COMPARISON STUDY BETWEEN MATH TEST SCORES FOR BRICK AND MORTAR AND ONLINE CLASSROOMS

by

Marisa May

Liberty University

A Dissertation Presented in Partial Fulfillment

of the Requirements for EDUC990

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ABSTRACT

With the emergence of online education, opportunities have risen for students who seek alternatives to attending a traditional school. However, the rise of virtual education has highlighted the challenges educators and students face in this environment such as academic integrity and quality control. In both learning environments, students often struggle to grasp mathematical concepts despite resources that are intended to aid learners in understanding abstract concepts. With an emphasis on state testing, educators are faced with the challenge to improve both math learning and performance on math standardized tests given at the state level. This study aimed to answer whether there is a difference between the performance of students on math state tests when comparing students who attended a traditional classroom versus those who attended a fully online classroom. Furthermore, this study aimed to identify whether there is a difference between the performance of male and female students on math state standardized tests between students in a brick and mortar classroom and those in an online learning environment. The study used a causal-comparative design of quantitative data with participants drawn from a convenience sample of ninth grade students who attended a virtual public high school in Texas during the 2017–2018 school year. Descriptive statistics were compiled and analyzed. An independent samples *t*-test was used to determine that a significantly significant difference exists between the performance of students who attended a virtual high school and those who attended a traditional school. Furthermore, a significant difference was also found in the performance of male and female students on a math state test after attending a virtual high school when compared with their peers in a traditional high school.

Keywords: traditional school, state testing, student performance, virtual school

Dedication

This paper is dedicated to my family. First, to my husband, Chris, who rode the roller coaster of emotions with me through this entire process. Your wisdom and discernment are invaluable to our family and especially me. I appreciate the way you lead our family to a deeper walk with the Lord.

To my children, you are my world. To my daughter, Kendall, thank you for your patience with me and your encouragement to do the right thing simply because it is the right thing. To Alyssa, I appreciate your consistent encouragement to finish the task. By putting in hard work each day, we really can reach the finish line. To Bethany, I appreciate your tenderness to the Lord and the reminder that God is our Defender. To my sons, Collin and Caleb, thank you for always understanding when I had to spend time with this paper.

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CHAPTER ONE: INTRODUCTION

Overview

The digital platform, though still in its infancy, has progressed from its origin in the post-secondary arena as a way for adults to continue their education while pursuing their careers and maintaining their familial responsibilities. In today's landscape, digital learning has expanded to touch the lives of students from their early school experiences, through graduation of high school and into college. Due to these early stages of development, there is limited research at the secondary level regarding student performance on standardized tests while attending a full-time virtual school. The field of online learning is gaining momentum as an alternative to the traditional classroom with teachers teaching students in a physical location. Therefore, it is imperative to identify areas of concern that are associated with the change in curriculum delivery for secondary students.

Background

State assessments are often used to judge the success of a school. Originally, state assessments were used to evaluate whether students in a state were reaching agreed upon levels of understanding, knowledge, and performance. While No Child Left Behind (2001) was introduced with the goal of having students demonstrate proficiency at their grade level in math and reading, it has been regarded as one of the most controversial pieces of legislation for many years. Federal entities used the bill to hold states accountable for reaching all students regardless of their ethnicity, economic status, or learning ability. In addition, the statistics speak to a failure of the bill to reach its goal. According to the Nation's Report Card in 2013, the proficiency levels were below 50% in all ethnic groups in both reading and math at both the fourth and

eighth grade level. The only exception to this were students of Asian descent, who were on average 60% proficient in both subject areas (Nation's Report Card, 2013).

In 2015, President Obama released many of the restrictive measures on state accountability systems when the Every Student Succeeds Act was signed into law (Every Student Succeeds Act: Federal Elementary and Secondary Education Policy, 2017). While states must continue to perform state assessments and collect data with regard to student progress and student achievement, the states now submit plans which are designed to improve instruction, increase achievement, and provide equity for all students to the federal government annually (Every Student Succeeds Act: Federal Elementary and Secondary Education Policy, 2017).

