2016

A Comparison of the Academic Achievement of English Learners and Non-English Learners in Digital and Non-Digital Learning Environments

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A COMPARISON OF THE ACADEMIC ACHIEVEMENT OF ENGLISH LEARNERS AND NON-ENGLISH LEARNERS IN DIGITAL AND NON-DIGITAL LEARNING ENVIRONMENTS

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Education
in the School of Teaching, Learning, and Leadership
College of Education and Human Performance
at the University of Central Florida
Orlando, Florida

Summer Term
2016

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ABSTRACT

The purpose of this study was to identify the extent to which learning in a digital school environment impacts the reading and mathematics achievement of English learners (ELs) in elementary and secondary school settings. In addition, this study intended to determine the extent, if any, that learning in a digital school environment narrows the achievement gap in reading and mathematics between ELs and their non-EL counterparts in elementary and secondary schools. Based on data collected from the first year of a 1:1 digital pilot implementation in a large urban school district in Florida, the results of this study identified grade levels and school levels where the 2014 Florida Comprehensive Achievement Test (FCAT) 2.0 Reading and Mathematics Developmental Scale Scores (DSS) of ELs in digital school settings were significantly higher than in non-digital school settings. In addition, the study yielded some statistically significant differences in the learning gains in DSS of the 2014 FCAT 2.0 Reading and Mathematics of ELs and non-ELs in digital school settings. These findings may be used to inform the planning of technology integration, academic interventions, and teacher preparation that focuses on the academic improvement of ELs.

ACKNOWLEDGMENTS

I dedicate this dissertation to the memory of my mother, Elena, who used her faith, generosity, and open heart to overcome obstacles and ensure that I received a quality education. You are the source of my inspiration, strength, and persistence.

Above all, I thank my wife, Melody, and our family, for supporting me through all of life's challenges. This success is ours.

Throughout history, teachers have taken on the responsibility of instilling self-discovery and a love for learning in their students. By believing in them, their students learn to believe in themselves. Great teachers set high expectations and empower their students to exceed these expectations. Teachers are humble, reliable, compassionate, and selfless. They instill passion, confidence, and self-belief in their students. A teacher's contributions cannot be quantified. The positive impression that a teacher leaves is everlasting. Thank you, Dr. Rosemarye Taylor, for serving as my committee chair and guiding me through this journey. You are a teacher in every sense of the word.

I would like to thank my committee members, Dr. Lee Baldwin, Dr. Joyce Nutta, and Dr. Walter Doherty for their insight and guidance. I am also eternally appreciative of the kindness and encouragement that I received from my fellow cohort members.

Throughout my career, I have been the recipient of exceptional mentoring from many outstanding public school leaders and colleagues. I have also been blessed with the opportunity to work with exemplary faculty and staff members. Their positive impact has increased my desire to elevate others through my leadership.

Lastly, I would like to thank all of the children that I have been blessed to encounter throughout my career in education. I have learned so much from serving you.

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Introduction

National demographic data indicate that English learners (ELs) represent the fastest-growing student population in the United States, with significant growth in grades 6 through 12 (Nutta, Mohktari & Strebel, 2012). During the 2007-2008 school year, ELs represented 10.6 percent of the kindergarten through grade 12 (K-12) public school enrollment, or more than 5.3 million students (Nutta, Mohktari & Strebel, 2012). National performance disparities in academic achievement between ELs and non-ELs in the United States are thoroughly documented by the National Assessment of Educational Progress (Lopez, 2009). For example, the 2005 NAEP results indicate that a 29 percentage point performance gap in mathematics between ELs and non-ELs in grades 6-8 and a 40 percentage point performance gap in reading between ELs and non-ELs in grades 6-8 (NCES, 2005).

Several studies have explored the efficacy of various forms of interactive technology on student learning outcomes (Lopez, 2009). These interactive technologies include wireless laptops (Barak, Lipson & Lerman, 2006; Varvel & Thurston, 2002); digital response devices (Zha, Kelly, MeeAeng & Fitzgerald, 2006); and web-based instructional programs (Lopez, 2009). It has been asserted that the use of interactive classroom technology in digital learning environments promotes multimedia learning, fosters social interaction among students, and increases the frequency and promptness of specific feedback provided to students (Lopez, 2009; Magana & Marzano, 2014). Multimedia learning, increased social interaction, and specific feedback are instructional strategies that have been associated with effective pedagogy for English learners (Wright, 2010; Freeman, 2012; Taylor, Watson, & Nutta, 2014). Because digital learning facilitates the use of these instructional strategies, digital learning may positively impact the academic growth of English learners.

Problem Statement

The rapid growth of the English learner (EL) population and the achievement gap that exists between ELs and non-ELs continue to be an area of national concern among contemporary educational leaders (San Miguel, 2013; Wright, 2010). Efforts to improve the English reading achievement of English learners have included the implementation of academic interventions and the use of alternate instructional strategies and materials. One type of intervention is increased emphasis on the daily use of digital technology, which has been explored as a method of improving pedagogy. The use of digital learning has been correlated with improved student achievement (Lee, Waxman, Wul, Michko, & Lin, 2011; Liao, Chang & Chen, 2008; Tamim, Bernard, Borokhovski, Abram,i & Schmid, 2011). More specifically, digital learning has demonstrated a moderate effect on reading achievement (Moran, Ferdig, Pearson, Warddrop, & Blomeyer, 2008). It has been theorized that digital learning has a positive impact on the academic success of English learners (Lopez, 2009; Miller & Glover, 2002; Freeman, 2012). Consequently, some schools have digital learning environments containing interactive technology (interactive white boards, devices, digital versions of textbooks, web-based programs) to enhance the instructional delivery for ELs. The problem to be studied is the academic achievement gap that exists between English learners and non-English learners. There is a lack of research on the effect of digital learning on the academic achievement of English learners.

Purpose Statement

The purpose of this study is to identify the extent to which learning in a digital school environment impacts the reading and mathematics achievement of English learners in elementary and secondary school settings. In addition, this study intends to determine the extent, if any, that learning in a digital school environment narrows the achievement gap in reading and mathematics between ELs and their non-EL counterparts in elementary and secondary schools.

Significance of the Study

There is a fundamental question concerning whether or not the use of interactive classroom technology adds value and creates beneficial student outcomes for ELs that otherwise would not be there (Wright, 2010). While much attention has been focused on implementing digital programs and using them in settings that serve ELs, there is a lack of research base and framework for evaluating the effectiveness of digital learning (Wright, 2010; Chapelle, 2001). A limited amount of studies have associated digital learning with improved EL reading achievement (Lopez, 2009; Bhatti, 2013) and improved EL mathematics achievement (Freeman, 2012; Li & Ma, 2010; Lopez, 2009). There is a need for additional research to determine to what extent, if any, that digital learning affects the academic growth of ELs and decreases the gap in reading and mathematics achievement between ELs and their non-EL counterparts.

Definition of Terms

In order for the purpose of this study to be clear, the operational definition of the term digital is defined as a school where students are (a) immersed in the use of interactive whiteboard technology; and (b) digital versions of textbooks and digital devices are issued to students to be used as their primary instructional materials in all classrooms and at home. Conversely, a non-digital school will be defined as a school where paper textbooks, workbooks and notebooks are the primary instructional materials used by students in all classrooms, even though digital tools maybe used some learning experiences.

The following is a definition of terms is used to clarify the terminology to be used throughout this study:

Computer-assisted Instruction: Computer-assisted instruction (CAI) involves applying computer hardware and software to a teaching-and learning environment (Bhatti, 2013; Butler-Pascoe, 2011; Chun, 2001). CAI provides individualized instruction which matches with the student's level of understanding and pace of learning.

Computer-assisted Language Learning: Computer-assisted language learning (CALL) is a term used to describe the use of computer software and online programs to teach foreign languages (Felix, 2005). CALL can be used as a supplementary resource in a foreign language class or as the primary instructional tool in an independent learning setting.

Developmental Scale Score (DSS): A Developmental Scale Score (DSS) is a vertical scale that allows for comparison of student academic progress over time in consecutive grades for FCAT 2.0 Reading and FCAT 2.0 Mathematics (Florida Department of Education, 2014).

Digital School/Digital School Environment: For the purposes of this study, a digital school/digital school environment will be defined as a school where: (a) students are immersed in the use of interactive whiteboard technology; and (b) digital versions of textbooks and school-issued devices as their primary instructional materials in all classrooms and throughout the school day and at home.

English as a Second Language (ESL): ESL (English as a Second Language) refers to the teaching of English to students with different native or home languages using specially designed programs or techniques (Wright, 2010). ESL is an English-only instructional model, and most programs attempt to develop English skills and academic skills simultaneously. The purpose of ESL is "to enable ELs to master the skills of listening, speaking, reading, and writing in English to the extent that they are able to use the English language appropriately for communicative purposes and to achieve success in mainstream classes taught in English" (Wright, 2010, p.82).

English Learners: The No Child Left Behind Act of 2001 (NCLB) equates the term English learner with limited English proficiency and describes them as "students aged three through twenty-one, who are enrolled or preparing to enroll in an elementary or secondary school and whose difficulties in speaking, reading, writing, or understanding English may affect their ability to: (a) participate fully in society; (b) succeed in classrooms where the language of instruction is English; and (c) to meet state proficiency levels on state assessments". English learners may include immigrants and migrants as well as U.S. born citizens whose language proficiency is affected by an environment in which a language other than English is spoken at home. English learners (ELs) typically require specialized or modified instruction in both English language arts and in their other academic courses.

Florida Comprehensive Assessment Test 2.0 (FCAT 2.0): The Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) is a standardized measurement of student achievement based on the Next Generation Sunshine State Standards (NGSSS) in reading, mathematics, science, and writing (Florida Department of Education, 2014).

Interactive Classroom Technology: The use of interactive classroom technology creates interactivity between an educator and their students (Freeman, 2012). Educators use this technology to engage learners in content, to check the progression of knowledge in specific subjects, and to provide feedback to students (Freeman, 2012; Lee, Waxman, Wul, Michko &

Lin, 2011; Hattie, 2009). The following are forms of interactive classroom technology: interactive whiteboards, polling and surveying applications, web links, online programs, video conferencing, social media, and online collaboration sites.

Interactive Whiteboards: An interactive whiteboard (IWB) is a touch-sensitive device that allows users to interact with digital materials (Smith, Hardman & Higgins, 2006). This device connects a computer to a projector and shows resources on the surface of the board. A user can control an IWB by using a pen, finger, or devices on a computer such as a mouse or keyboard.

Learning Gains: The learning gains in reading and mathematics achievement of the ELs and non-ELs in this study were measured by the increase in performance from the 2013 to the 2014 FCAT 2.0 reading and mathematics examinations.

One-to-One Program: The term one-to-one is applied to programs that provide all students in a school, district, or state with their own laptop, netbook, tablet computer, or other mobile-computing device.

Sheltered Instruction: Sheltered instruction refers to settings in which English learners are "sheltered" together to learn English and academic content simultaneously while not in the presence of their non-EL counterparts (Wolfe, 2009). Teachers are specially trained in sheltered instructional techniques that may require a distinct licensure or endorsement. There are many different sheltered models.

Students with Interrupted Formal Education (SIFE): Some ELs are recently arrived immigrants or refugees who may have experienced war, social turmoil, persecution, and significant periods of educational disruption. In some extreme cases, for example, adolescent-age students may have had little or no formal schooling, and they may suffer from medical or psychological conditions related to their traumatic experiences (e.g. war, natural disasters). The term students with interrupted formal education, or SIFE, is often used in reference to this subpopulation of English learners (DeCapua, Smathers &Tang, 2007).

Theoretical Framework

English Learners

Educators use a number of terms when referring to English language learners, including English learner (EL), limited English proficient student (LEPs), non-native English speaker, language minority student, and bilingual student. With so many terms, there can be confusion in meaning. Some states and school districts use these terms interchangeably, but some states and school districts use these terms to distinguish different classifications of English language learners. The commonality is that all of these terms refer to a group of students who are not English proficient as defined in specific states or school districts. However, it is important for both the reader and the researcher to be aware of how the term is used in a specific educational context.

In general terms, English learners are students who do not have the English language ability needed to participate fully in American society or achieve their full academic potential in schools and learning environments in which instruction is delivered largely or entirely in English (Wright, 2010). In most cases, students are identified as ELs after they complete a formal assessment of their English literacy. These English literacy assessments typically measure reading, writing, speaking and listening comprehension. When these assessments demonstrate significant deficiencies, English learners are typically enrolled in either dual-language (bilingual) classes or placed in English as a second language (ESOL) programs.

English learners may also be students who were formerly classified as limited English proficient, but who have since acquired English language abilities that have allowed them to transition into regular academic classes taught in English (Wright, 2010). While these students may have achieved a level of English literacy that allows them to participate in an English-only instructional setting, some may still struggle with academic language.

English learners are not only the fastest-growing segment of the school-aged population in the United States, but they are also a tremendously diverse group representing numerous languages, cultures, ethnicities, nationalities, and socioeconomic backgrounds. (San Miguel Jr., 2013). While many ELs were born in the United States, their parents are often immigrants who speak their native language at home. In addition, ELs may face a variety of challenges that could adversely affect their learning progress and academic achievement, such as poverty, familial transiency, or non-citizenship status (DeCapua, Smathers, & Tang, 2007). Some ELs are also recently arrived immigrants or refugees who may have experienced war, social turmoil, persecution, and significant periods of educational disruption. In some extreme cases, for example, adolescent-age students may have had little or no formal schooling, and they may suffer from medical or psychological conditions related to their traumatic experiences (e.g. war, natural disasters). The term students with interrupted formal education, or SIFE, is often used in reference to this subpopulation of English learners (DeCapua, Smathers, & Tang, 2007).

Digital Learning

The use of digital learning tools has been linked with improved student achievement (Lee, et al., 2011; Liao, Chang & Chen, 2008; Tamim, et al., 2011). More specifically, digital learning has demonstrated moderate effects on both reading achievement (Moran, et al., 2008) and mathematics achievement (Li & Ma, 2010). Furthermore, a meta-analysis of 76 studies (Hattie, 2009) demonstrated that computer-assisted instruction had a positive effect size of d=0.37. In addition, Hattie (2009) offered the following summary of the major uses of computers in classrooms and their corresponding effect sizes: (a) online tutorials (d=0.71); (b) drill and practice (d=0.34) and; (c) simulations (d=0.34).

Hattie (2009) asserted that providing effective feedback to students has been found to have a high positive effect size on student learning (d=0.73). An additional benefit of computer-assisted instruction is that “they respond to all students, despite who they are—male or female, Black or White, slow or fast” (Hattie, 2009, p.227). The private nature of computer feedback can be potentially less threatening to students. In addition, the instantaneous assessment results that students may receive via digital learning tools provide students with feedback more promptly, enabling students to reflect on their learning and examine their errors in reasoning more effectively (Magana & Marzano, 2013).

It has been theorized that digital learning has a positive impact on the academic success of English learners (Lopez, 2009; Miller & Glover, 2002; Freeman, 2012). When teachers effectively integrate technology into the curriculum, English learners improve their language acquisition rates (DelliCarpini, 2012). Emerging technologies and Computer-Assisted Language Learning (CALL) used with ELs are "ideal for fostering reading and writing skills in the target language" (Johns & Torrez, 2001, p. 11). DelliCarpini (2012) suggests that the use of technology with ELs can develop language, literacy, and technological literacy skills as well as help teachers differentiate content and maintain high levels of engagement. Through this method, ELs have full access to the curriculum so they are able to reach the same goals as mainstream learners.

Computer-assisted language learning (CALL) is a term used to describe the use of computer software and online programs to teach foreign languages (Felix, 2005). CALL can be used as a supplementary resource in a foreign language class or as the primary instructional tool in an independent learning setting. Specifically related to the success of CALL, a meta-analysis of 52 studies was conducted (Felix, 2005) and the general findings were that there are positive effects for ELs in terms of vocabulary development, reading, and writing and that generally, student perceptions of CALL are positive if the technologies are "stable and well supported" (Felix, 2005, p.16). Some of the negative feedback associated with CALL that was noted in the study was the lack of sufficient training in computer literacy for both students and teachers. These findings coincide with the aforementioned meta-analysis of computer-assisted instruction (Hattie, 2009) that suggested that the use of computers is more effective when there is teacher pre-training in the use of computers as a teaching and learning tool. Therefore, it can be asserted that when consistently accompanied by a sufficient amount of professional development and support, CALL implementation can yield positive English learning outcomes.

An interactive whiteboard (IWB) is a touch-sensitive device that allows users to interact with digital materials (Smith, Hardman & Higgins, 2006). This device connects a computer to a projector and shows resources on the surface of the board. A user can control an IWB by using a pen, finger or devices on the computer such as a mouse or keyboard. One of the benefits of a teacher's use of an IWB is "the ability to move quickly between varieties of electronic resources, with greater speed in comparison to non-electronic resources, with opportunities to edit, record and retrieve data" (Hur & Suh, 2012, p. 323). Several studies indicate the benefits of interactive whiteboards for teaching and learning, such as promoting learner motivation, supporting the whole class while teaching, creating effective and engaging presentations, and making it easier to interrelate tests, images and videos (Higgins et al., 2007; Wall, Higgins & Smith, 2005). Smith and colleagues (2006) reported that "IWBs motivate pupils to offer answers to teachers' questions because of the strong visual and conceptual appeal of the information that is displayed and because of the way they allow pupils to physically interact with the board in search of those answers" (p. 445).

Digital Learning Tools and English Learners

Lopez (2009) asserted that the use of interactive technologies enhances EL student engagement, and therefore, promotes improved achievement in reading and mathematics. These interactive technologies included interactive whiteboards, wireless laptops, electronic video games and web-based programs. In Lopez's study, ELs who received instruction in a digital environment outperformed their EL counterparts in non-digital environments on their corresponding state assessments in reading and mathematics. Lopez attributed his findings to the following reasons: (a) Student learning builds on previous experiences. Teachers can use interactive whiteboards to link students' prior experience to new learning, thereby facilitating the acquisition of new knowledge; (b) Learning takes place in a social setting. Interactive whiteboard use promotes group interactions with the content, making lessons more enjoyable and interesting, resulting in improved attention and engagement; and (c) Feedback and frequent evaluation of learning enhances skill development. By using interactive whiteboards, teachers can more frequently include assessments in their lessons and activities.

There are a wide variety of instructional models and academic-support strategies for English language learning used throughout the United States. Three dominant forms identified by Wolfe (2000) are dual-language education, English as a second language (ESL), and sheltered instruction.

Dual-language education, formerly called bilingual education, refers to instructional programs that are taught in two languages. While schools and teachers may use a wide variety of dual-language strategies, each with its own specific instructional goals, the programs are typically designed to develop English fluency, content knowledge and academic language simultaneously.

ESL (English as a Second Language) refers to the teaching of English to students with different native or home languages using specially designed programs and techniques. English as a second language is an English-only instructional model, and most programs attempt to develop English skills and academic knowledge simultaneously. It is also known as English for speakers of other languages (ESOL), English as an additional language (EAL), and English as a foreign language (EFL).

Sheltered instruction refers to programs in which English-language learners are "sheltered" together to learn English and academic content simultaneously, either within a regular school or in a separate academy or building. Teachers are specially trained in sheltered instructional techniques that may require a distinct licensure, and there are many different sheltered models and instructional variations.

There are numerous techniques and strategies that teachers can use to increase the effectiveness of their EL instruction. Within this variation are commonly accepted best practices that overlap into both ESL and sheltered EL classroom settings. These best practices include new vocabulary development, increased interaction among students, and creating a positive learning environment (Wright, 2013).

One way to help English learners acquire new academic English language is through the use of visual and audio aids (Hickman, Pollard-Durodola, & Vaughn, 2004). Digital learning can increase a teacher's ability to create and incorporate audio-visual aids more frequently. Providing ELs with multi-modal exposure to words or sentences promotes confidence in word meaning, contextual appropriateness and pronunciation of words (Hur & Suh, 2012). The ability to access Internet resources and project videos and images can effectively support language development for ELs by allowing them to see relevant pictures (Hur & Suh, 2012). ELs may already know words in their native language, but not know how to pronounce them. Showing digital images can allow ELs to link their native language to English (Hur & Suh, 2012).

In addition to understanding the information that is communicated to them, English learners need the opportunity to practice communicating as well (Nutta, Strebel, Mokhtari, Mihai, & Crevecoeur-Bryant, 2014). An effective way to promote communication practice is to provide ELs with frequent opportunities to express their ideas and to interact with one another in small groups (Taylor, Watson, & Nutta, 2014). Digital tools can provide many opportunities for students to interact with fellow classmates or real-life audiences outside of their own classroom, city, or even country. Students can interact with classmates by working on technology activities together, such as working on a software program in pairs, writing and revising a story with a partner, or collaborating on a shared digital document (Magana & Marzano, 2013). In all of these instances, students can benefit from one another's knowledge, practice their verbal skills conversing with one another (whether about how to use the technology or the instructional content itself), and practice listening comprehension by listening and responding to their partners (Wright, 2010). Social media sites, when monitored appropriately, also provide a productive platform for English language learners and other classmates to communicate and interact with one another (Magana & Marzano, 2013).

Research Questions

The literature review revealed several areas that need to be addressed related to the academic growth of English learners and the use of digital tools. There is a lack of research the addresses whether or not digital learning adds value and creates beneficial outcomes for ELs. Therefore, this study will address the following four research questions:

1. What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners in digital and English learners in non-digital elementary and secondary school settings?
2. What is the difference, if any, between the Developmental Scale Scores (DSS) of the 2014 Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) Mathematics of English learners in digital and English learners in non-digital elementary and secondary school settings?
3. What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?
4. What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?

Table 1

Research Questions, Variables, and Data Sources

Research Questions	Variables	Data Sources
1. What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners in digital and English learners in non-digital elementary and secondary school settings?	Dependent: FCAT 2.0 Reading DSS Independent: Digital learning implementation	2014 FCAT 2.0 Reading Developmental Scale Scores for grades 3-10.
2. What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners in digital and English learners in non-digital elementary and secondary school settings?	Dependent: FCAT 2.0 Mathematics DSS Independent: Digital learning implementation	2014 FCAT 2.0 Mathematics Developmental Scale Scores for grades 3-8.
3. What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?	Dependent: FCAT 2.0 Reading DSS Independent: Digital learning implementation	2014 FCAT 2.0 Reading learning gains in Developmental Scale Scores for grades 3-10.
4. What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?	Dependent: FCAT 2.0 Mathematics DSS Independent: Digital learning implementation	2014 FCAT 2.0 Mathematics learning gains in Developmental Scale Scores for grades 3-8.

Methodology

Context of the Study

To reduce the number of variables, this comparative study will focus on the academic growth of English learners enrolled in the digital pilot program of one large urban school district (LUSD) during the 2013-2014 school year. All of the schools within LUSD are supposed to follow the same curriculum and order of instruction, have access to the same teacher resources via a shared instructional management system, administer common benchmark examinations and school district and state assessments, and use the same evaluation tools for teacher and school leader performance.

At the time of this study, LUSD was the 10th largest school district in the United States and the 4th largest school district in the state of Florida. Within this large urban public school district, the sample of digital learners was drawn from seven schools participating in the first year of a digital pilot program during the 2014-2014 school year. At the time of this study, the district was comprised of 123 elementary schools, 35 middle schools, and 19 high schools with a total student population of 187,000 students. Among these seven digital pilot schools was one high school (grades 9-12), three middle schools (grades 6-8), and three elementary schools (grades 3-5).

Data Collection

This study will utilize archived data maintained by LUSD and the Florida Department of Education. The required data will be obtained from the Assessment, Research, and Accountability (ARA) department of LUSD and the Florida Department of Education.

Participants

For this study, one group of participants will be derived from English learners who attended the digital pilot elementary and secondary schools in LUSD took the FCAT 2.0 Reading and FCAT 2.0 Mathematics during the 2013-2014 school year. A second group of participants will be derived from English learners who attended matched schools that were comparable non-digital elementary and secondary non-digital schools in LUSD and took the FCAT 2.0 Reading and FCAT 2.0 Mathematics during the 2013-2014 school year. The demographics that were considered in determining comparable matched digital and non-digital schools were: (a) overall student enrollment; (b) percentage of students who qualify for free-and-reduced lunch; (c) percentage of English learners enrolled; and (d) total number of English learners enrolled.

