teachers' responses to the BL professional development question through the lens of the three categories created, 4 teachers reported to have never participated in any form of BL professional development, 8 teachers reported to have participated in BL training over the course of one year, and 15 teachers reported to have participated in BL professional development for 2 or more years. The percentage of Reading teachers from my sample whose responses fell into each of the three created categories can be seen in Figure 7.

Figure 7

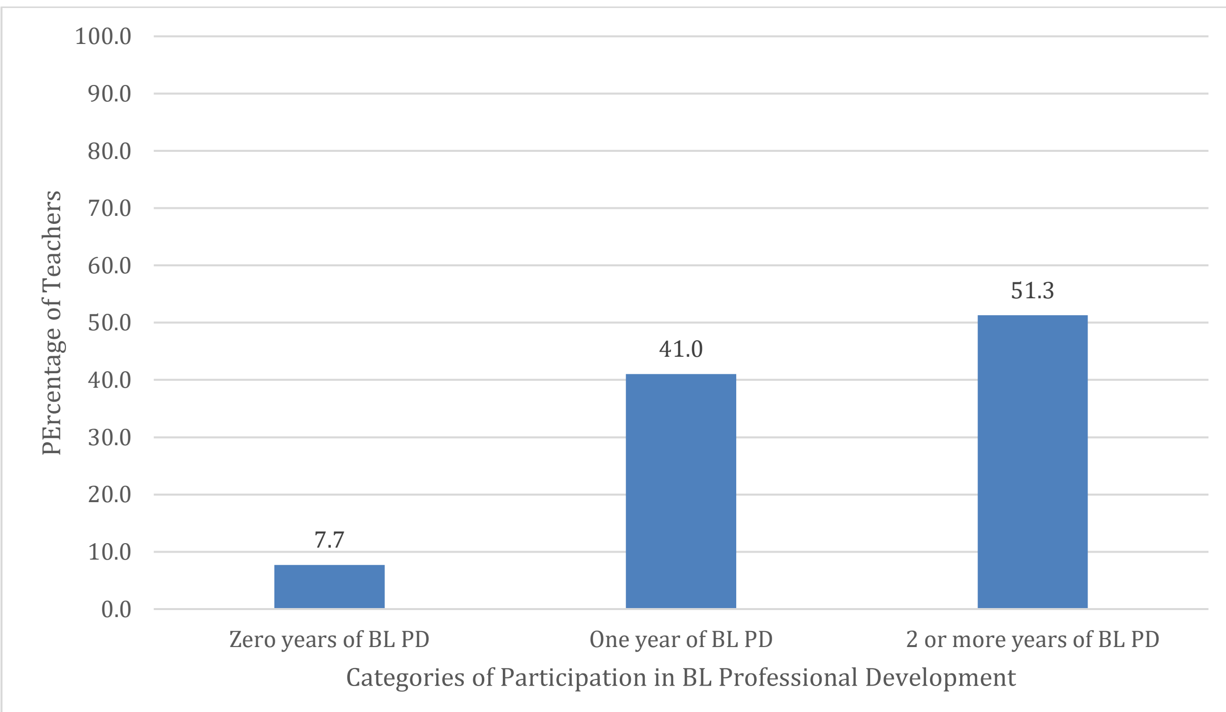
Percentage of Reading Teachers in Each BL Professional Development Category



Similarly, when considering the number of years of PD the Math teachers' responses to the BL professional development question indicated, 3 teachers reported to have never participated in any form of BL professional development, 16 teachers reported to have participated in BL professional development over the course of one year, and 20 Math teachers reported to have participated in some form of BL professional development for 2 or more years. The percentage of Math teachers from my sample whose responses fell into each of the three created categories can be seen in Figure 8.

Figure 8

Percentage of Math Teachers in Each BL Professional Development Category



The descriptive statistics presented here demonstrate the wide range of BL readiness of teachers as demonstrated by the BTRI scores as well as the wide range of student achievement outcomes measured by the STAAR test. The wide ranges in these variables reinforce the relevance of this thesis's research questions to determine if relationships exist among these variables.

Assumptions

After I calculated the descriptive statistics for the variables involved in the four research questions, I tested the assumptions for linear regression. The assumption of normality was met for both the Math dataset and the Reading aggregated datasets as the regression lines closely described the relationships tested. While all points on the P-P plot did not cover the line, most were close to the line as can be seen in Figures 9, 10, 11, and 12.