State assessment has long been a controversial issue among parents and educators. Dissenters of the use of standardized testing cite too much government involvement in schools at the local level as the problem. Standardized tests are looked upon negatively due to the lack of value they give to creativity and diversity. In addition, students with higher socio-economic status often perform better than those who have different cultural backgrounds. Educators point to the need to "teach to the test" and how much instruction time is consumed by preparing students to take standardized tests. Because schools are funded with federal, state, and local funds, LaFerrara (2013) states that schools are subject to the agenda of those gaining the "political upper hand." These funds are tied to a state's involvement in high stakes testing.

Many parents seek to meet the educational needs of their child through various schooling options. In several states, students begin their public school experience at a traditional brick and mortar school, while other states allow students to attend virtual schools from the lowest level at which students can enroll. Through elementary and secondary schools, families may find they wish to seek alternative schooling options to meet the needs of their unique students. Many

parents find the online public schooling environment to be a place where their student can receive publicly funded services from certified teachers while learning at home through an online learning management system. It is important to consider that another reason parents choose to enroll their students with a virtual school is to ensure safety. The home environment is much easier for parents to control and can provide a sense of security to families that brick and mortar institutions cannot. According to Saiger (2016), virtual schooling provides parents with the ability to keep their children at home while accessing resources that interest them in a timely manner from professionals.

According to the National Center for Education Statistics, there were 478 public virtual schools in the United States in 2013-2014 (Common Core of Data, America's Public Schools). Because they are public schools, the enrolled students must participate in state testing. In addition, these schools must also display Adequate Yearly Progress (AYP) as stipulated by No Child Left Behind (NCLB) and reaffirmed by the Every Student Succeeds Act (ESSA). Dynarski (2017) surmises that education at any level may be improved by online coursework. However, she goes on to confirm that while online learning has grown since its inception, it is still difficult to ascertain exactly how helpful online learning can be as the available studies simply cannot answer all the questions presented for a definitive conclusion.

Because online educational opportunities include blended teaching, which combines face-to-face learning with online learning, as well as solely online teaching, it is difficult to find studies that concentrate on one or the other. Additionally, the studies do not focus on the progression of the student regarding standardized testing as mandated by each State. According to Stack (2015), many factors contribute to the unreliability of such studies pertaining to the

results of online learning assessments versus face-to-face learning assessments, including lack of proctoring, the opportunity for cheating, and the subjective interpretation of said studies.

The need, therefore, exists for a study which incorporates a look at the progression of the online student regarding standardized testing versus progression of the traditional brick and mortar student with regard to standardized testing, as there are omissions in the current studies available regarding this particular aspect. Existing studies admit the lack of information available, as well as possible issues with review of the results of those studies.

Problem Statement

Montgomery (2014) explored graduation rates among virtual schools and traditional brick and mortar schools in South Carolina among one segment of students. It was found that there was no significant difference between graduation rates among high school students with low socio-economic status in South Carolina who attended completely virtual schools and their peers who attended traditional brick and mortar public schools. While a look at graduation rates speaks of the end results, there is a need for comparisons and parallels to be drawn to assess whether differences exist between students in an online school and their peers in a brick and mortar school at points before graduation. With these assessments, educators and administrators can determine whether changes should be made and plan a course of action to address deficiencies.

The same is true regarding state testing. If more information is found regarding whether there is a significant difference between the state test scores in math between ninth grade students who attend a brick and mortar school and ninth grade students who attend a public virtual high school, then administrators and educators can make changes to improve student performance. According to Dreyer (2013), most online programs where students attend

exclusively do not score well on the state mandated accountability exams. Dreyer goes on to state she believes that statement to be a simplistic view of a complex issue, as there are many factors which contribute to this somewhat false finding. The lack of focus on specific issues in this research supports the need for additional research with more definitive parameters. The problem is that the research available for this particular subject is not defined by more specific guidelines or questions, thus resulting in somewhat scattered determinations.

Purpose Statement

The purpose of this study is to determine if there is a statistical significance between high school students' performance on a state assessment in math after attending a virtual high school as compared to those students' performance on a state assessment in math after attending a brick and mortar high school using a quantitative design. Specifically, this quantitative study will focus on students residing in Texas and attending both a public brick and mortar school and a publicly funded virtual school operating as a charter school under the Texas Education Agency. By specifying more narrow parameters for the research, a more significant result may be obtained, thus providing necessary information for future progress in this area.