Table 2

Demographics of Matched Digital and Non-Digital Elementary Schools

Name of School	Total Student Population	Number of ELs	Number of non-ELs	Percentage of ELs	Percentage of Economically Disadvantaged
Digital Elementary 1	778	252	526	32%	80%
Non-Digital Elementary 1	825	265	560	32%	77%
Digital Elementary 2	987	398	589	40%	100%
Non-Digital Elementary 2	760	321	439	42%	100%
Digital Elementary 3	620	159	461	26%	100%
Non-Digital Elementary 3	659	189	470	29%	100%
Totals	4629	1584	3045	34%	93%

Table 3

Demographics of Matched Digital and Non-Digital Middle Schools

Name of School	Total Student Population	Number of ELs	Number of non-ELs	Percentage of ELs	Percentage of Economically Disadvantaged
Digital Middle 1	1259	121	1138	10%	56%
Non-Digital Middle 1	1163	113	1050	10%	60%
Digital Middle 2	1036	338	698	33%	83%
Non-Digital Middle 2	1070	355	715	33%	83%
Digital Middle 3	1081	198	883	18%	48%
Non-Digital Middle 3	1189	200	989	17%	48%
Totals	6798	1325	5473	19%	63%

Table 4

Demographics of Matched Digital and Non-Digital High Schools

Name of School	Total Student Population	Number of ELs	Number of non-ELs	Percentage of ELs	Percentage of Economically Disadvantaged
Digital High 1	2373	266	2107	11%	60%
Non-Digital High 1	1831	157	1674	9%	57%
Totals	4204	423	3781	10%	59%

Data Analysis

For Research Questions 1-2, the 2014 Grade FCAT 2.0 Reading Developmental Scale Scores and FCAT 2.0 Mathematics Developmental Scale Scores of English learners in digital pilot schools in LUSD and English learners in non-digital schools in LUSD will be compared using an independent samples *t*-test to determine the extent to which the scores of the groups differed on each assessment.

For Research Questions 3-4, the learning gains in reading and mathematics of ELs and non-ELs in digital school environments based on their performance on the 2013-2014 FCAT 2.0 Reading and 2013-2014 FCAT 2.0 Mathematics will be compared using an analysis of co-variance (ANCOVA). The learning gains in reading and mathematics achievement of the ELs and non-ELs in this study were measured by the increase in performance as indicated by the Developmental Scale Scores (DSS) from the 2013 to the 2014 FCAT 2.0 reading and mathematics examinations.

Limitations

Many variables outside the control of the researcher could impact the student achievement information in the study and be seen as limitations:

1. This study was conducted during the first year of the target school district's digital curriculum implementation. The teachers were still undergoing some initial professional learning during the time of this study.
2. Due to varying levels of teacher familiarity and teacher perception of digital learning, there may be varying levels of consistency and fidelity with the use of the digital resources.

3. There is a variation in teacher knowledge and experience working with ELs among the schools participating in the study.
4. There is a diverse level of student familiarity with using digital tools that can affect student motivation and student performance.
5. These variables may include: first-year implementation of digital curriculum, variation in teacher knowledge and experience working with ELs, teacher familiarity with digital tools, student perceptions of digital learning,

Delimitations

One delimitation of this study is that the data collected will only come from one large public school district. Therefore, the generalization of results from this study to other school districts is limited.

Assumptions

This study included the following assumptions: (a) the data collected accurately measured the growth in reading and mathematics achievement of the participants; (b) the digital curriculum implementation was consistent in the seven digital pilot schools involved in the study.

Organization of the Study

This research study is presented in five chapters. Chapter I includes the background of the study, statement of the problem, purpose of the study, definition of terms, assumptions, limitations, delimitations, theoretical framework, and research questions, methodology, and significance of the study.

Chapter II presents a review of the literature, which includes a discussion of English learners, digital learning and using digital tools to improve EL learning outcomes.

Chapter III describes the methodology used for this research study. It includes the selection of participants, instrumentation, data collection, and data analysis procedures.

Chapter IV presents the study's findings, including demographic information, testing the research questions, factor analysis, and the results of the data analyses of the research questions.

Chapter V provides a summary of the entire study, discussion of the findings, implications of the findings for theory and practice, recommendations for further research, and conclusions.

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction

The English learner (EL) population, as well as the diversity that exists among ELs enrolled in U.S. public schools, continues to increase. In addition, the achievement gap that exists between ELs and non-ELs continues to be an area of national concern among contemporary educational leaders (San Miguel, 2013; Wright, 2010). Consequently, improvement efforts in U.S. public schools have included attempts to develop effective pedagogy and academic interventions to meet the diverse needs of ELs. Among these efforts is an increased emphasis on the daily use of digital tools.

The use of digital learning has been correlated with improved student achievement in reading and mathematics (Lee, Waxman, Wul, Michko, & Lin, 2011; Liao, Chang & Chen, 2008; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). It has been theorized that digital learning has a positive impact on the reading and mathematics achievement of ELs (Lopez, 2009; Miller & Glover, 2002; Freeman, 2012). As a result, some schools have immersed ELs in digital learning environments that utilize interactive technology (interactive white boards, devices, digital versions of textbooks, web-based programs) to enhance the instructional delivery for ELs.

With the assistance of the library resources at the University of Central Florida, a database search was conducted. Several databases were researched that include ERIC- EBSCO HOST, JSTOR, PROQUEST, Linguistics and Language, Behavior Abstracts, Dissertation and Thesis Full Text, and Web of Science. The key terminology used to search the databases were digital learning, computer assisted instruction, computer assisted language learning, educational technology, technology uses in education, language fluency, language proficiency, educational learning strategies, second language learning, second language instruction, foreign language instruction, English as a second language, achievement gap, interactive white boards, academic vocabulary, and academic English. Literature was reviewed from online or print journals such as *Language Learning & Technology, Computer Assisted Language Learning, Computers and Education, Learning, Media and Technology, Educational Technology & Society, Journal of Literary Research, Journal of Latinos and Education, Review of Educational Research, TESOL Quarterly,* and *the English Language Teaching Forum.* Several books written by experts in the field of academia, digital learning, English learner pedagogy, and second language acquisition have also been incorporated representing a culmination of the searches conducted.

The literature review that follows is organized into five sections.   Section one offers a description of the EL population and the achievement gap that exists between ELs and non-ELs. Section two discusses the instructional needs of ELs and effective EL pedagogy. Section three provides a discussion of digital learning environments and their impact on reading and mathematics standardized test achievement, and the implications that digital initiatives have for professional development. Section four, the last section, analyzes 1) the need for integrating digital learning into EL instruction, 2) cultural considerations for digital learning and ELs, 3) the impact of digital learning on EL reading and mathematics achievement and, 4) implications for the professional learning of teachers who serve ELs in digital school settings.

English Learners

Characteristics of English Learners

In general terms, English learners are students who do not have the English language ability needed to participate fully in American society or achieve their full academic potential in schools and learning environments in which instruction is delivered largely or entirely in English

(Wright, 2010). In most cases, students are identified as ELs after they complete a formal assessment of their English literacy. These assessments typically measure reading, writing, speaking and listening comprehension. Based upon their levels of proficiency on these assessments, English learners are frequently enrolled in either dual-language (bilingual) classes or placed in English as a second language (ESOL) programs as a result.

The No Child Left Behind Act of 2001 (NCLB) equates the term English learner with limited English proficiency and describes them as "students aged three through twenty-one, who are enrolled or preparing to enroll in an elementary or secondary school and whose difficulties in speaking, reading, writing, or understanding English may affect their ability to: (a) participate fully in society; (b) succeed in classrooms where the language of instruction is English; and (c) to meet state proficiency levels on state assessments". English learners may include immigrants and migrants as well as U.S. born citizens whose language proficiency is affected by an environment in which a language other than English is spoken at home. English learners (ELs) typically require specialized or modified instruction in both English language arts and in their other academic courses.

ELs consist of the fastest growing percentage of the overall student population in U.S. public schools (NCELA, 2009). According to recent statistics released by the United States Department of Education in 2010, there are approximately 4.7 English learners in U.S. schools. From 1979 to 2003, the total number of ELs increased by 124 %, while other student populations increased by 19 % (National Center for Education Statistics, 2004). Additionally, the EL population is spread out over several states in the nation (Flynn and Hill 2005). Spanish is the native language of approximately the majority of the English learners in the United States, but some districts have students who represent more than 100 different language groups (NCELA, 2009). In order to address the instructional needs of ELs, there needs to be a deeper understanding of their diverse backgrounds. ELs possess a wide variety of educational and cultural experiences as well as linguistic differences (Echeverria, Vogt & Short, 2008). These differences have implications for instruction, assessment, and program designs for ELs.

English Learner Diversity

All ELs are not alike. They enter public schools in the United States with a wide range of English and native language proficiencies. ELs also vary in the amount of subject matter knowledge that they have. ELs possess a wide variety of educational and cultural experiences as well as linguistic differences (Echeverria, Vogt, & Short, 2008). Approximately 180 native languages are spoken among ELs in the U.S. (Echeverria, Vogt, & Short, 2008). There is also diversity in the educational backgrounds, socioeconomic status, age of arrival, and parents' education levels and proficiency in English. All of these factors impact the needs of ELs, and consequently, affect the instructional decisions that need to be made to ensure their academic success. In order to address the instructional needs of ELs, there needs to be a deeper understanding of their diverse backgrounds.

Some ELs are immigrants. There is a variety, however, in their academic backgrounds. Some immigrant ELs had strong academic backgrounds in their native countries, are literate in their native languages, have been exposed to grade level mathematics, history, and science instruction, and may have already begun studying a second language. For these students, the key to their success is English language development (Echeverria, Vogt, & Short, 2008). Gaining proficiency in English enables them to transfer their previous knowledge into coursework taken in the United States (Genesee, Lindholm-Leary, Saunders, & Christian, 2006). Among all of the EL subgroups, these students are most likely to achieve academic success if they receive appropriate English language instruction and content instruction in their schools (Genesee, Lindholm-Leary, Saunders, & Christian, 2006; Echeverria, Vogt, & Short, 2008).

On the other hand, some ELs have very limited formal schooling experience. These students have weak literacy skills in their native languages. Some may not have had schooling experiences such as sitting at desks all day, changing teachers per subject, or taking standardized tests (Echeverria, Vogt, & Short, 2008; San Miguel, 2013). They have significant gaps in their educational backgrounds, lack knowledge in specific subject areas, and often need time to adjust to U.S. public school routines and expectations (Echeverria, Vogt, & Short, 2008). ELs with limited formal schooling and literacy skills that are below grade level are "most likely to struggle academically as they enter U.S. schools with weak academic skills at the same time that schools are emphasizing rigorous, standards-based curricula and high stakes assessments" (Echeverria, Vogt, & Short, 2008, p.7).

Also included in the groups of ELs are students who were born in the U.S. but speak a language other than English at home. According to Batalova, Fix, & Murray (2007), 57 percent of adolescent ELs were born in the U.S. and are second- or third-generation immigrants. Some of these students are literate in their home language, but not in English. Others, however, have mastered neither their home language nor English. It can be asserted that the large numbers of second- and third-generation ELs who continue to lack English proficiency suggests that schools in the U.S. are not meeting their instructional needs (Echeverria, Vogt & Short, 2008; Batalova, Fix, & Murray, 2007; Cummins, 2013).

Some ELs are recently arrived immigrants. Other ELs are refugees. Often, refugees experience chaotic experiences. Sometimes, these chaotic experiences can result in a disruption in schooling. The term, students with interrupted formal education (SIFE) is often used in reference to this subpopulation of ELs (DeCapua, Smathers, & Tang, 2007).

Gaps in English Learner Reading and Mathematics Achievement

The No Child Left Behind Act of 2001 (NCLB) played a large role in making the academic achievement of ELs a priority for educational leaders in the United States. However, since the implementation of NCLB, there has been an increase in the number of ELs not receiving their diplomas due to failure of standardized tests that are mandatory graduation requirements (Biancarosa & Snow, 2004). ELs have some of the highest drop-out rates of all of the subgroups monitored by NCLB (Echeverria, Vogt, & Short, 2008) and are more frequently placed in lower ability groups than non-ELs (Echeverria, Vogt, & Short, 2008). According to results on the 2007 NAEP report, the significant gap in the mathematics achievement between ELs and their English-speaking counterparts still persists (Kim & Chang, 2010). In the 2008-2009 school year, only 10 states met their NCLB target goals for ELs (Kim & Chang, 2010). This improvement was not sustained. The number of states who met their NCLB target goals for ELs decreased to 8 in the 2010-2011 school year (Hur & Suh, 2012).

The gap in academic achievement between ELs and their native English-speaking counterparts is evident on both state and national measures of achievement. For example, according to Perrie, Grigg, and Donahue (2005), only 4 percent of eighth-grade ELs and 20 percent of students classified as “formerly EL” demonstrated proficiency on the reading portion of the 2005 National Assessment for Educational Progress (NAEP). California, Florida, Texas, New York, and Illinois account for over 40% of all U.S. public school students and have been referred to as mega-states in public education (NCES, 2013). Among the 18.7 million students who attended schools in these states in 2005, 2.9 million of them were ELs. A comprehensive report of NAEP achievement indicated achievement gaps of at least 30% between fourth grade ELs and non-ELs for each one of these five states on the NAEP performance in reading (NCES, 2013).

In their analysis of the mathematics performance of ELs in elementary, middle and high school settings in four states (Maine, Massachusetts, North Carolina, and Wisconsin), Albus, Thurlow, and Liu (2002) reported low math achievement scores and a consistent gap between ELs and non-ELs. According to Lee, Grigg, and Dion (2007), 44% of ELs scored below basic when compared with 16% of non-ELs in fourth grade. The gap became wider in eighth grade with 70% of ELs scoring below basic while 27% of non-ELs scored below basic (Lee, Grigg, & Dion, 2007). Reardon and Galindo (2007) examined the mathematical performance of Hispanic elementary students and found that Hispanic students who use English as their primary language had higher mathematical performance than Hispanic students from non-English speaking homes. The results of Abedi's (2002) comparison of the mathematical performance of ELs and non-ELs showed that ELs showed lower proficiency in mathematical analytical skills, concepts, estimation, and problem solving than non-ELs. However, there was a smaller gap between the procedural fluency of ELs and non-ELs, especially when performing mathematical computations that did not require English language skills.

Meeting the Instructional Needs of English Learners

Language Development

Much of the contemporary discourse of the language development of ELs and its implications for EL instruction draws its origins from the work of Jim Cummins. Cummins (1984) suggests that there is a distinction between social and academic language acquisition and has adopted the terms Basic Interpersonal Communication Skills (BICS) and Cognitive

Academic Language Proficiency (CALP). BICS and CALP can be used to describe the language proficiency of single language students. However, in the United States they are primarily used as a way to understand and evaluate the language level of ELs.

According to Cummins (1984), Basic Interpersonal Communication Skills (BICS) are language skills needed in social situations. It is the day-to-day language needed to interact socially with other people. While at school, for example, ELs use BICS when they are in the cafeteria, interacting with peers in extra-curricular activities, and participating in sports activities. BICS are typically acquired quickly by many ELs. This is particularly so with ELs who spend a lot of their school time interacting with native speakers of English and whose native languages are similar to English (Haynes & Zicarian, 2010).

Social interactions usually occur in a meaningful social context, and therefore, are context embedded (Cummins, 1984). Context embedded means that the conversation is often face-to-face, offers many cues to the listener such as facial expressions, gestures, concrete objects of reference. (Cummins, 1984; Cummins & McNeely, 1987; Cummins, 1981). Because they are used mostly in informal, social settings, Cummins describes BICS as being language skills that are unspecialized and cognitively undemanding. Cognitively undemanding language is easy to understand, deals with everyday words and expressions, and uses simple language structure (Cummins, 1984; Cummins & McNeely, 1987; Cummins, 1981). Upon arriving to the United States, immigrant ELs typically develop BICS within six months to two years.

By contrast, Cummins (1984) describes Cognitive Academic Language Proficiency (CALP) as the language necessary to understand and discuss content in the classroom. CALP is the basis for a child's ability to cope with the academic demands placed upon him/her in the various subjects. Cummins asserts that while many children develop native speaker. While at school, CALP is developed while students are learning in the classroom. Unlike BICS, which can be developed through peer interactions in social settings, CALP development primarily is dependent upon the instruction that a student receives in the classroom. Therefore, an ELs ability to improve CALP relies heavily on the knowledge and instructional abilities of their teachers (Nutta, Strebel, Mokhtari, Mihai, & Crevecoeur-Bryant, 2014; Nutta, Mokhtari, & Strebel, 2012).

CALP refers to formal academic learning and develops while students are listening, speaking, reading, and writing about subject area content material. CALP is required for ELs to succeed in school. Unlike BICS, Cummins (1984) describes CALP as being context reduced because there are fewer non-verbal cues. In addition, CALP is considered to be more cognitively demanding than BICS because it relates to abstract concepts, has specialized vocabulary, and uses more complex language structures than BICS (Cummins, 1984; Cummins & McNeely, 1987; Cummins, 1981). Cummins reported that while many children develop native BICS within two years of immersion in the target language, it takes between 5-7 years for a child to develop CALP that is comparable to native English speakers of the same age.

As ELs proceed through school, the level of CALP progressively increases as well. Acquiring academic language goes beyond understanding content area vocabulary (Haynes & Zacarian, 2010; Echeverria, Vogt, & Short, 2008) and evolves into using content knowledge to perform tasks that require students to compare and contrast, classify, synthesize, evaluate, and draw inferences (Taylor, Watson, & Nutta, 2014). In addition, new ideas, concepts, and academic vocabulary are presented to students at the same time. Rather than being placed in a socially relevant context, information is more likely to be read from a textbook or presented by the teacher.

Academic English is defined as "the ability to read, write, and engage in substantive conversations about mathematics, science, history, and other school subjects" (American Educational Research Association, 2004, p. 2). Academic English "relies on a wide understanding of words, concepts, language structures, and interpretation strategies and includes vocabulary used beyond social conversations and required to communicate effectively and comprehend materials in academic content area classes" (Freeman & Crawford, 2007, p. 12.). In the United States, academic English is prevalent in classrooms, textbooks, tests, standardized assessments, college applications, and job interviews (Franco, 2006; Freeman & Crawford, 2007). According to Franco (2006), academic language is often confused with content language, that is, language particular to a field of academic content. Franco also contends that content language is just a part of academic English.

Problems and misconceptions about the ability of ELs may arise when teachers and administrators think that a student is proficient in a language when they demonstrate BICS. It is incorrect to assume that ELs who demonstrate a high degree of social language fluency (BICS) have obtained the same high level of academic language fluency (CALP). Students who have exited from the ESL program, for example, may still be in the process of catching up with the CALP of their native speaking peers. An EL's language ability can easily be over-estimated by looking at the BICS and not realizing the difficulty that second language students have in acquiring CALP in the second language.

Cummins (1984) theorizes that in the course of learning one language a child acquires a set of skills and implicit metalinguistic knowledge that can be drawn upon when working in another language. This common underlying proficiency, referred to as CUP by Cummins, provides the foundation for the formation of both the first language (L1) and the second language

(L2). Cummins found that any increase of CUP that occurs in one language will positively impact the development of the other language.

In his research on bilingual education, Cummins (1991) made a distinction between additive bilingualism and subtractive bilingualism. In additive bilingualism, the native language continues to be developed and the first culture to be valued while the second language is added. In subtractive bilingualism, the second language is added without developing the native language or embracing the native culture. As a result, the student's value of their native language and culture is diminished (Cummins, 2000). In his research, Cummins (1994) found that ELs working in an additive bilingual environment gain English proficiency, and as a result, experience success in all content areas to a greater extent than ELs working in a subtractive environment. As a result, some efforts to improve the pedagogy of those who teach ELs have emphasized promoting awareness of diverse cultures and the use of culturally relevant teaching practices (Nutta, Strebel, Mokhtari, Mihai, & Crevecoeur-Bryant, 2014; Haynes & Zacarian, 2010).

Instructional Practices

Pedagogical approaches and instructional strategies intended to improve the academic success of ELs have evolved over the past 50 years. Teachers have adjusted their approaches in accordance with research findings and trends in the field of serving ELs. In the 1950s and 1960s, most language teaching utilized a direct method of instruction that focused primarily on vocabulary and translation (Echevarria, Vogt, & Short, 2008).

In the 1970s, language learning instructional practices shifted towards the use of the audio-lingual method (Barker, 2001; Echevarria, Vogt, & Short, 2008). Like the direct method, the audio-lingual method advised that students be taught a language directly, without using the students' native language to explain new words or grammar in the target language. However, unlike the direct method, the audio-lingual method didn't focus on teaching vocabulary, but rather, focused on drilling students in the use of grammar. (Barker, 2001; Harmer, 2001; Echevarria, Vogt, & Short, 2008). For example, the instructor would present the correct model of a sentence and the students would have to repeat it. The teacher would then continue by presenting new words for the students to sample in the same structure. In the audio-lingual method, there is no explicit grammar instruction. Rather, everything is simply memorized in form. The idea is for the students to practice the particular construct until they can use it spontaneously.

One of the flaws of the audio-lingual method of language instruction is that since the lessons are built on repetitive and static drills, students have little or no control of their own responses (Butzcamm & Caldwell, 2009; Barker, 2001; Harmer, 2001; Echevarria, Vogt, & Short, 2008). Seeking a more interactive and social dynamic, ESL instruction turned to more communicative methods (Whong, 2011; Butzcamm & Caldwell, 2009; Echevarria, Vogt, & Short, 2008). Communicative language teaching (CLT) is an approach to language teaching that stresses student interaction as the means, and purpose, of language acquisition (Whong, 2011; Butzcamm & Caldwell, 2009; Echevarria, Vogt, & Short, 2008). CLT prepares students to use language in functional, purposeful ways. Proponents of the communicative approach to language learning favor its relevance and interactive approaches (Bax, 2003). In addition, the use of CLT has been associated with increased EL motivation, participation in class, and accountability for their own learning (Echevarria, Vogt, & Short, 2008; Bax, 2003; Harmer, 2001) as well as being encouraged to experiment with language and take risks in conversations with peers (Richards & Rodgers, 2001; Mitchell, 1994).

Building upon the benefits of CLT, “educators of ELs have developed content-based ESL curricula and accompanying instructional strategies, to help better prepare the students for their transition into mainstream classes” (Echevarria, Vogt, & Short, 2008, p. 15). In content-based ESL classes, all of the students are ELs. Even though the primary goal of content-based ESL is still English language development, it has also been seen as an effective way to prepare students for mainstreaming opportunities (Cantoni-Harvey, 1987; Crandall, 1993; Mohan, 1986; Short, 1994). Effective content-based ESL presents content from multiple subject areas through thematic or interdisciplinary (Echevarria, Vogt, & Short, 2008). Because the language instruction incorporates information that students are likely to be exposed to in their content areas, it builds their English language proficiency.

Even though content-based ESL instruction promotes English language development, it is not sufficient enough to ensure that ELs will perform well in all of their subjects (Echevarria, Vogt, & Short, 2008; Echevarria & Graves, 2007). Sheltered instruction refers to settings in which ELs are sheltered together to learn English and academic content simultaneously while not in the presence of their non-EL counterparts (Wolfe, 2009; Short & Echeverria, 1999). In other words, through sheltered instruction “ELs participate in a content course with grade-level objectives delivered through modified instruction that makes the information comprehensible to them (Echevarria, Vogt, & Short, 2008, p. 13). Some favor the use of sheltered instruction because it enables ELs to receive language support while also mastering content subjects (Echevarria, Vogt, & Short, 2008; Echevarria & Graves, 2007; Guarino, Echevarria, Short, Schick, Forbes, & Rueda, 2001).

The concept of sheltered instruction for ELs was first introduced by Stephen Krashen in the early 1980s as a way to use second-language instructional strategies while teaching content-area curriculum (Krashen, 1984; Echevarria & Graves, 2007). In schools across the United States, the term sheltered is used to describe content-area classes for ELs. Some of the instructional strategies that are prevalent in sheltered instruction are modified texts and assignments, use of visual representations, and occasional support given in the native language (Echevarria & Graves, 2007).