Figure 9

P-P Plot Using Reading Data at the Teacher Level

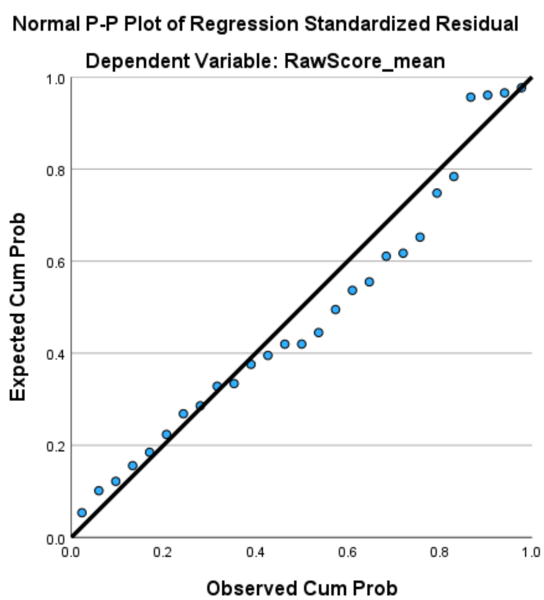


Figure 10

P-P Plot Using Reading Data at the Student Level

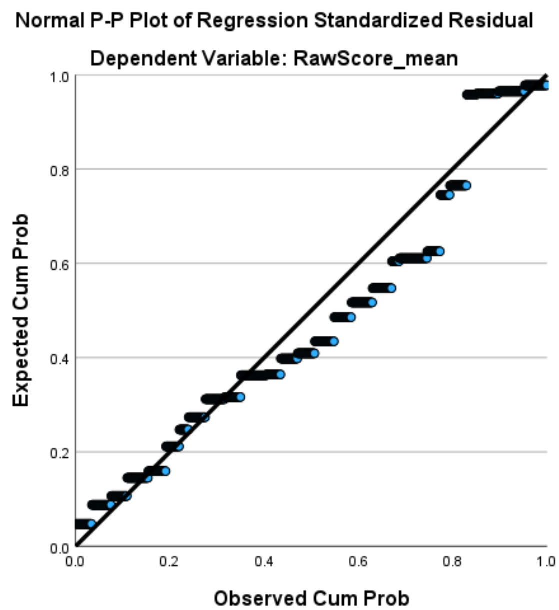


Figure 11

P-P Plot Using Math Data at the Teacher Level

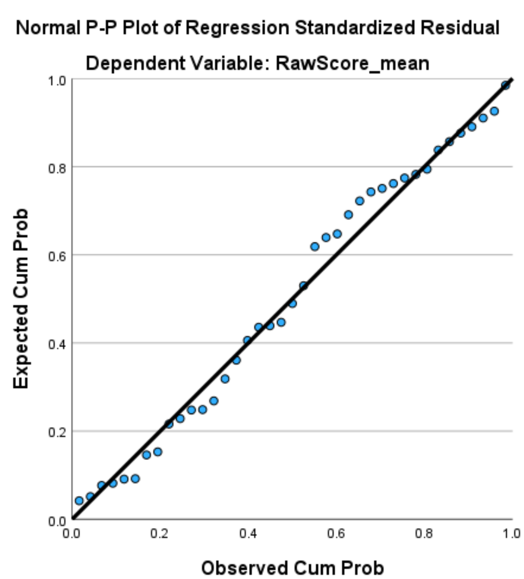
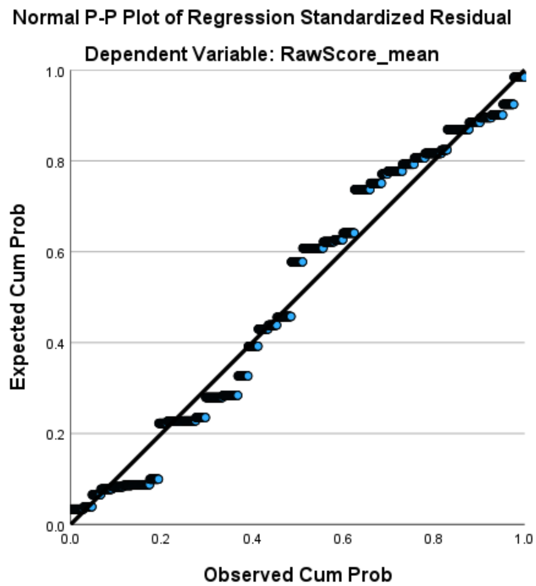


Figure 12

P-P Plot Using Math Data at the Student Level



The assumption of homoscedasticity was met with a visual inspection of the scatterplots as the residuals appeared to have similar variance across the range of predicted values. This can be seen below in Figures 13, 14, 15, and 16.