Significance of the Study

With information about student performance on state assessments while attending a virtual high school, educators and administrators at various levels will be able to adjust to curriculum and policies to affect student performance and achievement. Current studies (Panigrahi, Srivastava, & Sharma, 2018; Cela, Sicilia, & Sánchez-Alonso, 2016) reflect a general result regarding graduation and/or success with online higher education; however, by including the specific question as to whether standardized test scores are comparable between online learning and traditional brick and mortar learning, this will provide a better opportunity for early

intervention if the standardized testing results reflect a problem at either source. In addition, the findings of this study will aid parents as they consider the best schooling option for their child. Understanding the struggles for either schooling environment allows parents to seek resources that will assist their student in overcoming these challenges.

There is no doubt online learning is becoming more available to the general public, and more parents are taking advantage of this opportunity for their students at an earlier age. In determining the specific results as to how standardized test scores are affected by online learning, programs can be developed that address the areas that are lacking. On the other hand, if the research reveals standardized testing is lower at a traditional brick and mortar facility, administrators may begin to build programs in which educators may avail themselves of further support in this regard. With current research focused primarily on retention rates and engagement (Boulton, Kent, & Williams, 2018; Vuopala, Hyvönen, & Järvelä, 2016), an opportunity for early intervention and necessary educational programs is being missed.

Research Questions

RQ1: Is there a difference between high school students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for Algebra 1 after attending a virtual high school for the previous school year as compared to those students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a brick and mortar high school for the previous school year?

RQ2: Is there a difference between the performance of high school males on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to males' performance on the State of Texas

Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year?

RQ3: Is there a difference between the performance of high school females on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to females' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a brick and mortar high school for the previous school year?

Definitions

1. *Virtual High School* - A virtual high school is a high school where student learning occurs entirely over the Internet (Means, Toyama, Murphy, Bakia, & Jones, 2010). Students are not required report to a physical school building for lessons but may attend from wherever they are via the internet with no schedule limitations.
2. *Traditional High School* - a school where students attend face-to-face from 4 to 6 hours per day for 5 days a week (Zimmer, Gill, Booker, Lavertu, Sass, & White, 2009)

CHAPTER TWO: LITERATURE REVIEW

Overview

Modern education offers many different options for students of all ages and levels. Some of these options include physical, traditional, private, and online courses that supplement the traditional school model, while another option is fully immersed online school. The evolution of education includes the introduction of a variety of distance learning programs where students with traditional work schedules or competing personal demands can attend school on a part-time basis, or work school attendance around scheduling conflicts.

A traditional school is one in which students attend classes with a teacher and other students in physical classroom location. Students are often taught from an approved curriculum by a different teacher for each subject. The traditional school model dates to the Boston Latin School, which was founded in 1635.

Horace Mann (1796-1859) is often referred to as the father of public education because he pushed to bring local schools under a state authority in order to create a uniform education system. The traditional school can be defined as a public school that is funded by the state or federal government. However, if the primary source of funding for the school is derived from private donors, or fees are charged to the families of students, the institution is classified as a private school. Unlike any other time in the history of education, students can now attend school through methods tailored more closely to their academic abilities, schedule, and needs, which provides them with a customized learning experience.

Online learning allows students who otherwise would not be able to attend school to have access to the educational programs provided by these institutions. Whether students are seeking their education online due to illness, ailments, or geographical limitations, delivering curriculum

through online learning platforms has led to increased opportunities for students around the world. Furthermore, federal agencies and educators want to ensure that students who attend a fully virtual school are performing at a level comparable to their peers in a traditional brick and mortar environment. To investigate, these organizations have set up tests to ensure online institutions meet the same standards as traditional schools. This study increases in importance due to a great need for research in which online learners are compared to their peers in the brick and mortar classroom at the secondary level. With further research in this area, federal agencies may require necessary changes in curriculum, student/teacher interaction, and other areas which may need improvement.

The education system has made leaps and bounds in the category of improvement. In the late 1800s, education as a whole was made available primarily to males only from affluent backgrounds. These individuals were asked to travel to one location at one time to learn from a master teacher. In 1890, William Rainey Harper set out to make education available to a different group of people: people who could not afford to leave their home and pursue education at one of these institutions. Despite Harper's efforts, many educators of the time saw distance education as a lesser method of instruction. In fact, according to Pittman (1991), educators felt that correspondence courses provided inferior instruction. However, distance education created the opportunity for more individuals to earn an education.