In an attempt to provide teachers with a model of effective practices involved with providing sheltered instruction to ELs, researchers developed the sheltered instruction observation protocol, or SIOP (Echevarria, Vogt, & Short, 2000; Echevarria, Vogt, & Short, 2004). This protocol has become popular and is currently used in all 50 states. Among the teaching practices that are part of SIOP and have been associated with improved EL performance are using wait time, identifying key vocabulary within a unit of study, creating language objectives, using supplementary materials, and building upon student background experiences ((Echevarria, Vogt, & Short, 2000; Echevarria, Vogt, & Short, 2004; Hattie, 2009; Guarino, Echevarria, Short, Schick, Forbes, & Rueda, 2001).

The use of audio/visual methods has been reported by some to be an effective instructional strategy for EL instruction (Echeverria, Vogt, & Short, 2008; Allison & Rehm, 2007). Some common uses of audio/visual methods include pictures, television, slides, music, photos, maps, cartoons, recordings, and videos (Allison & Rehm, 2007; Hattie, 2009). In their survey of middle school teachers, Allison and Rehm (2007) found that the majority of teachers use visuals to teach concepts in all content areas, and to all students. Because visuals provide ELs with alternative ways of representing their thoughts and concepts, some teachers consider visuals to be the most effective teaching tool for meeting the classroom needs of ELs (Allison & Rehm, 2007).

Instructional Challenges in Mathematics

The notion that mathematics is a universal language that students from all linguistic backgrounds can master is a debatable one. Mastery of academic vocabulary impacts EL achievement in mathematics (Moschkowitch, 2010). Language impacts how students interpret, view, and conceive abstract math ideas (Engler, Jeschke, Ndjeka, Ruedi, & Steinmüller, 2006). In addition, members of different cultures may visualize mathematical concepts differently and express their ideas differently when processing and solving problems (Engler, Jeschke, Ndjeka, Ruedi, & Steinmüller, 2006).

It can be argued that mathematics is a technical language that can be challenging for students to master (Freeman & Crawford, 2008; Moschowitz, 2010; Murphree & Murphree, 2007; Echevarria, Vogt, & Short, 2000). Some have equated the difficulty of learning of mathematical language with the difficulty of learning a foreign language (Freeman & Crawford, 2008; Echevarria, Vogt, & Short, 2000). Consequently, any difficulties that students encounter with learning this technical language of can impede their mathematics achievement. Because of their limited English proficiency, ELs are more likely to encounter difficulties learning the technical language of mathematics when presented to them in a non-native language.

Most mathematical terms are new to young students. In addition, many mathematical terms are based on familiar words, but their everyday meaning is changed in mathematics (e.g. value, scale, chance, product), thereby making them confusing to distinguish and difficult to recall (Freeman & Crawford, 2008). ELs are likely to struggle in the same manner. According to Freeman and Crawford (2008), “this can lead to students thinking they understand these terms and the concepts they represent long before they really do—which, in turn, can lead to misconceptions that students must overcome before they are able to master the concepts” (p. 11).

When learning mathematics, students use not only mathematical words, but also mathematical symbols. In addition to the aforementioned challenges that accompany learning new mathematical terms, learning new symbols can also be as challenging as learning a foreign language (Freeman & Crawford, 2008). Some students struggle more with learning mathematical symbols than terms. Some ELs come to school with prior school experience in their native languages and come from countries that use different mathematical symbols (e.g. multiply can be shown as X or *). (Freeman & Crawford, 2008). In order for one to be able to learn the big ideas of mathematics, one must be able to use mathematical words fluently (Freeman & Crawford, 2008; Moschowitz, 2010; Murphree & Murphree, 2007; Echevarria, Vogt, & Short, 2000). In order to engage in mathematical computations and problem-solving, one must be able to know how to identify and use mathematical symbols (Freeman & Crawford, 2008; Murphree & Murphree, 2007).

A considerable amount of research has been conducted to evaluate the effectiveness of intervention programs that develop EL reading skills. By contrast, the low level of mathematics achievement by ELs has attracted considerably less attention from researchers, practitioners, policy makers, and parents (Robertson & Summerlin, 2005; Secada, 1996). However, there is growing evidence that limited English proficiency also has implications for EL performance in mathematics (Moschowitz, 2010; Lopez, 2009). For example, in California less than 40% of ELs passed the math portion of the high school exit exam, which requires only Grade 6 math proficiency for a passing score (California Department of Education, 2007). Failure in high school Algebra courses has been found to be associated with increased high school drop-out rates (Helfand, 2006). More than half of the ELs enrolled in Algebra 1 courses schools fail the class at least once (Helfand, 2006). Consequently, because of their inability to perform well in mathematics, it can be asserted that ELs are at risk of dropping out of high school.

There is a limited amount of research that investigates how limited English proficiency relates to the mathematics achievement of ELs. Some assert that if ELs cannot easily understand a teacher's explanations or the textbook materials due to their limited English proficiency, they will not benefit from the instruction to the same extent as a non-EL (Guerrero, 2004; Secada, 1996). Helwig, Rozek-Tedesco, Tindal, Heath, and Almond (1999) found that poor readers performed better when math word problems were presented by video than text, suggesting that reading difficulties can undermine math problem solving. This study, however, did not specifically focus on ELs. Morales (1998) found that the ability of ELs in elementary school to solve word problems correctly varied with their ability to comprehend the text in the word problem. Beals, Adams, Niall, and Cohen (2010) found increased EL reading proficiency to be a predictor of increased EL mathematics proficiency.

Some conclusions about the impact of limited English proficiency on the mathematics performance of ELs can be drawn from the effectiveness of classroom modifications and testing accommodations for ELs on standardized tests. Helwig, Rozek-Tedesco, Tindal, Heath, and Almond (1999) found that poor readers performed better when math word problems were presented to them by video than text, suggesting that reading difficulties can undermine math problem solving. This study, however, did not specifically focus on ELs. Morales (1998) found that the ability of ELs in elementary school to solve word problems correctly varied with their comprehension of the text in the word problem. Abedi (2004) found that modifying the language of questions used on mathematics examinations can increase ELs performance by up to 20%.

Digital Learning Environments

Digital Learning

The increased use of technology in everyday life is a national trend that is currently occurring in the United States. The use of technology in education is "no longer to be thought of as a choice to be made on the part of teachers, nor can it be considered an add-on to the curriculum or reserved for special occasions in the classroom" (Dellicarpini, 2012, p. 14). In addition, "it has been argued that there is a gap that continues to widen between the types of knowledge and skills students learn in U.S. schools and the actual types of knowledge and skills they need to be successful in the 21st century workforce and global economy" (Dellicarpini, 2012, p. 14). Among these 21st century skills are the ability to collaborate and communicate effectively through electronic means. Consequently, there has been an increased emphasis on the use of digital learning in public school settings.

The notion that digital learning is a positive component of a student's school experience is growing in consensus. Because of its positive effect on student engagement, many students and teachers are proponents of digital learning environments (Palfrey & Gasser, 2008; Paraiso, 2010; Richardson, 2006; Riddle, 2009; Rosen, 2010; Ryan, 2008; D. Silvemail & Gritter, 2007; Tapscott, 2009). In their survey of teachers in the United States, Purcell, Heaps, Buchanan, and Friedrich (2013) found that 92% of teachers reported that the Internet has a major impact on their ability to find materials and prepare for teaching. Magana and Marzano (2014) found that 90% of teachers view technology as an effective tool to support their teaching.

Digital learning is any instructional practice that effectively uses technology to strengthen a student's learning experience. It emphasizes high-quality instruction and provides access to challenging content, feedback through formative assessment, and individualized instruction to ensure all students reach their full potential to succeed in college and a career. Because of the availability of mobile devices, digital learning provides opportunities for students to learn both anytime and anywhere. For the purposes of this study, a digital school/digital school environment will be defined as a school where: (a) students are immersed in the use of interactive whiteboard technology; and (b) digital versions of textbooks and school-issued devices as their primary instructional materials in all classrooms and throughout the school day and at home. Among the list of digital resources are: online courses, blended/hybrid courses, digital textbooks, and web-based resources.

The notion of the global achievement gap (Wagner, 2008) and the increased emphasis on public school accountability that resulted from the No Child Left Behind Act (NCLB) has resulted in deeper examinations of effective pedagogy and more efficient adoption of resources that impact school improvement efforts. Magana and Marzano (2013) assert that digital learning advances school reform by increasing equity and access to educational opportunities, improving effectiveness and productivity of teachers and administrators, providing student-centered learning to ensure college and career readiness for all students, and recognizing teachers as education designers. Positive outcomes related to improved 21st century workforce and research skills have been associated with digital learning (Mouza, 2008).

Computer-assisted Instruction

Practicing new skills and applying new knowledge are fundamental aspects of student learning (Marzano, 2010; Hattie, 2009). Research addressing the effectiveness of the use of computer-assisted instruction (CAI) to provide students with daily drill and practice of basic skills dates back to as early as the 1960s. In their evaluation of two computer-based drill and practice programs, Suppes and Morningstar (1969) reported that these programs helped schools maintain consistent drill and practice routines and found higher rates of learning gains among economically disadvantaged students. In a meta-analysis of 10 studies, Vinsonhaler and Bass (1972) found that elementary school students who routinely used computerized drill and practice programs showed 1-8 months of performance gains over students who received non-digital practice. In his meta-analysis of computer-assisted mathematics instruction, Hartley (1977) asserted that CAI was an effective way to deliver mathematics instruction to elementary and secondary school students.

CAI has been determined to also serve as an effective supplement to traditional instruction (Jamison, Suppes, and Wells, 1974) and initiatives that have supplemented traditional instruction with CAI have shown to be more effective than traditional instruction alone (Edwards, Norton, Taylor, Weiss, & Dusseldorp, 1975). Research conducted in the following two decades yielded similar results. Hasselbring (1986) found that CAI accelerated student learning and that CAI worked best as an instructional supplement. Kulik (1994) found that teachers were able to cover more curriculum when they used CAI and that students expressed more satisfaction when their classroom environments incorporated digital tools. More recently, Christmann and Badgett (2003) also found that elementary school students who received traditional instruction that was supported by CAI outperformed their counterparts who learned in non-digital environments. Furthermore, a meta-analysis of 76 studies (Hattie, 2009) demonstrated that CAI had a positive effect size of d=0.37.

A meta-analysis of 76 studies (Hattie, 2009) demonstrated that CAI had a positive effect size of d=0.37. Hattie (2009) offered the following summary of the major uses of digital learning and their corresponding effect sizes: (a) online tutorials (d=0.71); (b) drill and practice (d=0.34) and; (c) simulations (d=0.34). He also added that “computers are used effectively (a) when there is a diversity of teaching strategies; (b) when there is pre-training in the use of computers as a teaching and learning tool; (c) when there are multiple opportunities for learning (e.g., deliberative practice, increasing time on task); (d) when the student, not the teacher, is in "control" of the learning; (e) when peer learning is optimized; and (f) when feedback is optimized" (Hattie, 2009, p. 221).

In order to address the multitude of learning styles and abilities within a classroom, teachers must differentiate and scaffold their instruction (Tomlinson, 2014). One of the advantages of integrating digital tools into everyday classroom instruction students get to experience learning via two different teaching strategies (Hattie, 2009). Blended learning environments (classrooms which incorporate both digital and non-digital resources) have been associated with increased student engagement and improved achievement in reading and mathematics (Smith & Suzuki, 2015; Yapiki & Akbayan, 2012; Bottge, Ma, Gassaway, Toland, Butler, & Cho, 2014). In addition, Hattie (2009) found that using computer-based practice as a supplement to teacher instruction was more advantageous than using computer-based learning as a replacement for teacher instruction.

One of the key components of contemporary schooling and proficiency of Common Core standards involves increased student accountability for their learning (Taylor, Watson, & Nutta, 2014; Magana & Marzano, 2014; Marzano, 2007). In other words, there has been a greater emphasis placed on students taking ownership and control of their learning. Niemiec, Sikorski, & Walberg (1996) found that when students were in control of their learning (pacing, time allocated for mastery, choice of practice items, reviewing), the effects were greater than when teachers controlled these factors. Digital learning is also more effective when the student, not the teacher, is in control of the learning (Hattie, 2009; Abrami et al., 2006; Cohen & Dacanay, 1994). For example, digital learning environments that used software that was mostly student-controlled showed higher gains in learning than those who used software that was mostly system-controlled (Lou, Abrami, & d'Apolloni, 2001), but only when students were learning in groups.

One way to encourage students to take control over their learning via a digital resource is by using word processor programs to facilitate student writing. When using word processors, students tend to write more than they would if asked to write on paper and the quality of their writing is enhanced (Bangert-Downs, 1993; O'Dwyer, Russell, Bebell, & Tucker-Seeley, 2005). In addition, students are more likely to make revisions and make fewer errors when writing using digital tools (O'Dwyer, Russell, Bebell, & Tucker-Seeley, 2005; Goldberg, Russell, & Cook, 2003; Schramm, 1991). In their meta-analysis of studies conducted from 1992-2002, Tongerson and Elbourne (2002) found that when compared to students who learned to write on paper, students who used computers when learning how to write were more engaged, more motivated, produced longer writing passages, and wrote higher quality essays.

Another characteristic of contemporary instruction is the emphasis on student communication and collaboration. When students work together, they get exposed to multiple perspectives, varied explanations for solving problems, more sources of feedback, and different ways to revise their thinking (Hattie, 2009). Likewise, using digital tools in pairs is more effective than when they are used alone or in larger groups (Hattie, 2009; Lou, Abrami, & d'Apollonia, 2001). Some examples of digital tools that promote peer learning are posting comments/blogging on social media websites, sharing Google documents, and engaging in teacher-created web quests. In order for positive outcomes to occur from digital peer learning, however, teachers need to decide when and how to capitalize for these students to collaborate, and more importantly, how to monitor individual student progress and effort during small group settings (Marzano, 2007; Magana & Marzano, 2014).

Providing students with feedback on their progress has a high effect on their learning (Hattie, 2009). There are many different types of feedback, each with a different impact on learning. Feedback has its highest effect size when it accompanies appropriate, challenging tasks (Hattie, 2009). Because of its impersonal nature, computer feedback can potentially be less threatening to students (Blok, Oostdam, Otter, & Overmaat, 2002; Magana & Marzano, 2014). Computerized feedback can also be delivered in a more consistent, systematic manner (Blok, Oostdam, Otter, & Overmaat, 2002). In addition to using computerized feedback, teachers can communicate their own feedback to students through digital means. Muskawa (2006) found that online feedback had a positive effect on student-teacher relationships, encouraged cooperation among students, and motivated students to revise their errors.

One-to-One Programs

Because of the uniqueness and innovation involved with the use of interactive classroom technology, it has been asserted that digital learning tools are more engaging, and as a result, create improved learning outcomes (Palfrey & Gasser, 2008; Paraiso, 2010; Richardson, 2006; Riddle, 2009; Rosen, 2010; Ryan, 2008; D. Silvemail & Gritter, 2007; Tapscott, 2009; Magana & Marzano, 2014). Active engagement, participation in group assignments, frequent interaction and feedback, and connection to real-world contexts have all been identified as beneficial features of digital learning environments (Magana & Marzano, 2013; Lopez, 2009; Mouza, 2008; Roschelle et al., 2000). In addition, Mouza (2008) reported that digital learning leads to improvements in students' attitudes towards school and increased persistence in completing school assignments. Because of these benefits, many schools and school districts have implemented one-to-one digital programs as a way to transform the quality of the instruction in their classrooms (Penuel, 2006; Topper & Lancaster, 2013; Lee, Waxman, Wul, Michko & Lin, 2011).

The use of one-to-one digital learning environments has been correlated with improved student achievement (Lee, Waxman, Wul, Michko & Lin, 2011). Sauers and McLeod (2012) conducted a meta-analysis of research concerning the effectiveness of one-to-one settings and found several benefits to digital learning. Among these positive quantitative outcomes were measurable gains on standardized tests and improved grade point averages (GPAs). In addition, the meta-analysis produced qualitative findings that suggested improved interest, attendance, and motivation for both teachers and students who participate in one-to-one projects (Sauers & McLeod, 2012). Because student interest, motivation, and attendance have been linked to successful academic achievement (Hattie, 2009) and are areas of concern for at-risk students, it can be asserted that these benefits of digital learning can lead to improved student performance within student subgroups who are at-risk.

Interactive Whiteboard Use

An interactive whiteboard (IWB) is a touch-sensitive device that allows users to interact with digital materials (Smith, Hardman & Higgins, 2006). This device connects a computer to a projector and shows resources on the surface of the board. A user can control an IWB by using a pen, finger or devices on the computer such as a mouse or keyboard. One of the benefits of a teacher's use of an IWB is "the ability to move quickly between varieties of electronic resources, with greater speed in comparison to non-electronic resources, with opportunities to edit, record and retrieve data" (Hur & Suh, 2012, p. 323). Due to the increased frequency of IWB usage in schools, there is a need for increased research about the effects that IWBs have on pedagogy and student achievement.

The IWB has become a popular tool that has "enabled teachers to use a combination of innovative styles and presentation and the rapid succession of different kinds of multimedia information" (Gillen, Staarman, Littleton, Mercer, & Twiner, 2007, p. 255). IWBs provide teachers with the ability to modify and highlight text, download resources, save student work for future comparisons, incorporate images and photographs, utilize quick hyperlinks, and easily access the Internet for classroom demonstrations (Shenton & Pagett, 2007). In addition, IWBs enables teachers to capture key points through various functions, modify content, and conduct quick reviews by skipping back to previous screens (Haldane, 2007). Kennewell and Beauchamp (2007) found that teacher questioning, prompting, responding, and repeating information was done more effectively and efficiently through the use of an IWB.

Some studies indicate the benefits of interactive whiteboards for teaching and learning, such as promoting learner motivation, supporting the whole class while teaching, creating effective and engaging presentations, and making it easier to interrelate tests, images and videos (Higgins et al., 2007; Wall, Higgins & Smith, 2005). Woods and Ashfield (2008) associated the use of IWBs with an increase in student concentration, motivation, attention, and focus of students. Smith (2006) reported that "IWBs motivate pupils to offer answers to teachers' questions because of the strong visual and conceptual appeal of the information that is displayed and because of the way they allow pupils to physically interact with the board in search of those answers" (p. 445). Woods and Ashfield (2008) found positive relationships between the use of IWBs and student outcomes in reading and mathematics because IWBs enabled teachers to quickly access curriculum materials and easily save, retrieve, and edit data.

In their survey of secondary school students and teachers, Hall and Higgins (2005) found that both students and teachers favor the use of IWBs. Some of the benefits of IWB use mentioned by teachers in the study were the ability to access more resources such as video clips, educational software, and games. In addition, increased amounts of time spent planning lessons and technical malfunctions were reported by teachers to be negative attributes of IWB use. Students reported that using the IWB made the classroom more fun. In addition, students responded favorably to the use of the IWBs visual, audio and touch-screen features. Some of the negative aspects mentioned by students were technical problems, not being able to always see what was displayed on the IWB, and inconsistent use of IWBs among teachers in the same school.

Flory (2012) found no positive relationship between the use of IWBs and student outcomes in mathematics. He did, however, observe an increase in student motivation in mathematics during lessons that incorporated the use of IWBs and concluded that "how interactive whiteboard technology is being used during instruction is more important than how often interactive whiteboard technology is being used. If the technology is only being used to create perfect visuals it is not being used to its full potential" (Flory, 2012, p. 2).

In order for schools to gain the most benefit from having IWBs in digital classrooms, there is a need for increased teacher knowledge of effective pedagogy with this technology (Smith, Hardman & Higgins, 2006; Flory, 2012). The increased levels of student engagement that can result from IWB use are dependent on the teachers' skills and familiarity with this tool (Gillen, Staarman, Littleton, Mercer, & Twiner, 2007). Therefore, in order to maximize their instructional benefits, the increased presence of IWBs in public schools must be accompanied by an increased emphasis on providing professional development to teachers on the effective use IWB features.

Impact on Reading and Mathematics Standardized Test Achievement

The recent research on digital learning and its impact on reading and mathematics standardized test achievement has yielded a wide range of findings. Some studies have associated digital learning with academic improvement in all content areas (Hattie, 2009; Lee, Waxman, Wu, Michko, & Lin, 2011) as well as improvement in reading (Lee, Waxman, Wu, Michko, & Lin, 2011; Liao, Chang, & Chen, 2008; Moran, Ferdig, Pearson, Wardrop, & Blomeyer, 2008; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011).

Improved writing performance has also been found among students who learn in digital school environments (Mouza, 2008; Penuel, 2006; Russell, Bebell, & Higgins, 2004). In a large scale quantitative study in Massachusetts, researchers found that after controlling for prior achievement and socio-economic status, those students in fourth grade who reported using technology to edit papers had statistically significant higher scores on the Massachusetts Comprehensive Assessment System (MCAS) than those students who reported lower levels of technology usage (O'Dwyer, Russell, Bebell, &Tucker-Seeley, 2005).

It has been asserted that the use of digital tools has positive effects on mathematics performance (Lei & Zhao, 2007; Lopez, 2010; Kim & Chang, 2010; Mendicino, Razzaq, & Heffernan, 2009). Lei and Zhao (2007) found that computer assisted mathematics instruction led to increased achievement among middle school students. Mendicino et al. (2009) explored the effectiveness of digital homework programs that provided immediate feedback and web-based assistance in mathematics for fifth grade students and found higher levels of performance from students doing web-based homework compared with those doing traditional paper-and-pencil homework assignments. Lopez (2010) studied the use of interactive whiteboards (IWB) and found positive gains in mathematics proficiency among 3rd and 5th grade students.

Many school districts in the U.S. have strategically increased the use of digital learning as a means of improving student performance in all content areas. However, a need for continued research in this area remains. Some studies, for example, have found that the use of digital learning does not correlate to gains in all content areas, but rather, only improved student achievement in some areas (D. Silvemail & Gritter, 2007; D. L. Silvemail, Pinkham, Wintle, Walker, & Bartlett, 2011). In addition, digital learning environments have been linked with inconclusive or negative results on student outcomes (Carr, 2012; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Sheppard, 2011. In spite of the gains in some subject areas, some critics have questioned the value of digital initiatives (Carr, 2012; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Sheppard, 2011). Due to the financial commitment that is associated with digital initiatives, some have debated whether digital learning is a worthwhile fiscal investment (Carr, 2012; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Sheppard, 2011).

Digital Learning and English Learner Achievement

The Need for Technology Integration

The use of technology surrounds our lives today. In both the United States and various other nations, many children are actively engaged in the use of digital devices every day. The presence of digital technology in today's society inevitably influences the reading and writing skills of students in U.S. public schools (Beaufort, 2009; Miller, 2007; Patterson, 2000; Unsworth, 2001; Ware & Warschauer, 2005; Weigel & Gardner, 2009). In order to remain connected with the lives of students, there is an increased need for schools to infuse digital learning into their instructional approaches. Among this generation of students who are actively engaged in the use of technology inside and outside of school are ELs. This is especially so in the case of ELs who were born and raised in the U.S.

Culturally relevant instruction that incorporates the interests, perspectives, and identities of students has been found to be an integral component of the academic success of ELs (Ajayi, 2009; Cope & Kalantzis, 2000). Teachers of ELs must integrate the native language skills, life experiences, knowledge, interests, perspectives, and identities of their students in order to deliver effective EL pedagogy (Ajayi, 2009; Cope & Kalantzis, 2000). For digital natives, including those who are ELs, engaging in the use of digital technology is a culturally relevant daily practice. Therefore, in order to maximize the learning potential of ELs, efforts must be made by schools to incorporate effective digital learning practices into their school environments.

In order to accelerate their acquisition of English, and as a result, improve their academic success, ELs need rich learning experiences. More specifically, ELs need classroom environments where they can practice speaking, listening, reading, and writing English. Interactive classroom technology can provide ELs with additional opportunities to practice these skills in a more engaging, authentic, and individualized manner.

Quality instruction is a precursor to improved EL academic success. Because digital learning has been associated with increases in student engagement, motivation, and academic achievement (Hattie, 2009; Magana & Marzano, 2014; Dellicarpini, 2012; Mouza, 2008; Rockman, 2003), the effective use of interactive classroom technology has been embedded into contemporary expectations of high quality instruction. Walqui (2006) stated that ELs “benefit from the same good teaching as all learners do, but they need even more of it” (p. 169). Similarly, in their discussion of Common Core State Standards proficiency, Taylor, Watson, and

Nutta (2014) asserted that “what defines ELs—their still-developing proficiency in listening, speaking, reading and writing English as a second language—sets their needs apart from other students, requiring the same strategies known to be effective for others, plus something more (p.47)”. The something more, namely scaffolding, academic language development, and differentiated instruction via small group and individualized approaches (Taylor, Watson, & Nutta, 2014), can be enhanced through the use of digital learning tools and resources.

