THE EFFECTIVENESS OF BLENDED LEARNING UTILIZING EDMENTUM'S COURSEWARE MATH LIBRARY IN THE CARLYNTON MIDDLE SCHOOL MATHEMATICS CLASSROOMS

A Doctoral Capstone Project

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Abstract

This Capstone Project investigates the relationship between the use of Edmentum's Courseware Math Library software and students' math achievement in the middle school mathematics classrooms of a small school district in southwestern Pennsylvania during the 2019 -2020 school year. Grade level data was collected regarding the use of a supplemental math software program called Edmentum's Courseware Math Library. Data on students' mathematics achievement was collected from the Study Island Benchmark Assessments version 4 that acted as a pretest and posttest. The data were compared to determine mean differences in achievement between the students who were provided the Edmentum Courseware Math Library in a blended learning environment (experimental group) and those who did not (control group). Data were analyze using a two-sample t-test for independent samples to determine the possible relationship between the use of the Courseware Math Library and students' math achievement on these measures. The Capstone Project results can be utilized to inform school educational leaders as they invest in technology tools and integrate technology into the mathematics classroom. Regardless of using Edmentum's Courseware Math Library in 2019-2020, the achievement of the experimental group was not significantly higher than that of the control group. Several variables should be taken into account, such as limited data, teacher training in blended learning and the Edmentum Courseware Math Library and time intervals that the students access the modules. Another factor that could have played a significant role in the results is the interruption of the educational process due to the COVID-19 virus outbreak that forced the school to enter into a Continuity of Education plan that altered the blinded learning environment for a part of the project.

CHAPTER I

Introduction

Our district is a relatively small school district located just six miles southwest of Pittsburgh in southwestern Pennsylvania. It unites the three very proud communities of Carnegie, Crafton and Rosslyn Farms. These communities make up a very diverse area consisting of various ethnic, racial and socioeconomic populations. The district currently enrolls 1374 students and houses approximately 643 students in our Junior-Senior High school. The district currently has an 18.8 percent special education enrollment and an economically disadvantaged population of 53.2 percent. Since the inception of the PA Core Standards and the development of the corresponding Pennsylvania System of School Assessment (PSSA) test, the mathematics scores of our middle school has been deficient. It seems that every year there has been at least a 10 percent drop in proficiency rates starting at the 6th-grade level, and it continues to decline through Grade 8. The tricky part is that this is not the case when it comes to the same cohort of students and their proficiency rates on the ELA portion of the test. To continue to add to the dilemma, once these students reach the Keystone Exams in Algebra 1, their cohort proficiency rates seem to double.

Since student achievement scores from the individual cohorts have demonstrated that students can learn at higher levels in ELA and Algebra 1, there is a need to focus on our middle school mathematics program. We need to determine what instructional practices can be changed to provide a continued increase in our students' mathematical achievement on our PSSA test. Through observations of our middle school mathematics classrooms, it was determined to be a predominantly traditional learning environment.

Classrooms are in rows and columns; a teacher is in the front of the room with the students watching and taking notes from the example problems the teacher provides. Most have prescribed to the "I Do, We Do, You Do" method of scaffolding and the students go and complete the homework assignments independently. It was frequently observed through observations that teachers check homework for completion (not correctness) the next day, and students are permitted to ask the teacher questions about the homework assignment before beginning the lesson of the day. This raises many issues on implementing different instructional strategies that will increase active student engagement in the learning process, provide immediate feedback to the students on how well they are mastering the subject matter, and over the year, how well did the intervention work to increase student achievement.

As the Director of Curriculum, Instruction, and Assessment of our district, I believe one of my primary roles is to be the instructional leader of our district and work collaboratively with the building principals to find different ways to increase student achievement. Through the use of our assessment data, we have gone a long way to determine if the issues we are having are curricular problems, teacher problems, or student problems. We have taken many action steps over the past three years to address the results of our analysis. We have rearranged the mathematics department in the Junior-Senior High School to place our strongest teachers with what we perceive are our areas in most need of growth and improvement. We have rewritten the curriculum and revised it every year since the inception of the PA Core Standards to address the eligible content that the students have historically demonstrated that we have struggled with the most. We have researched and adopted a K – 12 mathematics program that aligned to the PA Core and provides consistency in learning materials from one year to the next. We have even added an extra period of mathematics every week by placing this time in one of our middle school rotations. Although we have made modest gains every year based on these steps and finally reached the state average in mathematics proficiency, we are still below the proficiency rates of these same cohorts in ELA and eventually in Algebra 1 by half. It has become time for us to look at our instructional strategies and our classroom methods to determine what are the best strategies to use with our students. Although there are many different strategies in our teacher toolboxes, it is time to investigate which of these research-based methods and strategies are the most effective for middle school students in our district.

Mathematics instruction has changed since I began teaching over 29 years ago. Methods, assessments, and technological advancements have all changed the learning environment in our classrooms. However, teaching and learning is still a collaborative process between the teacher and the student. Each has a responsibility for the success of this process. Students must be active participants who are engaged and involved in the learning activities selected by the teacher. Students today are considered to be the first generation to grow up with new technologies and have been called digital natives. They have been exposed to the digital age their entire lives. They have used computers, listened to music on digital music players, played video games, carried cell phones, and played with all the other tools and toys of this new age. Is it possible we are trying to teach these digital natives by traditional means? Could this be the disconnect that has caused our middle school students to underachieve when it comes to mathematics education?

Because of this, the school district invested in an intervention program called Edmentum Courseware Math Library. The program focuses on improving mathematics skills in an online format and provides an intervention for the experimental group of this study. Edmentum Courseware is a customizable digital curriculum that provides our teachers the control to restructure the mathematics content and even add their content to create a blended learning environment in their classes. The teachers are able to include online activities in their classrooms where the students will interact with the online materials. Within this digital curriculum, students will view video tutorials, engage in learning activities with opportunities for practice, and participate in a variety of formative and summative assessments. Students will still have a teacher to interact with as they progress through the prescribed activities, and the teachers will be able to monitor their students learning and engagement through observation, computer-generated assessments, and time on task statistics.

The purpose of this study is to explore the effectiveness of the implementation of the Edmentum Courseware Math Library into a blended learning environment in our middle school mathematics classes. To determine this effectiveness, the study will focus on three research questions:

Q1 How does the overall achievement of students using the Edmentum Courseware Math Library intervention compare with the achievement of students who are not using the intervention?

Q2 Is there a difference in overall achievement of males and females who received the Edmentum Courseware Math Library intervention compared with males and females who are not using the intervention?

Q3 What skills do students demonstrate greater achievement using the Edmentum Courseware Math Library intervention?

The researcher will propose a hypothesis for each research question in this study to make the results quantifiable. The researcher will also create a null hypothesis and an alternative hypothesis to provide a formal method of reaching conclusions or making decisions on the basis of the data. A two-sample t-test of independent samples will be used to test each of the hypotheses because the researcher believes that it is the most commonly used test for comparing whether the mean difference between two groups are statistically significant.

At the conclusions of this study, a determination will be made concerning the effectiveness of this intervention and if it will be recommended as a Grade 7 and 8 strategy for future implementation in our district. The data will help us to decide whether the $3609 budget expenditure for full implementation of this computer resource, coupled with blended learning, will provide the increase in student achievement that we have been so diligently working.

CHAPTER II

Literature Review

Introduction

Educational stakeholders understand that mathematics plays a crucial role in gainful 21st-century employment, as well as in everyday life. Although there have been repeated calls for funding increases, more rigor, and better performance in mathematics (Maltese & Hochbein, 2012), American students' overall performance remains lower than those in other countries. The Program for International Student Assessment, Organization for Economic Co-Operation and Development (2012), and the National Assessment of Educational Progress (NAEP) reported that the average mathematics test scores fall into the below basic category for fourth and eighth-graders (National Center for Education Statistics, 2013).

Although no one questions the importance of mathematics as it relates to science, the technological fields, and everyday life, mathematics has remained unpopular with many students. Students still perceive mathematics as a complicated subject and prefer to learn mathematics in an enjoyable and dynamic environment. As a result, teachers continue to seek better approaches to meet students' demands for exciting ways to learn mathematics.

The influx of technology has provided a gateway for the development of several new approaches to learning. These include learning online, using the internet, computer-aided or web-based, and in blended formats, which are gaining popularity in education. One of the approaches to help students with meaningful learning in an educational setting through "information and communication technologies" is blended or hybrid learning

(Gecer & Dag, 2012). Recently, there have been recommendations for the use of technology for instruction in mathematics. Two of the main goals for mathematics teachers are to gain proficiency in the use of technology and the ability to design curriculum and instruction using these technological resources. Interactive learning objects can engage the students through their learning styles of visual, kinesthetic, and auditory learning. Using these interactive learning objects for instruction, remediation, and enrichment is a way of utilizing information and communication technology for various classroom activities.

Comparing the results of fully computer-mediated teaching with those of traditional pedagogy has been the main focus of the research on the effectiveness of computer-assisted learning. As a result of this research focus, conclusions are often found to be contradictory or inconclusive. However, later studies generally show that there are no significant differences in student achievement (Bernard et al., 2004; Means, Toyama, Murphy, Bakia, & Jones, 2009). However, incorporating the internet into traditional education led to positive effects on academic achievement (Means et al., 2009; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). The infusion of technology into the education environment is not a homogenous intervention (Ross, Morrison, & Lowther, 2010). Means, Toyama, Murphy, Bakia, and Jones, (2009) state that educators can use the internet to facilitate different types of learning.

In analyzing mathematics instruction from a historical perspective, some researchers agreed that the educational potential of the Internet for developing and implementing various classroom activities, educators had indicated optimism concerning this potential (Dreyfus & Eisenberg, 1996; Fetterman, 1998; Owston, 1997). Therefore, mathematics teachers should engage with a variety of available software programs and experiment with computers in the classroom environment so they may appreciate the usefulness of these technologies when teaching mathematics. Student learning activities, such as projects and real-world application problems, are effective resources for different learning technologies. With this technology, students can benefit from determining which tools, processes, and techniques are appropriate for use and when to use them.

Blended Learning

Today, our educational system is transitioning. To reduce the challenges of meeting the individual needs of students, the educational stakeholders are attempting to adopt new technologies and explore new paths to reach the goal of providing quality education to everyone. The nature of blended learning is a new and ingenious idea that incorporates the best of both traditional (face-to-face) instruction with the advantages of computer-assisted learning. This will include both offline and online learning. To help educators understand the concept of blended learning, the goal of the current study is to explain the individual components comprising and defining blended learning.

Traditionally, educators considered learning as a reciprocal interaction between students and teachers. Traditional learning takes place in a classroom environment where there is direct face-to-face contact between two individuals (Hassan, Abiddin, & Yew, 2014). However, some researchers contended that a traditional classroom is a combination of many types of relationships. These relationships can be among students, students and teachers, and students with the different subjects and methods of learning. These relationships may extend from the contexts of interpersonal relationships between individuals to the students' thoughts on the structure of the classroom (Anderson, 1970; Jou, 2010).

Traditional teaching occurs when students receive adequate time to collaborate with their instructors, and therefore, are influenced by the instructor's behaviors, personality, and values. Face-to-face interaction provides the benefits of synchronous communications, where teachers and students receive prompt feedback that is conducive to teaching and learning. These interpersonal interactions are inspiring for students and teachers, as well as and providing a human element to the educational process. Students not only learn from teachers through their classroom curricula but also from the interactions with other students in their peer groups. (Lalima & Dangwa, 2017). Gaimaro and Lomellini (2019) stated that traditional learning consists of (a) face-to-face learning activities that take place in a designated physical location; (b) student learning from the teacher (sage-on-the-stage) with traditional resources such as textbooks, journal articles, and multi-media recordings; (c) a lecture-based learning environment where students receive direct instruction; and (d) a face-to-face interaction in teacher-directed learning environment disseminates the curricula.

While traditional classroom learning continues to dominate in schools around the globe, an increasing number of schools are contributing to the advancement of alternative pedagogies that employ online learning (Chaney, 2017; Vaughan, 2010). Online learning is a form restricted to content delivered over the Internet (Watson & Kalmon, 2005). Online courses can be asynchronous or synchronous. Asynchronous classes have no set time for instruction, and students have access to digital curriculum to which they can respond electronically on their timeframe. Whereas synchronous classes occur with real-time interactions, such as a group of students engaging in learning together at the same time. Instructors create online courses with both assignments and discussions that can occur using prescribed software (Watson & Kalmon, 2005). As defined by Watson, Murin, Vashaw, Gemin, and Rapp (2013), "fully online schools are the main education process for their students, who do not need to go to a physical school to access any aspect of their education (although they may do so)" (p.16). Picciano, Seaman, Shea, and Swan (2012) described online learning as "a course where most or all of the content is delivered online and typically has no face-to-face meetings" (p.128). Online programs do not dependent on student meetings with instructors; however, the students may schedule times and places when face-to-face meetings are available. Watson et al. (2013) stated that in the 2012 to 2013 school year, "the total number of states that support statewide fully online schools is 29" (p.22).

Nowell (2011) stated that "blended courses integrate online with face-to-face instruction in a planned, pedagogically valuable manner" (p.13). After years of development, Staker and Horn (2012) concluded that blended learning is:

> A formal education program in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from home. (p. 3)

Online instruction is typically self-paced where students have the time they need and can set their schedules as opposed to working within a teacher's structure as designed for a group. The Clayton Christensen Institute (2012) defined blended learning as:

> A formal education program in which a student learns: (1) at least in part through learning, with some element of student control over time, place, path, and/or pace; (2) at least in part in a supervised brick-and-mortar location away from home; (3) and the modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience. (para.1)

As blended learning continues to develop, other researchers have suggested that the definition should include additional components. For example, Chou and Chou (2011) characterized that the concept of blended learning as adopting "multiple learning methods and combines both traditional and online learning activities," and the "blended learning method continuously changes the ways of the learning method and technological infrastructure" (p. 463). Chou and Chou also cited blended learning as "maximizing the best advantages of face-to-face and online education" (p. 464). Dziuban, Hartman, and Moskal (2004) suggested that to have true blended learning, the online component must reduce the time students occupy classroom desks and participate in face-to-face or traditional classroom instruction. Some suggested that blended learning should consist of a balance or a ratio of traditional learning time to online. Clark (2012) proposed a ratio of two hours of in-class work to a one-hour online work as an example of blended learning. The Sloan Corporation called for blended learning to consist of 30% to 79% online course work while dedicating the remaining time to traditional face-to-face learning (Allen, Seaman, & Garrett, 2007). Hu, Kuh, and Li (2008) offered that blended learning requires "a fundamental redesign that transforms the structure of, and approach to, teaching and learning" (p.5). However, the educational community has accepted none of those proposed additions to the definition of blended learning, but they have adopted the general idea that blended learning requires some combination of traditional learning experiences with an online learning component.

Hybrid learning is synonymous with blended learning. Kazu and Demirkol (2014) determined that blended learning is another term used interchangeably with blended learning. Xin, Kempland, and Blankson (2015) extended the hybrid learning definition by suggesting that the online portion of instruction should be 30% to 74% of the total instruction time. Allen and Seaman (2013) claimed that in blended or hybrid learning, 30% to79% of instructional time should be online instruction.

Rovai and Jordan (2004) suggested that blended learning offers the conveniences of online courses without completely losing the benefits of face-to-face contact. They stated that blended learning is a more powerful learning experience than traditional or online learning alone due to the flexible approach to course design. Colis and Moonen (2001) pointed out that blended learning is that the online component should be a natural expansion of face-to-face classroom learning. Blended learning should not be an add-on to the traditional instructional environment, nor should it be wholly an online learning experience. However, Garrison and Kanuka (2004) considered that it is unclear how much online learning is essential to blended learning.

The idea of blending online learning with traditional learning was a natural progression once online learning became widely accepted and easily available. In 2011, Queen and Lewis estimated the number of K-12 US public school students who participated in a learning environment blending online with traditional learning was approximately 2 million. Although it has become a part of the everyday educational vocabulary, the blended learning moniker did not appear in the research literature until the year 2000. However, since that time, blended learning has been a consistent topic for researchers (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014; Bliuc, Goodyear, & Ellis, 2007).

Researchers and educators have expanded the definition of blended learning over time, associating it with a variety of pedagogies. Some definitions became so general that they seemed to include almost all forms of learning (Koohang, 2009; Singh & Reed, 2001; Verkroost, Meijerink, Linsten, & Veen, 2008). Other definitions are more concise but not necessarily universally understood; for example, Staker and Horn (2012) emphasized giving attention to the relative blend of online and face-to-face instruction components and whether either played a more significant part in the learning process. Furthermore, they stated that blended learning occurs "any time a student learns at least in part in a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path and/or pace" (p.3). With the offering of these diverse definitions of blended learning, the commonality exists in its being a combination of online and face-to-face learning aimed to utilize the more exceptional characteristics of both forms of instruction. Torrisi-Steele (2015) concluded that blended learning unites the best of online and traditional learning.

> According to Watanabe-Crockett (2018), blended learning consists of specific characteristics. These characteristics are “a portion of the learning is delivered with digital or online media, some of the learning is student-directed in terms of time, pace, path, and place,” and “it provides a learning experience that is appealing, and that delivers successful learning outcomes” (p. 1).

The combination used of online learning and face-to-face learning can depend on specific learning objectives, and the use of these could be complementary to accomplish better the specific objectives (Rose & Ray, 2011). Recent statistics showed that the educational community accepts blended learning. Queen and Lewis (2011) found that there was a form of blended learning in every state available to some of the public-school students. In 2010, 55% of school districts reported the following:

> Students enrolled in distance education courses in 2009–10. Among those districts, 96 percent reported having students enrolled in distance education courses at the high school level, 19 percent at the middle or junior high school level, 6 percent at the elementary school level, and 4 percent in combined or ungraded schools . . . and districts reported an estimated 1,816,400 enrollments in distance education courses for 2009–10. Seventy-four percent of the distance education enrollments were in high schools, 9 percent were in middle or junior high schools, and 4 percent were in elementary schools. (p. 3)

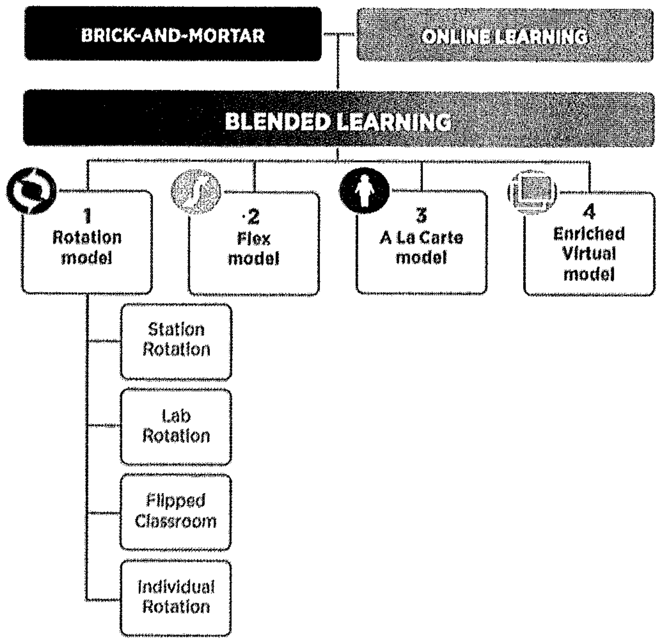
Districts also reported on the different types of distance education courses in which these students enrolled. The responses showed that students enrolled in credit recovery at a 62% rate, dual enrollment at 47%, Advanced Placement at 29%, career and technical education at 27%, and other types of academic courses 65%. The International Association for K-12 Online Learning (2013) indicated that "there were an estimated 1,816,400 enrollments in distance-education courses in K-12 school districts in 2009-2010, almost all of which were online courses" (p. 1). Staker (2011) found that the estimates of K-12 students involved in online learning could be higher than reported by others, and the Innosight Institute concluded, "that the number of K-12 students should reach over four million by 2010" (p. 1).