This new opportunity was not easy, as it required significant effort on the part of the student. In the early stages, the mail service was the only method of delivery for the correspondence courses. Curriculum materials were mailed to the student at their home location. Students would then work independently to perform research and complete learning assessments.

Once completed, the student would then return the materials to the educational institution through the mail again.

Theoretical Framework

Online learning is a subset of learning (Garrison & Shale, 1990), meaning traditional learning theories can apply to online learning. Functioning with this understanding, constructivism is often applied to online learning. Piaget's Cognitive Constructivism theory (1952) indicates that providing learning opportunities for students allows them to construct meaningful learning. This theory also states that children learn as they interact with their environment by interpreting various clues they receive from it. Flynn, Vermette, and Mesibov (2013) explain in Constructivism theory that learners must first engage with the content to gain understanding and they use this knowledge to apply it thoroughly.

Another principle is Moore's Transactional Distance Education Theory (TDET), which gives a pedagogical framework for distance education programs. TDET is the first theory developed as a comprehensive concept to define the field of distance education in terms of pedagogics (Moore, 2007). The idea of transaction in education refers to the interaction of teachers and students while they are in separate geographical locations. Moore's TDET is often applied to various learning environments in which the teacher and student are separated. Moore (1997) pointed to three components of transactional distance education which must be considered: dialogue, structure, and learner autonomy. Dialogue, in this case, refers to more than just communication between two individuals. Instead, it refers to communication in various forms, "within the context of clearly defined educational targets, cooperation and understanding on the part of the teacher, and, ultimately, it culminates in solving the learners' problems" (Giossos, Koutsouba, Lionarakis, & Skavantzos, 2009, p. 2). This type of communication is

accomplished in the online learning environment through email, instant messages, phone calls, and video calls.

The second component, structure, refers to the flexibility of a course. This can be seen in whether the objectives of the course are predetermined, whether or not the course is teacher-centered or student-focused, and the nature of the assessments in the course (Zhang, 2003). The third and final component of TDET, learner autonomy, refers to the perception of interdependence and independence by the learner as they interact with the course. Moore's theory contends that an increase in one component of the transactional distance education will cause a decrease in one of the other components (McIsaac & Gunawardena, 1996). Gorsky and Caspri (2005) confirm the use of TDET as a framework with which to investigate distance education programs. While this study seeks to determine whether a difference exists in the performance of students in a fully virtual school versus their peers in a brick and mortar school, Moore's theory provides a theoretical framework for distance education programs, including the fully virtual secondary school.

Related Literature

The changes to adult education have also filtered down to K-12 education, allowing younger students the same flexibility of school attendance through an array of options such as private school, charter school, homeschool, and virtual school. Many parents choose to have their child educated in a virtual setting for a variety of reasons. First, with the rise of bullying and school violence, some families choose to educate their children online from the safety of home. Secondly, families of children with disabilities find that online schooling provides the student with an opportunity to learn with an individualized learning plan created specifically to meet the needs of the student.

Because the aforementioned options have been extended to K-12 education, state and federal education standards apply to each. In both brick and mortar and online schools, teachers and administrators deliver curriculum to students, provide feedback, and allow students opportunities to show mastery of the state-approved standards. Ways in which these tasks can be accomplished differ in each of the unique learning environments. In a traditional brick and mortar classroom, a state certified teacher designs lessons that engage students, introduce concepts, and demonstrate mastery of the concept. Likewise, in an online classroom, a certified teacher completes these same tasks, but the method of delivery is different. For instance, in a brick and mortar classroom, a teacher can engage the students by reading a poem to them. In an online classroom, the same teacher can read a poem to students who log into a synchronous video call.

While there are similarities between the two learning environments, the differences between them present new challenges for which educators strive to find solutions. Learning integrity and the need for community in the online learning environment are topics of concern as the use of online learning develops. The Every Student Succeeds Act (ESSA) (2015) requires that states assess 95% of all students and 95% of students in subpopulations in both English and math if the school receives federal funding. These standardized tests measure each student's ability across a standardized reading and mathematics curriculum. Standardized testing is widely regarded as a suitable method for appraising a student's past academic achievement as well as their future potential. With the advent of virtual schooling for K-12 students, there is now a population of learners who complete standardized testing while their primary learning environment has been online. When the results of these students are compared with those from a traditional classroom setting, there tends to be differentiation between the two sets of scores.