Digital learning has been used to support language teaching and learning. There are both benefits and challenges associated with the use of digital learning to support the instruction of ELs. Digital learning has been linked to successful EL outcomes in reading and mathematics (Lopez, 2009; add others). However, many teachers of ELs in the U.S. either “sparingly use technologies for instruction or use them at low level” (Yang & Walker, 2015, p. 179). Digital tools (e.g., computer software, online resources, interactive whiteboards, mobile applications) can provide support for language teaching and learning, but these tools are not being used to their fullest potential in ESL instruction in the U.S. (Healey, Hanson-Smith, Hubbard, Ioannou-Georgiou, Kessler, & Ware, 2011). Some of the challenges that account for the under-utilization of classroom technology in EL instruction are inadequate teacher education of technology use, the undervalued role of technology in EL instruction, and the lack of digital skills and knowledge of EL teachers (Yang & Walker, 2015). In a case study conducted by Yang and Walker (2015), one teacher reported that “While there was increased support from the standards and her school for technology integration and greater availability of technologies, the support was inadequate and she lacked the necessary professional development on technology integration in ESL instruction” (p. 180).

Lopez (2010) studied the use of interactive whiteboards (IWB) and found positive gains and a narrowing of the achievement gap between ELs and non-ELs in 3rd and 5th grade. Lopez theorized that the increased student engagement, personalized learning, and frequency of feedback from the teacher, all benefits of the digital learning environment, positively impacted the performance of the ELs in the study. Lopez (2010) studied the use of interactive whiteboards (IWB) and found positive gains and a narrowing of the achievement gap between ELs and non-ELs in 3rd and 5th grade. Lopez theorized that the increased student engagement, personalized learning, and frequency of feedback from the teacher, all benefits of the digital learning environment, positively impacted the performance of the ELs in the study. Increased student engagement and personalization of instruction were also two factors linked to positive academic outcomes in a study of the use of digital research projects with middle school EL students (Paraiso, 2010).

Cultural Considerations and Issues of Equity

The growing presence of ELs in U.S. public schools is expected to continue throughout our nation. Similarly, the frequency of digital learning is also expected to continue to expand. Prior to making the push for increased digital learning environments in settings that serve ELs, however, school leaders should examine the cultural considerations and issues of equity that may arise.

The discrepancy in access to technology resources among different socioeconomic groups, more commonly referred to as the Digital Divide, is a consideration when determining digital curriculum implementation (Roblyer & Doering, 2010; Magana & Marzano, 2014). The greatest factor for determining home access to technology is socioeconomic status (Roblyer & Doering, 2010). Even though children from all income levels have greatly increased their

Internet and mobile device use since 2000, low-income and minority students still lag far behind other students in home and school access to technology (Roblyer & Doering, 2010; Lopez, 2009). Many ELs come from economically disadvantaged households, and as a result, may be less likely to have access to technology than their non-EL counterparts. Student unfamiliarity with technology has been associated with lower academic achievement in digital school settings (Crawford, 2013; Lopez, 209; Freeman & Crawford, 2008). Without proper supports and direct instruction on how to use digital tools, ELs in digital learning environments may have to endure even more challenges in school than they did before.

While the use of technology has become increasingly popular in American households, other nations have not embraced the daily use of digital technology at the same rate. Some ELs are recently-arrived immigrants who may have migrated from nations with less prevalent technology use, and as a result, may lack many of the basic digital skills needed to succeed in a digital learning environment. Considerations need to be made for ELs, especially those who are recent immigrants, as well as those who are SIFE.

There are cultural implications that can potentially impact EL performance in digital learning environments. Within certain ethnic groups, technology use is more prevalent among males (Roblyer & Doering, 2010). When compared with males and white students, females and Hispanic students use computers less and enter careers in math, science, and technology at a lower rate (Lopez, 2009; Roblyer & Doering, 2010). Due to the diversity in the family composition and multitude of nationalities represented by ELs, it is difficult to determine the extent to which these factors may impact their digital learning. However, it is likely that many ELs may come from families where gender roles, family values, and customs may not emphasize the importance of developing competence with digital technology.

The power of digital learning is “a double-edged sword that presents obvious potential for changing education and empowering teachers and students, but can also further divide members of our society along socioeconomic, ethnic, and cultural lines and widen the gender gap” (Roblyer & Doering, 2010, p. 20). Schools, more specifically teachers, will need to ensure that ELs are provided with the appropriate supports and accommodations to succeed in contemporary digital learning environments.

Computer-assisted Language Learning

There is a growing amount of research and literature on how digital learning may benefit the academic outcomes of ELs. Computer-assisted language learning (CALL) is a term used to describe the use of computer software and online programs to teach foreign languages (Felix, 2005; White & Gillard, 2011). CALL can be used as a supplementary resource in a foreign language class or as the primary instructional tool in an independent learning setting. The use of CALL has been associated with gains in foreign language acquisition and literacy (Grgurovical, Chapelle, & Shelly, 2013; Felix, 2005; White & Gillard, 2011).

In his meta-analysis, Felix (2005) found that CALL led to improvements in vocabulary, reading and writing for ELs. In addition, he found that students reported that using CALL was beneficial as long as “the technologies are stable and well supported" (Felix, 2005, p.16). These outcomes coincided with the findings of studies that focused on using computer-assisted instruction in other content areas (Magana & Marzano, 2014; Marzano, 2010; Hattie, 2009; Christmann & Badgett, 2003). In a similar meta-analysis, Grgurovical, Chapelle, and Shelly (2013) compared digital and non-digital foreign language instruction. In these studies, the students who received the digital instruction were able to acquire the foreign language at a higher rate than the students who received the non-digital foreign language instruction. Successfully implementing digital initiatives such as CALL require both financial investments and professional development efforts. Therefore, there is still a need for further research to determine the return on investment of using CALL as a means of accelerating English language development.

Some of the negative feedback associated with CALL is the lack of sufficient training in computer literacy for both students and teachers (Chapelle, 2010; Felix, 2005). These findings coincide with Hattie's (2009) meta-analysis of computer-assisted instruction that suggested that the use of computers is more effective when there is teacher pre-training in the use of computers as a teaching and learning tool. Therefore, it can be asserted that when consistently accompanied by a sufficient amount of professional development and support, CALL implementation can yield positive English learning outcomes.

Instructional Practices Enhanced by Technology

The rapid growth of the EL population and the increased use of technology both outside and inside the classroom has required teachers of ELs to learn how to infuse digital learning into their daily classroom instruction. In order to do so effectively, some have made deliberate efforts to enhance ESL best practices by using interactive technology and various digital tools. As schools proceed to integrate digital interventions as a means of supporting EL instruction, efforts to align effective EL pedagogy with appropriate uses of classroom technology must continue. There is not an abundance of research-based recommendations for technology integration that effectively promotes the academic success of ELs. There is a need for continued research that analyzes the extent that digital tools improve EL instruction.

Digital programs and the Internet can be a plentiful source of comprehensible input that accommodates students with a variety of learning styles (Dukes, 2007). Increasing comprehensibility by using visual representations and classroom demonstrations is considered to be an effective EL practice (Dukes, 2007; Echevarria, Vogt, & Short, 2008; Echevarria & Graves, 2007). Digital tutorials other web-based resources can provide a wide variety of sound, pictures, animations, and other multimedia resources that can support and supplement EL instruction.

The use of audio/visual methods has been reported by some to be an effective instructional strategy for EL instruction (Echeverria, Vogt, & Short, 2008; Allison & Rehm, 2007). Some common uses of audio/visual methods include pictures, television, slides, music, photos, maps, cartoons, recordings, and videos (Allison & Rehm, 2007; Hattie, 2009). In their survey of middle school teachers, Allison and Rehm (2007) found that the majority of teachers use visuals to teach concepts in all content areas, and to all students. Because visuals provide ELs with alternative ways of representing their thoughts and concepts, some teachers consider visuals to be the most effective teaching tool for meeting the classroom needs of ELs (Allison & Rehm, 2007). Providing ELs with multi-modal exposure to words or sentences promotes confidence in word meaning, contextual appropriateness and pronunciation of words (Hur & Suh, 2012). The ability to access Internet resources and project videos and images can effectively support language development for ELs by allowing them to see relevant pictures (Hur & Suh, 2012). ELs may already know words in their native language, but not know how to pronounce them. Showing digital images can allow ELs to link their native language to English (Hur & Suh, 2012).

In addition to acquiring new language skills, ELs need to practice communicating with each other (Taylor, Watson, & Nutta, 2014; Haynes & Zacarian, 2010; Echeverria, Vogt, & Short, 2008). Increasing student interaction has been associated with improved academic outcomes for students in general (Hattie, 2009; Marzano, 2007) as well as for ELs (Whong, 2011; Butzcamm & Caldwell, 2009; Echevarria, Vogt, & Short, 2008). Digital learning environments can provide many opportunities for students to interact with each other while learning new content. For example, students can work on a software program in pairs, share electronic documents and prepare presentations together, and interact with digitally through the use of social media websites and blogging.

Making learning authentic helps to prepare ELs for "real world" English communication and increases EL academic motivation (Dukes, 2007; Hattie, 2009) as well as improving BICS and CALP skills (Cummins, 1984; Haynes, 2004). Because the use of the Internet and other interactive classroom technologies can offer communication in real-time, (e.g. e-mails, live digital chats, video-conferencing), it can increase the authenticity of classroom experiences for ELs.

Affective factors such as self-esteem and classroom comfort level can directly impact a student's learning (Hattie, 2009; Marzano, 2007). Because ELs often come from different ethnic backgrounds and are faced with English language obstacles, they can be more vulnerable to emotional issues that can negatively impact their success in school (Harjehausen, 2004). Learning outcomes have been positively correlated with group cohesion and positive interpersonal relationships between students (Hattie, 2009). Positive learning environments can be described as being supportive and open (Dukes, 2007; Harjehausen, 2004) and allow students to take risks without fear of being ridiculed. In some cases, digital learning can be an effective way of giving students opportunities to practice their English skills without worrying about worrying about the responses of their classmates or their teachers (Dukes, 2007; Chapelle, 2010). Computer applications such as anonymous student response systems and blogging can be effective ways to promote classroom engagement among students who are reluctant to participate (Magana & Marzano), including ELs (Lopez, 2009).

Effects on Reading and Mathematics Achievement

Digital learning has been found to be associated with increased student engagement and positive reading and mathematics outcomes for ELs in college and high school (Arslan & Sahin-Kizil, 2010; Kinash, Brand, Mathew, & Kordyban, 2011; Reid, 1997), ELs in middle school (Berryman, 2011; Carlo et al., 2004; Paraiso, 2010; Sturtevant & Kim, 2010; M. A. Williams, 2010), and ELs in elementary school (Lopez, 2009; Freeman & Crawford, 2008). However, there is still a need for further research to see the extent that digital learning has on ELs in both elementary and secondary school settings.

The acquisition of English literacy skills by non-native speakers has been linked to improved reading ability, and the ability to read and comprehend material is a precursor to success in school (Cummins, 1984; Echeverria, Vogt, & Short, 2008; Wolfe, 2009). Increasing one's knowledge and familiarity with new vocabulary is an essential component of second-language development. Direct vocabulary instruction (repeated, contextual and varied exposures to words) has been linked to improved reading comprehension (Freeman & Crawford, 2008; Marzano, 2004). Students who receive deliberate, systematic vocabulary instruction can score up to 33% higher than students who do not receive similar instruction on standardized measures of reading comprehension (Marzano, 2004). Digital learning can facilitate systematic vocabulary instruction with increased frequency and individualization, thereby accelerating the English language acquisition and reading comprehension ability of ELs.

It has been proposed that frequent computer use is associated with improved vocabulary development and reading comprehension for ELs. Proctor, Dalton and Grisham (2007) found accelerated rates of improved reading comprehension and in classrooms that implemented digital text-to-speech read-aloud tools to provide vocabulary support. Lan (2013) found higher rates in learning second language vocabulary development among English learners who used a digital vocabulary program than those who used a comparable, non-digital program. Similarly, Allie (2006) found that ELs who interacted daily with computer software for twenty minutes over a six-week period and followed the county reading and EL curriculum showed greater gains in reading achievement than students at the comparison school who followed the county reading and ELL curriculum without using technology. These increased gains, however, were not substantial. Allie (2006) also noted that the students' levels of familiarity with technology was correlated with their gains in reading achievement using the digital resource.

In a case study analysis of a TESOL classroom, Meskill (2005) concluded that an instructional environment that was enriched by the use of computer games and simulations led to increased EL motivation, and consequently, improved learning of new academic vocabulary terms, reading comprehension, and writing.

Segers, Takke, and Verhoeven (2004) examined the vocabulary learning of immigrant and native kindergartners when stories were read by teachers or by computers and found that immigrant children acquired significantly more vocabulary when teachers read the stories than when computers did. Factors such as teachers being more adaptive in reading children's facial expressions, elaborating stories with extra words, and providing more gestures and non-verbal expression were determined to be more impactful in this study than the digital features (Segers, Takke, & Verhoeven, 2004).

Computer use for mathematics has been associated with a reduction in the mathematics achievement gap between ELs and non-ELs (Kim & Chang, 2010). Lopez (2010) studied the use of interactive whiteboards (IWB) and found positive gains in mathematics proficiency and a narrowing of the achievement gap between ELs and non-ELs in third and fifth grade. Lopez theorized that the increased student engagement, personalized learning, and frequency of feedback from the teacher, all benefits of the digital learning environment, positively impacted the performance of the ELs in the study.

Due to their lack of fluency in English, ELs must simultaneously learn mathematical terms and apply them to solve problems and perform mathematical computations. Accommodating for ELs by using simplified language in mathematical word problems has demonstrated positive results (Abedi & Dietel, 2004). In their analysis of mathematics software programs, Ganesh and Middleton (2006) found that there was an absence of mathematics language in many digital programs that revolved around drill and practice and focused primarily on learning basic calculations. Furthermore, the findings of their study suggested that using technology can provide ELs with language experiences, motivates ELs to use their second language, helps ELs identify mathematical patterns, and enables ELs to communicate their knowledge with little need for translation (Ganesh & Middleton, 2006). In addition, "the untiring, non-judgmental nature of the computer makes it an ideal tool to help ELs feel sufficiently secure to make and correct their own errors without embarrassment of anxiety" (Ganesh & Middleton, 2006, p. 103).

In spite of the potential attributes of digital learning on EL mathematics instruction noted by Ganesh and Middleton (2006), the study's results reported no significant improvements in the achievement of the ELs who used the digital mathematics intervention. They concluded that the following factors had a higher impact on the mathematics achievement of the ELs in the study, and therefore, led to the lack of improved results: (a) the software program did not offer the use of manipulatives, (b) the teachers did not have strong mastery of the digital intervention program and its features, and (c) the teachers did not have strong backgrounds in teaching ELs. These findings partly coincided with Hattie's (2009) notion that computer-assisted instruction must be accompanied with adequate teacher preparation in order for it to positively impact student learning.

Positive outcomes in mathematics achievement have been associated with ELs who used the computer-based HELP (Help with English Language Proficiency) Math intervention program (Crawford, 2013; Freeman & Crawford, 2008). The HELP Math program "incorporates specific techniques of sheltered instruction such as visuals, repetition, synchronicity, and building on prior knowledge, to make mathematics instruction comprehensible to the ELs while simultaneously developing English language proficiency" (Freeman & Crawford, 2008, p. 12). Because of its lack of native language support, however, ELs with higher levels of English proficiency experienced more accelerated mathematics achievement than newly arrived ELs with low levels of English proficiency. Providing support for language and literacy development in the home language provides a foundation for success in English (Snow, Burns, & Griffin, 1998). Therefore, one may conclude that digital interventions that target the acceleration of ELs must incorporate extra native language support in order to meet the needs of a greater amount of ELs.

Implications for Professional Learning

In a survey of teachers, Ragan (2006) showed that (a) nearly 70% of the teachers surveyed have students in their classes whose first language is not English, (b) 90% of all teachers surveyed say their ELs need extra help to learn the content and skills required in their grade level, and (c) teachers consider all four subject areas—reading, math, science, and social studies—significantly more difficult for ELs than for native English speakers. According to the

U.S. Department of Education, only 20% of U.S. teachers feel well prepared to meet the needs of such students (Lewis et al., 1999).

In many cases, teachers certified in ESL are not trained or competent in teaching content area subjects (e.g.; social studies, science, and mathematics). According to the National Center for Educational Statistics, in the 1999–2000 school year, at three quarters of the middle school ESL or bilingual teachers did not report holding a major certification in the subject that they taught (Seastrom, Gruber, Henke, McGrath, & Cohen, 2002). Many teachers of ELs have difficulty, and even fear, teaching mathematics (Freeman, 2008; Zaslavsky, 1994). Similarly, many mainstream content area teachers are not trained in effective EL instructional practices, and therefore, do not have the language development skills needed to help ELs overcome their language barriers and succeed in their content area classes (Nutta, Strebel, Mokhtari, Mihai, & Crevecoeur-Bryant, 2014; Haynes & Zacarian, 2010; Freeman, 2008).

Due to the prevalent use of technology inside and outside of the classroom, it has become increasingly important for teachers to accept the demand for classroom technology use and obtain the skills needed to engage their students in lessons that incorporate digital learning. However, technology does not “have any impact on its own- it all depends on how we use it” (Stokes, 2012, p.8). Therefore, there is a need for further research that focuses on how teachers should use technology in their classrooms to maximize the learning outcomes of their students.

With society’s current reliance on the use of digital technology, even the most effective teachers struggle with engaging the majority of their students when technology is not used (Prensky, 2005). It has been argued that current middle school literacy instruction relies heavily on practices that are outdated and do not meet the needs of 21st century students (Ajayi, 2009). In order to meet the demands of more rigorous standards of instruction, instruction must have relevance and meaning in the lives of its students (Marzano, 2007). Being able to integrate the digital literacy that student possess into the classroom has become a required skill for elementary and secondary school teachers (Ajayi, 2009; Grabill & Hicks, 2005; Lankshear & Knobel, 2006; Ware & Warschauer, 2005).

Much like the rest of American society, teachers are frequent users of digital technology. However, many teachers find it difficult to incorporate digital resources into their classroom instruction (Cuban, 2001; Hattie, 2009) and perceive interactive technology as being sources of student distraction and disengagement (Magana & Marzano, 2014). In addition, many teachers are digital non-natives, and as a result, did not experience digital learning during their schooling (Roblyer & Doering, 2010). For many teachers, "teaching using computer resources is not part of their grammar of schooling" (Hattie, 2009, p.223). Abrami, Bernard, Wade, Schmid, Borokhowski, and Tamim (2006) added that "many teachers are still on the threshold of understanding how to design courses to maximize the potentials of technology" (p. 32).

Teacher preparation and professional development can substantially impact both teacher and student performance (Hattie, 2009). In his meta-analysis, Hattie (2009) reported that digital learning is more effective when there is teacher preparation in the use of computers as a teaching and learning tool. In his analysis of pre-training for teachers using computer-assisted instruction, Jones (1991) found that pre-training had a $d = 0.31$ effect on the effectiveness of teachers implementing digital learning. This effect increased to $d = 0.53$ when teachers were provided with more than ten hours of pre-training. In addition, Jones (1991) reported that teachers who received more than ten hours of pre-training achieved up to 72 percent more gain than the average digital classroom. It can be argued, therefore, that in order to maximize the effectiveness of digital learning environments, school leaders must provide the necessary support and professional development to teachers who are transforming their instructional practices.

The rapid growth of the EL population and the increased use of technology both outside and inside the classroom has required teachers of ELs to learn how to infuse digital learning into their daily classroom instruction. In order to do so effectively, some have made deliberate efforts to enhance ESL best practices by learning how to integrate the use of interactive technology and digital tools. There is an absence, however, of technology integration among professional development and teacher certification programs that prepare teachers to work with ELs. In other words, ESL certification and teacher preparation programs do not strongly emphasize how to effectively incorporate digital learning into ESL instruction. As schools proceed to integrate digital interventions as a means of supporting EL instruction, efforts to align effective EL pedagogy with appropriate uses of classroom technology must continue. There is not an abundance of research-based recommendations for technology integration that effectively promotes the academic success of ELs. There is a need for continued research that analyzes the extent that digital tools improve EL instruction. This knowledge is needed to improve the likelihood that teachers of ELs will receive the support needed to meet the diverse needs of their students through innovative digital methods.

Digital learning emphasizes the use of many different tools and resources to support and empower teachers and students. In addition, digital learning can be used to provide individualized professional learning opportunities for teachers. Hixon and So (2009) made recommendations for infusing digital learning into teacher preparation programs by using technology to observe teachers at other locations, video-conference with mentors, and use virtual settings to conduct simulated classroom lessons. Cutri and Johnson (2010) found the use of digital story-telling to be an effective use of technology in teacher education and professional development programs.

The use of digital learning as a means of supporting teacher development and instructional improvement has some limitations. Hixon and So (2009) identified the following four limitations of technology-enhanced teacher education programs: “(a) lack of interaction between teachers and students; (b) limited reality and complexity; (c) limited availability of relevant cases; and (d) technical problems and delays” (p. 299). Furthermore, the opportunities for teachers to improve their ability to “develop emotional engagement and make judgements that foster positive relationships with students is limited when using simulated scenarios for professional development” (Cutri & Johnson, 2010). This is due in part to the impersonal nature of teaching and learning with technology.

CHAPTER THREE: METHODOLOGY

Introduction and Design

The purpose of this study is to identify the extent to which learning in a digital school environment impacts the reading and mathematics achievement of English learners in elementary and secondary school settings. In addition, this study intends to determine the extent, if any, that learning in a digital school environment narrows the achievement gap in reading and mathematics between ELs and their non-EL counterparts in elementary and secondary schools. The focus of this study centers around four research questions. Research questions one and two quantitatively compare the reading and mathematics achievement of ELs in digital and non-digital school environments based on their performance on the 2013-2014 FCAT 2.0. Research questions three and four compare the learning gains in reading and mathematics of ELs and non-ELs in digital school environments based on their performance on the 2014 FCAT 2.0.

This study is comprised of four research questions. The research questions, initially stated in Chapter One, are restated as follows:

1. What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners in digital and English learners in non-digital elementary and secondary school settings?
2. What is the difference, if any, between the Developmental Scale Scores (DSS) of the 2014 Florida Comprehensive Assessment Test 2.0 (FCAT 2.0) Mathematics of English learners in digital and English learners in non-digital elementary and secondary school settings?
3. What is the difference, if any, in Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners and non-English

learners after adjusting for the previous year's scores in digital elementary and secondary school settings?

4. What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?

This chapter presents the methodology employed to test the research questions. This chapter is organized into three sections: (a) selection of participants, (b) instrumentation, (c) data collection, and (d) data analysis.

Selection of Participants

To reduce the number of variables, this exploratory study will focus on the academic growth of English learners enrolled in the digital pilot program of one large urban school district (LUSD) during the 2013-2014 school year. All of the schools within LUSD are supposed to follow the same curriculum and order of instruction, have access to the same teacher resources via a shared instructional management system, administer common benchmark examinations and school district and state assessments, and use the same evaluation tools for teacher and school leader performance.

At the time of this study, LUSD was the 10th largest school district in the United States and the 4th largest school district in the state of Florida. Within LUSD, the sample of digital learners was drawn from seven schools participating in the first year of a digital pilot program during the 2014-2014 school year. At the time of this study, the district was comprised of 123 elementary schools, 35 middle schools, and 19 high schools with a total student population of

187,000 students. Among these seven digital pilot schools was one high school (grades 9-12), three middle schools (grades 6-8), and three elementary schools (grades 3-5).

For this study, one group of participants will be derived from English learners who attended the digital pilot elementary and secondary schools in LUSD and took the FCAT 2.0 Reading and FCAT 2.0 Mathematics during the 2012-2013 and 2013-2014 school years. A second group of participants will be derived from English learners who attended matched schools that were comparable non-digital elementary and secondary non-digital schools in LUSD and took the FCAT 2.0 Reading and FCAT 2.0 Mathematics during the 2012-2013 and 2013-2014 school years. The demographics that were considered in determining comparable matched digital and non-digital schools were: (a) overall number of students enrolled; (b) percentage of economically disadvantaged students; (c) total number of English learners enrolled; and (d) percentage of English learners enrolled.