Figure 13

Scatterplot Using Reading Data at the Teacher Level

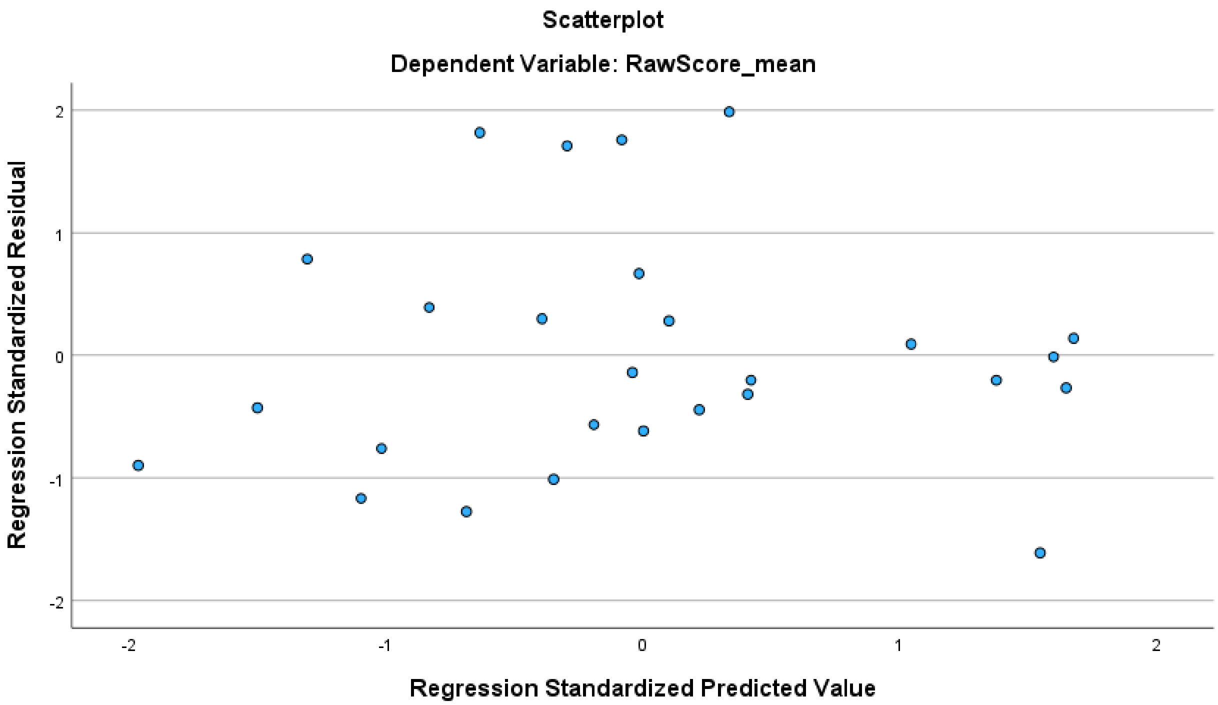


Figure 14

Scatterplot Using Reading Data at the Student Level

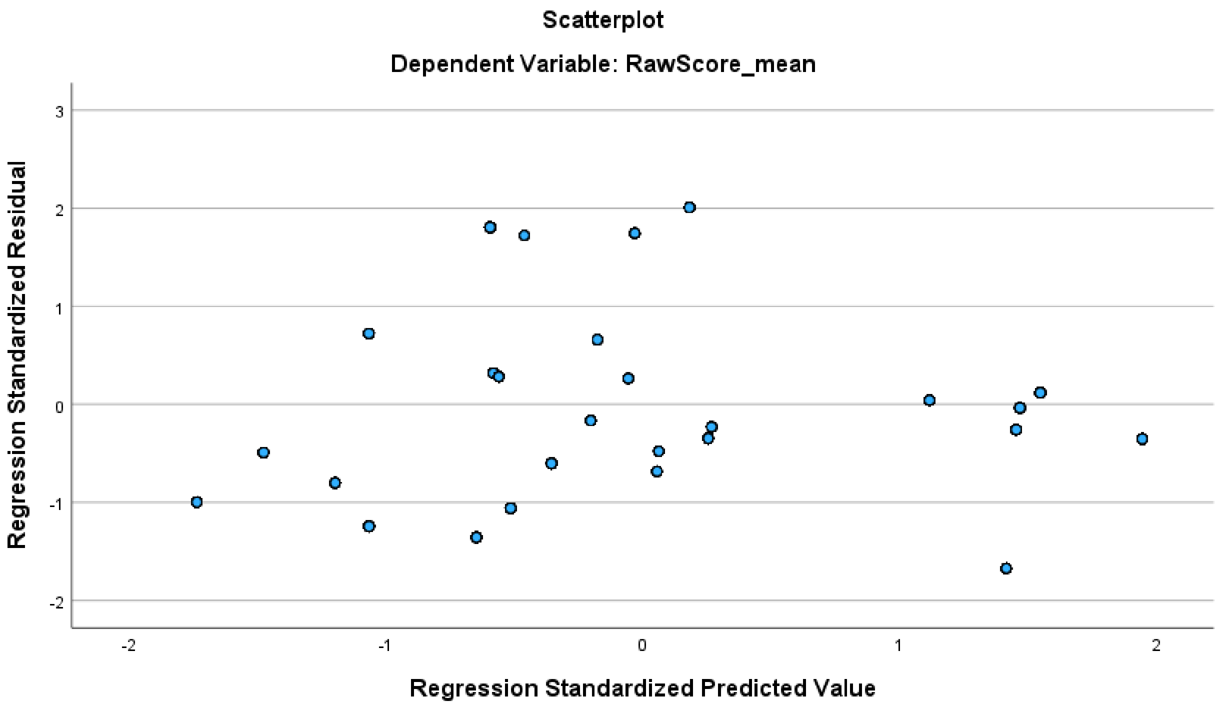


Figure 15

Scatterplot Using Math Data at the Teacher Level

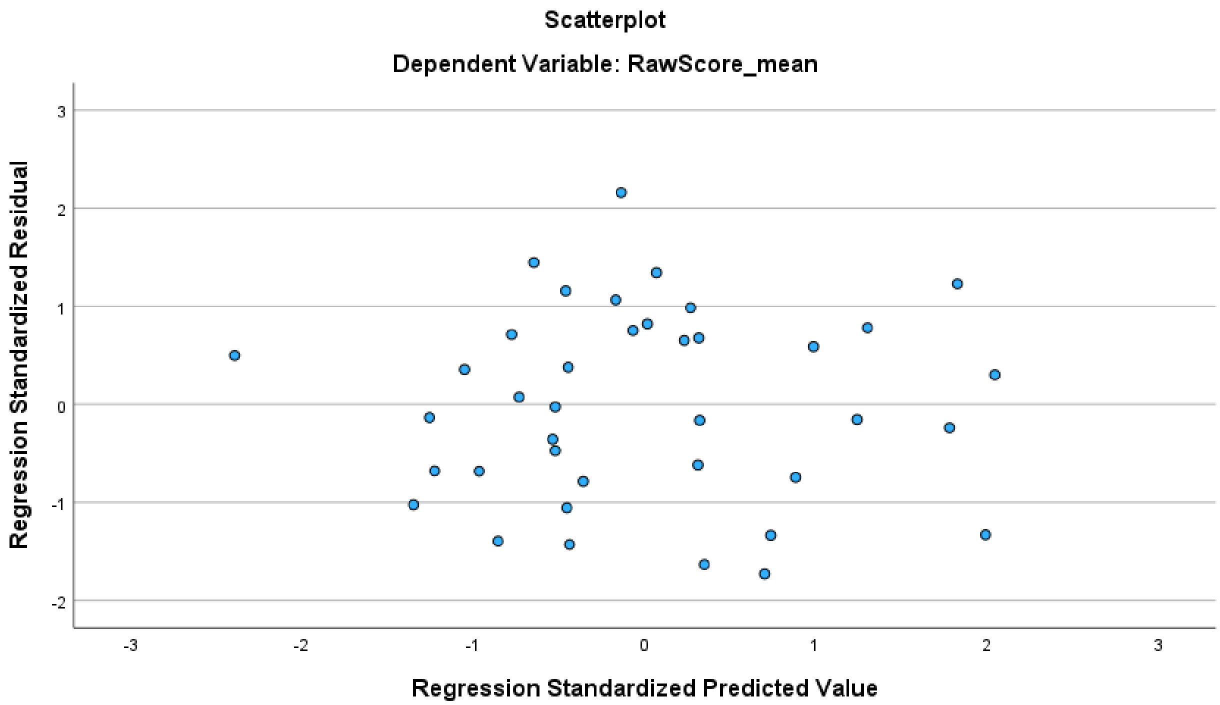
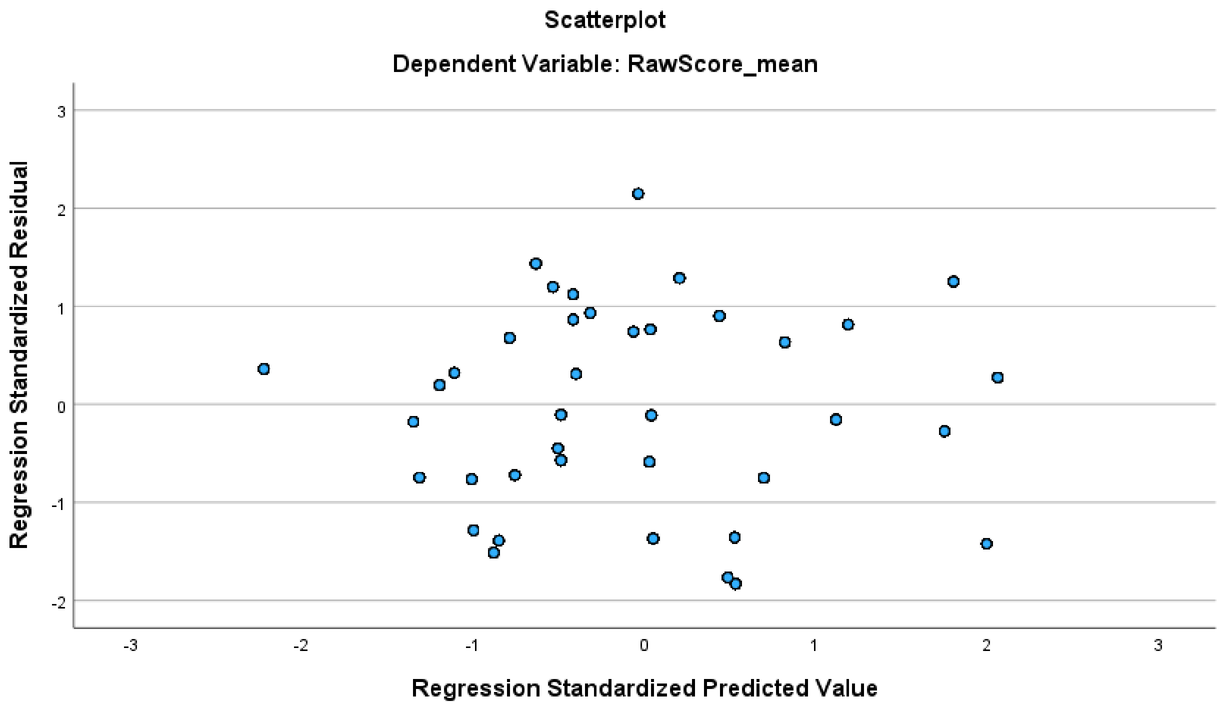


Figure 16

Scatterplot Using Math Data at the Student Level



For both the Math and Reading aggregated datasets, Cook's distance indicated that there were potential outliers. I looked at removing the high or low scores, but doing so did not improve the Cook's distance. Given the small sample size of the aggregated data at the teacher level, I decided to also use the full data sets for both Math and Reading. The independence of observations assumption was met by the aggregated datasets with a Durbin-Watson statistic of 2.4 for the Reading data aggregated by teacher and a 2.1 for the Math data aggregated by teacher. When I looked at the student level datasets, neither the Math or Reading datasets met the independence of observations assumption with a Durbin-Watson statistic of 0.05 for the Reading data at the student level and .047 for the Math data at the student level. All four data sets met the assumption of multicollinearity with High Variance Inflation Factors (VIFs) under two.