Blended Learning Model

The Clayton Christensen Institute (2012) studied blended learning models and determined four different models that describe most blended courses in schools: (a) rotation, (b) flex, (c) à la carte, and (d) enriched virtual. The rotation model includes four sub-models known as, (a) station rotation, (b) lab rotation, (c) flipped classroom, and (c) individual rotation. The Clayton Christensen Institute created these definitions as a common terminology for blended learning. However, many schools do not treat these models as mutually exclusive. Some schools implement more than one model or multiple components from models they find most effective to create something unique to meet the needs of their students. In contrast, Horn and Staker (2014) found that most blended-learning programs fit into one of the four well-defined model.

Figure 1

Blended Learning Models



Note. Adapted from "Blended learning model definitions", by Clayton Christensen Institute. 2012. Clayton Christensen Institute for Disruptive Innovation

The fuller definitions for these models are:

1. **Rotation Model** - a course or subject in which students rotate on a fixed schedule or at the teacher's discretion between learning modalities, at least one of which is online learning. Other modalities might include activities such as small-group or full-class instruction, group projects, individual tutoring, and pencil-and-paper assignments. The students learn mostly on the brick-and-mortar campus, except for homework assignments. The Four sub-models-are:

a. *Station Rotation* – a course or subject in which students experience the rotation model within a contained classroom. The station rotation model differs from the individual rotation model because students rotate trough all stations, not only those on their custom schedule.

b. *Lab Rotation* – a course or subject in which students rotate to a computer lab for the online -learning station.

c. *Flipped Classroom* - a course or subject in which students participate in online learning off-site in lieu of traditional homework and attend the brick-and-mortar school for face-to-face, teacher-guided practice, and projects. The primary delivery of content and instruction is online, which differentiates a flipped classroom from instruction that includes only homework exercises online in the evenings.

d. *Individual Rotation* - a course or subject in which each student has an individualized playlist and does not necessarily rotate to each available station or modality. An algorithm or teacher(s) sets individual student schedules.

2. **Flex Model** - a course or subject in which online learning is the backbone of student learning, although the online program can direct students to offline activities sometimes. Students proceed through individually customized, fluid schedules across learning modalities. The teacher of record is on-site, and students attend mostly on the brick-and-mortar campus, except for homework assignments. The teacher of record or other adults provide face-to-face support on a flexible and adaptive as-needed basis through activities such as small-group instruction, group projects, and individual tutoring. Some implementations have substantial face-to-face support, whereas others provide minimal support. For example, some flex models may include certified teachers in a face-to-face mode who supplement online learning daily whereas others may provide little face-to-face enrichment. Still, others may have different staffing combinations. These variations describe particular uses of flex models.

3. **À la carte Model** - a course that takes place entirely online to accompany other experiences that students are having in a brick-and-mortar school or learning center. The teacher of record for the à la carte course is the online teacher. Students may take the à la carte course either on the brick-and-mortar campus or o□-site. This flexibility differs

from full-time online learning because it is not a whole-school experience. Students take some courses à la carte and others face-to-face on a brick-and-mortar campus.

4. **Enriched Virtual Model** - a course or subject in which students have required face-to-face learning sessions with their teacher of record and are free to complete their remaining coursework remotely. Online learning is the core of instruction because the students are located remotely. The same teacher typically serves as the online and face-to-face instructor. Many enriched virtual programs began as full-time online schools and then developed into blended programs to provide students with brick-and-mortar school experiences. The enriched virtual model differs from the flipped classroom because in enriched virtual programs, students seldom regularly meet face-to-face with their teachers. It differs from fully online instruction because face-to-face learning sessions are more than optional office hours or social events; the model requires these online sessions.

These models are not the only ways of implementing blended learning but are useful starters in determining how to implement blended learning in classrooms.

Uses of Blended/Online Learning

The goal of blended learning is to combine the most useful aspects of face-to-face with the advantages of online learning and provide a hybrid learning experience for students. Headden (2013) stated, "The beauty of a hybrid model, also known as blended learning, is that it enhances the human element" (p.16). Headden further mentioned:

> While teachers still work with entire groups, students also break off for independent work and to work with peers. This is not distance learning, a kid sitting alone at home in front of a monitor. Students are in the same classroom no matter what mode of instruction is being used (p.16).

Horn and Staker (2011) considered that the online components of blended learning provide an opportunity for individualized student learning and greater success through individualized instruction.

The origins of K-12 online learning began with the need to offer students alternative opportunities, such as remedial or advanced courses in schools where these opportunities were not readily available (Horn & Staker, 2015). Educators once considered online instruction as a substandard alternative to the traditional classroom (Horn & Staker, 2015); however, they have continually improved online instruction and learning. In some cases, online has replaced face-to-face instruction. However, it is notable that often students in an online environment are working without supervision or face-to-face interactions with an instructor (Horn & Staker, 2015).

School administrators turn to online learning for many different purposes, and many student populations (McFarlane, 2011; Picciano & Seaman, 2009; Wicks, 2010). In some rural areas, online instruction provides students with courses that are not available in traditional classroom settings (Aronson & Timms, 2004). Aronson and Timms (2004) mentioned, web-based courses can provide an important supplement to high school students who would otherwise be limited in their academic pursuits, either because their school does not offer anything more than a very basic curriculum or because scheduling conflicts prevent them from taking desired classes (p. 13).

School leaders and districts, depending on the needs of their students, may provide an online option as a way for students to recover credits toward graduation. Furthermore, this is a viable option for those students who are considered at-risk for dropping out of school (Eduviews, 2009; Watson & Gemin, 2008). In states, charter and private school administrators elect to offer online learning opportunities in virtual schools to assist students in credit acquisition (Christensen, Horn, & Johnson, 2008; Lawrence, 2012; Watson, Murin, Vashaw, Gemin, & Rapp, 2013). For example, the Georgia Virtual School offers students a chance to earn credits that enable them to stay in school, graduate, and become productive citizens in society (AdvancED, 2012; Watson & Gemin, 2008; Watson et al., 2013). Another example is the Florida Virtual School (FLVS), where officials have partnered with school district "to create on-site Virtual Learning Labs (VLLs) where students are registered for FLVS courses allowing the district to use FLVS teachers with school personnel as an onsite facilitator" (FLVS, 2013, p. 3). The VLLs program is a newer instructional approach and is an example of the many unique approaches to blended learning that are developing (Staker, 2011). The FLVS (2013a) reported that these VLLs have grown from 60 school sites in 2010 to 86 school sites in 2012.

There are several different online credit recovery models available to assist students in need. Watson and Gemin (2008) determined:

> Credit recovery programs have taken place in traditional classrooms during school hours, after regular school hours, in the evening and on weekends, in summer school, and through student-teacher correspondence. Some schools offer full alternative programs, while others focus on returning the student to the traditional classroom. (p. 8)

In some programs, such as the Bridge Program in the Salem-Keizer School District in Oregon, the district gives students a distinct option. According to Watson and Gemin, the district provides:

> An alternative school that combines online curriculum and instruction with a classroom/computer lab component staffed by highly qualified teachers and mentors. The mandatory attendance and lab support provided in the physical locations create the structure and motivation students need to succeed, while the online delivery of content and instruction provides the flexibility that allows these students to complete their diplomas (p. 11).

Furthermore, Watson and Gemin explained that students who fall behind in credits could recoup credits and learning by taking "one course at a time, working on completing six to eight half-credit courses in succession during a semester" (p. 11).

Administrative Perceptions

In the mid-2000s, Picciano and Seaman, (2007, 2009) carried out a series of surveys of school administrators in the United States to determine teacher and administrator perceptions of online learning. Of the many research questions that shaped these studies, only two dealt with attitudes towards K-12 online and blended learning. First was about the perceived importance of online learning and blended learning, and the second concerned the perceived obstacles that hindered the expansion of online learning and blended learning (Picciano & Seaman, 2007, 2009). In response to the question about the perceived importance of online and blended learning, the participants were predominantly positive about its use for meeting the needs of specific student groups (Picciano & Seaman, 2007, 2009). The school administrators who responded to the survey in both studies indicated that they could address the needs of several student groups within the district with online learning (Picciano & Seaman, 2007, 2009). They believed that the potential existed in each school for online learning to meet the needs of some student groups. Administrator responses, support the perception that online learning is meeting the specific needs of a range of students from those who need extra help to those who want to take more advanced courses and whose districts do not have enough teachers for specific subjects (Picciano & Seaman 2007, p. 10).

In the follow-up survey in 2008, Picciano and Seaman (2009) found that administrators' concurred with the previous 2007 study. For example, these authors summed up some administrator responses as, the perception that online learning is still meeting the needs of a wide range of students from those who need to make-up coursework (e.g., credit recovery) to those who need extra help, and to those who want to take more advanced placement and college-level courses (Picciano & Seaman, 2009, p. 13).

Many administrators responded that the use of online learning allowed them to offer courses not available by any other means, including advanced placement courses, and the offering of online courses has led to greater participation in these high-level classes. Also Picciano & Seaman, (2009), indicated that one administrator indicated that they found value in online learning because it has been "very successful for credit recovery and drop-out prevention" and "on-line offerings have made it possible for at-risk students to earn make-up credit for graduation purposes" (p.13). Positive responses from administrators indicate that they favor online or blended learning when grouped as concepts of student-centering which included: (a) meeting the needs of specific groups of students (74%), (b) offering courses not available at the school (76%), and (c) offering advanced placement or college-level courses online for students (68%).

However, in a 2005-2006 survey as well as that in 2007-2008, Picciano and Seaman (2007, 2009) reported that administrators relayed concerns regarding the value of online learning. These issues mostly pertain to the quality of the curriculum and student learning. Forty-eight percent of administrators indicated that the most significant concern and substantial barrier to online implementation was course quality. Picciano and Seaman (2007) highlighted the following:

> Part of educating a child is to learn social and teamwork skills...human interaction is very important in any child's social growth . . .Online courses should not replace face-to-face instruction because the program does not seem to be as effective as face to face coursework. (p.16)

Some argued that a traditional classroom environment provided teacher interaction and support that online instruction did not. Some administrators in the Picciano and Seaman (2007) study remarked that their "community (including teachers) are critical of the quality, content" (p.15). Other administrators responded with a lack of confidence for online learning as an effective option; thus, they hesitated to use these methods in an instructional model. One administrator offered that as online courses are evaluated and proven to be a formidable means of delivering quality instruction, the community will more fully embrace this instructional model. Another stated that there are some reservations about the effort, quality of work, and the authenticity of the summitted work.

The purpose of the second Picciano and Seaman study in 2009 was to replicate the original study published in 2007. They sought to update their original findings and determine if there had been changes in online learning in the school districts during the intervening two years between the studies. Picciano and Seaman examined issues related to planning, operational concerns, and online learning providers; they concluded that the earlier findings were substantiated.

The respondents identified concerns about online education were (a) "students need to be ready and "more disciplined" to succeed in online courses; (b) in K–12 schools, especially at the primary and middle school level, the social and emotional development of students is an important aspect of the overall school experiences; (c) a blended approach can ease this concern by providing some face-to-face time" (Picciano & Seaman, 2007, p.19).

Blended Learning and Personalization

A vital component for the successful delivery of blended learning, as well as personalized learning, is the ability to adapt the instruction as student learning progresses. Adaptive learning is a computer-based or online educational system that modifies the presentation of material in response to student performance (Getting Smart Staff, 2014). Simply stated, "adaptive learning software adjusts the learning content or assessment items it presents to each student based on observations made of student performance" (Intel Corporation, n.d.). In an adaptive learning system, each student receives an appropriate level of challenge with an appropriate amount of support.

Although there are instructional challenges associated with blended learning, there are several advantages to a carefully constructed blended learning system. Teachers and students have choices in determining the content included in curriculum and when its taught, and teachers can adjust the material's rigor level when student input demonstrates understanding. It can also provide more corrective materials when student responses show they lack understanding. Teachers tend to struggle when attempting to reach students at their current level of understanding and differentiate instruction to meet the needs of individuals. Delisle (2015) stated that differentiated instruction does not work. The author based the conclusion on how educators group students in classrooms. Delisle (2015) stated that educators:

> Toss together several students who struggle to learn, along with a smattering of gifted kids, adding a few English-language learners and a bunch of academically average students and expect a single teacher to differentiate for each of them. That is a recipe for academic disaster if ever I saw one. (p.35)

Delisle continued with "although fine in theory, differentiation in practice is harder to implement in a heterogeneous classroom than it is to juggle with one arm tied behind your back" (p.31). In contrast, Tomlinson (2015) stated, "that with intelligent, sustained support, most teachers can learn—step by step and over time—the attitudes and skills necessary to provide plus-one (differentiated) learning in the context of classrooms that are both academically rich and academically diverse" (p.32). Furthermore, Tomlinson countered that "never felt differentiation was a panacea" and "never advocated what I'd call a Noah's Ark classrooms assigned two of every kind of learner in the school" (p.32). However, Tomlinson (2015) acknowledged the difficulties of differentiating instruction.

A method to improve differentiated instruction could be to assign a tutor for every student. However, computers with an adaptive learning program can simulate personal tutors and m provide differentiation to meet individuals' needs. Computer-assisted instruction approximates the one-on-one tutoring that every student could use to reach their fullest learning potential. However, in a blended environment, if the computer-assisted instruction is not producing the desired results, a teacher is available to help advance learning.

Many teachers know that education and instruction appear to be cyclical. Teaching strategies evolve and reappear in various forms. However, educational strategies tend to move forward where methods and tools appear to improve learning. Although there are short cycles of strategy as well as more lasting trends, the widely accepted and tested ideas in education tend to grow and persist. These ideas include the importance of classroom teachers, the value of teacher persistence, the need to engage human cognition to its fullest range, and, most of all, active construction of knowledge through social interaction (McLeod, 2017). As digital technology and its use have grown, the educators revised some traditional notions of teaching and student learning out of necessity. Nevertheless, some core principles of teaching and learning appear unchanged.

Edmentum is a company that produces learning software. For more than 50 years, the organization had the vision to foresee the potential benefits of digital online learning. Edmentum demonstrated this vision of thorough research to bring excellence to their products using the essentials of behaviorist, cognitivist, and constructivist instructional design to these modern platforms (McLeod, 2017). Over the past three decades, the digital revolution dramatically expanded the options for integrating technology into education. The refinement of educational tools and delivery of on-screen material in elegant formats has grown tremendously. Many products that emerged failed to meet the needs of digital learners. However, among the many existing products and service offerings, Edmentum may provide a product that can fulfill the needs of these learners.

Although the brand is relatively new, Edmentum was formed in the early 1960s, long before computers were every home or pocket. Under the original name PLATO, the organization created what is arguably the first authentic computer-assisted learning system designed for widespread use. This first digital learning system was a breakthrough, not because it was computer-based but because learning scientists designed it. PLATO epitomized innovative instructional principles by including the leading insights from education and psychology into its design (McLeod, 2017). This digital learning system featured graphics and animation, which textbooks cannot imitate. This mode of presentation is useful for the social learning that occurs with teacher-student interaction, a more robust curriculum, aligned assessments, and personalized learning strategies to increase student motivation and achievement (McLeod, 2017). PLATO could not have materialized without the involvement and commitment of educators. More recently, the PLATO system has taken on the name of Edmentum Courseware.

Edmentum claims to use world-class instructional methodology and architecture that goes back to its original device in 1960. Over the years, professionals such as educational psychologists, educational researchers, and educational philosophers have continued to build on the learning theory that Edmentum rigorously applied to their products (McLeod, 2017). Although in the past, some argued that online learning was in contrast to classroom learning, many no longer emphasize the distinctions and outcomes between these modes of learning. Students have opportunities to move smoothly and continuously between online learning and traditional instruction. Many teachers depend on online learning to aid all levels of instruction. They can capture and analyze student performance data in real-time or deliver individualized content in a blended-learning classroom. Edmentum maintains that teaching is both an art and a science based on class characteristics and the professional judgments of educators. However, the organization also maintains that online courseware will continue as a valuable option to incorporate into an educator's creative mix (McLeod, 2017).

The foundation of educational best practices is continuously expanding as stakeholders evaluate innovative approaches regularly. The role of research in education is to provide administrators and teachers a basis for prescribing the interventions they employ. Sound rationales for practice can draw from applied research as well as theory. The use of explicit and enduring theories with compelling research explains why Edmentum Courseware can be an effective tool to include in an educator's professional domain. Harasim (2017) warned that "a common tendency of educators has been to merely integrate technology into traditional ways of teaching" (p.2). To that point, teachers could integrate email, wikis, blogs, and Google docs into traditional classrooms to determine better use of these methods. Edmentum suggested it is a "worthwhile first to take a step back and distill the principles that have traditionally come to inform sound educational practice into a handful of solid foundations that form the bedrock of Edmentum's methodology" (McLeod, 2017, p.5).

Edmentum bases the foundation of its courseware on the principle that here students must be active participants in the learning to construct meaning. Learners need more than direct instruction, regardless of the form of the instruction; for example, direct instruction through lectures, spoken, demonstrations, and presented through video or other multimedia. In the constructivist model, students conceptualize using what cognitive psychologists refer to as schemas. A schema is a pattern of thought that organizes categories of information and the relationships among the categories. At a fundamental level, people learn by observing the environment. Individuals form informal rules about how objects and events are related (i.e., how these fit schema), and people adapt their schemas if they experience contradictory information. Therefore, education is most effective when it combines the learning experiences of the student with the many different sources and modes of transferring information

In the Edmentum courseware lessons, the lessons begin with students' responses to warm-up questions. The questions concern their thoughts, and students record these thoughts concerning the workings of things. As the lessons develop, students can review their initial responses to the warm-up questions and reflect on them. This kind of self-reflection and metacognition is at the center of constructivist learning. Edmentum's Algebra 1 course content challenges students during the warm-up to solve a quadratic equation by graphing the solution point by point. Farther into the lesson, students can use an online graphing calculator to manipulate the parameters of three different forms of the quadratic equation. Through this type of scaffolding, students come to understand the graphing rules for each equation form. Students can also experience the value of having different equation forms as instruments in their math toolbox for robust problem-solving.

Moreno and Mayer (2007) outlined evidenced-based foundations of learning with media, by describing the features of digital-learning environments that provide the performance tasks that make learning possible. Moreno and Mayer (2007) stated that virtual and physical interaction of humans with computer environments offer conditions conducive for learning. This is because acquiring knowledge uses both digital and analog representations concurrently to process information. Paivio (1986) was the first to introduce this concept, which Moreno and Mayer recognized as an influential idea at the forefront of cognitive psychology in the twentieth century. Paivio (1986) described dual processing, later referred to as parallel processing, in which the brain represents objects from and in multiple modalities, which is prevalent in human cognition. Duel processing is a subtle, but profound psychological principle.

Edmentum designed each of the courses to ensure benefits for teachers and learners (McLeod, 2017). One advantage of the self-paced learning environment is that it includes multiple learning modalities. Learning styles, multiple intelligences, and individual differences are part of the movement toward individualized learning. Edmentum courseware purports to support the ability of students to advance at their own pace using multiple learning modalities. They also contend that their product is dynamic, interactive and that the content is engaging. Developed with this in mind, Edmentum's courseware intends to actively engage students with their lessons.