There are a total of 9,069 participants in this study. From this total, 1,584 of the students are classified as ELs. The remaining 7,485 are classified as non-ELs. The tables below indicate the breakdown of the ELs and non-ELs in both the digital and non-digital schools involved in this study. On these tables, the schools are listed according to their level (elementary, middle, and high). Elementary school participants represent students from grades 3 through 5 who took the FCAT 2.0 Reading and FCAT 2.0 Mathematics during the 2012-2013 and 2013-2014 school years. Middle school participants represent students from grades 6 through 8 who took the FCAT 2.0 Reading and FCAT 2.0 Mathematics during the 2012-2013 and 2013-2014 school years. High school participants represent students from grades 9 and 10 who took the FCAT 2.0 Reading during the 2012-2013 and 2013-2014 school years.

Table 5

Participants from Digital and Non-Digital Elementary Schools N=1,351

Elementary Schools	Number of ELs	Number of non-ELs	Total
Digital Elementary 1	69	148	217
Non-Digital Elementary 1	90	185	275
Digital Elementary 2	93	146	239
Non-Digital Elementary 2	94	115	209
Digital Elementary 3	43	135	178
Non-Digital Elementary 3	48	185	233
Total of All Elementary Schools	437	914	1351

Table 6

Participants from Digital and Non-Digital Middle Schools N=5,788

Middle Schools	Number of ELs	Number of non-ELs	Total
Digital Middle 1	96	899	995
Non-Digital Middle 1	94	939	1033
Digital Middle 2	162	708	870
Non-Digital Middle 2	281	615	896
Digital Middle 3	162	823	985
Non-Digital Middle 3	158	851	1009
Total of All Middle Schools	953	4835	5788

Table 7

Participants from Digital and Non-Digital High Schools N=1,930

High Schools	Number of ELs	Number of non-ELs	Total
Digital High 1	134	930	1064
Non-Digital High 1	60	806	866
Total All High Schools	194	1736	1930

Instrumentation

The first operational tests for the Florida Comprehensive Assessment Test (FCAT) were administered in 1998 after field testing the previous year (FLDOE, 2005). The FCAT was used to measure student academic achievement in grades 3-10 and were based on benchmarks found in the Sunshine State Standards (SSS), which were adopted by the Florida State Board of Education in 1996 (FLDOE, 2005). With the purpose of measuring student achievement on a more rigorous newly adopted set of standards, the Next Generation Sunshine State Standards (NGSSS) in reading, writing, science, and mathematics, the FCAT was replaced by the FCAT 2.0 in 2011. This study uses two assessments to evaluate student achievement, the FCAT 2.0 Reading and the FCAT 2.0 Mathematics.

The FCAT 2.0 Reading is a 140 minute assessment administered in two 70 minute sessions for all students in grades three through ten. It consists of 50-55 items forming four content categories: vocabulary; reading application; literary analysis: fiction and nonfiction; and informational text and research process.

The FCAT 2.0 Mathematics for grades three through ten is administered in two 70 minute sessions. The assessments for grades three through seven consist of 50-55 items, while the eighth grade FCAT 2.0 Mathematics consists of 60-65 items forming numerous content categories that build upon each other from one year to the next (FLDOE, n.d.).

Test items are categorized by difficulty and cognitive complexity (FLDOE, 2012a). Item difficulty refers to the percentage of students who answer the question item correctly. Items are categorized as easy (70% or more correct), average (40%-70% correct), and challenging (less than 40% correct) (FLDOE, 2012a). “Cognitive complexity refers to the cognitive demand associated with an item” (FLDOE, 2012a, p. 1). According to the FLDOE (FLDOE, 2012a), cognitive complexity for the FCAT 2.0 is measured using a cognitive classification system based on Dr. Norman L. Webb's Depth of Knowledge (DOK) level (p. 1) which focuses on the expectations of the items rather than student ability. Complexity levels are categorized as low complexity, moderate complexity, and high complexity. "Low-complexity items rely heavily on recall and recognition. Moderate-complexity items require more flexible thinking and may require informal reasoning or problem solving. High-complexity items are written to elicit analysis and abstract reasoning" (FLDOE, n.d.).

Two types of question formats appear in the FCAT 2.0 Reading and Mathematics. Multiple choice (MC) questions for which students select the best response from four answer choices appear in both the FCAT 2.0 Reading and Mathematics assessments. Gridded-response and fill-in response questions for which students enter responses into a grid or type in answers appear on the FCAT 2.0 Mathematics assessments for grades four through eight (FLDOE, 2014b).

FCAT 2.0 scores are reported in various forms. Reading and mathematics developmental scale scores (DSS) link assessment results for individual students from year to year in order to determine student academic progress (FLDOE, 2014b). The FCAT 2.0 Reading developmental score scale ranges from 140 to 302 and the FCAT 2.0 Mathematics scale ranges from 140 to 298 (FLDOE, 2014b). The DSS are tied in to a second way in which scores are reported—through achievement levels. "Achievement Levels describe the level of success a student has achieved with the content assessed. Achievement Levels range from 1 (lowest) to 5 (highest)" (FLDOE, 2014b, p. 6). Students must earn a level three or higher on the FCAT Reading and Mathematics to pass each respective test. An achievement level of three represents a satisfactory understanding of the grade level benchmarks (FLDOE, 2014b). Table 3 shows achievement levels for the FCAT 2.0 Reading DSS and Table 4 shows achievement levels for the FCAT 2.0 Mathematics DSS.

Data Collection

The study followed all rules and regulations regarding research required by the local school district and the university. All individual identifiers within the data were destroyed upon receipt from the school district in adherence to the Family Education Rights Privacy Act (U.S. Department of Education, 2012). The study relied on non-identified individual student performance data from seven schools not publicly available through the Florida Department of Education.

This study was a requirement in the fulfillment of a university doctoral program. The following sections outline the protocols for data collection from the university and local school district. This study employed a quantitative methodology of data collection and analysis. These data were obtained in accordance with the protocols of the university and local school district involved in the study.

The university required approval by its Institutional Review Board (IRB) prior to the conduction of research. The researcher submitted application to the Institutional Review Board and subsequently received approval to conduct the research described (Appendix C).

The local school district required an application for research be submitted and approval of the application before any data were collected. The application included general information about the researcher, documentation of recent completion of Collaborative Institutional Training Initiative (CITI) training involving human research, a signed dissertation proposal defense for the topic to be researched including the problem and purpose of the research, the research questions, the specific data required to answer the research questions, and a description of how the findings would be used. Chapter one was submitted with the application for approval. Approval was received on September 2, 2015.

All quantitative data collected were provided by LUSD. All identifying characteristics within the data were destroyed upon collection in order to maintain the anonymity of the students involved. Records for individual students representative of the population involved in the study were provided to the researcher. Quantitative data were used to answer research questions one through four.

The data requested represented students who enrolled as in the seven LUSD digital pilot schools and students enrolled in seven demographically comparable LUSD non-digital schools. In addition, both the ELs and non-ELs in the study all participated in the FCAT 2.0 Reading and FCAT 2.0 Mathematics during the 2012-2013 and 2013-2014 school years. Specific data requested for this study included the school of enrollment, year of enrollment, English language learner (ELL) status, Free-and-Reduced Lunch (FRL) status used to determine socioeconomic status, Florida Comprehensive Assessment 2.0 (FCAT) Reading developmental scale scores (DSS), Florida Comprehensive Assessment 2.0 (FCAT) Mathematics developmental scale scores (DSS), Learning gains (LG) on Florida Comprehensive Assessment 2.0 (FCAT) Reading, and Learning gains (LG) on Florida Comprehensive Assessment 2.0 (FCAT) Mathematics.

Data Analysis

In order to examine the impact of digital learning on EL reading and mathematics achievement, this study compared the reading and mathematics achievement of ELs in digital and non-digital elementary and secondary school settings. The reading and mathematics achievement of the ELs in this study was measured by their performance on the 2014 FCAT 2.0 Reading and Mathematics. In addition, in order to examine the impact of digital learning on the achievement gap between ELs and non-ELs in reading and mathematics achievement, this study compared the learning gains in reading and mathematics of ELs and their non-EL counterparts in digital elementary and secondary school settings. The learning gains in reading and mathematics achievement of the ELs and non-ELs in this study were measured by the increase in performance from the 2013 to the 2014 FCAT 2.0 Reading and Mathematics.

This study was guided by four research questions. Research Question One compared the reading achievement of ELs in digital and non-digital school environments based on their performance on the 2014 FCAT 2.0. Research Question Two compared the mathematics achievement of ELs in digital and non-digital school environments based on their performance on the 2014 FCAT 2.0. Research Question Three compared the reading of ELs and non-ELs in digital school environments based on their performance on the 2014 FCAT 2.0 after adjusting for the previous year's scores. Research Question Four compared the mathematics achievement of ELs and non-ELs in digital school environments based on their performance on the 2014 FCAT 2.0 after adjusting for the previous year's scores.

This study employed quantitative data analysis methods. Research questions one and two used quantitative analyses in order to measure the impact of digital learning on EL achievement in reading and mathematics. Research questions three and four used quantitative analyses in order to measure the impact on digital learning on the learning gains of ELs and non-ELs in digital school environments. All quantitative data were analyzed using IBM SPSS version 20. The table below indicates the research questions, independent variables, and sources of data, and statistical methods used to analyze the data in this study.

Table 8

Research Questions, Variables, Data Sources, and Methods of Analysis

Research Questions	Variables	Data Sources	Analysis
1. What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners in digital and English learners in non-digital elementary and secondary school settings?	Dependent: FCAT 2.0 Reading DSS Independent: Digital learning implementation	2014 FCAT 2.0 Reading Developmental Scale Scores for grades 3-10.	Independent t-test
2. What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners in digital and English learners in non-digital elementary and secondary school settings?	Dependent: FCAT 2.0 Mathematics DSS Independent: Digital learning implementation	2014 FCAT 2.0 Mathematics Developmental Scale Scores for grades 3-8.	Independent t-test
3. What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?	Dependent: FCAT 2.0 Reading DSS Independent: Digital learning implementation	2014 FCAT 2.0 Reading Developmental Scale Scores for grades 3-10.	ANCOVA
4. What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?	Dependent: FCAT 2.0 Mathematics DSS Independent: Digital learning implementation	2014 FCAT 2.0 Mathematics Developmental Scale Scores for grades 3-8.	ANCOVA

For research question one and two, the 2014 Grade FCAT 2.0 Reading Developmental Scale Scores and FCAT 2.0 Mathematics Developmental Scale Scores of ELs in digital pilot schools in LUSD and ELs in non-digital schools in LUSD will be compared using an independent samples *t*-test to determine the extent to which the scores of the groups differed on each assessment.

For research questions three and four, the 2014 Grade FCAT 2.0 Reading Developmental Scale Scores and FCAT 2.0 Mathematics Developmental Scale Scores of ELs in digital pilot schools in LUSD and ELs in non-digital schools in LUSD will be compared after adjusting for the previous year's scores using an analysis of co-variance (ANCOVA).

Summary

In conclusion, this chapter presented the methodologies used to conduct this quantitative study. Included in this chapter was a description of the design of the study, the selection of the participants, the methods and sources of data collection, and the statistical tests used to analyze the data for each one of the four research questions.

Chapter three identified the primary population of this study to be ELs who attended digital and non-digital elementary and secondary schools within the selected urban school district. In addition, comparing the learning gains in reading and mathematics achievement of ELs and non-ELs in digital school settings was also of interest to this study. The pairing of comparable digital and non-digital schools included in these comparisons were based upon the following school demographics: (a) school size; (b) free-and-reduced lunch rate; (c) total number of ELs enrolled; and (d) percentage of ELs enrolled. A discussion of data collection methods, including the university and local school district protocols, was presented. The last section discussed the statistical analyses that will be used to answer each of the four research questions. The findings from these analyses will be presented in chapter four.

CHAPTER FOUR: PRESENTATION AND ANALYSIS OF DATA

Introduction

The purpose of this study is to identify the extent to which learning in a digital school impacts the reading and mathematics achievement of English learners. In addition, this study intends to determine the extent, if any, that learning in a digital school environment narrows the achievement gap in reading and mathematics between ELs and their non-EL counterparts in elementary and secondary schools. The focus of this study centers around four research questions. Research Question One compared the reading achievement of ELs in digital and non-digital school environments based on their performance on the 2014 FCAT 2.0. Research Question Two compared the mathematics achievement of ELs in digital and non-digital school environments based on their performance on the 2014 FCAT 2.0. Research Question Three compared the reading achievement of ELs and non-ELs in digital school environments after based on their performance on the 2014 FCAT 2.0 after adjusting for the previous year's scores. Research Question Four compared the mathematics achievement of ELs and non-ELs in digital school environments based on their performance on the 2014 FCAT 2.0 after adjusting for the previous year's scores.

Testing the Research Questions

This was a quantitative research study that was conducted to address four research questions. In order to examine the impact of digital learning on EL reading and mathematics achievement, this study compared the reading and mathematics achievement of ELs in digital and non-digital elementary and secondary school settings. The reading and mathematics achievement of the ELs in this study was measured by their performance on the 2014 FCAT 2.0.

For research question one and two, the 2014 Grade FCAT 2.0 Reading Developmental Scale Scores and FCAT 2.0 Mathematics Developmental Scale Scores of ELs in digital pilot schools in LUSD and ELs in non-digital schools in LUSD was compared using an independent samples t-test to determine the extent to which the scores of the groups differed on each assessment.

In addition, in order to examine the impact of digital learning on the achievement gap between ELs and non-ELs in reading and mathematics achievement, this study compared the reading and mathematics achievement of ELs and their non-EL counterparts after in digital elementary and secondary school settings after adjusting for the previous year's scores. For research questions three and four, the 2014 FCAT 2.0 Reading Developmental Scale Scores and FCAT 2.0 Mathematics Developmental Scale Scores of ELs in digital pilot schools and non-English learners in digital pilot schools were compared using an analysis of co-variance (ANCOVA).

Research Question One

Research Question One: What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners in digital and English learners in non-digital elementary and secondary school settings?

The reading achievement of the ELs in this study was measured by their performance on the 2014 FCAT 2.0 Reading. To answer this research question, the 2014 Grade FCAT 2.0 Reading Developmental Scale Scores of ELs in digital pilot schools in LUSD and ELs in non-digital schools in LUSD was compared using an independent samples *t*-test to determine the extent to which the scores of the groups differed on each assessment.

For this research question, one group of participants was derived from English learners who attended one of the seven digital pilot elementary and secondary schools in LUSD and took the FCAT 2.0 Reading during the 2013-2014 school year. Each of these seven digital pilot schools was matched with a demographically comparable non-digital school. The demographics that were considered in determining comparable matched digital and non-digital schools were: (a) overall student enrollment; (b) percentage of students who qualify for free-and-reduced lunch; (c) percentage of ELs enrolled; and (d) total number of ELs enrolled. There were three elementary school matches, three middle school matches, and one high school match.

A series of independent samples *t*-tests was conducted to determine the difference, if any, between the mean FCAT 2.0 Reading DSS of the ELs in the following ways: (1) by overall performance of all digital vs all non-digital schools; (2) by school level (all digital elementary schools vs all non-digital elementary and all digital middle schools vs all non-digital middle); (3) by each grade level (3-8) for all digital vs all non-digital schools; and (4) by each matched pair of digital and non-digital schools.

Comparison of Overall EL Reading Achievement

In this comparison, the combined means and standard deviations of the FCAT 2.0 Reading DSS of ELs in all seven digital schools in the study were compared with the combined means and standard deviations of all seven non-digital schools. The mean FCAT 2.0 Reading DSS of the ELs in all digital schools (M = 218.49) was higher than the mean FCAT 2.0 Reading DSS of the ELs in non-digital schools (M = 212.45). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in all digital and non-digital schools are reported in Table 9.

Table 9

Reading Developmental Scale Score (DSS) of All ELs Digital and Non-Digital

Schools	N	Mean	Standard Deviation
Digital	790	218.49	20.113
Non-Digital	867	212.45	19.365

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in the combination of all seven digital schools (*M* = 218.49, *SD* = 20.113) and non-digital schools (*M* = 212.45, *SD* = 19.365) in the study. The results showed that the Reading DSS of ELs in digital schools were significantly higher than the Reading DSS of ELs in non-digital schools, $t(1,655) = 6.219$, $p < .05$. These results are indicated in Table 10.

Table 10

Independent Samples t-test Comparison of Reading Developmental Scale Score of ELs in All Digital and Non-Digital Schools

t	df	Significance (2-tailed)
6.219	1,655	0.000

Note: $p<.05$

Comparison of EL Reading Achievement by School Level

The mean FCAT 2.0 Reading DSS of the ELs in all digital elementary schools (*M* = 208.57) was higher than the mean FCAT 2.0 Reading DSS of the ELs in non-digital elementary schools (*M* = 203.44). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in all digital and non-digital elementary schools are reported in Table 11.

Table 11

Reading Developmental Scale Score Means of Elementary School ELs Digital and Non-Digital

School	*N*	Mean	Standard Deviation
Digital Elementary	188	208.57	18.268
Non-Digital Elementary	223	203.44	17.767

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in digital elementary schools (*M* = 208.5, *SD* = 18.268) and non-digital elementary schools *M* = 203.44, *SD* = 17.767). The results showed that the Reading DSS of ELs in digital elementary schools were significantly higher than the Reading DSS of ELs in non-digital elementary schools, $t(409) = 2.879$, $p < .05$. These results are indicated on Table 12.

Table 12

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Elementary School ELs Digital and Non-Digital

t	df	Significance (2-tailed)
2.879	409	0.004

Note: $p<.05$

The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in all digital and non-digital middle schools are reported in Table 13. The mean FCAT 2.0 Reading DSS of the ELs in all digital middle schools (*M* = 220.99) was higher than the mean FCAT 2.0 Reading DSS of the ELs in non-digital middle schools (*M* = 215.03). These results are indicated on Table 13.

Table 13

Reading Developmental Scale Scores of Middle School ELs Digital and Non-Digital

Schools	*N*	Mean	Standard Deviation
Digital Middle	540	220.99	19.875
Non-digital Middle	511	215.03	19.179

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in digital middle schools (*M* = 220.99, *SD* = 19.875) and non-digital middle schools (*M* = 215.03, *SD* = 19.179). The results showed that the Reading DSS of ELs in digital middle schools were significantly higher than the Reading DSS of ELs in non-digital middle schools, $t(1{,}049) = 4.944$, $p < .05$. These results are indicated in Table 14.

Table 14

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Middle School ELs Digital and Non-Digital

t	df	Significance (2-tailed)
4.944	1,049	0.000

Note. p <.05

The mean FCAT 2.0 Reading DSS of the ELs in digital high schools (*M* = 217.48) was lower than the mean FCAT 2.0 Reading DSS of the ELs in non-digital high schools (*M* =

226.93). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in all digital and non-digital high schools are reported in Table 15.

Table 15

Reading Developmental Scale Scores of High School ELs Digital and Non-Digital

Schools	N	Mean	Standard Deviation
Digital High	134	217.48	17.885
Non-Digital High	61	226.93	17.203

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in digital high schools (M = 217.48, SD = 18.131) and non-digital high schools (M = 226.93, SD = 17.203). The results showed that the Reading DSS of ELs in digital high schools were significantly lower than the Reading DSS of ELs in non-digital middle schools, $t(120) = 3.515$, $p < .05$. These results are indicated in Table 16.

Table 16

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs by School Level-All Digital and Non-Digital High

t	df	Significance (2-tailed)
3.515	120	0.006

Note. $p < .05$

Comparison of EL Reading Achievement by Grade Level in Elementary Schools

The mean FCAT 2.0 Reading DSS of the ELs in grade 3 in all digital elementary schools (M = 177.57) was lower than the mean FCAT 2.0 Reading DSS of the ELs in grade 3 in all non-digital elementary schools (*M* = 187.68). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in grade 3 of all digital and non-digital elementary schools are reported in Table 17.

Table 17

Reading Developmental Scale Scores of ELs in Grade 3 of All Digital and Non-Digital Elementary Schools

Schools	N	Mean	Standard Deviation
Digital Elementary	7	177.57	19.739
Non-Digital Elementary	28	187.68	15.875

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in grade 3 in digital elementary schools (*M* = 177.57, *SD* = 19.739) and non-digital elementary schools (*M* = 187.68, *SD* = 15.875). The results showed no statistically significant difference between the Reading DSS of ELs in grade 3 in digital and non-digital elementary schools, $t(33) = -1.437$, $p = 0.160$. These results are indicated in Table 18.

Table 18

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs in Grade 3 of All Digital and Non-Digital Elementary Schools

					95% Confidence Interval of the Difference	
t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
1.437	33	.160	-10.107	7.033	-24.417	4.202

Note: $p>.05$

The mean FCAT 2.0 Reading DSS of the ELs in grade 4 in all digital elementary schools (*M* = 208.79) was higher than the mean FCAT 2.0 Reading DSS of the ELs in grade 4 in all non-digital elementary schools (*M* = 202.81). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in grade 4 of all digital and non-digital elementary schools are reported in Table 19.

Table 19

Reading Developmental Scale Scores of ELs in Grade 4 of All Digital and Non-Digital Elementary Schools

Schools	N	Mean	Standard Deviation
Digital Elementary	96	208.79	17.656
Non-Digital Elementary	100	202.81	15.931

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in grade 4 in digital elementary schools (*M* = 208.79, *SD* = 17.656) and non-digital elementary schools (*M* = 202.81, *SD* = 15.931). The results showed that the Reading DSS of ELs in grade 4 in digital elementary schools were significantly higher than the Reading DSS of ELs in grade 4 in non-digital elementary schools, $t(194) = 2.492$, $p < .05$. These results are indicated in Table 20.

Table 20

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs in Grade 4 of All Digital and Non-Digital Elementary Schools

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
2.492	194	.014	5.892	2.400	1.248	10.716

Note: p<.05

The mean FCAT 2.0 Reading DSS of the ELs in grade 5 in all digital elementary schools (*M* = 210.88) was higher than the mean FCAT 2.0 Reading DSS of the ELs in grade 5 in all non-digital elementary schools (*M* = 208.76). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in grade 5 of all digital and non-digital elementary schools are reported in Table 21.

Table 21

Reading Developmental Scale Scores of ELs in Grade 5 of All Digital and Non-Digital Elementary Schools

Schools	N	Mean	Standard Deviation
Digital Elementary	85	210.88	16.643
Non-Digital Elementary	95	208.76	17.401

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in grade 5 in digital elementary schools (*M* = 210.88, *SD* = 16.643) and non-digital elementary schools (*M* = 208.76, *SD* = 17.401). The results showed no statistically significant difference between the Reading DSS of ELs in grade 5 in digital and non-digital elementary schools, *t*(178) = .835, *p* = 0.405. These results are indicated in Table 22.

Table 22

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs in Grade 5 of All Digital and Non-Digital Elementary Schools

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
.835	178	.405	2.124	2.545	-2.898	7.147

Note: $p > .05$

Comparison of EL Reading Achievement by Grade Level in Middle Schools

The mean FCAT 2.0 Reading DSS of the ELs in grade 6 in digital middle schools (*M* = 216.34) was lower than the mean FCAT 2.0 Reading DSS of the ELs in grade 6 in non-digital middle schools (*M* = 217.71). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in grade 6 of all digital and non-digital middle schools are reported in Table 23.

Table 23

Reading Developmental Scale Scores of ELs in Grade 6 of All Digital and Non-Digital Middle Schools

Schools	N	Mean	Standard Deviation
Digital Middle	185	216.34	19.449
Non-Digital Middle	214	217.71	18.323

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in grade 6 in digital middle schools (*M* = 216.34, *SD* = 19.449) and non-digital middle schools (*M* = 217.71, *SD* = 18.323). The results showed no statistically significant difference between the Reading DSS of ELs in grade 6 in digital and non-digital middle schools, $t(397) = -.727$, $p = .468$. These results are indicated in Table 24.

Table 24

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs in Grade 6 of All Digital and Non-Digital Middle Schools

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
.727	397	.468	-1.375	1.893	-5.096	2.346

Note: $p > .05$

The mean FCAT 2.0 Reading DSS of the ELs in grade 7 in digital middle schools (M = 214.70) was lower than the mean FCAT 2.0 Reading DSS of the ELs in grade 7 in non-digital middle schools (M = 216.98). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in grade 7 of all digital and non-digital middle schools are reported in Table 25.