Research Question 1 Results

In the first research question, I asked, "To what extent are there differences in teacher readiness depending on whether a teacher participated in BL professional development?" I used simple linear regression to answer the research question, analyzing the data separately for Math teachers and Reading teachers.

Reading

In looking at the aggregated Reading dataset, the ANOVA model was not significant (p = .580), which may be an artifact of the sample size. Furthermore, the coefficients were not statistically significant. Therefore, I failed to reject the null hypothesis that there is no significant difference in BL readiness depending on the level of BL professional development. Because of that, I looked at the student level data.

Analyzing the Reading data at the student level provided slightly different results because the sample size was much larger. For the student level Reading dataset, the ANOVA model was significant with a p-value of <.001. This model explains just under 8% of the total variability in BTRI scores with an R^2 of .08. The student level data showed that on average, teachers in the sample who had no BL professional development had a BTRI score that was 0.62 points lower than a teacher with two or more years of BL professional development (b = -0.62, p = < .001). Additionally, the student level data showed that on average, teachers in the sample who had one year of BL professional development had a BTRI score 0.16 points lower than a teacher with two or more years of BL professional development (b = -0.16, p = .001). The regression model significantly explained the outcome variances in teachers BTRI scores, F(2, 1117) = 46.02, indicating that having one or two years of BL professional development accounted for substantial additional variance beyond residual variability based on the large, significant F-ratio.

The effect sizes as explained by the Part correlation for teachers with no BL professional development (-0.28) and one year of BL professional development (-0.09) were small, which means that their practical significance is limited. The student level data did not account for clustering, and as a result, my standard errors are likely inflated. With a P-value of <.001, I rejected the null hypothesis that there is no significant difference in BL readiness depending on the level of BL professional development.

Math

When analyzing the Math dataset aggregated by teacher, the ANOVA model was not significant (p = .808), which may be an artifact of the sample size. Furthermore, the coefficients were not statistically significant. Again, when looking at the aggregated dataset, I failed to reject the null hypothesis that there is no significant difference in BL readiness depending on the level of BL professional development. Because of that, I looked at the student level data.

When looking at the much larger Math data at the student level, the model was significant, with a P-value of <.001. The R^2 was .016, indicating that 1.6% of the variance in BTRI scores were explained by this model. The student level data showed that, on average, teachers who had no BL professional development had a BTRI score that was 0.15 points higher than teachers with two or more years of BL professional development (b = 0.15, p = .035). Additionally, the student level analysis showed that, on average, teachers with one year of BL professional development had a BTRI score 0.18 points higher than teachers with two or more years of BL professional development (b = 0.18, p < .001). The analysis of variance showed the regression model significantly predicted outcomes on the BTRI, F(2, 1768) = 13.99, suggesting that having one or two years of BL professional development accounted for substantial additional variance beyond residual variability based on the statistically significant F-ration despite relatively large degrees of freedom. The effect sizes as explained by the Part correlation for teachers with no BL professional development (-0.05) and one year of BL professional development (-0.12) were small, which means that their practical significance is limited. The student level data did not account for clustering, and as a result, my standard errors are likely inflated. I was able to reject the null hypothesis because there is a significant difference in BL readiness depending on the level of BL professional development in which a teacher participated ($p <. 001$).

Research Question 2 Results

In the second research question, I asked, “To what extent does student achievement vary depending on whether a teacher participated in BL professional development?” I again used a linear regression to uncover if a relationship existed and to what extent.

Reading

When I analyzed the dataset aggregated by teacher, I found that the ANOVA model was not significant ($p = .975$), which may be an artifact of the sample size. Furthermore, the coefficients were not statistically significant. In looking at the aggregated Reading dataset, I failed to reject the null hypothesis that there is no significant difference in student achievement depending on the level of BL professional development. Because of that, I looked at the student level data.

After analyzing the Reading dataset at the student level, I found that the ANOVA model was not significant ($p=.011$), even with the larger sample size. Additionally, the coefficients were not statistically significant. Again, I failed to reject the null hypothesis that there is no significant difference in student achievement depending on teachers’ level of BL professional development.

Math

In looking at the aggregated Math dataset, the model was not significant ($p = .152$), which may be an artifact of the sample size. The coefficients were also not statistically significant. In looking at the aggregated Math dataset, I failed to reject the null hypothesis that there is no significant difference in student achievement depending on teachers' level of BL professional development. Because of that, I looked at the student level data.

After analyzing the Math dataset at the student level, I found that the model was statistically significant with a p-value of <.001. The R^2 was .077, indicating that almost 8% of the variance in average student raw scores was explained by this model. I found that the average student raw score for Math teachers who had no exposure to BL professional development was 5.62 points lower than the average student raw score for Math teachers with two or more years of BL professional development ($b = -5.62$, $p < .001$). Additionally, the average student raw score for Math teachers who had one year of BL professional development was 0.51 points lower than the average student raw score for Math teachers with two or more years of BL professional development ($b = -0.51$, $p = .026$). The analysis of variance demonstrated the regression model strongly and significantly predicted student raw score outcomes on the STAAR test, $F(2, 1768) = 74.21$, $p < .001$, with one year and two years of BL professional development accounting for sizable additional variance above residual variability evidenced by the very large, highly significant F-ratio despite the high residual degrees of freedom. The effect sizes as explained by the Part correlation for teachers with no BL professional development (-0.28) and one year of BL professional development (-0.05) were small based on traditional effect size measures; however, when considering the mean math raw score for the sample population was 23.2 with a standard deviation of 9.2, the effect size for teachers with no BL appears to be more meaningful. The effect size of 0.28 means a difference of approximately three points, which could mean the difference between passing or failing the state assessment. The student level data did not account for clustering, and as a result, my standard errors are likely inflated. With a P-value of <.001, I rejected the null hypothesis because there is a significant difference in student achievement depending on teachers' levels of BL professional development.

Research Question 3 Results

In my third research question, I asked, "To what extent is a teacher's blended learning readiness related to student achievement outcomes?" To answer this question, I utilized a regression analysis.

Reading

When I analyzed the dataset aggregated by teacher, I found that the ANOVA model was not significant (p = .562), which may be an artifact of the sample size. Additionally, the coefficients were not statistically significant. I failed to reject the null hypothesis that there is no significant difference in student achievement outcomes depending on BL readiness. Because of that, I looked at the student level data.