Courseware can customize course modules to meet local standards and mirror teachers' particular pacing guides. Products considered to be one-size-fits-all would not meet their needs because different states and districts have their particular standards and pacing guides. Sometimes it is not practical for teachers to encourage self-pacing. They may want to add lessons or even add practice sessions to their units. Teachers can customize the lessons to fit their goals and objectives. McLoud (2017) claims that Edmentum Courseware markets its product as a rigorous alternative to traditional classroom courses and stresses the rigor and relevance of course materials. He states that these elements are essential parts of the mastery learning approach and with emphasis on passion and persistence. Based on these ideas, Edmentum appears to devise courseware products to challenge students with rigor and relevant practice.

Advantages of Blended Learning

As the acceptance of blended learning began to increase, more researchers have started to identify several benefits to this method of learning. Considering there exist an abundance of literature that declares the potential for blended learning effectiveness, research on effectiveness still lacks (Dziuban, Picciano, Graham, & Moskal, 2016; Halverson, Graham, Spring, & Drysdale, 2012). Watson et al. (2013) conducted a study of programs that were being implemented across the country and determined that blended learning opportunities were increasing in the K-12 grade band. Picciano, Dziuban, and Graham (2014) stated that blended learning potentially improves the effectiveness of the educational environment. Researchers have also indicated that well developed blended learning environments with ample training of both teachers and students can provide benefits to students and schools by providing new learning opportunities that enhance student achievement (Oliver & Stallings, 2014). Other studies have shown that blended learning increases student participation and engagement, thus promoting effective learning (Asif, Vertejee, & Lalani, 2015; Clark, 2012).

Oliver and Trigwell (2005) considered the definition of blended learning to include “inconsistent and so useless as a way of understanding practice or as redundant” (p. 21) in the definition of blended learning. Many others considered blended learning as valuable to “facilitate easy and flexible learning and to increase teaching and learning efficiency” (Dalsgaard & Godsk, 2007, p. 29). These courses receive high marks for their flexibility, mostly because students are free to work when they want. Moskal, Dziuban, and Hartman (2013) stated a counter-argument that students dislike the absence of face-to-face interaction. Blended learning rectifies this issue by providing a structure that Vasileiou (2009) suggested is “flexible” and offers students the “most effective delivery options for each stage of learning” (p.83).

In blended learning, the typical learning experience is free from the confines of a traditional teacher-focused and synchronous approach. Thus, the online instruction component extends blended learning using an asynchronous student learning environment. Furthermore, blended learning allows for adaptable timing because there is “not any fixed ratios of synchronous and asynchronous in blended learning classrooms that may be considered to be correct or incorrect” and “the main aim is to advance the learning experience by using a blend of face-to-face and internet-based learning environments” (Massoud, Iqbal, Stockley, & Noureldin, 2011, p. 5). Therefore, blended learning provides educators the autonomy to decide how much time they dedicate to face-to-face and online learning. Teachers also have the flexibility to determine which learning activities will be part of each component. Educators tend to utilize traditional learning activities during a direct instruction segment of a lesson. However, Moskal et al. (2013) observed that the addition of blended learning could “increase access within the scope of existing resources while maintaining or enhancing quality” (p. 16). Educators also have wide latitude in choosing the online platforms, and the curricular sequence students follow within that platform. Through this flexibility, educators can provide learning materials that are “sufficient to create the basis for an individual and self-governed use and support various instructional needs to ensure overall good educational results” (Dalsgaard & Godsk, 2007, p. 41).

In blended learning, teachers do not confine the learning environment to a self-contained classroom. Blended learning is accessible in classrooms but also in any location where there is internet access. However, as previously defined, it must include some face-to-face interaction that is so crucial to this process. Moe and Rye (2011) emphasized this, "even if the Internet can facilitate increased flexibility and reduce the friction of time and space, some of the old needs for communication remain present" (p.165).

Vasileiou (2009) contended that a traditional environment maintains certain advantages that the virtual world can only simulate. These include an "organizational framework and motivation, and enables people to learn through their peers' experiences" and "classroom training will strengthen the learning experience and is the best place to deal with subtle organizational differences in practice, as well as exceptions to the rules" (p. 83). However, Blatchford, Kutnick, Baines, and Galton (2003) pointed out that there are learning stages that require social development, motivational theory interaction by describing "that learning and motivation are both developed in a social context" (p.1). Although differentiated instruction provides theoretical means to meet the needs of the individual students, most educators realize that a single teacher cannot provide individualized instruction in all subjects for every student. While recognizing that there is emotional and cognitive diversity in every classroom, Wilson and Smilanich (2005) suggested that "the traditional classroom model wasn't designed to handle these factors and can't meet all of the learning needs of every individual in every organization" (p. 3). There is a need for more personalized instruction, such as a tutor for each student, to create genuinely individualized instruction for each student.

From another perspective, Vasileiou (2009) presented two basic assumptions. First is that "no two students bring the same knowledge base to class," and the second is "that no two students learn at the same pace" (p. 84). Vasileiou continued:

> Individual students will have varying levels of attention and different degrees of motivation from day to day. Hence it is clear and obvious that technology, in combination with pedagogy, offers us the opportunity to overcome the negative effects of both these misleading assumptions. (p. 84)

The education community has called the blended instruction mix the best of both worlds (Anderson & Skrzypchak, 2011; Herrmann-Nehdi, 2009; Lapuh Bele & Rugelj, 2007) and it appears to be well-situated to address the characteristics of a productive learning environment. Moreover, the mix of instruction in blended learning could be adaptative for differentiation using the online component and the social aspects students experience in the classroom. Because blended learning aims to marry the best attributes of traditional teaching with those of online learning (Oliver & Stallings, 2014), positive outcomes such as increased effectiveness in students' learning (Lieser & Taff, 2013) and decreasing dropout rates (Lopez-Perez, Perez-Lopez, & Rodriguez-Ariza, 2011) become possible. Because "high school dropout and graduation rates remain a top concern for educators and policymakers" (Freeman et al., 2015, p.291), continued research with blended learning becomes critical.

Staker (2011) implied that blended learning "varies in the way that students experienced their learning across several dimensions, including teacher roles, scheduling, physical space, and delivery methods" (p.7) for a more individualized approach to education where students "have some control over the time, place, path, and/or pace" (p.

6). Staker (2011) contended that "online learning has the potential to be a disruptive force that will transform the factory-like, monolithic structure that has dominated America's schools into a new model that is student-centric, highly personalized for each learner, and more productive" (p. 3). According to Alonso, Manrique, Martinez, and Vines (2011), the blended-learning approach provides success due to more individualized instruction than traditional face-to-face learning. This style of instruction enables learners to navigate the space and time demands of other interests, as students can carry on other everyday activities without having to adapt to strict space and time constraints, and students can work cooperatively. They stated, "Cooperative activities help to promote information exchange flows among students, build up cognitive knowledge construction processes, and strengthen motivational and informal affective bonds of mutual support and friendship" (p.477). George-Walker and Keeffe (2010) noted that students could select their learning paths and formats to fit their evolving needs. They also suggested that it is not the teachers' roles to determine the nature of the blend because students have increased options through blended learning.

Many researchers found that utilizing technology transformed educational processes and roles. (Banados, 2006; Draffan & Rainger, 2006; Harnisch & Taylor-Murison, 2012). Halverson, Graham, Spring, and Drysdale (2012) analyzed research results concerning blended learning to determine the findings and the authors most frequently cited and found that researchers are most interested in the transformative potential of blending as opposed to technology-enhanced learning environments or enablement. Blended instruction can transform education into high level, learning-centered experiences. Integrating technology encourages students to be active learners in ways that traditional education cannot by utilizing new and effective methods of communication and collaboration, which exist in a blended learning environment (DePietro, 2013; García Valcárcel, Basilotta, & López, 2014).

School districts are employing technologies intending to create a student-centered meaningful learning environment. Students who are well acquainted with electronic communication have created a demand that supports the growth of blended learning (Garrison & Kanuka, 2004). Garrison and Kanuka (2004) suggested that these tools might "sustain the educational experience over time so essential to moving students to higher levels of thinking" (p. 99). Dalsgaard and Godsk (2007) indicated that blended learning allows students to produce more self-governed work, which provides a better way of working with the curriculum. Others contend that these best practices have encouraged active engagement in the classroom (Anwar, 2011) and that various Web 2.0 tools provide opportunities for students to become active learners while potentially creating a more dynamic classroom. (Williams & Chinn, 2009).

Blended Learning Impacts on Achievement (Results of other Published Studies)

One of the guiding questions that many researchers have been trying to answer is whether online learning is as effective as traditional classroom-based instruction in terms of student achievement. Cavanaugh, Gillan, Kromrey, Hess, and Blomey (2004) published one of the first meta-analyses of research on online learning in the K-12 context. These authors found the topic as compelling because, at that time, online learning appeared as a vital solution to educational challenges, and there were growing numbers of students learning online; thus, they studied the factors that affect student learning in online schooling environments. A goal was to examine the effects of distance education on achievement outcomes for K–12 students, as well as identifying the effects of distance education features on student outcomes. These features included content area, duration, frequency, student grade-level, instructor role, school type, the timing of interactions, and learning pace. The meta-analysis consisted of a review of studies from 1999 to 2004, which concerned 14 web-delivered K to 12 distance education programs with 116 effect sizes. The analysis showed that distance education affected student academic achievement equivalently to traditional instruction.

Cavanaugh et al. (2004) concluded that telecommuting students could have similar levels of success as in classroom settings. However, they interpreted their results as showing some variations in the students' success and expected that there was a need for more information before making firm conclusions. Consistent with these findings, Blomeyer (2002) suggested a need for well-designed and executed program evaluations and educational research as a high priority in all public and private agencies supporting the use of online learning in K–12 settings.

The West Virginia Department of Education partnered with researchers to produce The Educational Development for Planning and Conducting Evaluations (ED PACE) Project (Rockman et al., 2007). The purpose of the project was to develop a model for designing, conducting, and disseminating research related to technology interventions in education. The funding for this three-year project came from the U.S. Department of Education, which provided grants to nine states in total. The focus of the ED PACE in West Virginia was on the state's implementation and outcomes from a virtual Spanish program for seventh and eighth-grade as compared to a traditional classroom program. The measures used were the students' Spanish proficiency and their overall performance on the state's standardized achievement tests (Rockman et al., 2007). This student achievement study used a quasi-experimental design, with a mixed-methods approach to determine how achievement among virtual Spanish students' achievement compared to students receiving instruction in face-to-face classes.

Results of this ED PACE Project showed that online students performed as well as the traditional classroom students; moreover, the online students maintained a high-level of achievement over three years. The virtual students developed language skills along with positive attitudes and strong work habits (Rockman et al., 2007).

In collaboration with the U.S. Department of Education, Means, Toyama, Murphy, Bakia, and Jones (2010) conducted a significant and extensive meta-analysis focused on the effectiveness of online learning. The goal of this study, in its entirety, was to provide research-based suggestions to educators regarding the implementation of online learning in K–12 classrooms and teacher in-service. The aim of the study was to answer the following four questions:

- How does the effectiveness of online learning compare with that of face-to-face instruction?
- Does supplementing face-to-face instruction with online instruction enhance learning?
- What practices are associated with more effective online learning?
- What conditions influence the effectiveness of online learning?

They compared the results of multiple independent studies to estimate the overall efficiency of online education by comparing online and face-to-face instruction. An ancillary finding was that the small number of published studies contrasting online and face-to-face learning conditions for K–12 students. They initially located 1,132 studies, and after careful examination, only 99 studies comparing face-to-face and online learning remained. Further analysis showed that 46 studies had sufficient data for use in the meta-analysis, but only five of these studies involved K-12 learners (Angiello, 2010). However, a comparison of the blended learning students' outcomes with the traditional classroom students showed that the blended learning students demonstrated significantly better performance (Means et al., 2010).

In their conclusions, Means et al. (2010) stated that students who took all or part of their classes online, on average, outperformed those taking the same course through traditional face-to-face instruction. Where instruction combined online education with face-to-face components, blended instruction provided a considerable advantage over exclusively face-to-face instruction than did online instruction alone. In studies where online learners spent more time on task than did the traditional face-to-face students, results showed a more significant benefit for online learning. The effectiveness of online learning approaches was quite broad across different content and learner types. The effect sizes were larger in studies where the online and face-to-face environments varied in terms of curriculum material and aspects of instructional approach as well as the medium of instruction. (Angiello, 2010; Means et al., 2010).

Although some researchers have focused on the effectiveness of online mathematics programs, as blended learning programs have increased, there has been very little evidence-based research to guide educators concerning whether online mathematics learning is as effective as traditional face-to-face learning. O'Dwyer, Carey, and Kleiman (2007) addressed the void of evidence-based research to help inform educators about this growing initiative. They used a quasi-experiment model to examine the effect of the Louisiana Algebra I online model for online learning at the high-school level about student performance. They expressed this aim as:

> The Louisiana Algebra I online model was designed and implemented to bring highly qualified mathematics teachers to students in places where they would not be otherwise available, to provide students with the structure of a regular class period, and to provide a unique professional development model for local teachers. (p. 302)

O'Dwyer, Carey, and Kleiman (2007) aimed to analyze the model's impact on high school student achievement and attitudes as compared to traditional classroom models. To complement results from achievement outcomes, they used student survey responses from both student groups. Given that content delivery methods, such as online versus face-to-face delivery, might not hinder student learning, it was essential to understand student experiences in the treatment and comparison groups while participating in the online Algebra I online (Bernard et al., 2004).

In the 2004-2005 school year, O'Dwyer, Carey, and Kleiman (2007) included 18 classrooms in two private schools and six school districts with 257 students participating in the Louisiana Algebra I online project. The results showed that:

> When compared to the comparison group students, a higher percentage of students in the treatment group classrooms reported that they did not have a good learning experience. Considering the same content standards were covered in both groups, the difference in learning experience may have been a function of the

newness of the online model, specific differences in the curricula, and/or differences in classroom approaches. (p. 303)

Also, "despite having similar post-test means, compared to the comparison group, a lower percentage of students in the treatment classrooms reported feeling either confident or very confident in their algebra skills after the course" (p. 303).

Heppen et al. (2011) used a randomized control trial with the goal of measure the effects of offering a blended Algebra I course for eighth-grade students located in schools where Algebra I was not offered to eighth-graders, but determined to be ready for algebra. As the authors describe, “The study tested the impact of offering an online Algebra I course on students’ algebra achievement at the end of grade 8 and their subsequent likelihood of participating in an advanced mathematics course sequence in high school” (p. x). And they further stated that “The primary research questions asked whether access to online algebra I improves Algebra-Ready students' knowledge of algebra in the short term and whether it opens doors to more advanced mathematics course sequences in the longer term” (p.xi).

The secondary goal of the study was to estimate whether there are any unintended consequences of offering the online Algebra I to these students. For example, the taking of online Algebra I instead of general grade 8 mathematics could hinder the Algebra-Ready students' general mathematics achievement. Thus, an aim was to inform administrators who are considering investing in an online course as access to Algebra I for grade 8 students.

As previously mentioned, student achievement was not the exclusive focus of this study. It included other factors such as the technological capabilities of the schools, a teacher's capability to provide support to students, an end-of-year algebra exam achievement score, and subsequent high school math course enrollment. However, when students' post-test scores were compared with those of students who continued in the conventional eighth-grade math class, which also includes substantial algebraic conceptual content.

The conclusions were that offering Algebra I online to Algebra-Ready students is an effective way to broaden the availability of Algebra I content to eighth-graders in schools where it is not typically available. Participation in this online course significantly affected students' algebra achievement at the end of grade 8 and increased the likelihood of students taking advanced mathematics courses in high school. The course had no apparent side effects on Algebra-Ready students' general mathematics achievement at the end of grade 8 or adverse effects on non-Algebra-Ready students' measured outcomes. Heppen et al. (2011) stated that "the study demonstrates that an online course as implemented is more effective in promoting students' success in mathematics than existing practices in these schools"(p. xviii), and the course was judged to be effective in each area of inquiry.

Project Revolutionizing Education (RED) conducted a national survey to determine what has worked well in schools that are considered technology-transformed and show how technology could save costs when appropriately implemented. They researched 997 schools in 49 states and the District of Columbia that provide internet access for every student. The Project asked about the factors that contributed to the success or failure of the programs. Greaves, Hayes, Wilson, Gielniak, and Peterson (2012) stated that the Project was also:

> Searching for proof of cost savings from the implementation of technology in any K–12 environment, whether these savings come from online learning courses, professional development, concurrent enrollment in college courses, data mapping, special needs programs, or any other program. (p. 1)

Project RED followed a standard survey methodology that focused on educators that were "a self-selected sample of the public-and private-school professionals" (Greaves et al., 2012, p. 97). It "was inspired by the desire to contribute to the reengineering of education through research and through sharing compelling stories of transformation" (Greaves et al., 2012, p. ix).

By using a broad array of factors and variables, Project RED provides unprecedented scope, breadth, and depth to their study. They examine 11 different measures of educational success, 22 independent variables containing subcategories, provide comparisons of findings by student–to-computer ratios such as 1-to-1, 2-to-1, 3-to-1, and comprehensive demographic data correlated to their different survey results. Greaves et al. (2012) learned many essential things from the work of Project RED and revealed some significant findings of interest schools that are beginning or are already implementing technology in education. These included:

> (1) online collaboration increases learning productivity and student engagement; (2) proper implementation of technology is linked to education success; (3) 1-to-1 schools that properly implement technology outperform all other schools, including all other 1-to-1 schools; (4) technology-transformed intervention improves learning; (5) properly implemented technology saves money; (6) daily use of technology delivers the best return on investment (ROI); (7) a school

principal's ability to lead is critical to the success of an implementation effort. (p.10)

Project RED determined that "technology-transformed intervention classes, including English language learners, special education, Title I, and reading intervention programs, are the top-model predictor of improved high-stakes test scores, dropout rate reduction, course completion, and improved discipline" (p. 16). They attributed this assertion to the impact of a student-centric approach that technology integration provides. These included (a) each student works at his or her own pace, (b) individualized instruction where students learn at their own pace and engage in learning at exactly the right entry point, and (c) provides almost endless opportunities for personalized learning. Also, teachers have more time to address student difficulties with one-on-one instruction. Greaves et al. (2010) emphasized that the effect of a technology transformation is similar to that of a class size reduction from 30 to 10 students when measured by student-teacher facetime (p. 17). Greaves et al. (2010) concluded with some suppositions that they uncovered. They suggested that technology can reengineer the educational system and that it can and should transform learning as consistent with how it has transformed almost every other segment of society. Moreover, they asserted that when adequately implemented technology will lead to radical changes in education.

Kellerer et al. (2013) conducted a qualitative study exploring the perspectives of rural teachers on the impacts of blended learning on students and teachers. A team of researchers from Northwest Nazarene University's Doceo Center in partnership with Idaho Digital Learning Academy and the International Association for K–12 Online Learning conducted interviews, transcribed and analyzed responses concerning the perspectives of blended learning from eight randomly selected rural Idaho teachers. The aim was to determine the teacher's understanding of blended learning, how it might affect the way they teach, and whether blended learning changed their students.

From the researcher's evaluation and analysis, eight significant themes emerged from the analysis. The most frequently reported theme was related to an increased level of student engagement in blended learning classrooms. Kellerer et al. (2013) stated that among the significant themes regarding teacher perceptions of students' blended learning experiences were “a more personalized learning environment, the ability for students to be self-directed, the opportunity for students to create their own pace, and increased levels of student motivation" (p.4). Significant teacher themes also emerged as related to their blended learning classroom teaching experiences. According to Kellerer et al. (2013), teachers expressed that the "role that blended learning plays in cultivating a student-centered environment," "described their role as facilitators of learning” and “spoke to the importance of professional development in improving their quality of experience in implementing blended learning” (p.4). Kellerer et al. (2013) compared the results to a previous study conducted in Idaho by Werth, Werth, and Kellerer (2013). They determined that the "conclusions from this study supported many of the conclusions from the previous study including the positive impacts on students in the areas of motivation, student engagement, personalized learning and self-directedness" (p.4).