This study proposes to determine whether there is a significant statistical difference between the performance on the State of Texas Assessment of Academic Readiness (STAAR) End-of-Course Exam for Algebra 1 of students who attend a fully virtual school where 100% of the curriculum and instruction is delivered through an online platform, and the performance on the State of Texas Assessment of Academic Readiness (STAAR) End-of-Course Exam for Algebra 1 for students who attend a brick and mortar school where curriculum and instruction are delivered in a face-to-face setting. Achieving a passing grade on this End-of-Course Exam is required for graduation from a public school in Texas as mandated by the Texas Education Agency. In addition to this, all students who complete the Algebra 1 course at a Texas public high school are required to participate in these exams with few exceptions made by the Agency. While student performance can be evaluated on many levels, standardized testing provides a common tool used to evaluate students who attend public schools, whether fully online or brick and mortar.

The Evolution of Online Education

Distance education is not a new concept, though approaches to it evolve rapidly. It was not until the 1950s when technology evolved to allow for different delivery methods. Among the first in advancement, the University of Illinois attached a series of terminals that connected in an Intranet where students could listen to recorded lessons and access course materials. This Intranet, while in its infancy, led to the creation of Programmed Logic for Automatic Teaching Operations, also known as PLATO. PLATO eventually led to other social media components which are widely used today such as message boards, chat rooms, and screen sharing.

Another significant occurrence in the world of distance education occurred in 1979 when the computer game Lemonade Stand was released for the Apple IIe computer. The concept of

the game was simple in that it asked users to create their own lemonade stand. This simplistic game was marketed to Apple users throughout the 1980s and introduced the world to learning in the virtual environment. A couple of years later, in 1986, the University of Wisconsin began to develop technologies to incorporate audio and computer teleconferencing typified, creating a more effective delivery method for distance courses.

At inception, distance education was created to provide opportunity to students who otherwise would not be able to further their college education. This goal has been reached in that now, many females and minorities are now able to complete their college education through distance education opportunities. According to US News (2015), an outstanding 70% of online undergraduate students are women and 72% at the graduate level. In addition to this, the goal has expanded to include high school students of all kinds who would otherwise not be able to attend a traditional brick-and-mortar classroom. For instance, students who need flexible scheduling for their schooling naturally gravitate towards the online option. Students who compete in sports such as gymnastics or snowboarding often practice for many hours during the day. This means that they need flexibility in the timing of completing their school work. Online schooling provides them with the opportunity to receive a quality education, while continuing their training.

Since 20% of people in the United States have a disability, the support services at schools are necessary for students with disability to engage in the online classroom (Capozzi, 1998). While online classes are not addressed specifically in federal laws such as the Americans with Disabilities Act (ADA) and the Rehabilitation Act, courses that inhibit access to students with disabilities would violate these laws. Assistive technology is often necessary to help students with a disability to access online courses. This technology makes a computer more accessible to

a user on any device (Buggey, 2000). This technology can take on many forms such as hardware adaptations, large-print screen displays, or reading software that will read print from a screen to the learner.

Cavanaugh, Repetto, and Wayer (2011) published research to indicate an increase in the number of high-risk students with or without disabilities who are choosing virtual schools. This could be due to the struggles at-risk students face in the traditional classroom setting including time and space restrictions that do not contribute to their success. Furthermore, the research also indicated that teachers in the virtual environment have little to no experience at serving students with these issues in the online learning scenario. Proponents of the inclusion of special needs and at-risk students in the virtual classroom point to the flexibility in pacing as well as other adaptive technology that may be used to help individualize the learning experience for these learners. Students with health needs are more likely to take a math course online according to Fernandez, Ferdig, Thompson, Schottke, and Black (2016). This stems from the linear nature of math courses which require repetitive practice to master skill. Because students with health needs are frequently absent, the virtual learning environment provides an avenue for learning to which can happen on an adjustable timeframe.

In the beginning, distance education was provided only to those who could afford it. Typically, this included mostly wealthy males, although they might not have been able to travel to an academic institution. Conversely, very few females joined distance education courses that were provided through paper-based materials. However, the majority of females and minorities still were not able to afford distance education courses at first. This lack of opportunity for women spurred further development in the method of delivery and the cost efficiency of distance education. The distance education courses were not affordable for the majority of students. It is

important to note that the cost of distance education courses was not much lower than the cost of the traditional academic institutions.