After analyzing the Reading dataset at the student level, I found that the model to be significant with a p-value of <.001. The R^2 was .015, indicating that 1.5% of the variance in average student raw scores were explained by this model. The student level Reading dataset showed that for every one point higher that a Reading teacher self-reported on the BTRI, average student raw scores were 0.79 points lower (b = -0.79, p < .001). The analysis of variance showed the regression model significantly predicted student raw scores on the STAAR test, F(1, 1118) = 17.17, p <.001, suggesting teacher BTRI scores accounted for a modest bust statistically significant amount of variance beyond residual variability based on the significant F-ratio despite the relatively large residual degrees of freedom. The effect size as explained by the Part correlation was small (-0.12), which means that the practical significance of this finding is limited. The student level data did not account for clustering, and as a result, my standard errors are likely inflated. I rejected the null hypothesis that there is no significant difference in student achievement outcomes depending on teachers' BL readiness with a P-value of <.001.

Math

When I analyzed the dataset aggregated by teacher, I found that the ANOVA model was not significant (p = .082), which may be an artifact of the sample size. Furthermore, the coefficients were not statistically significant. Because I again failed to reject the null hypothesis that there is no significant difference in student achievement outcomes depending on BL readiness when looking at the data aggregated by teacher, I then analyzed the student level data.

After analyzing the Math dataset at the student level, I found that the ANOVA model was significant with a p-value of <.001. The R^2 was .110, indicating that 11% of the variance in average student raw scores were explained by this model. The student level Math data showed that for every one point higher that a Math teacher self-reported on the BTRI, average student raw scores were 2.24 points lower (b = -2.24, p < .001). The analysis of variance demonstrated the regression model strongly and significantly predicted student raw scores on the STAAR test, F(1, 1769) = 217.83, p < .001, with teacher BTRI scores accounting for a substantial amount of additional variance above residual variability evidenced by the very large, highly significant F-ratio despite the high residual degrees of freedom. The effect size of this data is explained by the Part of the Part and Partial model as small at -0.33. The student level data did not account for clustering, and as a result, my standard errors are likely inflated. I was able to reject the null hypothesis that there is no significant difference in student achievement outcomes depending on BL readiness with a P-value of <.001.

Research Question 4 Results

In my fourth research question, I sought to uncover the relationship between all of the variables in my study with the question, “To what extent does teacher readiness to use BL mediate (or help explain) the relationship between teacher participation in BL professional development and student achievement?” I utilized the PROCESS macro in SPSS to test for this mediation relationship (Hayes, 2018; Hayes, n.d.). The mediation model was used to test if a teachers’ BTRI score (M) mediates the relationship between number of years of BL professional development (X) and average student raw scores (Y).

Reading

The data analysis of the teacher level Reading data did not show that teacher readiness for blended learning, as measured by their BTRI scores, was a significant mediator between BL professional development and student achievement scores on the STAAR Reading test (indirect effect between PD and student achievement through BTRI = .37, 95% CI [-1.29, 2.78]). I was unable to reject the null hypothesis that blended learning readiness does not explain the relationship between BL professional development and student Reading scores.

Due to the small sample size created by aggregating student data by teacher, I also analyzed the data using Hayes (n.d.) PROCESS macro on the Reading data set at the student level. The data analysis revealed that teacher readiness for blended learning, as measured by their BTRI scores, was a significant mediator between BL professional development and student achievement scores on the STAAR Reading test (indirect effect between PD and student achievement through BTRI = .58, 95% CI [.37, .81]). When using the student level Reading data, the direct effect of having no exposure to BL professional development on average student raw scores was also significant (b = -1.21, p = .006). In summary, the results of the student-level Reading analysis allowed me to reject the null hypothesis and conclude that BTRI scores do partially mediate the link between BL professional development and student raw score averages such that BL readiness helps explain the negative relationship between a lack of teacher participation in BL PD and students' reading scores, although the effect size is small.

Math

I conducted the same mediation analysis using Math scores (aggregated to the teacher level and student level) to test whether teacher readiness for blended learning, as measured by their BTRI scores, was a significant mediator between BL professional development and student achievement scores on the STAAR Reading test. The teacher level data did not show that BTRI scores had a significant mediation relationship between BL professional development and student achievement scores on the STAAR Math test (indirect effect between PD and student achievement through BTRI = .08, 95% CI [-2.90, 3.16]). However, having no BL professional development had a significant direct effect on reducing average student raw scores (b = -5.97, p = .04). I was unable to reject the null hypothesis that blended learning readiness does not explain the relationship between BL professional development and student Math scores.

The student level data also did not show that teacher readiness for blended learning, as measured by their BTRI scores, was a significant mediator between BL professional development and student achievement scores on the STAAR Math test. (indirect effect between PD and student achievement through BTRI = -.33, 95%, CI [-.86, .014]). However, having no BL professional development had a highly significant direct effect on reducing average student raw scores (b = -5.30, p = < .001). Additionally having only one year of BL professional development also had a highly significant direct effect on reducing average student raw scores (b = -2.19, p = < .001). I was again unable to reject the null hypothesis that blended learning readiness does not explain the relationship between BL professional development and student Math scores.

Summary of Findings

In summary, there were several significant findings to note in this study. I found that Reading teachers' self-assessed readiness to teach in a blended learning environment increased when they had more exposure to BL professional development, while Math teachers' BTRI scores were higher for teachers who had no exposure to BL professional development. I also found that for both Reading and Math, the higher a teachers' BTRI scores, the lower their average student achievement. For both Reading and Math, having no exposure to BL professional development was negatively related to student achievement scores. After analyzing the Reading data at the student level, I found that teacher readiness for blended learning, as measured by their BTRI scores, was a significant mediator between BL professional development and student achievement scores on the STAAR Reading test. The findings for each research question follow in Table 4.

Table 4

Summary of Findings

Research Question	Reading Teacher-level	Reading Student-level	Math Teacher-level	Math Student-level
Research Question 1: To what extent are there differences in teacher readiness depending on whether a teacher participated in BL professional development?	Non-significant	Significant Effect size = -0.28 for teachers with no BL PD and -0.09 for teachers with one year of BL PD as compared to teachers with two or more years of BL PD.	Non-significant	Significant Effect size = 0.05 for teachers with no BL PD and 0.12 for teachers with one year of BL PD as compared to teachers with two or more years of BL PD.
Research Questions 2: To what extent does student achievement vary depending on whether a teacher participated in BL professional development?	Non-significant	Non-significant	Non-significant	Significant Effect size = -0.28 for teachers with no BL and -0.05 for teachers with one year of BL PD as compared to teachers with two or more years of BL PD.
Research Question 3: To what extent is a teacher's blended learning readiness related to student achievement outcomes?	Non-significant	Significant Effect size = -0.12	Non-significant	Significant Effect size = -0.33
Research Question 4: To what extent does teacher readiness to use BL mediate (or help explain) the relationship between teacher participation in BL professional development and student achievement?	Non-significant	Significant Indirect effect = .58, 95% CI [.37, .81]	Non-significant	Non-significant

Chapter V Discussion

The purpose of this study was to examine the relationships between blended learning (BL) professional development, teacher readiness to teach in a BL environment, and student achievement outcomes. This study was grounded in research that discusses BL, teacher readiness to teach in a BL environment, teacher self-efficacy, professional development, and the effects that teacher readiness, professional development, and technology have on student achievement outcomes. The findings outlined in the previous chapter provide evidence that significant but practically small relationships exist among these variables. In this chapter, I outline key findings from this study and their implications for researchers, practitioners, and policymakers. My research implications also address the mechanisms that I believe may be influencing my findings. I also address the limitations within this work.