In their conclusions, Kellerer et al. (2013) found, according to rural teacher perceptions, that blended learning is beneficial to both students and teachers. They discovered that teachers feel empowered to be facilitators of learning, adjusting opportunities to meet the needs of individual students, and teachers perceive that students are more highly engaged in the blended learning classroom, creating their own pathways to demonstrate understanding, moving through the curriculum at a pace that supports individual mastery of content and creating intrinsic levels of motivation to learn. (p.17)

Kellerer et al. (2013) noted that teacher responses also indicated "they are empowered to meet the challenges of a 21st-century classroom by learning and incorporating new technologies to meet the needs of a more diverse student population" (p.17). Finally, teachers also shared a few key ideas relating to implementing blended learning. They offered advice to just get started and seek professional development to support the implementation of blended learning.

The FLVS is a virtual school dedicated to personalized learning and provides online courses to middle and high school students via the Internet. Founded in 1997, the FLVS became a nationally recognized e-Learning model and was the nation's first statewide Internet-based public high school. In 2000, the Florida Legislature established the FLVS as a fully independent educational organization with a board appointed by their governor. It was the only public school to have their funding tied directly to student achievement. The FLVS offers several options to students, which include a fully online learning environment and a blended learning environment (FLVS, 2013b). This program supports an easy option for Kindergarten-5th grade, as well as a middle and high school option that consists of more than 190 free courses offering year-round enrollment and 24/7 course availability. In 2015-2016, local high schools launched courses using a blended environment with online learning and face-to-face teachers (Postal, 2015).

In Florida, the state administers a state-wide exam to students after completing specified courses in particular subject areas. Based on the Spring 2018 End-of-Course (EOC) assessments, this state determined the following:

> FLVS students outperformed state averages on the Algebra 1, Biology 1, Civics, Geometry, and U.S. History EOC Assessments . . . Comparing the 15 AP courses offered by FLVS and scored above those state qualifying AP averages in 11 of the 15 courses, FLVS students outperformed the overall national average by 4 percent in comparing the 15 AP courses offered by FLVS. (FLVS, 2018, p.6)

In their report titled "Final Report: A Comprehensive Assessment of Florida Virtual School," Florida Tax Watch Center for Educational Performance and Accountability (2007) examined the FLVS to determine if it was a credible alternative to traditional schooling in regards to both student achievement outcomes and cost-effectiveness. They wanted to "explore to what degree Florida Virtual School (FLVS) offers an efficient, taxpayer accountable alternative and supplemental system of education" (p.8). They undertook a comprehensive analysis of the FLVS data to answer fundamental questions about its efficacy. The two overarching queries were: (1) How does student achievement by the FLVS compared to those of students in traditional brick-and-mortar schools?, and (2) Is instruction via the FLVS a cost-effective approach?

The FLVS earned high marks in both. The Florida Tax Watch Center made the following findings:

> • FLVS high school students outperform their counterparts in two critical areas of measurement: test scores and grades earned in courses. (p.13)

• FLVS students consistently outperformed their public school counterparts on both the reading and mathematics on the Florida Comprehensive Assessment Test Section. (p.17)

• FLVS students consistently outperformed their public school counterparts on Advanced Placement Examinations. (p.19)

• Education via Florida Virtual School is a bargain for Florida taxpayers. (p.23)

Therefore, the research findings for the two original fundamental questions were positive. FLVS students "outperformed their statewide counterparts on two independent assessments, the Florida Comprehensive Assessment Test and Advanced Placement examinations" (p.2). The FLVS earned higher scores in parallel courses. The Florida Tax Watch report also remarked that "this was accomplished with less money than was typically spent for instruction in traditional schools" (p.2).

Chingos and Schwerdt (2014) appear concerned that online education has grown immensely in recent years, especially with state-sponsored virtual schools. However, they claim that "there is no prior credible evidence on the quality of virtual courses compared to in-person courses in U.S. secondary education" (p.1). To rectify this, they evaluated the academic performance of the FLVS. In this study, the FLVS shared all course records from their 2005-06 through 2010-11 school years. With this data, Chingos and Schwerdt (2014) compared "the performance of students who took core courses in algebra and English at their traditional public high school to the performance of students who took the same courses through the Florida Virtual School" (p.1). When it comes to virtual education, there seem to be at least two potential goals of it. First, "virtual education can increase access to education by enabling students to take courses that are not offered in their local school or that they cannot attend due to enrollment constraints or scheduling conflicts," and additionally, "virtual education might improve the quality of education through personalization, competition resulting from increased choice among providers, and other channels" (p.3). Also, even if virtual schools are determined not to be any better than traditional schools, can "they offer opportunities to increase productivity in education by operating at a lower cost?" (p.3). In their report, Chingos and Schwerdt (2014) indicated that virtual schools could provide a variety of courses that students can take anywhere and anytime; therefore, they meet the first goal almost by mere definition. The attainment of the second goal of improving the quality of education through personalization and providing competitive options for students is unclear.

In this study, Chingos and Schwerdt (2014) provided initial estimates about the effect of taking online courses by comparing the achievement of students enrolled in traditionally taught high school courses in algebra and English to the achievement of those who took one or both of these courses online through the FLVS while being enrolled in the same traditional schools. This study compared the following:

> 10th-grade test scores of students with similar 8th-grade test scores and demographics, some of whom took the algebra and English courses online with the Florida Virtual School and others who took the same courses in person at their local public school. (p.4)

Second, they selected students who enrolled in an online course and another course in-person to determine if the test scores differed between these courses. Regardless of the approach, "the Florida Virtual School students perform about the same as or better than non-Florida Virtual School students on state tests in reading and math" (p.4). Chingos and Schwerdt (2014) stated that the results for all students who took Algebra I or English I through the Florida Virtual School, scored higher on the reading or the math test than Non-FLVS students" (p.12). They also remarked that they found "no consistent evidence of subgroup effects and no evidence that the Florida Virtual School students are more likely to be absent from their regular school (p.4).

Of the two previously mentioned goals of virtual education, increasing access to education, and improving quality, the first goal was more readily attainable than the second. “As a student who takes a virtual course not otherwise available to him has gained access to the course as a result of the virtual option" (Chingos & Schwerdt, 2014, p.13). Alternatively, critics were concerned that virtual students would learn less than they would in a traditional classroom. The study's results supported “that those concerns were not supported by the evidence, both overall and for various subgroups of students” (p.13). Chingos and Schwerdt (2014) stated: “The true Florida Virtual School effects may be more positive than those reported here if students tend to take true Florida Virtual School courses to avoid lower quality teachers at their traditional school” (p.13). Chingos and Schwerdt (2014) concluded:

> [They did] not find any evidence of negative effects of virtual education on student learning, and a finding of equivalent quality, on average, between true Florida Virtual School and Non-true Florida Virtual School courses may suggest a higher level of productivity in the true Florida Virtual School courses. (p.14)

They concluded that per-pupil funding was 10% lower for the FLVS during that four-year period, suggesting that it was producing similar student achievement outcomes at a lower cost. However, their comparison "does not account for the fixed costs of educating Florida Virtual School's part-time students at their local brick-and-mortar schools" (p.14).

Gender Differences

Are there gender differences in mathematics education? There has been extensive attention paid by educational researchers on the topic of gender differences over the past few decades. Prior results indicated that males outperform their female counterparts in mathematics (Hyde, Fennema, & Lamon, 1990a). Hyde, Fennema, and Lamon (1990a) considered Maccoby and Jacklin's (1974) work on gender differences as notable for understanding differences in task performance and other issues. In their analyses, Maccoby and Jacklin (1974) based conclusions on approximately 1,600 studies in eight separate areas of achievement, personality, and social relationships. Maccoby and Jacklin reached four main conclusions "regarding sex differences that are fairly well established" (Cole, 1997, p.6). The conclusions have since been corroborated in numerous ways by subsequent research, and these are: (1) "Girls have the greater verbal ability, (2) Boys excel in visual-spatial ability, (3) Boys excel in mathematics, and (4) Males are more aggressive" (p.6).

Pallas and Alexander (1983) claimed that gender differences in mathematics result from different curricular choices so that the male advantage stems from more preparation in mathematics. Low mathematics achievement early on, especially in females, is likely to lead to a pattern of low performance in mathematics as a result of the cumulative nature of academic curricula (Kilpatrick, Swafford, & Findel, 2001). A new perspective on women's math achievement suggested that evidence supports that failure to obtain mathematics skills during the early grades can significantly limit future opportunities for learning and cognitive development (Kilpatrick et al., 2001). From a social-psychological standpoint, Entwisle and Alexander (1993) stated that beginning students develop a self-image in addition to the academic reputation they develop among their teachers, other students, and parents.

Researchers studying the effects of gender differences on academic achievement provided teachers of young children significant implications and specific guidance on actions to take. Some suggest that gender differences in mathematics achievement may develop during the period between the end of middle school and beginning of high school. The evidence suggested that gender differences in mathematics achievement originates later in students' school tenure than initially suggested. Levine et al. (1999) suggested that more recent studies provide evidence that gender differences may begin at a much younger age, as evidenced by studies of gender differences in spatial abilities, show a male advantage on mental rotation tasks at the age of 4 years and six months. These authors stated, "This difference appears to be the most substantial sex difference in cognitive functioning" (p. 841). Although little is known about the activities that promote spatial skills, researchers have supported that building Legos and puzzles, as well as playing video games, could be some of these. An interesting note is that boys tend to spend more time on these activities than girls. Levine et al.(1999) cited a few possible explanations in that "boys engage in spatial activities more than girls do whenever such activities are available because of a biological propensity," and that "boys engage more in these activities in certain cultural contexts because their environments make it more comfortable for them to do so" (p.841).

Because there is concern over equity for boys and girls in mathematics education, researchers have studied gender differences in mathematics achievement for over twenty years. The term "gender differences" refers to "non-biological characteristics, psychological features, or social categories" (Deaux & Major, 1987). In 2000, the National Center for Education Statistics published the "Trends in Educational Equity of Girls and Women" (Bae, 2000). The Center examined a broad scope of published and unpublished statistical materials to provide an overview of how girls and women in the US fair in education. The study included 44 separate indicators as to how "males and females avail themselves equally of these opportunities, perform at the same level, succeed at the same rate, and obtain the same benefits" (p.1). Coley (2001) reported the conclusions as (a) "in the early school years, girls are less likely than boys to repeat grades and have problems in school," (b) "girls outperform boys in reading and writing," (c) "girls lag behind boys in mathematics and science," and (d) "girls are more likely to major in subjects leading to lower-paying fields and less likely to major in engineering, physics, and computer science" (p.4).

Coley (2001) studied issues of whether gender differences differed among racial and ethnic groups. In this study, the data derived from many sources, including results from the NAEP, the Scholastic Aptitude Test (SAT), Graduate Record Examination (GRE), and Graduate Management Admissions Test (GMAT), and the Advanced Placement (AP) examinations. Coley concluded that among all racial and ethnic groups, the following gender differences held:

- Females scored higher than males in NAEP reading. (p.5)
- Females scored higher than males in NAEP writing. (p.5)

- Males scored higher than females in NAEP science. (p.5)
- White fourth grade males scored higher than females in NAEP mathematics. (p.5)
- Males scored higher than females on the SAT I Mathematics Test. (p.6)
- Males were more likely than females to score high in AP Calculus AB. (p.6)
- Males were more likely than females to score high in AP Biology. (p.6)
- Males had higher GMAT scores than females. (p.6)
- Males scored higher on the GRE Verbal, Quantitative, and Analytic Tests (p.5).

Based on these findings, gender differences likely exist in education. The differences are evident based on differences in gender performance in reading, writing, mathematics, science, and technology. Pajares (2001) stated that there are other gender differences besides achievement, and that is student motivation. It is also evident that gender differences in lower grades contributed to students' academic achievement, choices of major, and career choices at the university level. However, some researchers suggested that the level of gender difference has decreased significantly over the years.

Pallas and Alexander (1983) questioned the socialization explanations for gender differences in mathematics performance, and more specifically, the idea that high school programs are responsible for the sizable average difference on SAT. They wanted to know if the gender difference in SAT performance was due to differences in the pattern of coursework taken by high school males and females. They discovered that "females score somewhat lower than males on the SAT-M even after adjusting for sex differences in quantitative coursework" (p.179). They also found that "the male-female gap in SAT-M performance shrinks considerably when sex differences in quantitative high school coursework are controlled" (p.1). The results implied that increasing female enrollments in high-level mathematics courses could significantly reduce the gender differences in SAT performance. Finally, Pallas and Alexander (1983) determined "it would be premature to conclude that even the residual sex difference in SAT-M performance does not originate in socialization processes" (p.180).

The results from the Third International Mathematics and Science Study (Mullis et al., 2000), based on student test data from 1994-1995, showed "Few gender differences in the average mathematics achievement at the fourth and eighth-grade levels; however, there was a substantial gender difference in mathematics achievement for students in their final year of secondary school" (p.2). The report included that boys had significantly higher achievement in mathematical literacy in 18 out of the 21 compared. According to this TIMSS study, the US' mathematics achievement test shows that at the fourth-grade males only outscored females by a single point where males' mean score was 545, and the females' mean score was 544. However, there was a gender difference in the international average score in this category of only two points. At the eighth grade level, US males showed a 5-point difference over females; the males' mean score was 502, and females' mean score was 497. This is less than the gender difference in the international average score in this category that favored males by eight points. Finally, at the twelfth-grade level, the male students' mean score was significantly higher than that of their female counterparts. Males in the US registered a mean score of 466, and females' mean score was 456. The gender difference in the US was 10 points at this level, which was considerably lower than the international average score in this category, which was 33 points in favor of the males. When considering this data, there is evidence to conclude that there is a gender difference in male and female students' mathematics achievement scores, especially more predominant at the twelfth-grade level.

Based on results over the past few decades, educators cannot dismiss the performance differences of males and females in the areas of mathematics, science, reading, and writing if there is going to be an educational environment that is deemed equitable. As stated by Cheng and Seng (2001), "Gender differences in mathematics achievement are, by now, a well-known fact, and research in this area has a long history dating back to the seventies" (p.331). Since Maccoby and Jacklin's (1974) indicated that girls' performance in mathematics is below that of boys, many researchers studied these issues to determine if gender difference exists in mathematics education and the possible reasons for it. Eccles and Jacobs (1986) concluded:

> Adolescent boys have been found to score higher than girls on standardized mathematics achievement tests, males are more likely than females to engage in a variety of optional activities related to mathematics, from technical hobbies to careers in which mathematics skills play an important role, and adolescent males typically perform better than their female counterparts on spatial visualization tests. (p. 367)

Other findings suggested that the system systematically discouraged girls from courses of study in higher-level mathematics (Gober, 1998). Gober stated that a problem develops in the period between early elementary school and high school that discourages girls and young women from mathematics courses and careers. In this time, female students' achievement and confidence in mathematics decrease as they move toward higher-level courses (Gober, 1998). The National Center for Educational Statistics (1997) found that there are similar interests and abilities in mathematics among fourth-grade girls and boys. However, by the time they graduate from high school, they lag far behind their male counterparts (Sadker & Sadker, 1994).

Researchers have substantiated that confidence plays a large part in learning mathematics. Tartre and Fennema (1995) showed that the most effective variable that consistently related to mathematics achievement was confidence. They determined that confidence in learning mathematics is almost as strongly related to achievement as verbal and spatial visualization skills. Fennema and Sherman's (1977, 1978) concluded that even where there were no gender differences in mathematics achievement, girls often showed less confidence than boys in their ability to do mathematics. This supports that a student's lack of confidence in mathematics achievement may contribute to their lack of persistence when performing demanding tasks (Koehler, 1990; Peterson & Fennema, 1985).

Considerable evidence shows that there are gender differences in mathematics achievement. Results indicated that boys outperformed girls on standardized tests of mathematics (Fennema, 1996). There is a long history of boys outperforming girls on high profile tests, such as the mathematics section of the SAT (Burton, 1996). From the 1980s to the early 1990s, the male advantage in the College Board's Advanced Placement Program and Achievement mathematics examinations remained relatively constant (Stumpf & Stanley, 1996).

Gender differences have continued to exist in schools and influence the educational experiences of students. Educational equity is an enormous hurdle for teachers. Because students spend the majority of their time in school, it is essential to explore teacher beliefs regarding gender socialization (Garrahy, 2003).

Research on the topic of gender difference in mathematics suggests that gender difference increases as the students' progress to the higher-grade levels and that a teacher's belief may be responsible for gender differences for it. Fennema, Peterson, Carpenter, and Lubinski (1990) is one such study that investigated gender success in mathematics in terms of the teachers' knowledge and beliefs about boys and girls. Although the teachers' notions about student characteristics for mathematical success was similar for both boys and girls, the teachers' knowledge about why boys were successful was more accurate than about girls' success. Teachers attributed the boys' abilities to their successes and effort to the girls' successes. Weisbeck (1992) reported that teachers claimed to have considered boys more than girls during instruction; thus, adding some interesting insight into teachers' beliefs. However, the characteristics they used to describe the genders were very similar. Whatever the catalyst, by the middle school years, it is evident that both girls and boys stereotype mathematics as a masculine discipline (Benbow, 1988; Fennema, 1996).

Concerning gender equity and mathematics, much of what is known derived from the scholarship. Researchers have provided "documentation of and knowledge about variables that are related to gender and mathematics, and moderate change in what has happened to females within mathematics education has occurred partly because of this scholarship" (Fennema, 1996). Studies have included overt behaviors, such as responses on a mathematics exam, degree of agreement with an item on a confidence scale, and the interactions between students and teachers. Researchers must use new types of scholarship and methods focused on new questions. Such scholarship could help in identifying critical areas of study to advance research about gender differences and mathematics. Researchers can seek to understand issues about gender and mathematics, and it will be with this understanding that gender equity might be achieved.

CHAPTER III

Methodology

Introduction

This chapter provides an overview of the research conducted for this capstone project. The chapter contains the details of the middle school population and sample selection. It also includes an explanation of data gathering and the instruments. This quantitative study was a quasi-experimental design to investigate whether the implementation of Edmentum's Courseware Math Library into a blended learning environment improved middle school student's achievement in mathematics.

The research design integrates a rigorous pretest and posttest with active classroom and teacher training involvement to structure the study. This design was appropriate because no manipulation of the independent variable was possible. The independent variable was the type of learning environment: traditional classroom learning or a blended learning environment. Traditional learning is face-to-face and direct instruction by a teacher with no significant online learning involved. In contrast, blended learning integrates the methods of traditional classroom learning with online teaching and learning activities. For this study, the online intervention was Edmentum's Courseware Math Library. The purpose of the research study was to determine if the implementation of blended learning using Edmentum's Courseware Math Library results in higher academic achievement in middle school mathematics than the traditional face-to-face method of learning.

Purpose

Analysis of the historical test data of middle school mathematics achievement scores in our district shows an area of concern since the adoption of the PA Core

Standards and the development of the corresponding Pennsylvania System of School Assessment tests (PSSA). The data indicated that there is at least a 10% decrease in proficiency rates across grade-levels, starting at the 6th-grade and continuing to decline through Grade 8. The data also showed that this is not the case for the same cohort of students' proficiency on the ELA portion of the test. Further examination showed that once students reached the Keystone Exams in Algebra 1, their cohort proficiency rates doubled. These comparative scores suggest that this cohort of students can learn at very high levels in ELA and Algebra 1. This outcome suggests a need to focus on middle school mathematics programs to determine what instructional practices that could lead to increases in students' mathematical achievement on the PSSA Test.