The opportunities that distance education provide are extensive. Whether the degree will benefit a single mom or a student who must work to pay for the schooling, the door of opportunity is open. Interestingly, Jacobs (2013) presented research to indicate that schools have modified their services to meet the needs of a workforce that is changing career paths every ten years. Learners today are looking for an opportunity to learn and apply it quickly in the workplace. For this reason, land-based, traditional educational arenas are not the first choice of learners (Mazoue, 2013).

As stated previously, in the earliest stages of distance education, only wealthy males could afford the time and money necessary to physically attend an academic institution. Even now, the sacrifice of time off work is not something a non-traditional student can afford to make. Traditional students are those who graduate high school and immediately start college. They are at a point in their life when their parents are able to support them financially so that they can invest time in their education. However, a single mom, for example, must provide food, clothing, and shelter for herself and her family. She cannot afford the loss of income in order to invest in her education. This is a situation in which online schooling makes a difference. Because she can take her courses from home, she can even work on assignments after her children have gone to sleep for the night. Thanks to online courses she can complete her schooling, enhance her skills, and ultimately increase her income by making herself more marketable in the job market.

There are many other problems that can be solved through online schedules. For high school students, professional athletes, and children who need flexible schedules, online education

provides the answer to their problem. These students practice in the gym or on the field for more than 30 hours per week. Traditional school is just not feasible for them to keep up with their training schedule. This begs the question, "Why these students would choose online classes instead of correspondence courses?" The primary reason is that with online classes, the student receives some level of interaction, even though it is limited to phone and video, with the teacher. They are not left on their own to figure out school by themselves. They can keep up with their extracurricular activities and still complete their high school education.

At the start, distance education felt very stagnant for the student. Curriculum was provided via a paper-based delivery system. Materials arrived in the mail for the student to work through independently of the teacher. For example, a student who wanted to complete a distance education course in psychology would receive instruction by reading through documents mailed to him by the educational institution. The student would not have any contact with the instructor. The instructor, in turn, would serve primarily as a grader. The student would not receive any feedback on assignments for a lengthy period. As a result, the student did not have the opportunity of learning from his mistakes. From the perspective of the educational institution, the investment was primarily made up front in the curriculum development process. It is found the downside to this process is that changes to the curriculum materials require a significant investment of time.

In its early stages, the curriculum development process for distance education classes stemmed from a group of educators at a given institution. Collaboratively, these educators would create print-based materials. This curriculum development was housed at a traditional brick-and-mortar academic institution and distributed to students. Edits were made on a routine basis generally to accommodate an updated edition of the textbook. The individual instructor of

a given course served primarily as a grader of assessments, merely marking what was correct or incorrect before mailing it back to the student. This left the responsibility of learning the material to the students since the instructors were geographically absent from the learning process. Furthermore, in these times, there was no communication between the student and anyone in the curriculum department in the process of distance education. With the lack of timely feedback and routine communication, students were isolated from both the instructor and their peers. Through feedback, instructors can guide students through continued improvement in future assignments or tasks. Likewise, instructors also benefit from feedback in that they are able to assess the course and their own ability to instruct students effectively. One of the benefits of timely feedback and routine communication is that students feel a greater sense of community in the course as well an enhanced personal learning experience.

With the advances of technology, correspondence classes were offered online via the Internet. This eliminated the need to mail curriculum materials to students. Early on, in distance education, the course work and materials remained stagnant. It is important to note that at this point in the development, the internet simply was a vehicle to deliver the curriculum. The internet was not yet a means by which a student could gain their own understanding. Teachers severed the ties of interaction with students and focused solely on grading assessments. The only feedback provided was at the end of the course when the final grade was submitted.

Today's modern online education is a far cry from the education of the 1950s and 1960s. Recently, a synchronous component was added to online courses with many universities. Students were asked to complete a phone call with an instructor. This phone call is usually at the midpoint of the course, and its goal is to provide the student with some level of intermediate feedback on assessments so that improvement can be made before the course ends. While this

synchronous component of the course helps students tremendously, it is important to note that it is difficult to implement. The reason for this is that students who benefit from online course delivery often have difficult schedules as they attempt to juggle family, work, and school. This real-time communication with the instructor is difficult to schedule and complete. It is ironic that the one component that helped students to be successful in the course is also the most difficult to implement due to the nature of the students who the course is trying to serve.