Discussion of Findings and Implications

My study makes an important contribution to the research on blended learning professional development and teacher beliefs and their relationship to student performance at the elementary school level. There is minimal research, especially at the elementary level, about the academic effect of blended learning on K-12 classrooms (Li & Wang, 2022; Poirier et al., 2019; Prescott et al., 2018; Short et al., 2021). Similarly, while there is abundant research available on the implementation of one-to-one device initiatives in schools (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Harris et al., 2016; Heath, 2017; Lei & Zhao, 2008), there is little research on the effect of BL professional development and teacher readiness to teach in a blended learning environment on student achievement (Archibald et al., 2021). In this section, I will highlight my key findings, connect them to research, and identify opportunities for future research.

Research Question 1

My first research question asked, "To what extent are there differences in teacher readiness depending on whether a teacher participated in BL professional development?" My research found that teachers' readiness to teach in a BL environment and participation in BL professional development had both expected and unexpected relationships. When looking at the Reading data at the student level, I found that teachers in the sample who had no BL professional development on average had a BTRI score that was slightly lower than a teacher with two or more years of BL professional development. Additionally, the analysis of the student level data showed that, on average, teachers in the sample who had one year of BL professional development had a slightly lower BTRI score than a teacher with two or more years of BL professional development. These findings are aligned with Watson's (2006) prior research, which also found that professional development is positively related to teachers' self-efficacy, which is similar to Archibald et al.'s (2021) "readiness" construct. Archibald and colleagues (2021) also showed that the preservice teachers grew their skills and their readiness to teach in a BL environment after taking a college-level blended teaching course. The finding that reading teachers' self-perceived readiness to teach in a BL environment increased with more exposure to BL professional development suggests the need for high-quality BL professional development in this post-pandemic world in order to better prepare teachers for what is now an expectation.

In contrast, when looking at the student-level Math data, I also found significant differences in teacher readiness depending on whether a teacher participated in BL professional development; however, the relationship between the variables was unexpected. The student level Math data showed that, on average, teachers who had no BL professional development on average had a slightly higher BTRI score than teachers with two or more years of BL professional development. Additionally, the student level Math data analysis showed that, on average, teachers with one year of BL professional development on average also had a slightly higher BTRI score than teachers with two or more years of BL professional development. The finding that more BL professional development was related to lower perceptions of readiness to teach in BL environment (as measured by the BTRI) for Math teachers was unexpected and does not align with the literature discussing the relationship between professional development and teacher self-efficacy or readiness (Archibald, 2021; Watson, 2006).

One possible explanation for this unexpected result could be the lesson plan formats and expectations for teachers in Sunnyside ISD. In contrast to Math teachers in the district, Reading teachers in Sunnyside ISD were not provided with a curriculum that easily lent itself to a blended learning environment. Much of the Reading curriculum was expected to be taught in a whole group format as opposed to the blended learning formats of station rotation, small group instruction, or utilizing adaptive practice software data as part of their instruction (Staker and Horn, 2012). It is possible that few Reading teachers across the district were trying any BL model prior to this research. For that reason, the Sunnyside ISD Reading teachers could be easily compared to the preservice teachers in Archibald et al.'s (2021) study who had no experience with teaching in a BL environment prior to their BL college course. My results showed, just as the preservice teachers scored higher after exposure to a BL college course, the Sunnyside ISD Reading teachers who had little exposure to BL practices scored themselves higher on the BTRI after completing BL professional development.

On the other hand, Math teachers in Sunnyside ISD have been practicing parts of blended learning, such as small group instruction, station rotation, and utilizing adaptive practice software as part of the district Math curriculum for many years prior to this study. Therefore, it is possible that district Math teachers already had substantial knowledge of blended learning. For that reason, it is possible that teachers who did have professional development in blended learning actually had less experience and knowledge of BL than teachers who had less or even no professional development because the latter teachers may have been newer and therefore needed the additional support. Future research should examine these differences between Math and Reading teachers' self-perceived readiness levels to teach in a BL environment more carefully to determine why these differences exist. Additionally, future researchers should investigate the differences in teachers' BL beliefs contingent on how much professional development they have had to explore the possibility that more professional development might lead teachers to have more awareness of what they do not know.

Research Question 2

My second research question asked, "To what extent does student achievement vary depending on whether a teacher participated in BL professional development?" I found that student achievement was shown to significantly vary depending on whether a teacher participated in BL professional development in the Math student-level data. The average student raw score for Math teachers who had no exposure to BL professional development was 5.62 points lower than the average student raw score for Math teachers with two or more years of BL professional development. This could practically be the difference between not meeting and not meeting passing standards or the difference between meeting standards or reaching the "masters" level on the test. However, that difference shrinks substantially when we compare the students of Math teachers with one year of BL professional development to those of Math teachers with two or more years of BL professional development (only half a point difference). This finding provides additional support for Fazal et al.'s (2020) finding that increases in BL practices led to positive increases in student growth on Math assessments. Not only do my findings provide additional evidence for this relationship they also shed new light on the value of professional development specific to BL and its relationship to improved student achievement outcomes. This is one of the first studies to explore the relationship between teacher participation in BL professional development and student results on a state-required assessment. In looking at the impact of professional development, this finding also aligns with the findings of Wallace (2009) and Yoon et al. (2007), which indicated that the effects of professional development can be linked to teacher practice and subsequent student achievement outcomes (Wallace, 2009). Additionally, my findings also align to those of Borko et al. (2010), who posit that professional development is as an essential step for school improvement. Specifically, my findings indicate that professional development focused on BL is positively related to student achievement outcomes for Math instruction and has the potential to provide a more than five-point increase on a standardized state exams for students.