Through observations of our middle school mathematics classrooms, it was determined to be a predominantly traditional learning environment with desks in rows and columns. There is a teacher in the front of the room with the students watching and taking notes from the example problems the teacher provides. Most have employed the "I Do, We Do, You Do" method of scaffolding and the students replicate what the teacher has shown through demonstrations in a step by step fashion. After the presentation, the students complete the homework assignments independently. Frequent observations showed that teachers check homework for completion (not correctness), and students can ask questions about the homework assignment before beginning the lesson for that day. The historical data and the observations raise many questions about implementing different instructional strategies and the effect the strategies might have on students' achievement in mathematics at the middle school level. Will implementing other strategies increase the student's active engagement in the learning process, as well as provide immediate feedback to the students on how well they are mastering the subject matter?

The district has taken many action steps over the past three years, from rearranging the mathematics department to placing effective teachers in areas most in need of growth and improvement. We have revised and rewritten the curriculum yearly since the adoption of the PA Core Standards by the Commonwealth. The district has approved and adopted new resource materials for the K – 12 mathematics programs carefully aligned to the PA Core Standards. There is even an additional period of mathematics every week built into the students' schedules by placing it in one of our middle school rotations. The results of these actions have shown modest gains in the achievement scores every year. However, the mathematics proficiency rates at the middle school level are still below the proficiency rates of this same cohort in ELA and eventually in Algebra 1 by half.

The purpose of this study is to examine the effectiveness of the implementation of the Edmentum Courseware Math Library into a blended learning environment in our middle school mathematics classes. In determining the effectiveness of the intervention, this study will focus on three research questions:

Q1 How does the overall achievement of students using the Edmentum Courseware Math library intervention compare with the achievement of students who are not using the intervention?

Q2 Is there a difference in the overall achievement of males compared with females who received the Edmentum Courseware Math Library intervention compared with males and females who are not using the intervention?

Q3 What skills do students demonstrate greater achievement using the Edmentum Courseware Math Library intervention?

Setting and Participants

The setting is a grade 7-12 public junior-senior high school that has existed for approximately 50 years, where the population ranges from 95 to 112 students per grade. This study is being conducted with students enrolled only in grades 7 and 8. Being a small school district with usually one teacher in a discipline per grade level, there were only two mathematics teachers involved in this study. The district and school do not have a one-on-one technology program, which increased the challenge of implementing the intervention. Implementation required students to use Chromebooks from a shared mobile cart during class to interact with the computer-assisted instruction. A school-wide high-speed wireless network and Internet access made the integration of the technology possible for all the students in the study. The intervention did not include that students interacted with it outside of the classroom.

The students gave assent, and the parents and guardians gave informed consent before the study began. All students, along with their parents or guardians, returned an informed consent form as required by the California University of Pennsylvania Institutional Review Board (Appendix A). Steps were in place during the data collection and analysis to keep the identities of all the participants confidential. The Commonwealth issued PASecureID numbers for students were used instead of their names.

Due to the COVID-19 pandemic, the Governor of Pennsylvania canceled the remainder of the 2019-2020 school year for all districts. In doing so, the action canceled the state assessment tests for this year as well. The PSSA tests, given in the middle of

April of every school year, would have created one of two measurements for this study. These data would have been used to answer the three research questions presented in this study. However, the cancelation of the state assessments did not affect the participant population.

The participants for this study consisted of currently enrolled seventh and eighth-grade students in the district who took the PSSA exams in math in the 2019 school year. The students ranged from 13 to 15 years old and enrolled in a required mathematics course divided into seven sections. The sampling is a whole study population sample of students who took Math 7, Pre-Algebra, and Math 8 in the Carlynton School District Junior-Senior High School during the 2019 -2020 school year.

The modeling method was randomly selecting the sections for the Math 7, Pre-Algebra, and Math 8 classes and randomly placing them by class section into a control group and an experimental group. The students included in the study were those enrolled in the district and the previously mentioned math classes for the full academic year. These participants consisted of students who attended the Carlynton School District for both the 2018-2019 school year and the 2019-2020 school years and had a PSSA score and proficiency level in mathematics for the 2018-1019 school year. They included students who also participated in the Study Island Benchmark Test as a pretest and a posttest. Since the Carlynton JSHS does not permit for schedule changes after the beginning of the school year, the consistency of the rosters and the random selection process was not a concern.

The study explored the differences in achievement between the traditional model of education (control group) and blended model of instruction with the implementation of the Edmentum Courseware Math Library (experimental group) on the Study Island Benchmark Test. The dependent variable was the Study Island Benchmark test, which is a commercially created criterion-referenced pretest. The independent variables were a modality of instruction and, the commercially made a criterion-referenced posttest by Study Island. Each grade level (seventh and eighth) was analyzed independently because the grade level standards and eligible content are not comparable year-to-year due to content differences each year.

The experimental group received the intervention and the Study Island Benchmark criterion-referenced test as a pretest and posttest measure. The resulting data were analyzed and compared to determine the effectiveness of the instruction. The teachers reported the results of the pretest and the posttest after all class members completed the assessments. Both groups were to complete the appropriate grade level PSSA exam. The group scores were to be compared to the corresponding previous year's PSSA scores to determine the effects (growth) that the Edmentum Courseware Math Library had on each group's score. Due to the COVID-19 pandemic and the resulting cancellation of the state assessments by the Pennsylvania Department of Education, the 2019-2020 PSSA data will not be available to make the comparison and will not be used in this study.

Intervention Research Plan

Educators understand that mathematics plays a crucial role in employment in contemporary work and life. Although few question the importance of mathematics as related to science, technology, and daily life, mathematics remains unpopular with many students. Students perceive mathematics as a complicated subject and prefer to learn mathematics in an enjoyable and dynamic environment. Teachers are continuously looking for better approaches to meet both boys' and girls' demand for exciting ways to learn mathematics. Technology has provided a gateway for the development of several new approaches to learning. They are namely online learning and blended learning. There have been specific recommendations for the use of technology for instruction in mathematics reforms. Hybrid or blended learning is one approach to provide students with meaningful learning through information and communication technologies.

Incorporating the Internet into traditional education is shown to have positive effects on academic achievement (Means et al., 2009; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Interactive learning objects engage the students through their learning styles of visual, kinesthetic, and auditory learning. Using these interactive learning objects for instruction, remediation, and enrichment is a way of utilizing information and communication technology for various classroom activities. Mathematics teachers should engage with a variety of available software programs and experiment with computers in the classroom environment. In doing so, they may appreciate the usefulness of these technologies when teaching mathematics. Student learning activities, such as projects and real-world application problems, are effective resources for different learning technologies.

Our educational system is transitioning. To diminishing the challenges to meet individual student needs, the educational system is attempting to take on new technologies and explore new paths to reach the goal of providing quality education to everyone. The nature of blended learning is a new and ingenious idea that incorporates the best of both traditional (face-to-face) instruction with the advantages of computer-assisted learning. Blended instruction includes both offline and online learning. Helping teachers understand the concept of blended learning, current research outlined in the literature review attempts to explain the individual components that make up blended learning.

Blended learning is an instructional strategy where a student learns partly through content delivered online combined with traditional face-to-face instruction where students have some element of control over time, place, path, and pace in a supervised brick-and-mortar location away from home (Staker & Horn, 2012). Blended learning offers the conveniences of online courses without completely losing the benefits of face-to-face contact (Chou & Chou, 2011). Some purported blended learning to be a more powerful learning experience than traditional or online learning alone due to the flexible approach to course design (Rovai & Jordan, 2004). In blended learning, the typical learning experience is free from the confines of predominantly traditional (sage-on-a-stage) and synchronous communication. An online learning component providing an asynchronous student learning environment extends the traditional approach. Blended learning provides educators the autonomy to decide how much face-to-face learning and how much online learning will occur within the learning experience. It also allows the teachers flexibility to determine which learning activities will be part of each component. Educators tend to utilize traditional learning activities during the direct instruction segment of the lesson.

A goal of blended learning is to combine the best of face-to-face with the advantages of online learning to provide a hybrid learning experience for students. It can transform education into high level, learning-centered experiences. Integrating technology into the classroom encourages students to be active learners in ways that traditional education cannot by utilizing new and effective methods of communication and collaboration, which exist in a blended learning environment. While teachers work with the groups, some students do work independently or with peers in the same classroom, regardless of the mode of instruction (Haedden, 2013).

A vital component for the successful delivery of blended learning, as well as the personalized learning that can result from it, is the adaptability of student learning progressions. Although differentiated instruction provides theoretical means to meet the needs of the individual students, most educators realize that a single teacher cannot provide individualized instruction in all subjects for every student. Although there are instructional challenges associated with blended learning, there are several advantages to a carefully constructed blended learning system. Through blended approaches, teachers and students choose the content and when to use it. Teachers can adjust the level of rigor in a lesson as students demonstrate understanding. Similarly, lessons include remedial materials when students' responses indicate a lack of understanding. Teachers often struggle to differentiate instruction to meet the individual needs of students. One way to ensure differentiated instruction is through the assignment of tutors for every student. In contemporary learning settings, differentiation includes using computers with an adaptive learning component to simulate these personal tutors and make it possible to meet the individual needs of all learners. Computer-assisted instruction has become the one-on-one tutor that every student could use to reach their fullest learning potential. However, in a blended environment, if the computer-assisted instruction is lacking, a teacher is available to help advance the learning.

One of the guiding questions that many researchers have been trying to answer is whether online learning is as effective as traditional classroom-based instruction in terms of student achievement. With online learning becoming a universal solution to educational challenges as well as the growing numbers of students learning online, researchers such as Cavanaugh et al. (2004) felt compelled to study the factors that affect student learning in online schooling options. The results showed some variations in the student's degree of success, and the researchers suggested the need for more information before making firm conclusions. Others concluded that online instruction with face-to-face components had considerable advantages over exclusively face-to-face or online instruction. Online learners spent more time on task than did the traditional face-to-face students and found more significant benefits from online learning. With the limited research on the topic and the variety of conclusions and recommendations provided, it was instrumental for this study to determine the effects of blended learning and the implementation of the Edmentum Courseware Math Library would have on the achievement of the middle school students in this small southwestern Pennsylvania school.

The intervention consisted of the design and implementation of a computer-based curriculum enhancement program for use in the middle school mathematics classrooms. The study took place over the school year with analysis of the intervention ongoing over time.

The independent variable in this research project was the method of content delivery, i.e., the two instructional methods used in this study. The first was a traditional classroom learning environment with no blended learning utilizing face-to-face and direct instruction by a teacher, and the second was blended learning through a combination of face-to-face teaching and learning through online courseware delivered via the Internet during school hours. The dependent variables were achievement measured by scores on the Study Island Benchmark Test version 4. The researcher used this test instrument at pre-intervention and post-intervention to measure the dependent variables. The intent was to have multiple measurements of achievement to provide triangulation for the analysis and enhanced the credibility of the research, but the 2019-2020 PSSA test was not administered due to the school closures caused by the COVID-19 pandemic and subsequent cancellation of the tests.

In a pretest-posttest design, researchers estimate the change in outcomes before and after a prescribed intervention. The tests measured the dependent variable before and after the intervention. In this case, the researcher's interest was in the effectiveness of a computer-generated intervention program on middle school math students' achievement on the PSSA and Study Island Benchmark tests. The data collected would measure the achievement levels of our middle school students at a point during our first week of school, implement the intervention program during the following week, and measure their achievement again at the end of the school year. If the mean average posttest score is better than the mean average pretest score, then it is logical to conclude that the intervention may be responsible for the improved achievement. However, the degree of certainty is questionable because there are other explanations for the increase in performance, such as maturation. Students may be growing and learning on their developmental timelines between the pretest and the posttest.

The process for arranging this study required contacting the grade level teachers in obtaining their cooperation for the research within their classrooms. Once they have agreed to participate in the study, procuring the resource needed for their classes was necessary to conduct the study. The researcher arranged for the purchase of the Edmentum Courseware Library for mathematics and the Study Island Benchmark Test, as well as the in-service training for teachers. These teachers required the Chromebook carts to avoid altering the schedule of the pretest, posttest, and the implementation of the intervention into the experimental classrooms. This process took approximately three weeks following the initial identification of their needs.

The first in-service training with the middle-grade level teachers, since both teachers will have an experimental group and a control group on their schedules, consisted of discussing the use of computers in the classroom. A representative from Edmentum provided training on the setup and administration of the Study Island Benchmark tests. The trainer provided instruction for entering their teacher accounts, uploading students into the system, creating student accounts, building classroom rosters, selecting the appropriate version of the test, and building the test sessions. The training turned toward a discussion of materials concerning the blended learning model and other information the teachers needed to implement it. The trainer transitioned the discussion to the Edmentum Courseware Library and provided information similar to the in-service training on the Study Island Benchmark Tests. The trainer, once again, offered step-by-step instruction for creating their teacher accounts, uploading students into the system, and creating student accounts. They also reviewed classroom rosters, selecting and building lessons through the standards-aligned catalog, and instructions to help students gain access and work through the lessons. This training lasted approximately three hours and met the primary goal for this portion of the research project. The teaching and observation process were discussed and scheduled, and the teachers were encouraged to maintain a set schedule to maintain consistency and to ensure that the process was able to observe routinely.

In the initial engagement with the middle school classrooms, I introduced myself to the students and explained the mathematical study for which they would be engaged. Each student received a consent form that described the nature of the study, the data to be collected, a proposed benefit expected for the children, including improved mathematics learning, and a description of the work the students would be doing. The researcher instructed students to return the consent forms by the end of September 2019. All students assented and granted permission to participate in this Capstone project. This informed consent is a condition for approval by the Institutional Review Board of the university (Appendix A). Institutional Review Board approval was originally requested and granted for this capstone project on September 12, 2019 (Appendix B).

The researcher identified appropriate instruments (Study Island Benchmark and the PSSA Tests) to test the students at their current achievement level or the grade level at which they should be achieving. The tests must be appropriate for children in terms of age group, standards, outcomes, cultural background, and language. As a result, there was no expected need to modify tests for the classroom in any way. The PSSA tests were administered at the end of the previous school year, and the results were received in June 2019. The Study Island Benchmark test was administered during the second week of the school year. The test was accompanied by prior preparation and planning for the students to ensure that their current capabilities were reflected.

Once the pretests were completed, the classroom teachers introduced the Edmentum Courseware intervention into the experimental classrooms that were pre-selected. The first observation cycle took place over the first grading quarter. The goal was to observe each classroom for one class period every couple of weeks and during a computer lesson. The process of observing in the active classroom included identifying appropriate times when the teachers of each experimental class were engaged in classroom instruction and engaged in the computer intervention. These observations were accompanied by note-taking and interaction with the students to observe content learning. While observing, the researcher noted the different activity types the students were engaged in, how the activities were related to our curriculum. Any signs of frustration or other challenges during these activities were also noted. Students were informally interviewed about their experiences and feelings about the lessons. Also, at the end of each observation, conversations with the classroom teachers were using to identify and rectify any difficulties they may be experiencing.

The other in-service training took place 3 weeks later and was as a means of discussing and refining the implementation of the tools used, interpreting data collected, and improving the experience. The representative from Edmentum examined the notes and experiences from the initial process and discussed any particular difficulties, including both teacher and student difficulties. As a group, the participants brainstormed ways to overcome these difficulties and assessed how well the chosen tools were working. Then an action plan to move forward was suggested for the second stage of implementation for this computer-based intervention.

The second observation cycle was conducted in the same fashion as the first observation cycle. The observations consisted of classroom visits and the students engaging in the computer-based lessons. The researcher also made consultations with teachers and students and assisted in computer-based training activities as needed. During the observations, the researcher was attuned to signs of students' frustration and indications of challenges. The students were informally interviewed about their experiences with the lessons.

The final stage in conducting the research was to test the students after the intervention to examine potential differences in their test scores. The Study Island Benchmark test was administered during the third week in May of the 2019-2020 school year. The test was again accompanied by prior preparation and planning for the students to ensure that their current capabilities were reflected using the same standardized tests and instruments that were used in the pretesting stage to maintain consistency between the administrations. Students were provided a release slip for their parents that discussed the ending of the study and gathered contact information for any parents that wish to see the results of the investigation (Appendix C). There was a final in-service session at the end of the school year allowing for a final discussion of the outcomes of the implementation, identifying any difficulties or high points the teachers had and gathering their suggestions for improvement of the experience.

Teachers using the Edmentum courseware create standards-based coursework, measure the value and effectiveness of curriculum based on student performance, and design real-time content adjustments for individual groups of students. Edmentum's Courseware Math Library can be used in a lab setting, a blended model where online courses supplement the traditional curriculum, or a completely online learning experience. Edmentum Courseware provides teachers the flexibility to define implementation approaches that address a variety of learning needs. Instructors can configure the courses for individual students to work on their own at their own pace or for students working together concurrently in a group. To this study, the Edmentum's Courseware Math Library will be used in a blended learning model where the students will work as a group. This study will utilize this intervention within the blended learning environment where students will be using this curriculum in addition to the already established curriculum written for our middle school mathematics courses. Since it is customizable, the teachers align the intervention to match the current scope and sequences, so the students worked on the computer activities at the same time as they work on the established curriculum.

Edmentum's courses are divided into units, each of which contains various lessons. Individual lessons are skills-based and consist of tutorials and activities that students can work on at their own pace. After completing a lesson, students take a mastery test. Based on the scoring system, a mastery rate of 80% signals that the student is ready to move on to a new lesson. The scoring system can also accommodate custom cases where a 70% or 65% threshold is expected.

Edmentum's courseware consists of four types of learning activities that form the foundation of active learning for these courses. They are (1) lessons, (2) unit activities, (3) course activities, and (4) online discussions. Each lesson in this course contains an interactive tutorial and a correlated mastery test. Each tutorial includes one or more lesson activities that constitute mini-projects associated with the tutorial. Tutorials provide direct instruction, video instruction, and interactive checks of understanding. Students check their understanding and practice skills using a wide variety of technology-enhanced practice interactions, including drag-and-drop interactions, graphic interactions, matching questions, multiple-response questions, and fill-in-the-blank questions. Lesson activities are embedded within each tutorial. The mini-projects allow students to develop new learning and apply learning from the tutorials in a significant way. The lesson activities are designed to be an authentic learning activity as well as an assessment tool.

In Edmentum Courseware, lessons begin by students answering warm-up questions where they think and record their ideas about how the math works. As the lesson develops, students may review their initial responses to the warm-up questions and reflect on them. This kind of self-reflection and metacognition is the foundation of this application. For example, in Edmentum's Algebra course, students are challenged in the warm-up to solve a quadratic equation by graphing the solution point by point. As they move farther in the lesson, they use an online graphing calculator to manipulate the parameters of three different forms of the quadratic equation. Through this type of scaffolding, students come to understand the graphing rules for each equation form. They also could perceive the value of having these different equation forms as instruments in their math toolbox for robust problem-solving.

Finally, there are three goals for this research study. The first was to identify the difference in mathematics achievement between the control group and the experimental group. The second was to examine the differences in the overall performance of boys compared with girls who received the Edmentum Courseware Math Library intervention and compared with boys and girls who did not receive the intervention. The last was to determine the skills the experimental group demonstrated higher achievement using the Edmentum Courseware Math Library intervention during their experience.

Research Design

This quantitative study will examine the effectiveness of the Edmentum Courseware Math Library intervention implemented in a blended learning middle school environment. This quantitative research is significant because it will statistically show the amount of growth in student achievement with a before and after intervention design. The data for analysis was acquired from the Study Island Benchmark Test collected during the 2019-2020 school year to examine the intervention's effectiveness over time.