Table 25

Reading Developmental Scale Scores of ELs in Grade 7 of All Digital and Non-Digital Middle Schools

Schools	N	Mean	Standard Deviation
Digital Middle	178	214.70	19.448
Non-Digital Middle	185	216.98	20.663

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in grade 7 in digital middle schools (M = 214.70, SD = 19.448) and non-digital middle schools (M = 216.98, SD = 20.663). The results showed no statistically significant difference in the Reading DSS of ELs in grade 7 in digital and non-digital middle schools, *t*(361) = -1.085, *p* = .279. These results are indicated in Table 26.

Table 26

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs in Grade 7 of All Digital and Non-Digital Middle Schools

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
1.085	361	.279	-2.287	2.108	-6.432	1.858

Note: *p*>.05

The mean FCAT 2.0 Reading DSS of the ELs in grade 8 in digital middle schools (*M* = 222.96) was higher than the mean FCAT 2.0 Reading DSS of the ELs in grade 8 in non-digital middle schools (*M* = 221.58). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in grade 8 of all digital and non-digital middle schools are reported in Table 27.

Table 27

Reading Developmental Scale Scores of ELs in Grade 8 of All Digital and Non-Digital Middle Schools

Schools	N	Mean	Standard Deviation
Digital Middle	154	222.96	19.972
Non-Digital Middle	137	221.58	20.139

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in grade 8 in digital middle schools (*M* = 222.96, *SD* = 19.972) and non-digital middle schools (*M* = 221.58, *SD* = 20.139). The results showed no significant difference between the Reading DSS of ELs in grade 8 in digital and non-digital middle schools, $t(289) = .588$, $p = .557$. These results are indicated in Table 28.

Table 28

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs in Grade 8 of All Digital and Non-Digital Middle Schools

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
.588	289	.557	1.377	2.344	-3.236	5.990

Note: $p>.05$

Comparison of EL Reading Achievement by Grade Level in High Schools

The mean FCAT 2.0 Reading DSS of the ELs in grade 9 in digital high schools (M = 214.73) was lower than the mean FCAT 2.0 Reading DSS of the ELs in grade 9 in non-digital high schools (M = 223.13). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in grade 9 of all digital and non-digital high schools are reported in Table 29.

Table 29

Reading Developmental Scale Scores of ELs in Grade 9 of All Digital and Non-Digital High Schools

Schools	N	Mean	Standard Deviation
Digital High	70	214.73	17.745
Non-Digital High	31	223.13	16.581

An independent-samples t-test that was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in grade 9 in digital high schools (M =

214.73, *SD* = 17.745) and non-digital middle schools (*M* = 223.13, *SD* = 16.581). The results showed that the Reading DSS of ELs in grade 9 in digital high schools were significantly lower than the Reading DSS of ELs in grade 9 in non-digital high schools, $t(99) = -2.238$, $p < .05$. The results are indicated in Table 30.

Table 30

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs in Grade 9 of All Digital and Non-Digital High Schools

					95% Confidence Interval of the Difference	
t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
2.238	99	.027	-8.400	3.754	-15.849	-.952

Note: $p<.05$

The mean FCAT 2.0 Reading DSS of the ELs in grade 10 in digital high schools (*M* = 220.48) was lower than the mean FCAT 2.0 Reading DSS of the ELs in grade 10 in non-digital high schools (*M* = 230.87). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in grade 10 of all digital and non-digital high schools are reported in Table 31.

Table 31

Reading Developmental Scale Scores of ELs in Grade 10 of All Digital and Non-Digital High Schools

Schools	N	Mean	Standard Deviation
Digital High	64	220.48	17.687
Non-Digital High	30	230.87	17.218

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in grade 10 in digital high schools (*M* =

220.48, *SD* = 17.687) and non-digital middle schools (*M* = 230.87, *SD* = 17.218). The results showed that the Reading DSS of ELs in grade 10 in digital high schools were significantly lower than the Reading DSS of ELs in grade 10 in non-digital high schools, $t(92) = 2.675$, $p < .05$. These results are indicated in Table 32.

Table 32

Independent Samples t-test Comparison of Reading Developmental Scale Scores of ELs in Grade 10 of All Digital and Non-Digital High Schools

					95% Confidence Interval of the Difference	
t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
2.675	92	.009	-10.382	3.881	-18.090	-2.674

Note: *p*<.05

Comparison of EL Reading Achievement in Matched Elementary Schools

The mean FCAT 2.0 Reading DSS of the ELs in Digital Elementary School 1 (*M* = 212.88) was higher than the mean FCAT 2.0 Reading DSS of the ELs in Non-Digital Elementary School 1 (*M* = 207.55). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in demographically matched Digital Elementary School 1 and Non-Digital Elementary School 1 are reported in Table 33.

Table 33

Reading Developmental Scale Scores of ELs in Demographically Matched Digital Elementary School 1 and Non-Digital Elementary School 1

School	N	Mean	Standard Deviation	Standard Error of Mean
Digital Elementary 1	50	212.88	15.481	2.189
Non-Digital Elementary 1	91	207.55	13.947	1.462

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in Digital Elementary School 1 (M = 212.88, SD = 15.481) and Non-Digital Elementary School 1 (M = 207.55, SD = 13.947). The results showed that the Reading DSS of ELs in Digital Elementary School 1 were significantly higher than the Reading DSS of ELs in Non-Digital Elementary 1, $t(139) = 2.087$, $p < .05$. These results are indicated in Table 34.

Table 34

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Demographically Matched Digital Elementary School 1 and Non-Digital Elementary School 1

					95% Confidence Interval of the Difference	
t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
2.087	139	.039	5.331	2.554	.282	10.380

Note: $p<.05$

The mean FCAT 2.0 Reading DSS of the ELs in Digital Elementary School 2 (M = 209.51) was higher than the mean FCAT 2.0 Reading DSS of the ELs in Non-Digital Elementary School 2 (M = 200.27). The means and standard deviations of the FCAT 2.0 Reading DSS of

ELs in Digital Elementary School 2 and Non-Digital Elementary School 2 are reported in Table 35.

Table 35

Reading Developmental Scale Scores of ELs in Demographically Matched Digital Elementary School 2 and Non-Digital Elementary School 2

School	N	Mean	Standard Deviation	Standard Error of Mean
Digital Elementary 2	94	209.51	18.349	1.893
Non-Digital Elementary 2	95	200.27	19.604	2.011

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in Digital Elementary School 2 (*M* = 209.51, *SD* = 18.349) and Non-Digital Elementary School 2 (*M* = 200.27, *SD* = 19.604). The results showed that the Reading DSS of ELs in Digital Elementary School 2 were significantly higher than the Reading DSS of ELs in Non-Digital Elementary 2, $t(187) = 3.343$, $p < .05$. These results are indicated in Table 36.

Table 36

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Demographically Comparable Digital Elementary School 2 and Non-Digital Elementary School 2

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
3.343	187	.001	9.237	2.763	3.787	14.687

Note: $p<.05$

The mean FCAT 2.0 Reading DSS of the ELs in Digital Elementary School 3 (*M* = 201.68) was higher than the mean FCAT 2.0 Reading DSS of the ELs in Non-Digital Elementary School 3 (*M* = 201.49). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in Digital Elementary School 3 and Non-Digital Elementary School 3 are reported in Table 37.

Table 37

Reading Developmental Scale Scores of ELs in Demographically Comparable Digital Elementary School 3 and Non-Digital Elementary School 3

School	N	Mean	Standard Deviation	Standard Error of Mean
Digital Elementary 3	44	201.68	19.440	2.931
Non-Digital Elementary 3	37	201.49	19.587	3.220

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in Digital Elementary School 3 (*M* = 201.68, *SD* = 19.440) and Non-Digital Elementary School 2(*M* = 201.49, *SD* = 19.587). The results showed no significant difference between the Reading DSS of ELs in Digital Elementary School 3 and Non-Digital Elementary 3, $t(79) = 0.045$, $p = .964$. These results are indicated in Table 38.

Table 38

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Demographically Comparable Digital Elementary School 3 & Non-Digital Elementary School 3

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
.045	79	.964	.195	4.351	-8.465	8.856

Note: p>.05

Comparison of EL Reading Achievement in Matched Middle Schools

The mean FCAT 2.0 Reading DSS of the ELs in Digital Middle School 1 (*M* = 218.19) was higher than the mean FCAT 2.0 Reading DSS of the ELs in Non-Digital Middle School 1 (*M* = 214.07). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in Digital Middle School 1 and Non-Digital Middle School 1 are reported in Table 39.

Table 39

Reading Developmental Scale Scores of ELs in Demographically Comparable Digital Middle School 1 and Non-Digital Middle School 1

School	N	Mean	Standard Deviation	Standard Error of Mean
Digital Middle 1	97	218.19	18.538	1.882
Non-Digital Middle 1	95	214.07	16.636	1.707

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in Digital Middle School 1 (*M* = 218.19, *SD* = 8.538) and Non-Digital Middle School 1 (*M* = 214.07, *SD* = 16.636). The results showed no significant difference between the Reading DSS of ELs in Digital Middle School 1 and Non-Digital Middle School 1, $t(190) = 1.616$, $p = .108$. These results are indicated in Table 40.

Table 40

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Demographically Comparable Digital Middle School 1 and Non-Digital Middle School 1

					95% Confidence Interval of the Difference	
t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
1.616	190	.108	4.112	2.544	-.906	9.130

Note: $p>.05$

The mean FCAT 2.0 Reading DSS of the ELs in Digital Middle School 2 (*M* = 218.24) was higher than the mean FCAT 2.0 Reading DSS of the ELs in Non-Digital Middle School 2 (*M* = 211.43). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in Digital Middle School 2 and Non-Digital Middle School 2 are reported in Table 41.

Table 41

Reading Developmental Scale Scores of ELs in Demographically Comparable Digital Middle School 2 and Non-Digital Middle School 2

School	N	Mean	Standard Deviation	Standard Error of Mean
Digital Middle 2	282	218.24	20.441	1.217
Non-Digital Middle 2	257	211.43	18.879	1.178

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in Digital Middle School 2 (*M* = 218.24, *SD* = 20.441) and Non-Digital Middle School 2 (*M* = 211.43, *SD* = 18.879). The results showed that the Reading DSS of ELs in Digital Middle School 2 were significantly higher than the

Reading DSS of ELs in Non-Digital Middle School 2, $t(537) = 4.010$, $p < .05$. These results are indicated in Table 42.

Table 42

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Demographically Comparable Digital Middle School 2 and Non-Digital Middle School 2

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
4.010	537	.000	-6.817	1.700	-3.477	10.156

Note: $p<.05$

The mean FCAT 2.0 Reading DSS of the ELs in Digital Middle School 3 ($M = 227.44$) was higher than the mean FCAT 2.0 Reading DSS of the ELs in Non-Digital Middle School 3($M = 221.43$). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in Digital Middle School 3 and Non-Digital Middle School 3 are reported in Table 43.

Table 43

Reading Developmental Scale Scores of ELs in Demographically Comparable Digital Middle School 3 and Non-Digital Middle School 3

School	N	Mean	Standard Deviation	Standard Error of Mean
Digital Middle 3	163	227.44	18.063	1.415
Non-Digital Middle 3	159	221.43	19.555	1.551

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in Digital Middle School 3 ($M = 227.44$, $SD = 18.063$) and Non-Digital Middle School 3 ($M = 221.43$, $SD = 19.555$). The results showed that the Reading DSS of ELs in Digital Middle School 3 were significantly higher than the Reading DSS of ELs in Non-Digital Middle School 3, $t(320) = 2.868$, $p < .05$. These results are indicated in Table 44.

Table 44

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Demographically Comparable Digital Middle School 3 and Non-Digital Middle School 3

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
2.868	320	.004	6.014	2.097	1.888	10.140

Note: $p<.05$

Comparison of EL Reading Achievement in Matched High Schools

The mean FCAT 2.0 Reading DSS of the ELs in Digital High School 1 (M = 217.48) was lower than the mean FCAT 2.0 Reading DSS of the ELs in Non-Digital High School 1 (M = 226.93). The means and standard deviations of the FCAT 2.0 Reading DSS of ELs in Digital High School 1 and Non-Digital High School 1 are reported in Table 45.

Table 45

Reading Developmental Scale Scores of ELs in Demographically Comparable Digital High School 1 and Non-Digital High School 1

School	N	Mean	Standard Deviation	Standard Error of Mean
Digital High 1	134	217.48	17.885	1.545
Non-Digital High 1	61	226.93	17.204	2.203

An independent-samples t-test was conducted to compare the FCAT 2.0 Reading Developmental Scale Scores (DSS) of English learners in Digital High School 1 (M = 217.48, *SD* = 17.885) and Non-Digital High School 1 (*M* = 226.93, *SD* = 17.204). The results showed that the Reading DSS of ELs in Digital High School 1 were significantly lower than the Reading DSS of ELs in Non-Digital High School 1, $t(320) = 2.868$, $p < .05$. These results are indicated in Table 46.

Table 46

Independent Samples t-test Comparison of Reading Developmental Scale Scores of Demographically Comparable Digital High School 1 and Non-Digital High School 1

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
3.464	193	.001	-9.457	2.730	-14.842	-4.072

Note: $p<.05$

Research Question Two

Research Question Two: What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners in digital and English learners in non-digital elementary and secondary school settings?

The mathematics achievement of the ELs in this study was measured by their performance on the 2014 FCAT 2.0 Mathematics. To answer this research question, the 2014 Grade FCAT 2.0 Mathematics Developmental Scale Scores (DSS) of ELs in digital pilot schools in LUSD and ELs in non-digital schools in LUSD was compared using an independent samples *t*-test to determine the extent to which the scores of the groups differed on each assessment.

For this research question, one group of participants was derived from English learners who attended one of the six digital pilot elementary and secondary schools in LUSD and took the FCAT 2.0 Mathematics during the 2013-2014 school year. Each of these six digital pilot schools was matched with a demographically comparable non-digital school. The demographics that were considered in determining comparable matched digital and non-digital schools were: (a) overall student enrollment; (b) percentage of students who qualify for free-and-reduced lunch; (c) percentage of ELs enrolled; and (d) total number of ELs enrolled. There were three elementary school matches and three middle school matches.

A series of independent samples *t*-tests was conducted to determine the difference, if any, between the mean FCAT 2.0 Mathematics DSS of the ELs in the following ways: (1) by overall performance of all digital vs all non-digital schools; (2) by school level (all digital elementary schools vs all non-digital elementary and all digital middle schools vs all non-digital middle); (3) by each grade level (3-8) for all digital vs all non-digital schools; and (4) by each matched pair of digital and non-digital schools.

Comparison of Overall EL Mathematics Achievement

The mean FCAT 2.0 Mathematics DSS of the ELs in all digital schools (M = 215.65) was higher than the mean FCAT 2.0 Mathematics DSS of the ELs in non-digital schools (M = 215.00). The means and standard deviations of the FCAT 2.0 Mathematics DSS of ELs in all digital and non-digital schools are reported in Table 47.

Table 47

Mathematics Developmental Scale Scores of ELs by School Level-All Digital and Non-Digital Schools

Schools	N	Mean	Standard Deviation
Digital Schools	839	215.65	19.534
Non-Digital Schools	820	215.00	20.368

An independent-samples t-test was conducted to compare the FCAT 2.0 Mathematics Developmental Scale Scores (DSS) of English learners in digital schools (*M* = 215.65, *SD* = 19.534) and non-digital schools (*M* = 215.00, *SD* = 20.368). The results showed no significant difference between the Mathematics DSS of ELs in digital and non-digital schools, $t(1{,}650) = 1.961$, $p = .509$. These results are indicated in Table 48.

Table 48

Independent Samples t-test Comparison of Mathematics Developmental Scale Scores of ELs in All Digital and Non-Digital Schools

t	df	Significance (2-tailed)
1.961	1,650	0.509

Note: p>.05

Comparison of EL Mathematics Achievement by School Level

. The mean FCAT 2.0 Mathematics DSS of the ELs in all digital elementary schools (*M* = 212.17) was higher than the mean FCAT 2.0 Mathematics DSS of the ELs in non-digital elementary schools (*M* = 209.47). The means and standard deviations of the FCAT 2.0 Mathematics DSS of ELs in all digital and non-digital elementary schools are reported in Table 49.

Table 49

Mathematics Developmental Scale Scores of ELs by School Level-All Digital and Non-Digital Elementary Schools

Schools	N	Mean	Standard Deviation
Digital Elementary Schools	189	212.17	19.943
Non-Digital Elementary Schools	222	209.47	19.399

An independent-samples t-test was conducted to compare the FCAT 2.0 Mathematics Developmental Scale Scores (DSS) of English learners in digital elementary schools (*M* = 212.17, *SD* = 19.943) and non-digital elementary schools 1 (*M* = 209.47, *SD* = 19.399). The results showed no significant difference between the Mathematics DSS of ELs in digital and non-digital elementary schools, $t(409) = 1.391$, $p = 0.165$. These results are indicated in Table 50.

Table 50

Independent Samples t-test Comparison of Mathematics Developmental Scale Scores of ELs by School Level-All Digital and Non-Digital Elementary Schools

t	df	Significance (2-tailed)
1.391	409	0.165

Note: $p>.05$

The mean FCAT 2.0 Mathematics DSS of the ELs in all digital middle schools (*M* = 222.54) was higher than the mean FCAT 2.0 Mathematics DSS of the ELs in non-digital middle schools (*M* = 222.34). The means and standard deviations of the FCAT 2.0 Mathematics DSS of ELs in all digital and non-digital middle schools are reported in Table 51.

Table 51

Mathematics Developmental Scale Scores of ELs by School Level-All Digital and Non-Digital Middle Schools

Schools	N	Mean	Standard Deviation
Digital Middle Schools	540	222.54	21.655
Non-Digital Middle Schools	511	222.34	21.363

An independent-samples t-test was conducted to compare the FCAT 2.0 Mathematics Developmental Scale Scores (DSS) of English learners in digital middle schools (*M* = 222.34, *SD* = 21.655) and non-digital middle schools (*M* = 215.03, *SD* = 21.363). The results showed no significant difference between the Mathematics DSS of ELs in digital and non-digital middle schools, *t*(1,046) = 0.152, *p* = .879. These results are indicated in Table 52.

Table 52

Independent Samples t-test Comparison of Mathematics Developmental Scale Scores of ELs by School Level-All Digital and Non-Digital Middle Schools

t	df	Significance (2-tailed)
0.152	1,046	0.879

Note: p>.05

Comparison of EL Mathematics Achievement by Grade Level in Elementary Schools

The mean FCAT 2.0 Mathematics DSS of the ELs in grade 3 in all digital elementary schools (*M* = 206.66) was lower than the mean FCAT 2.0 Mathematics DSS of the ELs in grade 3 in all non-digital elementary schools (*M* = 211.48). The means and standard deviations of the FCAT 2.0 Mathematics DSS of ELs in grade 3 of all digital and non-digital elementary schools are reported in Table 53.

Table 53

Mathematics Developmental Scale Scores of ELs in Grade 3 of All Digital and Non-Digital Elementary Schools

Schools	N	Mean	Standard Deviation
Digital Elementary Schools	125	206.66	19.075
Non-Digital Elementary Schools	103	211.48	22.017

An independent-samples t-test was conducted to compare the FCAT 2.0 Mathematics Developmental Scale Scores (DSS) of English learners in grade 3 in digital elementary schools (*M* = 206.66, *SD* = 19.075) and non-digital elementary schools (*M* = 211.48, *SD* = 22.017). The results showed no significant difference between the Mathematics DSS of ELs in grade 3 in digital elementary and non-digital elementary schools, $t(226) = -1.771$, $p = 0.078$. These results are indicated in Table 54.

Table 54

Independent Samples t-test Comparison of Mathematics Developmental Scale Scores of ELs in Grade 3 of All Digital and Non-Digital Elementary Schools

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
1.771	226	.078	-4.820	2.722	-10.184	.544

Note: p>.05

The mean FCAT 2.0 Mathematics DSS of the ELs in grade 4 in all digital elementary schools (*M* = 212.71) was lower than the mean FCAT 2.0 Mathematics DSS of the ELs in grade 4 in all non-digital elementary schools (*M* = 213.07). The means and standard deviations of the

FCAT 2.0 Mathematics DSS of ELs in grade 4 in digital and non-digital elementary schools are reported in Table 55.

Table 55

Mathematics Developmental Scale Scores of ELs in Grade 4 of All Digital and Non-Digital Elementary Schools

Schools	N	Mean	Standard Deviation
Digital Elementary Schools	94	212.71	20.102
Non-Digital Elementary Schools	86	213.01	17.224

An independent-samples t-test was conducted to compare the FCAT 2.0 Mathematics Developmental Scale Scores (DSS) of English learners in grade 4 in digital elementary schools (*M* = 212.71, *SD* = 20.102 and non-digital elementary schools (*M* = 213.01, *SD* = 17.224). The results showed no significant difference between the Mathematics DSS of ELs in grade 4 in digital and non-digital elementary schools, $t(178) = .107$, $p = .915$. These results are indicated in Table 56.

Table 56

Independent Samples t-test Comparison of Mathematics Developmental Scale Scores of ELs in Grade 4 of All Digital and Non-Digital Elementary Schools

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
.107	178	.915	-.299	2.803	-5.830	5.232

Note: p>.05

The mean FCAT 2.0 Mathematics DSS of the ELs in grade 5 in all digital elementary schools (*M* = 216.71) was higher than the mean FCAT 2.0 Mathematics DSS of the ELs in grade 5 in all non-digital elementary schools (*M* = 216.63). The means and standard deviations of the FCAT 2.0 Mathematics DSS of ELs in grade 5 of all digital and non-digital elementary schools are reported in Table 57.

Table 57

Descriptive Statistics of Mathematics Developmental Scale Scores of ELs in Grade 5 of All Digital and Non-Digital Elementary Schools

Schools	N	Mean	Standard Deviation
Digital Elementary Schools	215	216.71	21.910
Non-Digital Elementary Schools	186	216.63	22.836

An independent-samples t-test was conducted to compare the FCAT 2.0 Mathematics Developmental Scale Scores (DSS) of English learners in grade 5 in digital elementary schools (*M* = 216.71, *SD* = 21.910) and non-digital elementary schools (*M* = 216.63, *SD* = 22.836). The results showed no significant difference between the Mathematics DSS of ELs in grade 5 in digital and non-digital elementary schools, $t(399) = .037$, $p = 0.971$. These results are indicated in Table 58.

Table 58

Independent Samples t-test Comparison of Mathematics Developmental Scale Scores of ELs in Grade 5 of All Digital and Non-Digital Elementary

t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
.037	399	.971	.083	2.237	-4.316	4.481

Note: *p*>.05

Comparison of EL Mathematics Achievement by Grade Level in Middle Schools

The mean FCAT 2.0 Mathematics DSS of the ELs in grade 6 in digital middle schools (*M* = 223.17) was higher than the mean FCAT 2.0 Mathematics DSS of the ELs in grade 6 in non-digital middle schools (*M* = 222.88). The means and standard deviations of the FCAT 2.0 Mathematics DSS of ELs in grade 6 of all digital and non-digital middle schools are reported in Table 59.

Table 59

Mathematics Developmental Scale Scores of ELs in Grade 6 of All Digital and Non-Digital Middle Schools

Schools	N	Mean	Standard Deviation
Digital Middle Schools	175	223.17	19.270
Non-Digital Middle Schools	177	222.88	19.479

An independent-samples t-test that was conducted to compare the FCAT 2.0 Mathematics Developmental Scale Scores (DSS) of English learners in grade 6 in digital middle schools (*M* = 223.17, *SD* = 19.270) and non-digital middle schools (*M* = 222.88, *SD* = 19.479). The results showed no significant difference between the Mathematics DSS of ELs in grade 6 in digital and non-digital middle schools, $t(350) = 0.140$, $p = 0.888$. These results are indicated in Table 60.

Table 60

Independent Samples t-test Comparison of Mathematics Developmental Scale Scores of ELs in Grade 6 of All Digital and Non-Digital Middle Schools

					95% Confidence Interval of the Difference	
t	df	Significance (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
.140	350	.888	.290	2.065	-3.772	4.352

Note: $p > .05$

The mean FCAT 2.0 Mathematics DSS of the ELs in grade 7 in digital middle schools (M = 230.53) was higher than the mean FCAT 2.0 Mathematics DSS of the ELs in grade 7 in non-digital middle schools (M = 229.31). The means and standard deviations of the FCAT 2.0 Mathematics DSS of ELs in grade 7 of all digital and non-digital middle schools are reported in Table 61.