Research Question 3

My third research question asked, “To what extent is a teacher’s blended learning readiness related to student achievement outcomes?” I found that average BTRI scores for both Reading and Math teachers were negatively related to student raw scores. My findings of a negative relationship between teacher self-reported readiness to teach in a BL environment and student achievement outcomes stand in contrast to prior research. Studies show a link between a high level of teacher self-efficacy and increased student achievement (Archibald et al., 2021; Heath, 2017; Watson, 2006). Furthermore, it has been demonstrated that low teacher efficacy has a detrimental effect on students' academic achievement (Watson, 2006). Watson (2006) found that elementary students assigned a teacher with high technology self-efficacy followed by a teacher with low technology self-efficacy did not improve their own skills as much as students who went from having a teacher with low technology self-efficacy to a teacher with high technology self-efficacy. Thus, according to Watson's (2006) research, stronger student performance is correlated with a teacher's technology self-efficacy, yet my research provided the opposite results. Both Math and Reading teachers in Sunnyside ISD with higher BTRI scores were correlated to students with lower state assessment results. It is possible that a teacher's BL readiness does not reflect whether or how effectively they actually implemented blended learning practices in their classrooms, which could explain the unexpected finding. Future research should be designed to account for actual implementation of BL practices and to analyze if BL implementation is related to student achievement outcomes.

Research Question 4

In my final research question, I asked, "To what extent does teacher readiness to use BL mediate (or help explain) the relationship between teacher participation in BL professional development and student achievement?" My analysis of the student-level Reading data showed that BTRI scores did mediate the link between BL professional development and raw score averages such that BL professional development indirectly predicted lower than average student achievement scores through reduced average BTRI scores. This novel finding warrants further research to uncover why this relationship was found to be significant for Reading, but not for Math, and why the relationship was negative.

Implications for Practice and Policy

In this section, I discuss implications for school and district leaders as well as policymakers who develop and implement training requirements for the certification and preparation of teachers. I offer suggestions to ensure that educators believe they are prepared to teach in the BL environments that are now an expectation of all teachers. Additionally, my findings offer several key takeaways regarding the preparation and training of teachers in the K-12 setting.

My finding that Reading teachers' self-perceived readiness to teach in a BL environment increased with more exposure to BL professional development points to the need for high-quality BL professional development in this post-pandemic world. Whether teachers are ready or not, all students are coming to school with technology and educators are expected to teach in a blended format utilizing both face-to-face and online resources. Especially due to the current teacher shortage crisis, school and district leaders must do everything we can to train teachers and ensure they feel comfortable teaching in this format in order to build and retain quality teaching staff.

Furthermore, my findings indicate that professional development specifically focused on BL has a significant positive effect on student achievement outcomes for Math with a more than 5-point increase in student raw score averages for teachers who had two or more years of BL professional development compared to those with no BL professional development. The implication of this finding is that we must continue to look for or construct new professional development opportunities that not only increases teacher knowledge of BL but also enhances BL instructional practices to improve student learning. Borko et al. (2010) state, “If we want schools to offer more powerful learning opportunities for students, we must offer more powerful learning opportunities for teachers” (p. 548). My findings substantiate this claim and provide evidence that BL professional development has a direct positive impact on student achievement.

Additionally, my findings showed that teacher participation BL professional development had a larger effect on student achievement outcomes than their beliefs about their readiness to implement BL (as measured by their BTRI scores) which suggests that professional development and resulting practice is more important than beliefs. In addition to offering professional development to teachers, principals and instructional leaders should carefully monitor and support teachers to ensure that they are implementing what they have learned during BL professional development. Feedback on implementation and classroom practices should be provided to teachers in order to grow and improve their BL classroom practices.

At the state and federal level, teacher certification and graduation requirements should change to include BL practices as an essential part of all teachers' required trainings. The 2017 National Education Technology Plan recommended "develop[ing] a teaching force skilled in online and blended instruction" (U.S. Department of Education, p. 40), yet few states have made any changes to their certification requirements for teachers in this area. As Fazal et al. (2020) attest, "Schools need high-impact strategies that demonstrate strong evidence of effectiveness and student achievement" (p. 71). Since my findings demonstrate that professional development focused on training teachers in BL strategies has a direct correlation to higher student achievement outcomes, these strategies should be required training for all current and aspiring teachers.

Based on the findings in this thesis, school and district leaders must make BL professional development a top priority for the improvement of student achievement. While some district leaders may not want to embrace BL, thinking it is only a passing fad, Short et al. (2021) predict that blended teaching practices will likely continue to gain momentum in growth due in large part to the investments made in technological infrastructures of schools as well as the experience and knowledge teachers gained through the necessity of emergency remote teaching during the COVID-19 pandemic. While districts worked to ensure schools had the infrastructure needed to support large amounts of technology use and teachers gained technology knowledge and skills out of necessity, there is still a gap in skills and training in how best to combine online and face-to-face instruction in the K-12 setting (Short et al., 2021). Yet, the onus of training and preparing teachers should not lie solely with districts and individual campuses. Based on the finding in this thesis that participation in BL professional development correlates to higher student achievement outcomes, university and alternative certification programs (ACPs) should require coursework and training in BL and blended teaching practices to best prepare teachers for success in the current classroom environment across not only our state, but our country and beyond.

Limitations and Recommendations for Further Research

As with all studies, my research was limited in the several ways. First, this study was designed to be a correlational study and not a causal study. While findings indicate that more participation in BL professional development has a positive correlation to higher student achievement scores, I cannot conclude the exact cause, only the correlation. Future research should be designed to determine if there is a causal relationship between teacher participation in BL professional development and student achievement outcomes.

Another limitation of this study was the lack of randomization of teacher participants. Because teachers were clustered together by schools, there may be unobservable teacher or school differences that could account for the findings. Additionally, there was a lack of randomization of teacher participation in BL professional development. For example, teachers at better-resourced schools may have had more access to BL professional development, while at the same time students at better-resourced schools historically perform better on average than those at lesser-resourced schools even without the BL professional development. Future research should be conducted to randomize teacher participation and teacher participation in BL professional development.

In the exploration of my first research question, “To what extent are there differences in teacher readiness depending on whether a teacher participated in BL professional development?”, I uncovered two opposite relationships for Math and Reading teachers. Another limitation of my research was that I did not control for the specific BL professional development that teachers attended. Math and Reading teachers may not have had the same access or exposure to high quality BL professional development and certain types of PD may have been more effective than other types. Future research should be conducted comparing different types of BL professional development to determine the most effective BL professional development practices as measured by teacher implementation of BL practices following the professional development and student achievement scores as a result of the professional development. Additionally, BL professional development should be researched across programs, districts, and states to determine the most effective professional development practices that correlate to the most student achievement gains.

My study also revealed that Reading teachers’ self-perceived readiness to teach in a BL environment (as measured by the BTRI) increased with exposure to BL professional development while Math teachers’ perception of their readiness to teach in a BL environment (as measured by the BTRI) decreased with greater exposure to BL professional development. The disparities between Math and Reading teachers' self-perceived readiness to teach in a BL setting should be more closely investigated in future studies. Further research should explore how teachers' BL beliefs change depending on how much professional development they have had in order to explore the idea that educators with more professional development may be more aware of what they do not know.