A quasi-experimental design was appropriate to address the research questions. It is a design that could provide consistent results within classrooms and provide an understanding of the effects of an intervention. In this study, the design allowed the use of a blended learning intervention in middle school mathematics classrooms in rigorous research design. Price and Jhangiani (2015) states that a quasi-experimental study reduces directionality questions in the relationship between variables; for example, the correlation suggests an association between variables, but this method does not indicate directionality. However, the design does not diminish the likelihood of additional influences on dependent and independent variables. According to Price and Jhangiani (2015), quasi-experimental research has higher internal validity than correlational studies but lower than experimental studies. The research design included two measurement intervals: one at pre-intervention and the other at post-intervention.

Methods of Data Collection

The PSSA test is the Pennsylvania state-mandated criterion-referenced and vertically scaled subject test, that is untimed. The DRC of Maple Grove, Minnesota, developed the test. All public-school students in grades 3 to 8 in Pennsylvania take this test in April, including those enrolled in charter schools and cyber charter schools. The intent was to have multiple measurements of achievement to provide triangulation for the analysis, but the 2019-2020 PSSA test were cancelled due to the school closures caused by the COVID-19 pandemic and subsequent cancellation of the tests.

Edmentum (Edmentum, 2014) is in the market to develop, evaluate, and refine assessments to continue to meet the rigorous standards required by professional organizations such as the American Psychological Association, and the National Council on Measurement in Education. Study Island assessments consist of a standards mastery component and a benchmarking component. The benchmarking part provides a set of four benchmark tests taken periodically throughout the school year. The benchmark tests are typically about 30 items long and mirror the structure and item types found in most state assessments, including the Pennsylvania System of School Assessment (PSSAs). The Pennsylvania System School Assessment is also a standards-based, criterion-referenced assessment that informs students, parents, and educators about school and student performance related to the mastery of the academic standards. Therefore, the results of each benchmark test will closely reflect how students should perform on these high-stakes tests.

Study Island Benchmark Assessments (Edmentum, n.d.) are the latest creation by Edmentum designed to accurately measure the Common Core State Standards (CCSS) and the PA Core Standards derived from them. These new benchmark assessments can be used to familiarize teachers and students with these standards and provide reliable and valid information on how well students are moving toward mastering these standards. They intend to give students an advantage when they are administered their grade level PSSA tests.

Study Island designed these Common Core Benchmark Assessments to measure the academic performance of students in grades 3-11 in the content areas of mathematics and ELA. Since these assessments were developed to measure the CCSS and the PA Core standards derived from them, they will provide information about the strengths and needs of individual students and classrooms. During the development stage of these assessments, preliminary items, and test-item analyses of these tests, as outlined in Edmentum's technical report, indicate that these assessments capture the focus and increased cognitive demands of the CCSS.

The Edmentum Common Core Benchmark Assessments include both multiple-choice and performance tasks to reflect the rigor and depth of the PA Core State Standards. The performance tasks enable teachers to monitor student understanding and proficiency with complex processes such as problem-solving and writing, and not just measuring discrete knowledge. These performance tasks require students to apply their knowledge within these real-world activities, yield a tangible product or performance that serves as evidence of learning, and the rubrics are scored for the cognitive skills measured.

Researchers and practitioners use test scores to make inferences about a students' performance in subjects and to a set of criteria. Criterion-referenced tests are used to determine an individual's comprehension and skills for a specific subject and content focus. The tests should show whether students have mastered the information from a particular discipline and grade. When students' performances are compared to target performance, the interpretation is criterion-referenced. Criterion-referenced tests are meant to measure students' achievement at target levels of learning, skills, and conceptual understanding related to developmentally appropriate grade levels.

Edmentum's Study Island Common Core Benchmark assessments are criterion-referenced tests that embed the CCSS and PA Core Standards as their criteria. The test items on these benchmark assessments were developed specifically to measure these exact standards. The Study Island Benchmark tests provide scores used for interpretations of individual students' progress toward expected achievement levels designated as mastery of the content.

The test framework for mathematics in grades 3 to 8 is based on the CCSS and the PA Core Standards derived from CCSS for math. All Study Island test items are designed to measure specific Eligible Content of the CCSS or PA Core Standards. Items on the grade level operational tests are organized by content domains as defined by these standards. Similar to PSSAs, the Standards for Mathematical Practice are embedded throughout the different forms of the Study Island grade-level assessment.

Scores reported for these grade-level tests are considered as Standards Mastery Components Scores and report as raw scores. Edmentum (2014) states that a raw score indicates the actual number on which the student responded correctly on a specific Study Island topic. The program converts the scores to a percentage of the total items for the topic. These scores are the primary indicators of a student's performance on these assessments and can be useful when describing a student's performance on a criterion-referenced test.

However, Edmentum (2014) indicates that raw scores and percentage-correct scores have a disadvantage in reporting because there is no way of directly comparing the number correct or percentage correct on one benchmark test form with the number correct on another benchmark test form. Edmentum (2014) goes on to state that the interpretation of these scores is related to the difficulty level of the test items on each particular test or test form. Because each test has a unique level of difficulty, there is no universal way to interpret these scores. Due to this inconsistency, the researcher administered the same version of the tests as a pretest and posttest. Each student took version four of the assessments.

The PSSA test was to be used to triangulate the data with the Study Island Benchmark to test validity through the convergence of these different data sources. Because of the cancelation of the PSSA tests, after the cancelation, this was no longer possible. The study proceeded with the use of only the Study Island Benchmark tests and the data received for these different groups of students. From the various reports generated from this test, the research questions were addressed using the available data, and conclusions were made based on these data.

Validity Evidence Summary

An essential quality when designing and evaluating an assessment is validity. Study Island produces a technical report each year describing the technical aspects of the assessments in support of score interpretations and uses. These technical reports provide essential evidence pertaining to score validation, test development, test administration, test scoring, item analysis, score reporting, and reliability. This yearly document summarizes and integrates the evidence based on the standards' framework.

Validity is defined by how well a test measures what it is designed to measure. This characteristic of an assessment and its results are fundamental to the quality of that measurement tool. A test should be valid for the results to be accurate and interpreted. There are a variety of different validity measures that used to provide this evidence, from criterion validity or how well a test correlates with a particular outcome, and construct validity or whether a test is measuring what it is supposed to be measuring. The extent an assessment is an accurate indicator of the attribute measured defines its validity for interpreting the content measured. In terms of educational testing and assessment, these are highly dependent upon the curriculum. For example, a teacher-created mathematics assessment might contain content significantly different from that which is expected to be taught in the classroom.

In contrast, a mathematics test designed to include a standards-aligned curriculum that fits the content needs of the class, school, district, and state more completely is more valuable to educators for understanding student achievement. Edmentum's Study Island Common Core benchmark assessments have been developed to measure the CCSS and the PA Core standards accurately. Each source of validity contributes to a body of evidence about the overall validity of score interpretations.

Edmentum (2014) defines content validity is "the degree to which an assessment is an accurate measure of the full range of common core or state-specific standards" (p. 22). According to Edmentum (2014), "content validity is the primary indicator of validity for standards-based assessments' (p.22). Evidence on content validity provides educators with critical information on how well the assessment items represent the taught curriculum and the standards addressed for each grade-level of mathematics. The item development process includes an assessment of content validity. For example, how test items and blueprints align with the curriculum and the CCSS and PA Core Standards measured by the assessment. Evidence of validity based on test content includes item alignment with the CCSS and PA Core Standards, the item-development and test-development processes, item bias and content appropriateness review processes, adherence to the test specifications, use of standardized administration procedures, and appropriate test administration training. In considering the Study Island Assessment validity, all Study Island test items are aligned by extensively trained curriculum and assessment experts and undergo several rounds of review for content fidelity and appropriateness. This process is similar to that used by DRC when developing test items for the current versions of the PSSA tests. Finally, tests are administered in a standardized manner because they have a computer-based format with specific accommodations. Test administrators must become familiar with the Study Island Administrator Manual and adhere to the procedures outlined in it. Again, this process is similar to the PDE and Edmentum in the administration of their tests.

Edmentum Courseware is customizable for the grades 6 to 12 digital curriculum to give teachers the control over restructuring mathematics content and add content to create a blended learning environment within their classes. Edmentum's Courseware Math Library is fully aligned with the PA Core Standards and is continuously updated to meet the needs of Pennsylvania students and teachers. The foundation of Edmentum Courseware is based on the principle that students must be active learners to construct meaning with the material. Students require more than direct instruction, regardless of the format, and can include lectures that are spoken, demonstrations, and presentations through video or other multimedia. Learning is most effective if it combines the learning experiences of the student with the many different sources and modes of transferring information.

Financial Implications

The financial impacts of this intervention on the budget consisted of the purchase of the Edmentum Courseware Math Library for all students in the 7th and 8th grades, the purchase of the Study Island Benchmark Assessment Licenses for all students in these grades, and teacher professional development in blended learning provided by the training staff of Edmentum and continued by the Allegheny Intermediate Unit.

The school and district purchased approximately 200 licenses for the Edmentum Math Courseware platform. The cost was $18 per license for a total cost of $3600. If more licenses are needed, the Edmentum representative stated that the company would supply a few more than purchased. This offer helps to fix the cost of the licenses from year to year. The same would apply to the purchase of the Study Island Benchmark Test. The costs are $3 per license for a total of $600 for the two grade levels. As with the Edmentum Math Courseware, if the school needs more than 200 licenses during the year, the company allows access to additional licenses at no extra cost.

Professional development on the implementation of the Edmentum Courseware and the Study Island Benchmark tests were established during the project, and the middle school teachers received training on these products before beginning the school year. The purpose of the training was to increase teachers' knowledge of implementing a blended learning environment into their classrooms. The professional development was also provided by the Allegheny Intermediate Unit personnel, who were scheduled for three of the regularly scheduled in-service days. The inclusion of this personnel ensured there was no need for substitutes so that teachers could attend outside professional development and incur additional costs to the district. A budgeted cost of $250 was paid to the Allegheny Intermediate Unit for providing the in-service for these three days. If the data shows that implementation of these interventions would increase middle school math achievement scores, the additional $4450 to implement the programs is a small cost relative to the need for addressing the issues middle schools face for math achievement.

There are few indirect costs involved in the full implementation of this intervention. The school has equipment such as laptop carts and computer labs where the students can access the software and the benchmark assessment. There will be no additional purchase of more computer equipment to implement the intervention. Although in the future, the school may choose to purchase laptop carts dedicated to the two middle school math teacher's rooms if current implementation becomes problematic for others.

Summary

The methodology included in the chapter is an overview of the conducted research for this Capstone Project. The study relies on the understanding that educational research should be shown as effective in the classroom environment before implementation as an appropriate intervention is considered. The research design integrated a rigorous pretest and posttest design with active classroom and teacher training involvement as controls for the structure of the research. The goal of Chapter IV is to present study results and demonstrate that the steps described in Chapter III were followed.

CHAPTER FOUR

Data Analysis and Results

Introduction

This study explores the effectiveness of the Edmentum Courseware Math Library's implementation into a blended learning environment in our middle school mathematics classes. The entire student population was divided by class sections into a control group and an experimental group. The control group received the traditional middle school math curriculum taught since the inception of the PA Core Standards. The experimental group was also taught the same middle school curriculum as the control group, except that they were exposed to Edmentum's Courseware Mathematics Library curriculum and the usual curriculum in a blended learning environment during its usage.

There are two intended measures used in the data collection for this study. One is the Pennsylvania System of School Assessment (PSSA) from the 2018-2019 school year and the 2019 – 2020 school year for these middle school students. The other is a commercially made Study Island Benchmark Test used as a pretest and a posttest. Analysis of the two data sets will be looking for differences in the mean averages of growth for the students in the control and the experimental groups on each of these data sets. The intent was to have multiple measurements of achievement to provide triangulation for the analysis, but the 2019-2020 PSSA test was canceled due to the school closures caused by the COVID-19 pandemic.

Data on students' math achievement was collected from the Study Island Benchmark tests by their school level reports before the Edmentum Courseware Math Library implementation. The data consisted of correct percentage scores from the Study

Island Benchmark Mathematics Test version 4. The data also included subgroup information indicating gender and skill domain subgroups for both the experimental group and the control group. Student's math achievement data were examined for growth, posttest minus pretest, to create a difference score. All tested mean values are the mean difference scores of the two assessments. A two-sample t-test for independent samples was conducted on the mean differences to test for the quality of group means. It was employed to provide a comparison whether the average mean difference between the two groups is statistically significant or instead due to random chance.

This study will make a determination concerning the effectiveness of this intervention and if it will be recommended as a middle school strategy for future implementation in our district. The data will help us decide whether the $3609 budget expenditure for full implementation of this computer resource, coupled with blended learning, will increase student achievement that we have been so diligently working to obtain.

Research Questions

To determine this effectiveness of this intervention, the study will focus on three research questions:

Q1 How does the overall achievement of students using the Edmentum Courseware Math Library intervention compare with the achievement of students who are not using the intervention?

Q2 Is there a difference in the overall achievement of males and females who received the Edmentum Courseware Math Library intervention compared with males an females who are not using the intervention?

Q3 What skills do students demonstrate greater achievement using the Edmentum Courseware Math Library intervention?

Hypotheses, Alternative Hypotheses, and Null Hypotheses

The researcher proposed a hypothesis for the first research question in this study to make the results quantifiable. The researcher created a null hypothesis and an alternative hypothesis, as well.

The first research question asked how the overall achievement of students using the Edmentum Courseware Math Library intervention compared with students who did not use the intervention. The researcher compiles data from middle school students (grades 7 and 8) in the district. The corresponding research hypotheses are:

Null Hypothesis 1: The middle school students who used the Edmentum Courseware Math Library have similar math achievement levels as the middle school students who do not use the Edmentum Courseware Math Library.

Alternative Hypothesis 1: The middle school students who used the Edmentum Courseware Math Library have a greater average difference in math achievement levels than the middle school students who do not use the Edmentum Courseware Math Library.

The second research question asks if there is a difference in the overall achievement of males and females who received the Edmentum Courseware Math Library intervention compared with males and females who did not use the Edmentum Courseware Math Library intervention. The researcher collects data from middle school students (grades 7 and 8) in the district. The corresponding research hypotheses are:

Null Hypothesis 2: The difference in the overall achievement of males who received the Edmentum Courseware Math Library intervention is similar to the achievement of males who did not receive the Edmentum Courseware Math Library intervention.

Alternative Hypothesis 2: The difference in the overall achievement of males who received the Edmentum Courseware Math Library intervention is greater than the achievement of males who did not receive the Edmentum Courseware Math Library intervention.

Null Hypothesis 3: The difference in the overall achievement of females who received the Edmentum Courseware Math Library intervention is similar to the achievement of females who did not receive the Edmentum Courseware Math Library intervention.

Alternative Hypothesis 3: The difference in the overall achievement of females who received the Edmentum Courseware Math Library intervention is greater than the achievement of females who did not receive the Edmentum Courseware Math Library intervention.

The third research question asked what skills (if any) do students demonstrate higher achievement using the Edmentum Courseware Math Library intervention. The researcher collects data from middle school students (grades 7 and 8) in the district. This research question requires six separate research hypotheses corresponding to the six different skill reporting categories considered in this study. The researcher creates six diverse alternative hypotheses and null hypotheses for this research question. These corresponding research hypotheses are:

Null Hypothesis 4: Students using the Edmentum Courseware Math Library intervention demonstrate no difference in achievement (posttest minus pretest) in the skills under the reporting category of Numbers and Operations (A-N).

Alternative Hypothesis 4: Students using the Edmentum Courseware Math Library intervention demonstrate a significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Numbers and Operations (A-N).
Null Hypothesis 5: Students using the Edmentum Courseware Math Library intervention demonstrate no difference achievement (posttest minus pretest) in the skills under the reporting category of Ratios and Proportional Relationships (A-R).

Alternative Hypothesis 5: Students using the Edmentum Courseware Math Library intervention demonstrate a significant difference achievement (posttest minus pretest) in the skills under the reporting category of Ratios and Proportional Relationships (A-R).

Null Hypothesis 6: Students using the Edmentum Courseware Math Library intervention demonstrate no difference achievement (posttest minus pretest) in the skills under the reporting category of Expressions and Equations (B-E).

Alternative Hypothesis 6: Students using the Edmentum Courseware Math Library intervention demonstrate a significant difference in achievement (posttest minus pretest) in the skills under the reporting category of Expressions and Equations (B-E).

Null Hypothesis 7: Students using the Edmentum Courseware Math Library intervention demonstrate no difference in achievement (posttest minus pretest) in the skills under the reporting category of Functions (B-F).

Alternative Hypothesis 7: Students using the Edmentum Courseware Math Library intervention demonstrate a significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Functions (B-F).

Null Hypothesis 8: Students using the Edmentum Courseware Math Library intervention demonstrate no difference in achievement (posttest minus pretest) in the skills under the reporting category of Geometry (C-G).

Alternative Hypothesis 8: Students using the Edmentum Courseware Math Library intervention demonstrate a significant difference in achievement (posttest minus pretest) in the skills under the reporting category of Geometry (C-G).

Null Hypothesis 9: Students using the Edmentum Courseware Math Library intervention demonstrate no difference in achievement (posttest minus pretest) in the skills under the reporting category of Statistics and Probability (D-S).

Alternative Hypothesis 9: Students using the Edmentum Courseware Math Library intervention demonstrate a significant difference in achievement in the skills under the reporting category of Statistics and Probability (D-S).

Results

In this study, a two-sample t-test for independent samples was used to test each of the nine research hypotheses. A two-sample t-test was selected for this study because it is considered the most commonly used hypothesis test for determining if the difference between the two groups is statistically significant or random. This test produces a "p-value," which can be used as evidence to decide whether there is a significant difference between the two population means. Select Statistical Services Limited (2016) defines the p-value as:

> The probability that the difference between the sample means is at least as large as what has been observed under the assumption that the population means are equal. The smaller the p-value, the more surprised we would be by the observed difference in sample means if there was no difference between the population means (Para.3).

This indicates that the smaller the p-value, the stronger the evidence is for rejecting the null hypothesis in favor of the alternative hypothesis. A significance level of .05 is selected, and a p-value less than the significance level is interpreted as indicating evidence of a difference between the population means. In the following section, the results of the t-tests for each of the research hypotheses are provided.

Hypothesis 1 Testing

A two-sample t-test is conducted to determine if a statistically significant difference in achievement exists between the pretest and posttest percentage scores on the Study Island Benchmark Test version 4 for a group of middle school students who received an intervention called the Edmentum Math Courseware Library in addition to the regular course curriculum (experimental group) and the group of middle school students who did not receive the intervention in addition to the regular curriculum (control group). The following charts, as displayed in Table 1 and Figure 2, show the collected data and findings based on the information collected from the students.