Research Question Three

Research Question Three: What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners and non-English learners after adjusting for the previous year’s scores in digital elementary and secondary school settings?

The differences in reading achievement of the ELs and non-ELs in this study were measured by the Developmental Scale Scores (DSS) on the 2014 FCAT 2.0 Reading examination after adjusting for the previous year’s scores. To answer this research question, the

FCAT 2.0 Reading DSS of English learners and non-English learners in digital pilot schools were compared using an analysis of co-variance (ANCOVA).

Comparison of Reading Achievement in Digital Elementary Schools

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Elementary School 1 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, F (238) = 0.71, p = .790. The mean score for the non-ELs (M = 221.86, SE = 15.869) was greater than the mean score for the ELs (M = 212.88, SE = 15.481). The ANCOVA was not associated with a statistically significant effect, F (1, 217) = .749, p = .388. After the adjustment for the 2013 DSS, there was not a statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Elementary School 1.

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Elementary School 2 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, F (238) = 0.71, p = .790. The mean score for the non-ELs (M = 218.38, SE = 20.354) was greater than the mean score for the ELs (M = 209.51, SE = 18.349). The ANCOVA was not associated with a statistically significant effect, F (1, 239) = 2.555, p = .111. After the adjustment for the 2013 DSS, there was not a statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Elementary School 2.

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Elementary School 3 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (177) = 1.451, *p* = .230. The mean score for the non-ELs (*M* =208.78, *SE* = 17.205) was greater than the mean score for the ELs (*M* = 201.68, *SE* = 19.440). The ANCOVA was not associated with a statistically significant effect, *F* (1, 178) = .003, *p* = .959. After the adjustment for the 2013 DSS, there was not a statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Elementary School 3.

Comparison of Reading Achievement in Digital Middle Schools

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Middle School 1 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (879) = 22.591, *p* = .000. The mean score for the non-ELs (*M* =235.17, *SE* = 20.528) was greater than the mean score for the ELs (*M* = 218.19, *SE* = 18.538). The ANCOVA was not associated with a statistically significant effect, *F* (1, 1095) = .673, *p* = .412. After the adjustment for the 2013 DSS, there was no statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Middle School 1.

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Middle School 2 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (869) = 1.422, *p* = .233. The mean score for the non-ELs (*M* =232.29, *SE* = 19.283) was greater than the mean score for the ELs (*M* = 211.43, *SE* = 18.879). The ANCOVA was associated with a statistically significant effect, *F* (1, 870) = 8.734, *p* = .003. After the adjustment for the 2013 DSS, there was a statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Middle School 2.

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Middle School 3 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (984) = 1.503, *p* = .220. The mean score for the non-ELs (*M* =244.17, *SE* = 19.624) was greater than the mean score for the ELs (*M* = 227.44, *SE* = 18.063). The ANCOVA was not associated with a statistically significant effect, *F* (1, 985) = 2.961, *p* = .086. After the adjustment for the 2013 DSS, there was no statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital Middle School 3.

Comparison of Reading Achievement in Digital High School

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital High School 1 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (1064) = 1.751, *p* = .186. The mean score for the non-ELs (*M* =240.68, *SE* = 18.533) was greater than the mean score for the ELs (*M* = 217.48, *SE* = 17.885). The ANCOVA was associated with a statistically significant effect, *F (*1, 1065) = 22.149, *p* = .000. After the adjustment for the 2013 DSS, there was a statistically significant difference in the SS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in Digital High School 1.

Research Question Four

Research Question Four: What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?

The mathematics achievement of the ELs and non-ELs in this study were measured by the Developmental Scale Scores (DSS) from the 2014 FCAT 2.0 Mathematics examination. To answer this research question, the 2014 FCAT 2.0 Mathematics DSS of ELs in digital pilot schools and non-English learners in digital pilot schools were compared using an analysis of co-variance (ANCOVA).

Comparison of Mathematics Achievement in Digital Elementary Schools

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Elementary School 1 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, F (216) = 0.316, p = .574. The mean score for the non-ELs (M =223.81, SE = 18.060) was greater than the mean score for the ELs (M = 216.34, SE = 20.314). The ANCOVA was not associated with a statistically significant effect, F (1, 217) =. 1.676, p = .197. After the adjustment for the 2013 DSS, there was no statistically significant difference in the DSS of the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Elementary School 1.

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Elementary School 2 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (238) = .072, *p* = .788. The mean score for the non-ELs (*M* =218.99, *SE* = 22.173) was greater than the mean score for the ELs (*M* = 213.13, *SE* = 19.783). The ANCOVA was associated with a statistically significant effect, *F(*1, 237) = 6.045, *p* = .015. After the adjustment for the 2013 DSS, there was a statistically significant difference in the DSS of the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Elementary School 2.

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Elementary School 3 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (178) = 2.594, *p* = .109. The mean score for the non-ELs (*M* =213.95, *SE* = 19.645) was greater than the mean score for the ELs *(M* = 205.56, *SE* = 18.605). The ANCOVA was not associated with a statistically significant effect, *F* (1, 179) = .005, *p* = .944. After the adjustment for the 2013 DSS, there was no statistically significant difference in the DSS of the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Elementary School 3.

Comparison of Mathematics Achievement in Digital Middle Schools

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Middle School 1 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (1095) = 3.418, *p* = .065. The mean score for the non-ELs (*M* =238.51, *SE* = 19.851) was greater than the mean score for the ELs (*M* = 224.68, *SE* = 19.854). The ANCOVA was not associated with a statistically significant effect, *F* (1, 1096) = .000, *p* = .989. After the adjustment for the 2013 DSS, there was no statistically significant difference in the DSS of the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Middle School 1.

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Middle School 2 truly resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (879) = 22.591, *p* = .000. The mean score for the non-ELs (*M* =233.82, *SE* = 19.482) was greater than the mean score for the ELs (*M* = 214.90, *SE* = 20.221). The ANCOVA was associated with a statistically significant effect, *F* (1, 880) = 16.493, *p* = .000. After the adjustment for the 2013 DSS, there was a statistically significant difference in the DSS of the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Middle School 2.

An analysis of co-variance (ANCOVA) was conducted to ensure that the DSS on the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Middle School 3 resulted from digital learning implementation and not a left-over, random effect of pre-test differences between these groups. The assumption of homogeneity of variance was tested and satisfied via Levene's F test, *F* (983) = 2.984, *p* = .084. Table 2 shows that the mean score for the non-ELs (M =250.34, SE = 17.579) was greater than the mean score for the ELs (*M* = 233.49, *SE* = 19.939). The ANCOVA was associated with a statistically significant effect, *F* (1, 984) = 10.653, *p* = .001. After the adjustment for the 2013 DSS, there was a statistically significant difference in the DSS of the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in Digital Middle School 3.

Summary of Research Question Findings

Results for Research Question One

A series of independent samples *t*-tests was conducted to determine the difference, if any, between the mean FCAT 2.0 Reading DSS of the ELs in the following ways: (1) by overall performance of all digital vs all non-digital schools; (2) by school level (all digital elementary schools vs all non-digital elementary, all digital middle schools vs all non-digital middle, and all digital high schools vs all non-digital high); (3) by each grade level (3-10) for all digital vs all non-digital schools; and (4) by each matched pair of digital and non-digital schools. The following is a summary of the results for Research Question One:

1. In the comparison by overall performance of all the digital and non-digital schools in the study, the FCAT 2.0 Reading DSS of ELs in digital schools were significantly higher than the FCAT 2.0 Reading DSS of ELs in non-digital schools, $t(1,655) = 6.219$, $p < .05$.
2. In the comparison by school level:

   a.) The FCAT 2.0 Reading DSS of ELs in digital elementary schools were significantly higher than the FCAT 2.0 Reading DSS of ELs in non-digital elementary schools, $t(409) = 2.879$, $p < .05$.

   b.) The FCAT 2.0 Reading DSS of ELs in digital middle schools were significantly higher than the FCAT 2.0 Reading DSS of ELs in non-digital middle schools, $t(1,049) = 4.944$, $p < .05$.

   c.) The FCAT 2.0 Reading DSS of ELs in digital high schools were significantly lower than the FCAT 2.0 Reading DSS of ELs in non-digital middle schools, $t(120) = 3.515$, $p < .05$.

3. In the comparison by each grade level, the FCAT 2.0 Reading DSS of ELs in digital elementary schools were significantly higher than in the non-digital elementary schools in grade 4. There was no statistically significant difference in the FCAT 2.0 Reading DSS of ELs in digital and non-digital middle schools, grade 6, 7, or 8. For grades 9 and 10, the FCAT 2.0 Reading DSS of ELs in the non-digital high school were significantly higher than in the digital high school of this study.
4. In the comparison by each pair matched pair of demographically comparable digital and non-digital schools:
   a.) In the comparison of elementary schools, the FCAT 2.0 Reading DSS of the ELs in two out of the three digital schools were significantly higher than in their matched non-digital schools. There was no statistically significant difference in the FCAT 2.0 Reading DSS of the ELs in the third pair of matched schools.
   b.) In the comparison of middle schools, the FCAT 2.0 Reading DSS of the ELs in all three digital middle schools were significantly higher than in their matched non-digital schools.
   c.) In the high school comparison, the FCAT 2.0 Reading DSS of the ELs in the digital school were significantly lower than in the non-digital school.

Results for Research Question Two

A series of independent samples *t*-tests was conducted to determine the difference, if any, between the mean FCAT 2.0 Mathematics DSS of the ELs in the following ways: (1) by overall performance of all digital vs all non-digital schools; (2) by school level (all digital elementary schools vs all non-digital elementary, all digital middle schools vs all non-digital middle, and all digital high schools vs all non-digital high); (3) by each grade level (3-10) for all digital vs all non-digital schools; and (4) by each matched pair of digital and non-digital schools. The following is a summary of the results of Research Question Two:

1. In the comparison by overall performance of all the digital and non-digital schools in the study, there was no significant difference between the Mathematics DSS of ELs in digital and non-digital schools, $t(1{,}650) = 1.961$, $p = .509$.
2. In the comparison by school level:
   a.) The FCAT 2.0 Mathematics DSS of ELs in digital elementary schools were significantly higher than the Mathematics DSS of ELs in non-digital elementary schools, $t(409) = 1.391$, $p = 0.165$.
   b.) There was no significant difference between the FCAT 2.0 Mathematics DSS of ELs in digital and non-digital middle schools, $t(1{,}046) = 0.152$, $p = .879$.
3. In the comparisons by each grade level, there were no statistically significant differences in any of the grades between the ELs in digital and non-digital elementary and secondary schools.
4. In the comparison by each pair matched pair of demographically comparable digital and non-digital schools:
   a.) In the comparison of elementary schools, the FCAT 2.0 Mathematics DSS of the ELs in two out of the three digital schools were significantly higher than in their matched non-digital schools. There was no statistically significant difference in the FCAT 2.0 Reading DSS of the ELs in the third pair of matched schools.
   b.) In the comparison of middle schools, the FCAT 2.0 Mathematics DSS of the ELs in in two out of the three digital schools were significantly higher than in their matched

non-digital schools. In the third pair of matched middle schools, the FCAT 2.0 DSS of ELs was significantly lower in the digital middle school.

Results for Research Question Three

A series of ANCOVAs was conducted to determine the difference, if any, between the FCAT 2.0 Reading DSS of ELs and non-ELs, after adjusting for the previous year's scores, in the digital schools of the study. The following is a summary of the results of Research Question Three:

1. In the comparison of ELs and non-ELs in digital elementary schools, there was no statistically significant difference in the FCAT 2.0 Reading DSS in any of the three digital elementary schools.
2. In the comparison of ELs and non-ELs in digital middle schools, there was a statistically significant difference in the FCAT 2.0 Reading DSS in one of the three digital middle schools.
3. In the comparison of ELs and non-ELs in the digital high school, there was a statistically significant difference in the FCAT 2.0 Reading DSS in the digital high school.

Results for Research Question Four

A series of ANCOVAs was conducted to determine the difference, if any, between the FCAT 2.0 Mathematics DSS of ELs and non-ELs, after adjusting for the previous year's scores, in the digital schools of the study. The following is a summary of the results of Research Question Four:

1. In the comparison of ELs and non-ELs in digital elementary schools, there was a statistically significant difference in the FCAT 2.0 Mathematics DSS in one of the three digital elementary schools.
2. In the comparison of ELs and non-ELs in digital middle schools, there was a statistically significant difference in the FCAT 2.0 Mathematics DSS in two of the three digital middle schools.

CHAPTER FIVE: SUMMARY, DISCUSSION, AND CONCLUSIONS

Introduction

The purpose of this study was to investigate the extent to which learning in a digital school environment impacts the reading and mathematics achievement of English learners. In addition, this study intended to determine the extent, if any, that learning in a digital school environment narrows the achievement gap in reading and mathematics between ELs and their non-EL counterparts in elementary and secondary schools. The problem studied was the academic achievement gap that exists between English learners and non-English learners. There is a lack of research on the effect of digital learning on the academic achievement of English learners.

This study was guided by four research questions. Research Question One compared the reading achievement of ELs in digital and non-digital school environments based on their performance on the 2014 FCAT 2.0. Research Question Two compared the mathematics achievement of ELs in digital and non-digital school environments based on their performance on the 2014 FCAT 2.0. Research Question Three compared the reading achievement of ELs and non-ELs after in digital school environments based on their performance on the 2014 FCAT 2.0 after adjusting for the previous year's scores. Research Question Four compared the mathematics achievement of ELs and non-ELs in digital school environments based on their performance on the 2014 FCAT 2.0 after adjusting for the previous year's scores.

Chapter one introduced the problem and its theoretical framework. Chapter two presented a review of the literature. Chapter three described the methodology used for this study. Chapter four presented the analysis of data for the study. Chapter five is comprised of an introduction, a summary of the study, discussion of the findings, implications for practice, recommendations for further research, and conclusions. The purpose of chapter five is to expand upon the findings for the impact of digital learning on the reading and mathematics achievement of ELs to guide future pedagogy and to present suggestions for future research on the topic.

Summary of the Study

This chapter begins with a summary of the purpose and structure of the study and is followed by the findings related to digital learning and EL reading and mathematics achievement. A discussion of findings is offered in relation to digital learning and pedagogy that best addresses the needs of ELs in the areas of reading and mathematics. Lastly, implications for professional learning, classroom technology implementation, and EL teacher preparation are presented and discussed.

The achievement gap that exists between ELs and their non-EL counterparts in reading and mathematics achievement continues to be a problem in public schools in the United States. Efforts to improve the reading and mathematics achievement of ELs have included the implementation of academic interventions and the use of alternate instructional strategies and materials. One type of intervention is increased emphasis on the daily use of digital learning, which has been explored as a method of improving pedagogy. The purpose of this study was to investigate the extent to which learning in a digital school environment impacts the reading and mathematics achievement of English learners. In addition, this study intended to determine the extent, if any, that learning in a digital school environment narrows the achievement gap in reading and mathematics between ELs and their non-EL counterparts in elementary and secondary schools.

This was a quantitative research study. In order to examine the impact of digital learning on EL reading and mathematics achievement, this study compared the reading and mathematics achievement of ELs in digital and non-digital elementary and secondary school settings. The reading and mathematics achievement of the ELs in this study was measured by their performance on the 2014 FCAT 2.0 reading and mathematics examinations. In addition, in order to examine the impact of digital learning on the achievement gap between ELs and non-ELs in reading and mathematics achievement, this study compared the reading and mathematics achievement of ELs and their non-EL counterparts in digital elementary and secondary school settings after adjusting for the previous year's scores.

This study was guided by four research questions. Research Question One compared the reading achievement of ELs in digital and non-digital school environments based on their performance on the 2014 FCAT 2.0 examination. Research Question Two compared the mathematics achievement of ELs in digital and non-digital school environments based on their performance on the 2014 FCAT 2.0 examination. Research Question Three compared the learning gains in reading of ELs and non-ELs after adjusting for the previous year's scores in digital school environments based on their performance on the 2014 FCAT 2.0 examinations. Research Question Four compared mathematics achievement of ELs and non-ELs after adjusting for the previous year's scores in digital school environments based on their performance on the 2014 FCAT 2.0 examinations.

Discussion of the Findings

Research Question One

Research Question One: What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners in digital and English learners in non-digital elementary and secondary school settings?

The reading achievement of the ELs in this study was measured by their performance on the 2014 FCAT 2.0 Reading. To answer this research question, the 2014 FCAT 2.0 Reading Developmental Scale Scores of ELs in digital pilot schools in LUSD and ELs in non-digital schools in LUSD was compared using an independent samples *t*-test to determine the extent to which the scores of the groups differed on each assessment.

A series of independent samples *t*-tests was conducted to determine the difference, if any, between the mean FCAT 2.0 Reading DSS of the ELs in the following ways: (1) by overall performance of all digital vs all non-digital schools; (2) by school level (all digital elementary schools vs all non-digital elementary, all digital middle schools vs all non-digital middle, and all digital high schools vs all non-digital high); (3) by each grade level (3-10) for all digital vs all non-digital schools; and (4) by each matched pair of digital and non-digital schools.

The first set of independent samples t-tests compared the 2014 FCAT 2.0 Reading DSS of ELs in all of the elementary and secondary schools in this study. Statistically, the overall reading achievement of ELs was significantly higher in the digital than in the non-digital schools.

When grouped by school level, the reading achievement of ELs in digital elementary and middle schools was significantly higher than in the non-digital elementary and middle schools in this study. This finding coincides with previous studies that have associated digital learning with improvement in reading (Lee, Waxman, Wu, Michko, & Lin, 2011; Liao, Chang, & Chen, 2008; Moran, Ferdig, Pearson, Wardrop, & Blomeyer, 2008; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011).

Conversely, the reading achievement of ELs in the digital high school was significantly lower than in the non-digital high school of this study. This finding supported previous studies where digital learning environments have been linked with inconclusive or negative results on student outcomes in secondary school settings (Carr, 2012; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Sheppard, 2011).

When grouped by grade level, the reading achievement of ELs in digital elementary schools was significantly higher than in the non-digital elementary schools of this study for grade 4. In grades 3 and 5, there was no significant difference between the two groups. There was no statistically significant difference in the reading achievement of ELs in digital and non-digital middle schools in grade 6, 7, or 8. For grades 9 and 10, the reading achievement of ELs in the non-digital high school was significantly higher than in the digital high school of this study.

In this study, the reading achievement of ELs who attended seven digital pilot schools (three elementary, three middle, one high) was compared to the reading achievement of ELs who attended demographically matched non-digital schools. In the comparison of elementary schools, the reading achievement of the ELs in two out of the three digital schools was significantly higher than in their matched non-digital schools. There was no statistically significant difference in the reading achievement of the ELs in the third pair of matched schools.

On the secondary level, the reading achievement of the ELs in all three digital middle schools was significantly higher than in their matched non-digital schools. In the high school comparison, however, the reading achievement of the ELs in the digital school was significantly lower than in the non-digital school.

In earlier studies involving the use of computer-assisted language learning (CALL) in foreign-language acquisition, the CALL groups outperformed the non-CALL groups (Grgurovical, Chapelle, & Shelly, 2013). In addition, the implementation of one-to-one digital learning environments has been correlated with improved student achievement (Lee, Waxman, Wul, Michko, & Lin, 2011) and improved performance on standardized tests (Sauers & McLeod, 2012). Furthermore, digital learning has been found to be associated with positive reading outcomes for ELs in college and high school (Arslan & Sahin-Kizil, 2010; Kinash, Brand, Mathew, & Kordyban, 2011; Reid, 1997), ELs in middle school (Berryman, 2011; Carlo et al., 2004; Paraiso, 2010; Sturtevant & Kim, 2010; M. A. Williams, 2010), and ELs in elementary school (Freeman & Crawford, 2008). The findings resulting from this research question support the notion that digital learning environments positively impact the reading achievement of ELs in elementary and middle schools.

Although this study compared the reading achievement of ELs in a small group of schools within a large urban school district, some of the findings reinforce prior research that has focused on the use of digital learning to improve EL reading performance (Lee, Waxman, Wu, Michko, & Lin, 2011; Liao, Chang, & Chen, 2008; Moran, Ferdig, Pearson, Wardrop, & Blomeyer, 2008; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). These results also align with previous studies that researched the effectiveness of the use of interactive whiteboards (IWBs) in reading instruction (Lopez, 2009; Woods & Ashfield, 2008). This is relevant because the use of IWBs was a predominant instructional practice within this digital pilot initiative.

The acquisition of English literacy skills by non-native speakers has been linked to improved reading ability, and the ability to read and comprehend material is a precursor to success in school (Cummins, 1984; Echeverria, Vogt, & Short, 2008; Wolfe, 2009). Increasing one's knowledge and familiarity with new vocabulary is an essential component of second-language development. A meta-analysis of computer-assisted language learning (CALL) yielded positive effects for ELs in vocabulary and reading development (Felix, 2005; Direct vocabulary instruction (repeated, contextual and varied exposures to words) has been linked to improved reading comprehension (Freeman & Crawford, 2008; Marzano, 2004). Because digital learning can facilitate systematic vocabulary instruction with increased frequency and individualization, the use of classroom technology may have accelerated the English language acquisition and reading comprehension ability of the some of the ELs enrolled in the digital elementary and middle schools of this study.

In digital learning environments, students are exposed to multi-media instruction more frequently than in non-digital environments. The use of visual and audio aids has been associated with positive reading outcomes (Hickman, Pollard-Durodola, & Vaughn, 2004; Allison & Rehm, 2007). Showing digital images can allow ELs to link their native language to English (Hur & Suh, 2012), thereby improving their reading ability. In addition, the ability to access Internet resources and project videos and images can effectively support language development for ELs by allowing them to see relevant pictures (Hur & Suh, 2012). Since the use of multimedia instruction has been associated with positive learning outcomes (Hattie, 2009), it can be suggested that the reading achievement of some of the ELs in the digital middle and elementary schools of this study was improved by the increased accessibility of these resources.

In order to accelerate their acquisition of English, and as a result, improve their reading ability, ELs need classroom environments where they can practice speaking, listening, reading, and writing English. In addition, ELs need frequent opportunities to practice communicating (Nutta, Strebel, Mokhtari, Mihai, & Crevecoeur-Bryant, 2014) as well as express their ideas to interact with one another in small groups (Taylor, Watson, & Nutta, 2014). Interactive classroom technology can provide ELs with additional opportunities to practice these skills in a more engaging, authentic, and individualized manner. Some of the digital practices that promoted peer interactions among the ELs in the digital schools of this study were posting comments/blogging on social media websites, sharing Google documents, and engaging in teacher-created web quests.

Some studies have found that the use of digital learning does not correlate to gains in all content areas, but rather, only improved student achievement in some areas (D. Silvemail & Gritter, 2007; D. L. Silvemail, Pinkham, Wintle, Walker, & Bartlett, 2011). In addition, digital learning environments have been linked with inconclusive or negative results on student outcomes (Carr, 2012; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Sheppard, 2011). Contrary to the elementary and middle school comparisons, the ELs in the digital high schools performed lower in reading achievement than their EL counterparts in the non-digital high school. There was only one pair of high schools in this study. Because of this limited sample size of high school ELs, it is problematic to generalize any conclusions from the high school reading outcomes.

Research Question Two

Research Question Two: What is the difference, if any, between the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners in digital and English learners in non-digital elementary and secondary school settings?

The mathematics achievement of the ELs in this study was measured by their performance on the 2014 FCAT 2.0 Mathematics. To answer this research question, the 2014

FCAT 2.0 Mathematics Developmental Scale Scores of ELs in digital pilot schools in LUSD and ELs in non-digital schools in LUSD was compared using an independent samples *t*-test to determine the extent to which the scores of the groups differed on each assessment.

A series of independent samples *t*-tests was conducted to determine the difference, if any, between the mean FCAT 2.0 Mathematics DSS of the ELs in the following ways: (1) by overall performance of all digital vs all non-digital schools; (2) by school level (all digital elementary schools vs all non-digital elementary and all digital middle schools vs all non-digital middle schools); (3) by each grade level (3-8) for all digital vs all non-digital schools; and (4) by each matched pair of digital and non-digital schools.