Another limitation of this study was that I did not explore actual teacher practice or implementation of BL practices in their classrooms following participation in BL professional development. Further research should be conducted to explore the impact of BL professional development on specific BL teacher practices in the classroom. Additionally, future research should be conducted to uncover the specific practices in math classrooms that have the greatest impact on student achievement outcomes and how those practices can be utilized across subject areas. The only factor impacting students that this study explored was student achievement outcomes. Poirier et al. (2019) found additional positive outcomes of teacher implementation blended learning practices other than academic achievement in their meta-analysis, including increased self-directed learning skills, increased attitude toward the content, increased engagement with the content, less boredom, and less confusion. Therefore, additional qualitative data should be collected through classroom observations, teacher interviews, and student focus groups to understand which aspects of blended learning teachers and students find most effective.

Conclusion

Following the necessity of emergency remote teaching caused by the COVID-19 pandemic, schools and districts across the globe obtained an exponential amount of technology devices. Now that educators and students are back in brick-and-mortar buildings with the addition of all of this newly acquired technology, there is still a gap in skills and training in how best to combine online and face-to-face instruction in the K-12 setting (Archibald et al., 2021; Short et al., 2021). While a great quantity of research demonstrates the positive correlation between one-to-one technology implementation and increases in student achievement and motivation (Bebell & Kay, 2010; Cavanaugh et al., 2011; Delgado et al., 2015; Harris et al., 2016; Heath, 2017; Lei & Zhao, 2008; Short et al., 2021), the literature clearly outlines the even greater potential that specific blended teaching strategies can have on student achievement (Archibald et al., 2021; Fazal et al., 2020; Graham et al., 2019a; Graham et al., 2019b; Prescott et al., 2018; Pulham & Graham, 2018), yet little research has been conducted in the K-12 setting to determine if BL professional development and teacher readiness to teach in a BL environment have an impact on student achievement scores, especially at the elementary level. The results of this thesis, however, indicate that any amount of BL professional development has a significant, positive impact on reading teachers' readiness to teach in a BL environment. Additionally, and even more significant, Math teachers with two or more years of BL professional development saw a correlation to student scores that were more than five points higher than students who had teachers with no exposure to BL professional development. Much remains to be learned about the specific BL professional development strategies and the specific BL teacher practices that have the greatest impact on student achievement, but one strategy appears to be beneficial – BL professional development for K-12 educators.

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Appendix A

Blended Teaching Readiness Instrument

1. DISPOSITIONS

Dispositions focus on the teachers' attitudes and beliefs towards blended learning and teaching.

Rate your agreement with the following beliefs . . . (1=very low to 6=very high)

Teachers should explore new teaching strategies that combine in-person and online learning	1 2 3 4 5 6
Students will have better learning experiences when teachers and students participate in online discussions.	1 2 3 4 5 6
Students should gain experience with online collaboration.	1 2 3 4 5 6
Online activities can result in learning that would be difficult for students to achieve without technology.	1 2 3 4 5 6
Teachers who regularly use data to inform their teaching will be able to help their students more than those who don't.	1 2 3 4 5 6
Online technology is important to ensure that each student has learned the material before moving on to the next lesson.	1 2 3 4 5 6
Students should use data to guide their own progress.	1 2 3 4 5 6
Students learn better when technology allows them to adjust the speed of their own learning.	1 2 3 4 5 6

2. ONLINE INTEGRATION

Online Integration focuses on the teacher ability to make and implement decisions related to selecting when and how to effectively combine online and in-person learning as part of core instruction.

Rate your ability to do the following… (1=very low to 6=very high)

Decide when it is better to interact with students in-person versus online.	1 2 3 4 5 6
Develop instructions for how students should find help when they are using	1 2 3 4 5 6

online technology.	
Decide when to use computer-based assessments (e.g., online examines, digital projects).	1 2 3 4 5 6
Find ways to combine online and in-person activities that help students control their own learning (e.g., when, where and how they learn).	1 2 3 4 5 6
Evaluate the strengths and limitations of specific online activities for your students.	1 2 3 4 5 6
Provide clear instructions for moving between online and in-person activities.	1 2 3 4 5 6
Develop guidelines to help students use their time online well.	1 2 3 4 5 6
Provide clear instructions for how students should use devices (e.g., laptops, tablets, headphones).	1 2 3 4 5 6
Help students manage their online accounts and passwords.	1 2 3 4 5 6
Decide if using online activities will improve student learning.	1 2 3 4 5 6

3. DATA PRACTICES

Data Practices focus on the teacher's ability to use digital tools to monitor student activity and performance in order to make informed choices about interventions to help all students progress.

Rate your ability to do the following… (1=very low to 6=very high)

Help students see their learning progress using online and offline assessment results.	1 2 3 4 5 6
Use technology that organizes and displays student assessment results so you can make decisions about instruction.	1 2 3 4 5 6
Evaluate the effectiveness of instruction for students with disabilities using online and offline assessment results.	1 2 3 4 5 6
See patterns in small group and whole-class learning using online and offline assessment results.	1 2 3 4 5 6
Improve student learning experiences by using technology to collect information about students (e.g., interests, background, learning preferences).	1 2 3 4 5 6

Check student progress by using online assessments frequently.	1 2 3 4 5 6
Decide which groups of individual students need additional help using online assessment results.	1 2 3 4 5 6
Use technology tools to check student participation in online activities (e.g., attendance, logins, time on each activity).	1 2 3 4 5 6

4. PERSONALIZING INSTRUCTION

Personalizing Instruction focuses on the teacher ability to implement a learning environment that allows for student customization of goals, pacing, and/or learning path.

Rate your ability to do the following… (1=very low to 6=very high)

Use online tools to make sure that students learn material before moving on to the next lesson.	1 2 3 4 5 6
Use technology that lets students choose how they show what they have learned.	1 2 3 4 5 6
Use educational software that adapts how each student progresses through lesson materials.	1 2 3 4 5 6
Use technology that gives students some choice in where they learn.	1 2 3 4 5 6
Use technology that lets each of your students adjust the speed of their learning.	1 2 3 4 5 6
Develop a set of online and offline resources to give students choice in how they learn.	1 2 3 4 5 6
Combine individual or small group instruction with educational software to help each student succeed.	1 2 3 4 5 6
Use technology that helps students see their progress towards goals that they have set.	1 2 3 4 5 6

5. ONLINE INTERACTIONS

Online Interaction focuses on the teacher ability to facilitate online interactions with and between students.

Rate your ability to do the following… (1=very low to 6=very high)

Communicate online with students while still maintaining professional student-teacher relationships.	1 2 3 4 5 6
Use online communication to help strengthen students' feeling that they belong to the class.	1 2 3 4 5 6
Give quick online feedback to students in a variety of ways using text, audio, or video.	1 2 3 4 5 6
Help students learn to interact well in online discussions.	1 2 3 4 5 6
Teach students how to communicate online respectfully.	1 2 3 4 5 6
Help students to interact well with guest presenters through video conferencing.	1 2 3 4 5 6
Give students a chance to help each other using online technology (both inside and outside of class).	1 2 3 4 5 6
Help students work well in small groups both online and in-person.	1 2 3 4 5 6