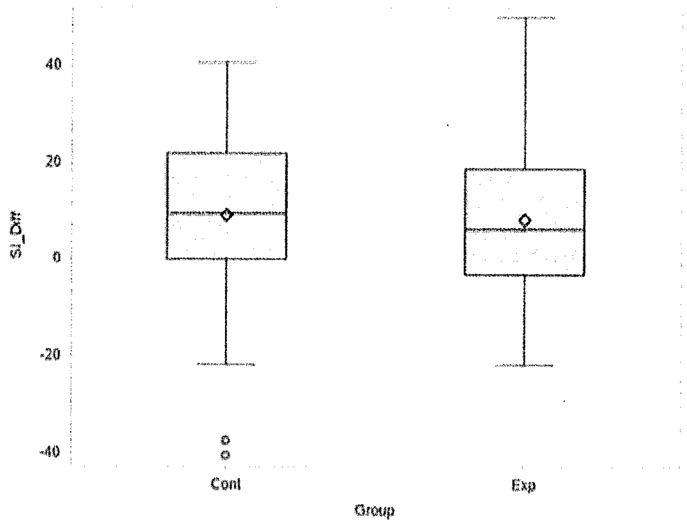
Table 1

Overall Achievement Experimental Group v. Control Group				
Group	**n**	**M**	**SD**	**Std Error**
Control	60	9.0567	17.3442	2.2391
Experimental	64	8.1641	15.3458	1.9182

Overall Achievement Experimental Group v. Control Group		
DF	**t-value**	**Pr > l t l**
117.91	0.30	0.3813

Figure 2

Overall Achievement Experimental Group v. Control Group



There was not a significant difference in achievement (posttest minus pretest) between the experimental group (M = [8.16], SD = [15.35]) and the control group (M = [9.06], SD = [17.34]) on the Study Island Benchmark Test version 4; p = [.3813]. At an alpha level of .05, the results indicate that there is no statistically significant difference between the two means: there is not sufficient evidence to reject the null hypothesis. The means of the group means do not differ between the two groups. Middle School students who used the Edmentum Courseware Math Library supplemental math software for one year have statistically similar math achievement scores as middle school students who did not use the Edmentum Courseware Math Library software.

Hypothesis 2 Testing

A two-sample t-test is conducted to determine if there is a statistically significant difference in overall achievement (posttest minus pretest) of males who received the intervention called the Edmentum Courseware Math Library (experimental group) compared with males who did not receive the Edmentum Courseware Math Library intervention (control group) The following charts (as displayed in Table 2 and Figure 3) show the collected data and findings based on the information collected from the students.

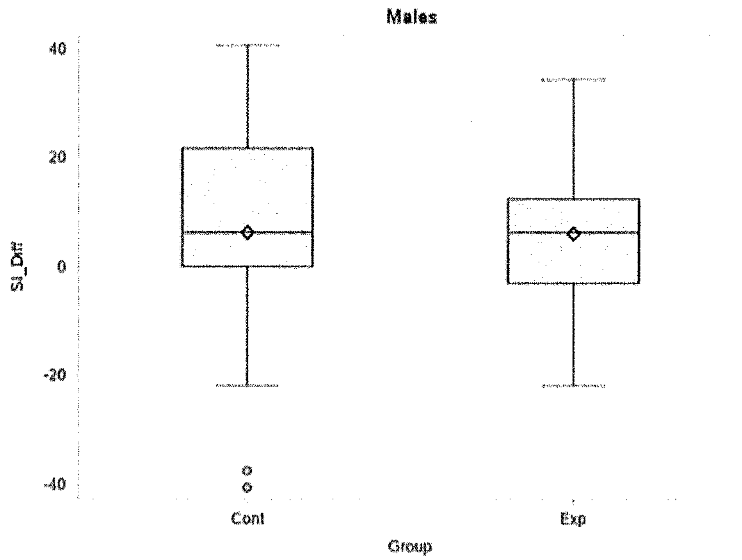
Table 2

Overall Achievement Male (Experimental Group) v. Males (Control Group)				
Group	**n**	**M**	**SD**	**Std Error**
Males (Control)	39	6.2487	17.6805	2.8331
Males (Experimental)	29	6.0345	13.2824	2.4665

Overall Achievement Males (Experimental) Group v. Males (Control Group)		
DF	**t-value**	**Pr > l t l**
65.986	0.06	0.4773

Figure 3

Overall Achievement Male (Experimental Group) v. Males (Control Group)



In the experimental group, there is no significant difference in achievement between the experimental group males (M = [6.04], SD = [13.28]) and the control group males (M = [6.25], SD = [17.68]) on the Study Island Benchmark Test version 4; p = [.4773]. At an alpha level of .05, the results indicate that there is not a statistically significant difference between the two means: there is not sufficient evidence to reject the null hypothesis. Middle School males who use the Edmentum Courseware Math Library supplemental math software for one year have statistically similar math achievement scores as middle school males who do not use the Edmentum Courseware Math Library software.

Hypothesis 3 Testing

A two-sample t-test is conducted to determine if there exists a statistically significant difference in overall achievement (posttest minus pretest) of females who received the intervention called the Edmentum Courseware Math Library (experimental group) compared with females who did not receive the Edmentum Courseware Math Library intervention (control group) The following charts (as displayed in Table 3 and Figure 4) show the collected data and findings based on the information collected from the students.

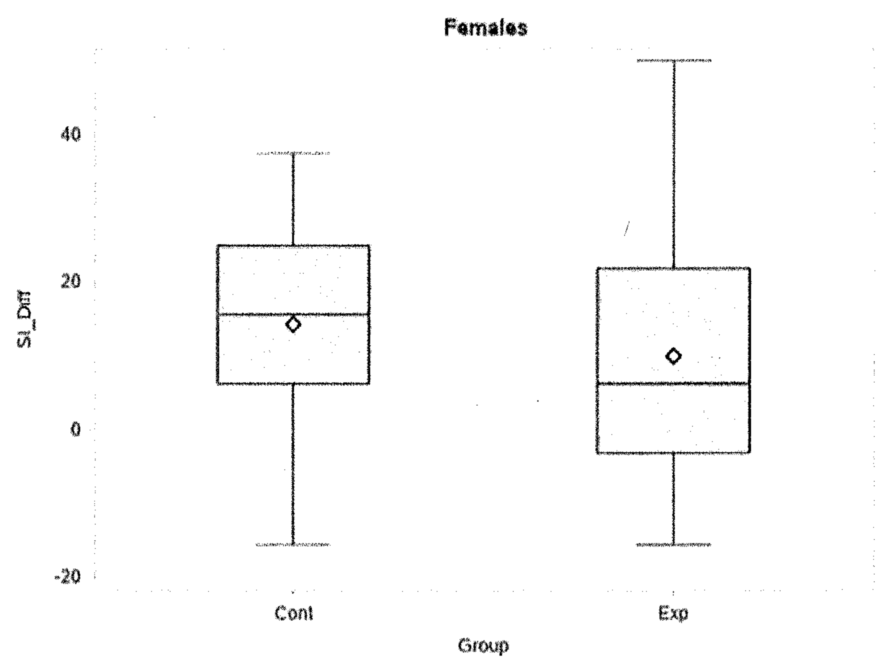
Table 3

Overall Achievement Female (Experimental Group) v. Females (Control Group)				
Group	**n**	**M**	**SD**	**Std Error**
Females (Control)	21	14.2714	15.7974	3.4473
Females (Experimental)	35	9.9286	16.8522	2.8485

Overall Achievement Females (Experimental Group) v. Females (Control Group)		
DF	**t-value**	**Pr > l t l**
44.47	0.97	0.1618

Figure 4

Overall Achievement Female (Control Group) v. Female (Experimental Group)



There is no significant difference in achievement between the experimental group females (M = [9.93], SD = [16.85]) and the control group females (M = [14.27], SD = [15.80]) on the Study Island Benchmark Test version 4; p = [.1684]. At an alpha level of .05, the results indicate that there is not a statistically significant difference between the two means: there is not sufficient evidence to reject the null hypothesis. Middle School females who use the Edmentum Courseware Math Library supplemental math software for one year have statistically similar math achievement scores as middle school females who do not use the Edmentum Courseware Math Library software.

Hypotheses 4 through 9 Testing

A two-sample t-test is conducted to determine if there is a statistically significant difference in overall achievement (posttest minus pretest) in the middle school students who received the Edmentum Courseware Math Library intervention within the individual Reporting Categories. The following tables show the collected data and findings based on the information collected from the students. The highlighted rows reveal the most significant difference between the pretest and posttest means. Although this is not conclusive evidence of a statistically significant difference in means between these tests, it provides some insight into which categories experienced a more substantial change in outcomes than the others.

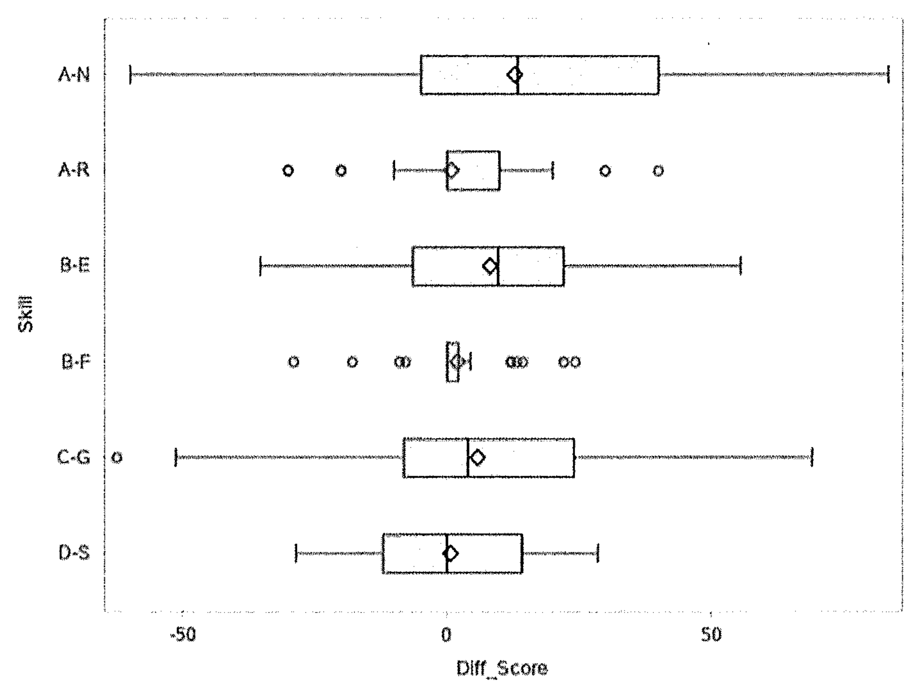
Table 4

Student Achievement by Reporting Category				
Skill Domain	**n**	**M**	**SD**	**Std Error**
Numbers and Operations (A-N)	64	12.8375	31.2830	3.9104
Ratios and Prop. Relationships (A-R)	64	0.7813	13.6049	1.7006
Expressions and Equations (B-E)	64	8.1453	22.1766	2.7721
Functions (B-F)	64	1.9531	8.1411	1.0176
Geometry (C-G)	64	5.7891	26.2357	3.2796
Statistics and Probability (D-S)	64	0.6750	15.9430	1.9929

Student Achievement by Reporting Category			
Skill Group	**DF**	**t-value**	**Pr > l t l**
Numbers and Operations (A-N)	**63**	**3.28**	**0.0017**
Ratios and Prop. Relationships (A-R)	63	0.46	0.6475
Expressions and Equations (B-E)	**63**	**2.44**	**0.0046**
Functions (B-F)	63	1.92	0.0595
Geometry (C-G)	63	1.77	0.0824
Statistics and Probability (D-S)	63	0.34	0.7360

Figure 5

Student Achievement by Reporting Category



Hypothesis 4 Testing

There is a significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Numbers and Operations (A-N) for the students who used the Edmentum Courseware Math Library (M = [12.84], SD = [31.28]) on the Study Island Benchmark Test version 4; p = [.0017]. At an alpha level of .05, the results indicate that there is a statistically significant difference between the two means: there is sufficient evidence to reject the null hypothesis. Middle School students who use the Edmentum Courseware Math Library supplemental math software for one year have a statistically significant difference in student achievement (posttest minus pretest) on the skills under the reporting category of Numbers and Operations (A-N).

Hypothesis 5 Testing

There is no significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Ratios and Proportional Relationships (A-R) for the students who used the Edmentum Courseware Math Library (M = [0.78], SD = [13.61]) on the Study Island Benchmark Test version 4; p = [.6475]. At an alpha level of .05, the results indicate that there is no statistically significant difference between the two means: there is insufficient evidence to reject the null hypothesis. Middle School students who use the Edmentum Courseware Math Library supplemental math software for one year have no statistically significant difference in student achievement (posttest minus pretest) on the skills under the reporting category of Ratios and Proportional Relationships (A-R).

Hypothesis 6 Testing

There is a significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Expressions and Equations (B-E) for the students who use the Edmentum Courseware Math Library (M = [8.15], SD = [22.188]) on the Study Island Benchmark Test version 4; p = [.0046]. At an alpha level of .05, the results indicate that there is a statistically significant difference between the two means: there is sufficient evidence to reject the null hypothesis. Middle School students who use the Edmentum Courseware Math Library supplemental math software for one year have a statistically significant difference in student achievement posttest minus pretest) on the skills under the reporting category of Expressions and Equations (B-E).

Hypothesis 7 Testing

There is no significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Functions (B-F) for the students who use the Edmentum Courseware Math Library (M = [1.95], SD = [8.14]) on the Study Island Benchmark Test version 4; p = [.0595]. At an alpha level of .05, the results indicate that there is no statistically significant difference between the two means: there is insufficient evidence to reject the null hypothesis. Middle School students who use the Edmentum Courseware Math Library supplemental math software for one year have no statistically significant difference in student achievement (posttest minus pretest) on the skills under the reporting category of Functions (B-F).

Hypothesis 8 Testing

There is no significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Geometry for the students who used the Edmentum Courseware Math Library (M = [5.79], SD = [26.24]) on the Study Island Benchmark Test version 4; p = [.0824]. At an alpha level of .05, the results indicate that there is no statistically significant difference between the two means: there was insufficient evidence to reject the null hypothesis. Middle School students who used the Edmentum Courseware Math Library supplemental math software for one year have no statistically significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Geometry (C-G).

Hypothesis 9 Testing

There is no significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Statistics and Probability (D-S) for the students who used the Edmentum Courseware Math Library (M = [0.68], SD = [15.94]) on the Study Island Benchmark Test version 4; p = [.7360]. At an alpha level of .05, the results indicate that there is no statistically significant difference between the two means: there is insufficient evidence to reject the null hypothesis. Middle School students who use the Edmentum Courseware Math Library supplemental math software for one year have no statistically significant difference in achievement (posttest minus pretest) on the skills under the reporting category of Statistics and Probability (D-S).

Discussion

Research question one focuses on the differences in math achievement for students who use the Edmentum Courseware Math Library supplemental math software in a blended learning environment during the 2019-2020 school year and students who do not use the Edmentum Courseware Math Library supplemental math software in a blended learning environment during the 2019-2020 school year. For hypothesis one (pertaining to the first research question) data analysis fails to reject the null hypothesis. The middle school students who use the Edmentum Courseware Math Library and the students who d0 not use the supplemental math software have statistically similar achievement scores on the Study Island Benchmark version 4 test.

Research question two focuses on the differences in math achievement comparing gender. It compares the males who use the Edmentum Courseware Math Library supplemental math software in a blended learning environment with the males who do not use the Edmentum Courseware Math Library supplemental math software in a blended learning environment during the 2019-2020 school year. For hypothesis two, data analysis does not reject the null hypothesis. The middle school male students who use the Edmentum Courseware Math Library and the male students who do not use the supplemental math software have statistically similar achievement scores on the Study Island Benchmark version 4 test.

In addition, the purpose is to determine the difference between females who use the Edmentum Courseware Math Library supplemental math software in a blended learning environment and the females who did not use the Edmentum Courseware Math Library supplemental math software in a blended learning environment during the 2019-2020 school year. For hypothesis three, data analysis fails to reject the null hypothesis. The middle school female students who use the Edmentum Courseware Math Library and the female students who do not use the supplemental math software have statistically similar achievement scores on the Study Island Benchmark version 4 test.

Research question three focuses on the six reporting categories of skills and the students who used the Edmentum Courseware Math Library supplemental math software. Data from the 2019-2020 school year show a significant difference in achievement in these categories. The results of comparisons of students' mean difference scores on the

Study Island Benchmark version 4 test suggest that there are two areas that are statistically significant within these six reporting categories of skills for the students who used the supplemental math software.

The researcher intended to utilize triangulation to validate and enhance the credibility of the research study through the cross verification of multiple sources of data. One was the pretest and posttest data of the Study Island Benchmark Test version 4 and the other was the 2018-2019 and 2019-2020 Pennsylvania System of School Assessment (PSSA) assessment data. Due to the late announcement of the PSSA exam cancellation, it was impossible for the researcher to find other assessment means within the Study Island Benchmarks system, the Edmentum Courseware Math Library, or any other outside data sources that provided a means to triangulate and support the conclusions of this study. Since the study focused on increasing student achievement and utilized a pretest-posttest design, the lack of a fixed data point at the beginning of the study for comparison was unavailable. As a result of the pandemic and the governmental actions associated with it, the study proceeded with only the data generated from the Study Island Benchmark Test version 4. Therefore, chapter five will present these findings, and present conclusions and recommendations for further research on the use of the Edmentum Courseware Math Library supplemental math software in a blended learning environment.

Summary

The purpose of this study was to explore the effectiveness of the implementation of the Edmentum Courseware Math Library into a blended learning environment in our middle school mathematics classes. Data was collected using a commercially marketed assessment called the Study Island Benchmark version 4. This was utilized as a pretest and posttest to determine mean differences in student achievement at two different points in time. The other data point that was to be collected was historical data from the 2018-2019 Pennsylvania System of School Assessment Test (PSSA) and the 2019-2020 administration of the PSSA. These were to be compared for mean differences in scale scores to help to triangulate the results and further determine the effectiveness of the intervention. On March 13, 2020, the Governor of Pennsylvania ordered the closure of schools due to the COVID-19 pandemic. The cancellation of the 2019-2020 administration of the PSSA soon followed. This data point, along with its analysis, could no longer be used for this study.

This study produced mixed results. The first null hypothesis focused on math achievement. There was no statistically significant difference between the mean difference scores of the students who used the Edmentum Courseware Math in a blended learning environment and students who did not work within a traditional classroom. This null was not rejected by the study when differences were determined to be statistically insignificant. The second null hypothesis focused on differences in math achievement comparing males within the control group with males within the experimental group. This null was not rejected by the study when all mean differences were statistically insignificant. The third null hypothesis focused on differences in math achievement comparing females within the control group with females within the experimental group. This null was not rejected by the study, as well, when all mean differences were determined to be statistically insignificant.

Lastly, nulls four through nine focused on the different skill sets defined by reporting categories for the students who used the Edmentum Courseware Math Library.

The data reported mixed results concerning these skill sets. Nulls five, seven, eight, and nine were not rejected by the study when their differences in the posttest and pretest for these skill sets were determined statistically insignificant. However, nulls four and six were rejected in favor of the alternative hypotheses when their differences in the posttest and pretest for these skill sets were found to be statistically significant.

This chapter provided the statistical information, analysis of the data, and results of that analysis. The following chapter will discuss the conclusions and recommendations of this study and answer the research questions posed from the outset. Then, the final determination on the effectiveness of the implementation of the Edmentum Courseware Math Library into a blended learning environment in our middle school mathematics classes will be made.

CHAPTER 5

Conclusions and Recommendations

Introduction

This study explored the effectiveness of the Edmentum Courseware Math Library's implementation into a blended learning environment in our middle school mathematics classes. The difference in mathematics achievement between the two groups, the experimental group, and the control group, was the primary focus of this quantitative analysis. This determines the success of the integration. The analysis data is the pretest and posttest scores of the Study Island Benchmark Test version 4. A two-sample t-test for statistical analysis is used to determine the overall difference in achievement in the same students over the 2019-2020 school year. The t-test established the number of students in the control group as compared to the students in the experimental group that experienced a statistically significant score improvement for the year. These between-groups tests are used to determine whether the difference in student achievement is dependent on the control or experimental groupings was statistically significant. The results are presented in a standard fashion, including tables demonstrating the changes identified, p-value, t-value, and interpretation of these results, as well as a final clarification of whether or not the outcomes are statistically significant. Based on the outcome of the statistical analysis, conclusions are drawn, and answers to the research question are provided in the next section.