The first set of independent samples t-tests compared the combined 2014 FCAT 2.0 Mathematics DSS of ELs in all of the elementary and secondary schools in this study. Statistically, there was no significant difference between the digital and non-digital schools.

When grouped by school level, there was no significant difference between the mathematics achievement of ELs in digital and non-digital elementary schools. On the secondary level, there was no significant difference between the mathematics achievement of ELs in digital and non-digital middle schools.

When grouped by grade level, There was no significant difference between digital and non-digital EL mathematics achievement in grades 3, 4, or 5. On the secondary level, there was no significant difference between the digital and non-digital middle schools in grades 6, 7, or 8.

In this study, the mathematics achievement of ELs who attended six digital pilot schools (three elementary, three middle) was compared to the mathematics achievement of ELs who attended demographically matched non-digital schools. In the comparison of elementary schools, the mathematics achievement of the ELs in two out of the three digital schools was significantly higher than in their matched non-digital schools. There was no statistically significant difference in the mathematics achievement of the ELs in the third pair of elementary schools.

On the secondary level, the mathematics achievement of the ELs in two out of the three digital middle schools was significantly higher than in their matched non-digital schools. In the third pair, the ELs of the non-digital school outperformed the ELs of the digital middle school.

The use of one-to-one digital learning environments has been correlated with improved student achievement (Lee, Waxman, Wul, Michko, & Lin, 2011) and improved performance on standardized tests (Sauers & McLeod, 2012). In addition, digital learning has been found to be associated with positive learning outcomes for ELs in college and high school (Arslan & Sahin-Kizil, 2010; Kinash, Brand, Mathew, & Kordyban, 2011; Reid, 1997), ELs in middle school (Berryman, 2011; Carlo et al., 2004; Paraiso, 2010; Sturtevant & Kim, 2010; M. A. Williams, 2010), and ELs in elementary school (Freeman & Crawford, 2008). In four of the six schools (2 elementary and 2 middle), the findings resulting from this research question support the notion that digital learning positively impacts the mathematics achievement of ELs in elementary and middle schools.

Although this study compared the mathematics achievement of ELs in a small group of schools within a large urban school district, some of the findings reinforce prior research that has linked the use of digital learning with improved EL mathematics performance (Lei & Zhao, 2007; Lopez, 2010; Kim & Chang, 2010; Mendicino, Razzaq, & Heffernan, 2009). Many of the findings, however, support the notion that digital learning has inconclusive or negative results on EL mathematics achievement (Ganesh & Middleton, 2006; Flory, 2012).

Even though this research question yielded some evidence to support the notion that digital learning improves EL mathematics outcomes in elementary and secondary schools, the findings in many of the comparisons showed no significant difference. This may be due in part to the varying levels of teacher knowledge and expertise of effective EL pedagogy. In elementary schools, many teachers of ELs have difficulty, and even fear, teaching mathematics (Freeman, 2008; Zaslavsky, 1994). Many secondary school teachers certified in ESL are not competent in teaching mathematics, and as a result, are more frequently assigned to teach English language arts or remedial reading classes. Similarly, many mathematics teachers are not trained in effective EL instructional practices, and therefore, do not have the language development skills needed to help ELs overcome their language barriers and succeed in their classes (Nutta, Strebel, Mokhtari, Mihai, & Crevecoeur-Bryant, 2014; Haynes & Zacarian, 2010; Freeman, 2008). Teachers who lack fundamental knowledge of effective EL instructional strategies are less likely to be able to utilize technology to improve these practices.

In the comparisons by grade level, there were was an absence of significantly higher outcomes for the ELs in the digital elementary and middle schools of this study. There is a lack of research that compares impact of digital learning on the mathematics achievement of ELs in elementary and middle schools. The outcomes of this study suggest a need for further study in this area.

Since the use of interactive whiteboards was a predominant instructional practice within this digital pilot initiative, it is important to indicate how these findings support and extend the results of previous studies. Woods and Ashfield (2008) found positive relationships between the use of IWBs and student outcomes in reading and mathematics because IWBs enabled teachers to quickly access curriculum materials and easily save, retrieve, and edit data. In his study of digital elementary classrooms, Lopez (2010) also linked IWB use with improved EL outcomes in mathematics. These positive mathematics outcomes coincide with those in two of the three digital elementary schools in the study. Kennewell and Beauchamp (2007) found that teacher questioning, prompting, responding, and repeating information was done more effectively and efficiently through the use of an IWB. Some studies indicate the benefits of interactive whiteboards for teaching and learning, such as promoting learner motivation, increasing student engagement, and creating effective and engaging presentations (Higgins et al., 2007; Wall, Higgins & Smith, 2005). These benefits may have contributed to higher EL mathematics scores in the two digital elementary and middle schools of this study.

Despite the increase in motivation of the students in his study, Flory (2012) found no positive relationship between the use of IWBs and student outcomes in mathematics. In the analysis of his findings, Flory determined that there was a lack emphasis on solving real-world mathematics problems in the instructional received by the ELs in his study. Further examination of the pedagogy used by the mathematics teachers in the digital schools that did not outperform their matched non-digital schools in this study may yield similar findings.

Increased student engagement, personalized learning, and frequency of feedback from the teacher are all attributes of digital learning environments that contribute to positive learning outcomes (Hattie, 2009), and more specifically, to effective EL pedagogy in mathematics (Lopez, 2009). Online tutorials and computer-based drill and practice programs have also been linked to positive outcomes in mathematics (Hattie, 2009). In digital schools, mathematics teachers have more opportunities to incorporate online tutorials and computer-based drill and practice activities into their instruction. However, the frequency of the use of these digital tools may have varied within the classrooms in this study, thus producing inconsistent and inconclusive outcomes.

Research Question Three

Research Question Three: What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?

The differences in reading achievement of the ELs and non-ELs in this study were measured by the performance on the 2014 FCAT 2.0 Reading examination after adjusting for the previous year's scores using an analysis of co-variance (ANCOVA).

A series of ANCOVAs was conducted to determine the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Reading of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings. In this study, the Reading DSS of ELs who attended seven digital pilot schools (3 elementary, 3 middle, 1 high) was compared to the Reading DSS of non-ELs in the seven digital pilot schools. In the first set of comparisons, there was no statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in any of the three digital elementary schools. In the second set of comparisons, there was a statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in one of the three digital middle schools. In the third set of comparisons, there was a statistically significant difference in the DSS of the 2014 FCAT 2.0 Reading of ELs and non-ELs in the digital high school.

Digital learning has been found to be associated with increased student engagement and positive reading outcomes for ELs in college and high school (Arslan & Sahin-Kizil, 2010; Kinash, Brand, Mathew, & Kordyban, 2011; Reid, 1997), ELs in middle school (Berryman, 2011; Carlo et al., 2004; Paraiso, 2010; Sturtevant & Kim, 2010; M. A. Williams, 2010), and ELs in elementary school (Lopez, 2009; Freeman & Crawford, 2008). In his study of EL achievement Lopez (2009) found that learning in a digital classroom led to performance parity between the ELs and non-ELs in grades 5-8. However, in Lopez's study, only the ELs received digital instruction. There is a need for further research to see the extent that digital learning has on narrowing the achievement gap in reading between ELs and their non-EL counterparts in one-to-one environments where all students receive digital reading instruction.

A factor that may have affected the results of this study is the professional learning that was provided to the teachers. The preparation of the teachers in the digital pilot schools focused primarily on accessing digital resources and using the new classroom technology (IWBs, laptop devices) in alignment with effective teacher practices. The professional learning sessions did not, however, intentionally focus on how to enhance effective ESL practices and teaching methods through the use of digital learning. As a result, in many cases, the instruction received by the ELs in the digital schools may have not been differentiated. In order for ELs to accelerate their reading achievement, they need a different classroom experience. The presence of interactive digital learning tools does not compensate for the absence of scaffolding and differentiated instruction.

The discrepancy in access to technology resources among different socioeconomic groups, more commonly referred to as the Digital Divide, may have affected the outcomes of this research question. Low-income and minority students still lag far behind other students in home and school access to technology (Roblyer & Doering, 2010; Lopez, 2009). The majority of the ELs in this study come from minority groups and reside in economically disadvantaged households. As a result, they may have been less likely to have access to technology than their non-EL counterparts, thereby hindering their performance in the digital classroom.

Student unfamiliarity with technology has been associated with lower academic achievement in digital school settings (Crawford, 2013; Lopez, 209; Freeman & Crawford, 2008). Without proper supports and direct instruction on how to use digital tools, ELs in digital learning environments may have to endure even more challenges in school than they did before. The lack of these proper supports may have prevented the ELs in this study from accelerating their reading achievement. However, the opposite may also be true. If the ELs in this study spent more time receiving direct instruction on how to use digital tools than their non-EL counterparts, they may have spent less time receiving the content area instruction, thereby negatively impacting their reading performance.

Providing ELs with additional time and opportunities to improve their digital competency may be a precursor to achieving performance parity in reading with their non-EL counterparts. As the ELs in the digital schools of this study continue to improve their familiarity with technology, they may begin to achieve higher learning gains in reading than their non-EL counterparts. Follow-up comparisons of the reading learning gains of the same cohorts of ELs and non-ELs in digital schools are recommended to examine whether or not the performance parity improves after the initial implementation year.

Research Question Four

Research Question Four: What is the difference, if any, in the Developmental Scale Scores of the 2014 Florida Comprehensive Assessment Test 2.0 Mathematics of English learners and non-English learners after adjusting for the previous year's scores in digital elementary and secondary school settings?

The differences in reading achievement of the ELs and non-ELs in this study were measured by the performance on the 2014 FCAT 2.0 Reading examination after adjusting for the previous year's scores using an analysis of co-variance (ANCOVA).

A series of ANCOVAs was conducted to determine the difference, if any, between the DSS of the 2014 FCAT 2.0 Mathematics of English learners and non-English learners after adjusting for the previous year's scores in all of the seven digital elementary and secondary schools in the study. In this study, the Mathematics DSS of ELs who attended six digital pilot schools (3 elementary, 3 middle) was compared to the Mathematics DSS of non-ELs in the six digital pilot schools. In the first set of comparisons, there was a statistically significant difference in the DSS of the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in one of the three digital elementary schools. There was no statistically significant difference in the other two digital elementary schools. In the second set of comparisons, there was a statistically significant difference in the DSS of the 2014 FCAT 2.0 Mathematics of ELs and non-ELs in two of the three digital middle schools.

Digital learning has been found to be associated with increased student engagement and positive mathematics outcomes for ELs in middle school (Berryman, 2011; Carlo et al., 2004; Paraiso, 2010; Sturtevant & Kim, 2010; M. A. Williams, 2010), and ELs in elementary school (Lopez, 2009; Freeman & Crawford, 2008). In addition, computer use for mathematics has been associated with a reduction in the mathematics achievement gap between ELs and non-ELs (Kim & Chang, 2010). In his study of EL mathematics achievement, Lopez (2009) found that learning in a digital classroom led to performance parity between the ELs and non-ELs in third and fifth grade. However, in Lopez's study, only the ELs received digital instruction. For this research question, both ELs and non-ELs learned in digital classrooms. There is a need for further research to see the extent that digital learning has on narrowing the achievement gap in reading between ELs and their non-EL counterparts in one-to-one environments where all students receive digital mathematics instruction.

Due to their lack of fluency in English, ELs must simultaneously learn mathematical terms and apply them to solve problems and perform mathematical computations. In their analysis of mathematics software programs, Ganesh and Middleton (2006) found that there was an absence of mathematics language in many digital programs. Most digital mathematics programs, including some of those used by the digital schools in this study, revolve around drill and practice and focus primarily on performing calculations. ELs need to receive direct vocabulary instruction in order to improve their mathematical language ability. Many teachers, including those with limited experience teaching ELs, rely heavily on the mathematics curriculum guides that they are provided with. The absence of mathematical language development in the digital mathematics curriculum may have negatively impacted the ELs more than the non-ELs.

The teachers in this study varied in their levels of expertise and familiarity with ESL practices. Not all of the teachers in this study had strong backgrounds in teaching ELs. As a result, the level of mathematics vocabulary development received by the students may have also varied, therefore yielding inconsistent outcomes. Accommodating for ELs by using simplified language in mathematical word problems has demonstrated positive results (Abedi & Dietel, 2004). However, if teachers are unaware of the importance of these accommodations and fail to provide them, it is less likely ELs will perform at the same level as their non-EL peers. There is a need for increased teacher preparation that aligns digital instruction with effective pedagogy for ELs.

Depending on their level of fluency, some ELs require support in their native language. Providing support for language and literacy development in the home language improves EL reading and vocabulary ability (Snow, Burns, & Griffin, 1998). Since reading and vocabulary impact mathematics performance, it is sometimes necessary to provide ELs with native language support within their mathematics instruction. It is very likely that there was variability in the amount of native language support that the ELs received in the mathematics classrooms of this study. In addition, the programs used in the digital classrooms may or may not have included support in the native language. Since the digital interventions that targeted the acceleration of ELs in this study did not consistently incorporate extra native language support in order to meet the needs of a greater amount of ELs, the opportunities for the ELs to make learning gains in mathematics were not maximized.

The use of manipulatives is an essential component of mathematics instruction. Often, students who struggle with using mathematics language use manipulatives to perform hands-on calculations and express their mathematics reasoning. Because of the transition to digital learning that occurred in the pilot schools of this study, some mathematics teachers may have abandoned some of these hands-on learning opportunities in their daily instruction. ELs often rely on using manipulatives and hands-on activities in their classrooms more than some of their non-EL counterparts. The inconsistent use of manipulatives and hands-on learning tasks may have led to mixed results in the mathematics learning gains of the ELs in this study.

Implications for Practice

The increased use of technology in everyday life is a national trend that is currently occurring in the United States. Furthermore, the use and value of technologies in reading and mathematics classrooms has been recognized as necessary and has increased in frequency. Culturally relevant instruction that incorporates the interests, perspectives, and identities of students has been found to be an integral component of the academic success of ELs (Ajayi, 2009; Cope & Kalantzis, 2000). For digital natives, including those who are ELs, engaging in the use of digital technology is a culturally relevant daily practice. Being able to integrate the digital literacy that students possess into the classroom learning experience has become a required skill for elementary and secondary school teachers (Ajayi, 2009; Grabill & Hicks, 2005; Lankshear & Knobel, 2006; Ware & Warschauer, 2005). To maximize the learning potential of ELs, teachers will need to combine these newly acquired digital skills with effective ESOL practices.

The purpose of this study was to compare the reading and mathematics achievement of ELs and non-ELs in digital and non-digital learning environments. The findings of this research offer some insights about digital learning implementation and improved EL reading and mathematics outcomes. In several instances, participation in a digital learning environment was associated with higher reading and mathematics scores in elementary and middle schools. However, these positive outcomes were not consistently found in all elementary and secondary grade levels. As the digital learning implementation continues to grow, and the number of digital schools in LUSD increases, repeated studies will be needed to see if research with a larger sample size of ELs yields similar or different results.

The findings of this study revealed some successful outcomes for ELs enrolled in digital schools. However, to make these positive outcomes more consistent across all grade levels, there is a need for improved EL pedagogy that incorporates classroom technology, especially in mathematics instruction. A contributing factor to that challenge is the variance in teacher knowledge of effective EL instructional strategies. There is not an abundance of research-based recommendations for technology integration that leads to improved EL academic success. There is a need for continued research that analyzes the extent that digital tools improve EL instruction.

Digital learning implementation does not have any impact on its own. It must be paired with effective pedagogy. Therefore, more research is needed to focus on how teachers can use digital tools in ways that coincide with best practices for EL instruction. The rapid growth of the EL population and the increased use of technology has required teachers of ELs to learn how to infuse digital learning into their daily classroom instruction. In order to do so effectively, some have made deliberate efforts to enhance ESOL best practices by learning how to integrate the use of interactive technology and digital tools. There is an absence, however, of technology integration among professional learning and teacher certification programs that prepare teachers to work with ELs. In other words, ESOL certification and teacher preparation programs do not strongly emphasize how to effectively incorporate digital learning into ESL instruction.

In addition to its impact on teacher practice, digital learning implementation has also posed new challenges and demands for school leaders. Visionary leadership that provides clearly communicated expectations is a crucial component of any successful school improvement effort. Therefore, in order for successful digital learning implementation to occur, district and school-based leaders have to provide a vision for effective technology integration. Once the expectations of effective digital instruction have been communicated to the stakeholders, leadership must then align this vision with systems of ongoing professional learning, support, feedback, and evaluation of performance. In order to do so, however, school leaders need to be extremely knowledgeable of effective digital pedagogy and the intended outcomes of classroom technology use. Because of the varying levels of digital expertise among school leaders, there is a need for research-based professional learning opportunities that provide leaders with frameworks for determining effective digital instruction.

Recommendations for Further Research

The goal of this study was to examine the extent to which learning in a digital school environment impacts the reading and mathematics achievement of ELs in elementary and secondary schools. In addition, this study intended to determine the extent to which digital learning impacts the achievement gap in reading and mathematics between ELs and their non-EL counterparts in elementary and secondary schools. The reading and mathematics performance of the students in the study were examined through four research questions. The findings, although meaningful, have some limitations. The following is a list of recommendations for further research based on the findings of this study:

1. A longitudinal study is needed to examine the impact of digital learning on the reading and mathematics achievement of the EL participants beyond the identified year in this study.
2. As the number of digital schools increases, repeated comparisons with a larger number of EL and non-EL participants are recommended across larger geographic areas and school districts.

3. The data analyzed in this study came from 2013 and 2014, prior to the implementation of the new Florida Standards Assessment in 2015. Therefore, a longitudinal study is needed to examine the sustainability of the positive outcomes of this study on the new Florida State Assessments in reading and mathematics.
4. Further research is recommended to determine the impact, if any, that digital learning has on EL achievement on other high school assessments such as Advanced Placement (AP) examinations, Scholastic Aptitude Tests (SAT), and American College Testing (ACT).
5. Further research is recommended to determine if the positive outcomes achieved in reading and mathematics for the ELs in this study transferred to classes in other subject areas such as science and social studies.
6. Further research is recommended to study the impact of teachers' years of experience teaching with digital tools on EL reading and mathematics performance.
7. Further research is recommended to study the impact of a principal's years of experience leading in a digital school environment on EL reading and mathematics performance in a digital school environment.
8. Further research is recommended to examine the competencies and traits of principals who lead successful digital implementation efforts for ELs.
9. Further research is recommended to analyze the level of emphasis placed on digital learning and EL pedagogy in professional learning and preparation programs for school leaders.

10. Further research is recommended to compare the impact of different types of digital learning environments on the reading and mathematics achievement of ELs.

Conclusion

The rapid growth of the English learner (EL) population and the achievement gap that exists between ELs and non-ELs continue to be an area of national concern among contemporary educational leaders (San Miguel, 2013; Wright, 2010). In order to improve their ability to meet the learning needs of ELs, public schools have implemented digital programs and increased the use of classroom technology in their daily instruction. This study expanded the work of previous researchers by comparing the reading and mathematics achievement of ELs and non-ELs in digital and non-digital learning environments. It also compared the learning gains in reading and mathematics of ELs and non-ELs in digital learning environments.

Guided by four research questions, this study revealed several findings. The findings from Research Question One demonstrated that in five out of the six elementary and middle school comparisons, the reading achievement of ELs in digital schools was higher than in non-digital schools. This higher reading achievement was apparent in grades 4, 6, 7, and 8. It was not apparent in the high school comparison. The findings from Research Question Two demonstrated that in four out of the six school comparisons, the mathematics achievement of ELs in digital elementary and middle schools was higher than in non-digital elementary and middle schools. The findings from Research Question Three demonstrated no evidence that digital learning led to higher learning gains in reading achievement for ELs than for non-ELs in elementary schools. In the secondary digital schools, one of the three middle schools and the high school showed significantly higher learning gains for ELs than their non-EL counterparts, thereby narrowing the achievement gap in reading between the two. The findings from Research Question Four analyzed the difference in learning gains in mathematics between ELs and non-ELs and yielded mixed results in both elementary and secondary school comparisons.

Despite the successful outcomes attained by some of the ELs enrolled in the digital schools in this study, “digital learning is not a silver bullet for improving EL student academic success” (Lopez, 2009, p. 914). In other words, digital learning cannot serve as a substitute for a teacher’s instructional effectiveness, content mastery, and cultural competence (Lopez, 2009). It also cannot outweigh other factors such as years of teaching experience and student efficacy. However, when used in alignment with effective ESOL pedagogy and high-yield instructional practices, digital tools can increase student engagement and improve the reading and mathematics achievement of ELs. In order to more consistently attain the positive outcomes that occurred for some of the ELs in this study, more research is needed to focus on how teachers can use digital tools in ways that coincide with best practices for EL instruction.

The outcomes of this study yielded some evidence that the reading and mathematics achievement ELs in digital school elementary and secondary school environments is higher than in non-digital environments. However, within the digital pilot schools in this study, there were only a few instances that demonstrated significantly higher learning gains made by ELs and their non-EL counterparts in reading or mathematics. In the majority of digital school comparisons, the achievement gap in reading and mathematics between ELs and non-ELs was not decreased. Digital learning improved the achievement of both groups at comparable rates. It can be concluded, therefore, that while digital learning may lead to improved outcomes for both ELs and non-ELs, there is still a need for a differentiated approach that accelerates learning and creates equitable opportunities for ELs to achieve in reading and mathematics.

It is important to consider that this study took place during the first year of the digital learning implementation for this school district. Therefore, the level of digital expertise of the teachers in the study was limited. During the first year, many teachers spent most of their lesson planning time learning how to replicate their instruction into a digital format instead of improving their past pedagogy and providing more rigorous, engaging instruction for the students. As the teachers in this study gain more experience teaching with technology, the proficiency and learning gains of the students may increase at a higher rate.

APPENDIX A: UNIVERSITY OF CENTRAL FLORIDA INSTITUTIONAL REVIEW BOARD

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

From : **UCF Institutional Review Board #1**
FWA00000351, IRB00001138
To : **Enrique Vela**
Date : **May 27, 2015**

Dear Researcher:

On 05/27/2015 the IRB determined that the following proposed activity is not human research as defined by DHHS regulations at 45 CFR 46 or FDA regulations at 21 CFR 50/56:

Type of Review:	Not Human Research Determination
Project Title:	An Exploratory Study of the Academic Growth of English Learners in a Digital School
Investigator:	Enrique Vela
IRB ID:	SBE-15-11345
Funding Agency:	
Grant Title:	
Research ID:	N/A

University of Central Florida IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are to be made and there are questions about whether these activities are research involving human subjects, please contact the IRB office to discuss the proposed changes.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Joanne Muratori

Signature applied by Joanne Muratori on 05/27/2015 10:22:38 AM EDT

IRB manager

APPENDIX B: NOTICE OF APPROVAL FOR RESEARCH

Notice of Approval

Approval Date: 9/2/15 Approval Number: **0017**

An Exploratory Study of the Academic Growth of English Learners in a Digital School Project Title:

Requester: Mr. Enrique Vela

Project Director/Advisor: Dr. Rosemarye Taylor

Sponsor Agency/Institutional Affiliation: University of Central Florida

Thank you for your request to conduct research in Orange County Public Schools. We have reviewed and approved your application. This Notice of Approval expires one year after issue, . 9/2/16

If you are interacting with OCPS staff or students, you should have submitted a Principal Notification Form with your application. You may now email the principals who have indicated interest in participating, including this Notice as an attachment. After initial contact with principals, you may then email any necessary staff. This notice does not obligate administrators, teachers, students, or families of students to participate in your study; participation is entirely voluntary.

OCPS badges are required to enter any OCPS campus or building (see the Security Clearance Flow Chart).

You are responsible for submitting a Change Request Form to this office prior to implementing any changes to the currently approved protocol. If any problems or unexpected adverse reactions occur as a result of this study, you must notify this office immediately by emailing a completed Adverse Event Report Form. On or before 8/2/16 , you must complete a Request for Renewal or Executive Summary Submission. Email all forms to research@ocps.net. All forms may be found at www.ocps.net/cs/services/accountability/Pages/Research.aspx.

Should you have questions or need assistance, please contact Mary Ann White at (407) 317-3201 or mary.white@ocps.net.

Best wishes for continued success,

Tavy Chen, Ed.D. tavy.chen@ocps.net

Director, Accountability and Research

Orange County Public Schools

Cc: Brandon McKelvey, Senior Director, brandon.mckelvey@ocps.net

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