Conclusions

Research question one seeks to determine how students' overall achievement using the Edmentum Courseware Math Library intervention compares with the achievement of students who are not using the intervention. The researcher hypothesizes that there is a statistically significant difference in student achievement in comparing with the students who utilized the Edmentum Courseware Math Library in the blended online learning environment with students in the traditional classroom who did not. The results of this study do not show a statistically significant relationship between the use of Edmentum Courseware Math Library on students' math achievement for those who use the supplemental math software and those who did not. Although, both the experimental group and the control group both showed an increase in achievement from pretest to posttest, the difference in these achievement scores determined that the two groups had statistically similar scores. As a result, the answer to research question one is that there is no significant difference in the achievement scores. The use of the Edmentum Courseware Math Library does not have an effect on the overall achievement of students using the Edmentum Courseware Math Library intervention compare with the students who are not using the intervention.

Research question two explores the difference in overall achievement by gender comparing the experimental group with the control group. Males who received the Edmentum Courseware Math Library intervention are compared with males who did not receive the intervention. In addition, females who received the Edmentum Courseware Math Library intervention are compared to females who are not using the intervention. The researcher hypothesizes that males who received the Edmentum Courseware Math Library demonstrated higher overall achievement as opposed to males who did not receive the intervention. The researcher also hypothesizes that females who receive the Edmentum Courseware Math Library demonstrate higher achievement than females who do not use the intervention. The answer to research question two is that there is no significant difference in the overall mean differences by either gender group. The use of the Edmentum Courseware Math Library within a blended learning environment does not have any effect on the overall achievement of students grouped by gender.

Research question three explores the advanced skills that are procured while utilizing the Edmentum Courseware Math Library intervention. The researcher proposes a series of six hypotheses, one for each skill set or reporting category of the PA Core Standards. Each hypothesizes that the students who use the Edmentum Courseware Math Library intervention demonstrate a significant difference in achievement (posttest minus pretest) in the skills under the designated reporting category or skill set. Statistical analysis shows that the reporting categories of Ratios and Proportional Relationships (A-R), Functions (B-F), Geometry (C-G), and Statistics and Probability (D-S) are not able to reject the null hypotheses. Students using the Edmentum Courseware Math Library intervention demonstrate no significant difference in achievement (posttest minus pretest).

The statistical data for the reporting categories of Numbers and Operations (A-N) and Expressions and Equations (B-E), differs from the other data. In these two skill sets, the data analysis rejects the null hypotheses in favor of the alternate hypotheses. Students using the Edmentum Courseware Math Library intervention demonstrate a significant difference in achievement in the skills under the reporting category of Numbers and Operations (A-N) and Expressions and Equations (B-E). Therefore, in answering research question three, students demonstrate higher achievement with the skills in the reporting categories of Numbers and Operations (A-N) and Expressions and Equations (B-E) when using the Edmentum Courseware Math Library intervention.

The research question intends to determine what skills demonstrate higher achievement using the Edmentum Courseware Math Library intervention. To answer this research question thoroughly, the researcher defines the skills associated with the two reporting categories that show a statistically significant difference in achievement (Numbers and Operations (A-N) and Expressions and Equations (B-E). The following are the defined skills that demonstrated a statistically significant difference in achievement for the students who used the Edmentum Courseware Math Library intervention. According to the Pennsylvania Department of Education (2014a, 2014b) (as defined in their publications outlining the mathematics grade level assessment anchors and eligible content), the skills under the domain of Numbers and Operations (A-N) are as follows:

- Apply the properties of operations to add and subtract rational numbers with real-world contexts.
- Illustrate the operations of addition and subtraction on a number line.
- Apply the properties of operations to multiply and divide rational numbers, including real-world contexts.
- Demonstrate that a decimal terminates or eventually repeat.
- Identify rational or irrational numbers.
- For a rational number, show that the decimal equivalent terminates or repeats.
- Rewrite a terminating and repeating decimals as a fraction.
- Estimate the value of irrational numbers (square roots) without a calculator.

- Compare and order irrational numbers using rational approximations.
- Approximate on a number line the location of rational and irrational numbers.

According to the Pennsylvania Department of Education (2014a, 2014b) (as defined in their publications outlining the mathematics grade level assessment anchors and eligible content), the skills under the domain of Expressions and Equations (B-E) are as follows:

- Apply properties of operations to add, subtract, factor, and expand linear expressions with rational coefficients.
- Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate.
- Solve real world problems using linear equations of the form $ax + b = c$ and $a(x + b) = c$, where a, b, and c are rational numbers.
- Solve real world problems using linear inequalities of the form $ax + b > c$ or $ax + b < c$, where p, q, and r are rational numbers and graph the solution set of the inequality.
- Determine the reasonableness of answer(s) or interpret the solution(s) in the context of the problem.
- Apply properties of integer exponents to generate equivalent numerical expressions without a calculator with final answers being written in exponential form containing positive exponents.
- Solve equations of the form x2 = c and x3 = c, where c is a positive rational number and represent the solutions using square root and cube root symbols.

- Determine the value of square roots of perfect squares and cube roots of perfect cubes without a calculator.
- Estimate extremely large or extremely small numbers by expressing them as a single digit times a integer power of 10 and determine how many times larger or smaller one number is than another.
- Add, subtract, multiply and divide numbers expressed in scientific notation, including problems where both decimal and scientific notations are used.
- Interpret scientific notation that has been created by technology.
- Graph proportional relationships and interpret the unit rate as the slope of the graph.
- Compare two different proportional relationships represented in different ways.
- Show and explain why the slope of a line is the same between any two distinct points using similar triangles on a non-vertical line in the Cartesian plane.
- Write an equation in the form of $y = mx$ for a line through the origin.
- Write an equation in the form of $y = mx + b$ for a line intercepting the vertical axis at b.
- Identify and write linear equations in one variable that have one solution, infinitely many, or no solutions by showing which of these possible outcomes is the case by transforming given equations into simpler forms of $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).
- Solve linear equations with rational coefficients, which include equations require using the distributive property and collecting like terms.

- Interpret solutions (points of intersection of the graph) to a system of two linear equations in two variables.
- Algebraically solve systems of two linear equations in two variables. Estimate the solutions of two linear equations by graphing the equations.
- Solve mathematical problems including real world contexts leading to a system of two linear equations in two variables.

This study does not find a statistically significant difference in overall math achievement levels for students in the experimental group who used the supplemental math software compared to the students who did not. The study does not determine a significant difference in math achievement when the experimental group was further divided by gender (males and females) in the experimental group and compared to the gender groups (male and female) in the control group. Finally, four out of the six reporting categories do not contain a statistically significant difference in achievement between the experimental group's posttest and pretest scores. This data analysis results cannot be considered as evidence of a positive relationship between using the Edmentum Courseware Math Library as an intervention in a blended learning environment and increasing students' math achievement.

As a result, the Edmentum Courseware Math Library's implementation into a blended learning environment in our middle school mathematics classes was deemed not to be an effective intervention to increasing the overall math achievement of our students. Based on the information obtained from this study, the researcher will not be recommending this intervention as a middle school strategy for future implementation in our district. The data provided evidence that a $3609 budget expenditure for full implementation of this computer resource, coupled with blended learning, will not provide the increase in student achievement that we have been so diligently working to achieve. This intervention will not be recommended for full middle school implementation or eventual district-wide implementation.

Limitations

According to Chen and Jones (2007), research has historically shown that blended learning has brought to light many positive aspects on student achievement. Although this study may not have supported that outcome, several possible factors may have impacted this study's results.

One possible explanation for the results of the study is that the intervention relied primarily on lessons assigned by the classroom teacher to place students in learning modules. These selected modules may have put students into learning activities that were either too complex or too simplistic for the students' current ability levels. Meaning, the reliance on assigned lessons was only as effective as the teachers making the assignments and their accurate assessment of students' ability levels for successful engagement with a particular math topic. The school's implementation of the Edmentum Courseware Math Library may be a mitigating factor in explaining the study results. The teachers did receive training on the functionality of the software; however, the training was not extensive. In-depth training and support for all math teachers regarding the implementation of the intervention, including professional development in the blended learning model, may produce different results for schools choosing to implement this or other supplemental software. Other schools considering implementing this intervention may need to consider investing in extensive and ongoing teacher training and support during the implementation to ensure students' high-quality engagement with the software.

A second possible explanation is that students' use of the intervention was spread out too much to have lasting effects on student achievement. While students were regularly scheduled to work with the intervention, the schedule was often interrupted by school holidays, snow days, and especially the transition to remote learning beginning in late March 2020. More concentrated use of the software may have allowed students to maintain more consistency in their learning and progress within each learning module. While fidelity of implementation regarding the number and length of usage was maintained over the 2019-2020 school year, the intervention's use was not associated with higher levels of math achievement. Achievement levels were only statistically significant for two of the six skill domains for those who used the Edmentum Courseware Math Library.

Third, a possible explanation for the results may be that the intervention attempted to teach new mathematical content instead of supplementing the regular math teacher's classroom instruction. While the assigned modules were appropriate for each grade's standards-aligned curriculum, some students may have missed significant classroom instruction due to attendance issues, off-task behaviors, teacher absences, or the disruption of the classroom environment with virtual learning. These students would not benefit from the direct instruction before engaging with the lesson module content provided by the intervention. As a result, some students may have been engaging with math lessons and content that were new or beyond their current learning, rather than reinforcing or extending learning.

Finally, COVID-19 may have had a direct effect on the outcome of this study. When the governor of Pennsylvania ordered all schools closed, the typical school environment changed for the remaining nine weeks. Schools were forced to implement online learning as part of our Continuity of Education plans required to be submitted to the Pennsylvania Department of Education. The ability to control the educational environment became a challenge. The traditional curriculum was still being taught virtually through Google Classroom to both groups. The experimental groups still received the Edmentum Courseware Math Library modules as a supplement to their regular curriculum. However, the instruction was not delivered traditionally. As a result, the experimental group was no longer in a blended learning environment, and the intervention became just another activity in the new virtual learning environment. Although the teachers received training in implementing the Edmentum software into their classrooms as part of this study, they were not entirely trained to deliver the instruction exclusively online through Google Classroom. Without the disruption, the results of this study regarding the effectiveness of the intervention may have been different.

While the Edmentum Courseware Math Library developers would likely offer that students needed to increase their use of the intervention during the school year to show significant results, the instructional time during the school day and the school year is limited. The school invested in the physical resources of a dedicated computer cart, the human resources of a certified math teacher, and the instructional time over the 2019-2020 school year. The school's investment represents a significant amount of resources and time in this research project. A significant shortcoming of the school's implementation of the software may be the lack of ongoing training and support for the classroom teachers about the degree of customization of each learning module that addresses the individual student's learning needs. While the Edmentum Courseware Math Library seems to have the potential to help students increase their math achievement, the intervention implementation in this study was not associated with higher levels of math achievement by students who interacted with it.

Future Directions for Research

This study was extremely helpful in investigating how effective the Edmentum Courseware Math Library was in increasing student math achievement in a blended learning environment. Further research needs to be conducted utilizing the Edmentum Courseware Math Library as well as other similar software programs currently used to help students increase their achievement in mathematics. However, there are several recommendations for future research and studies about Edmentum's software program and other software programs alike.

First, the sample size in this study was 124 students, all of whom came from the same local Junior-Senior High School. There was no specific effort to include or exclude students who are classified as English Language Learners or students with disabilities. Therefore, the study cannot speak to the subgroup effects of this implementation other than gender. A more extensive and more diverse population will be needed to prove any hypothesis about the effectiveness of the Edmentum Courseware Math Library. Studies with larger groups from multiple schools also have the potential to show whether the use of the software has any effect on math achievement among students with diverse backgrounds, which may be different from the students in this study. Studies involving students in other school districts, other states, and other parts of the country could show different results and therefore contribute to the body of research about the effectiveness of supplemental math programs in a blended learning environment. Future research could include more national or international populations to analyze student math achievement to make the results more broadly applicable to a wider range of students.

Second, the study would be more valid by comparing more classes and data from subsequent years. The study could also be more improved upon by testing it on the other subjects that use the Pennsylvania System of State Assessment exams as a state assessment. Lastly, a variety of other instruments could have been used to evaluate and analyze the effectiveness of other computer programs that could enhance classroom instruction. More research and similar studies must be conducted to analyze which programs would be best to use.

Future studies should also attempt to gather evidence of teacher training and support for all math teachers regarding the software functionality as well as blended learning models throughout the implementation period. Research that focuses on the effectiveness of the supplemental software component and practice variations would also be beneficial. Online learning can include a host of different activities as well as providers, and asynchronous learning can be blended into a classroom in several very different ways. These variables may impact student achievement and learning growth and produce different results. Given the importance of quality instruction for current students and our future workforce, this topic deserves more attention and further analysis in educational research.

Summary

The conceptual underpinning of this study is to explore the effectiveness of the Edmentum Courseware Math Library's implementation into a blended learning environment in the middle school mathematics classes. Would Edmentum Courseware Math Library show to improve student achievement in mathematics as demonstrated by the pretest and posttest scores on the Study Island Benchmark Test version 4? The study hypothesized that implementing the modules of Edmentum Courseware Math Library as a supplement to the regular middle school mathematics curriculum would improve overall mastery of the eligible content of the PA Core Standards. While the statistics show that the Study Island Benchmark Test scores improved from pretest to posttest, there was no significant difference in the mean differences between the groups of students who utilized the intervention and those who do not.

In conclusion, the outcomes of the study suggested that Edmentum Courseware Math Library is not an effective intervention within a blended learning environment for our middle school mathematics students. The Null Hypothesis was accepted for the overall achievement of the two groups, and the overall differences by genders for those groups. The Null Hypotheses were accepted for four out of the six skill domain subgroups of the PA Core Standards. The study showed that the Edmentum Courseware Math Library does not improve the students' achievement levels. However, more research and analysis are suggested to get more conclusive results regarding the effectiveness of this intervention.

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Appendix A
Parental Consent Form

Parental or Guardian Permission Form for Research Involving a Minor

Department of Curriculum, Instruction and Assessment

Title of Project: The Effectiveness of Blended Learning Utilizing Edmentum's Courseware Math Library in the Carlynton Middle School Mathematics Classrooms

Researcher(s): Edward P. Mantich

Dates of Study: 9/12/19 to 9/11/20

Your permission is being sought to have your child's PSSA and Study Island Benchmark Data used as part of this study. Please read the following information carefully before you decide whether or not to give your permission to use this data.

Purpose of the research: The purpose of this study is to explore the effectiveness of the implementation of the Edmentum Courseware Math Library into a blended learning environment in our middle school mathematics classes.

Procedure to be followed: The study explores the differences in achievement between the traditional model of education and blended model of education with the implementation of the Edmentum Courseware Math Library on PSSA tests and the Study Island Benchmark Test. The Study Island Benchmark Test will be used as a pre-test and a post-test to be administered during the first few weeks of school and as the final exam of the course. The second data points will be the Spring 2019 administration of the PSSA and the Spring 2020 administration of the PSSA. These come in csv. files from Data Recognition Corporation and the Pennsylvania Department of Education.

Discomforts/risks: The risks in this study are minimal, no greater than those ordinarily encountered in daily school life or the routines of the average middle school students. There are no foreseeable discomforts or dangers to your child in this study.

Incentives/benefits for participation: There is no direct benefit to the student from being in this study, but if the use of their assessment data is part in this study, they may help researchers and district personnel better understand what methodology, pedagogy, and resources best fit the learning styles of middle school mathematics students in our district, and may result in programs or policies that are better able to meet the needs of our students.

Time duration of participation: Participation for the students require no additional time than normally spent during class and completing homework.

Statement of Confidentiality: All records are kept confidential and will be available only to professional researchers and staff. If the results of this study are published, the data will be presented in group form and individual children will not be identified.

Voluntary participation: Your child's participation is voluntary. If you feel your child has in any way been coerced into participation, please inform the faculty advisor. We also ask that you read this letter to your child (if age-appropriate) and inform your child that participation is voluntary.

Questions regarding the research should be directed to:
Edward P. Mantich, Director of Curriculum, Instruction and Assessment
edward.mantich@carlynton.k12.pa.us
412-522-2600

Questions or concerns regarding participation in this research should be directed to:
Edward P. Mantich, Director of Curriculum, Instruction and Assessment
edward.mantich@carlynton.k12.pa.us
412-522-2600

SIGNING THE FORM BELOW WILL ALLOW YOUR CHILD TO PARTICIPATE IN THE STUDY DURING SCHOOL HOURS WITHOUT YOUR PRESENCE. Please return by Monday, September 30th.

Parent Signature Box

I, the parent or guardian of ________________________________, a minor _____ years of age, permit his/her participation in a program of research named above and being conducted by Edward P. Mantich.

______________________________ ________________

Signature of Parent or Guardian Date

____

Please print your name here

Student Signature Box

I, ______________________________, agree to participate in the program of research named above and understand that my participation is voluntary.

______________________________ __________

Signature of Student Date

____

Please print your name here.

Signature of Investigator ____________________________ Date________________________

Appendix B
Institutional Review Board Approval

Institutional Review Board
California University of Pennsylvania
Morgan Hall, 310
250 University Avenue
California, PA 15419
instreviewboard@calu.edu
Melissa Sovak, Ph.D.

Dear Edward,

Please consider this email as official notification that your proposal titled "The Effectiveness of Blended Learning Utilizing Edmentum's Courseware Math Library in the Carlynton Middle School Mathematics Classrooms" (Proposal #18-097) has been approved by the California University of Pennsylvania Institutional Review Board as amended.

The effective date of approval is 9/12/19 and the expiration date is 9/11/20. These dates must appear on the consent form.

Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)

(2) Any events that affect the safety or well-being of subjects

(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).

(4) To continue your research beyond the approval expiration date of 9/11/20 you must file additional information to be considered for continuing review. Please contact instreviewboard@calu.edu

Please notify the Board when data collection is complete.

Regards,

Melissa Sovak, PhD.
Chair, Institutional Review Board

Appendix C
Completion Notification Form

Parental or Guardian Completion Notification Form

Department of Curriculum, Instruction and Assessment

Title of Project: The Effectiveness of Blended Learning Utilizing Edmentum's Courseware Math Library in the Carlynton Middle School Mathematics Classrooms.

Researcher(s): Edward P. Mantich
Dates of Study: 9/12/19 to 9/11/20

Dear Parent(s)/ Guardian(s),

The purpose of this research study was to explore the effectiveness of the implementation of the Edmentum Courseware Math Library into a blended learning environment in our middle school mathematics classes. This research project explored the differences in achievement between the traditional model of education and a blended model of education with the implementation of the Edmentum Courseware Math Library on PSSA tests and the Study Island Benchmark Test. The Study Island Benchmark Tests were utilized as a pre-test and a post-test and were administered early in the month of September 2019 and as the final exam of the course. The second data points were to be the Spring 2019 administration of the PSSA and the Spring 2020 administration of the PSSA. Due to the COVID-19 pandemic and the closure of schools, the 2020 administration of the PSSAs were canceled. These PSSA data points were no longer available for analysis and were eliminated from this study. Therefore, the study was concluded with only the data generated by the Study Island Benchmark Tests.

The data collection for this project has been completed and the data has been analyzed. All records have been and will be kept confidential and will be available only to professional researchers and staff. Once the final report is completed, the data will be promptly destroyed. If the results of this study will be published, the data will be presented in group form and individual students will not and cannot be identified. The final results of the study will be completed and presented to the university by August 14, 2020.

If you interested in reviewing the results of this study, please contact me by email at edward.mantich@carlynton.k12.pa.us. I will send you a copy of the analysis and conclusions for this research.

Yours in Education,

Edward P. Mantich
Director of Curriculum, Instruction and Assessment
Carlynton School District