Early in the creation of distance education, teachers and instructors used a textbook and taught as they saw applicable. In an effort to standardize the curriculum which students encountered, institutions began to use curriculum development teams to write more robust materials to address the learning objectives for the course. With the curriculum in place and provided by professionals who specialize in design and pedagogy, schools sought to standardize the materials and ideas included in the course. In some ways, these standardized courses help to ensure that students who finish the course are able to master the same content as other students who have taken the course as well.

Most of online learning began with a reading and writing focus. Students were required to read on their own and produced a finished product, typically a research paper. The research paper was then graded by the professor or instructor. Math was not even considered to have an online component except for situations in which the problems were given, and students produced solutions on paper. Students were left on their own to find resources to help them solve the problems with little instruction other than what was available in print. This method simply does not work for most learners. The reasoning behind this is because most learners are not able to comprehend math concepts through reading. Most students need to see and hear examples that are accompanied with immediate feedback when learning a new skill.

Some of the best practices in math instruction begin with engaging students, introducing new topics, guided practice, and end with independent practice. This implies that teachers must spend time in the lesson cycle engaging students around the content before they introduce a new topic. This engagement can take on many forms. The goal is for the teacher to pique the interest of the students through personal stories, problems, or prior learning. Once students are engaged, the teacher can introduce a new concept through exploration, data collection, or another form of modeling. It is of the utmost importance in this step for the teacher to use the proper terminology at the introduction stage. This is done to ensure that the students are accustomed to the vocabulary, thus spurring growth in the student. The focus here is that the student and teacher are interacting at every stage of the lesson cycle. Without this interaction, the student is not engaged and does not become familiar with the use of the terminology associated with new concepts. As the lesson continues through the stage of guided practice, the student and teacher work collaboratively to complete a task or problem.

This process allows the teacher to lead, but the student is still an active participant in the learning. This process also strives to ensure that they have enough understanding to further the practice process on their own. In math particularly, the lesson cycle is necessary to ensure student learning and to check for understanding. When any step is skipped or omitted, the student is left confused and often frozen in inactivity. This further adds to the frustration that usually stems from previous struggles in math, and students feel defeated before they even begin a math course.

To help accommodate some of the student needs in online learning, adaptive resources are available in the online learning environment to provide interactive manipulatives that help to solidify learning for students who have a visual learning style. In addition, these adaptive

resources assess the mastery level of a student and then provide learning resources to bridge the gaps in the student's learning. For instance, an adaptive software assesses that a student has a gap in learning in the standard algorithm of subtraction. The software will then prescribe a learning resource to help the student better understand the concept. Students are then provided with the opportunity to practice this concept and demonstrate mastery before continuing in the learning program to a new topic.

Today's online college classes provide fast and smooth delivery via learning management systems such as Blackboard, Canvas, etc. With courses delivered via the internet, students have access to both their instructor as well as other students in their class. Due to the advancement of technology, students can now interact with faculty and classmates in multiple ways. This peer-to-peer interaction allows students to digest curriculum materials while communicating with others. Most of this interaction is asynchronous to accommodate varying schedules, one of the many benefits of online classes. While synchronous communication provides immediate feedback with peers, the idea of getting students to all appear online or in a phone call at the same time presents logistic and scheduling issues. Nevertheless, this level of communication and interaction is necessary for students to learn in math.

According to Dick and Hollebrands (2011), student learning in mathematics is strengthened when it is combined with an appropriate use of technology. Instructional software can be used to deliver instruction with methods different than those of a teacher in a traditional classroom. Roblyer and Doering (2013) wrote a book titled Integrating Educational Technology which focuses on the advantages of using instructional software in the online math classroom. Some of these benefits include providing all the instructional activities that a student

would need to master a topic and increasing student engagement by using gamification or simulation.

Standardized Testing

Standardized testing is a controversial issue in the K-12 system. Test scores are often associated with stereotypical threats, and researchers have found that minority students have been perceived to have lower achievement scores (Vershelden, 2017). According to Santelices and Watson (2010), developers of these standardized tests are tasked with the difficult goal of developing a test to be administered fairly to the diverse population in American schools. Linn (2001) cites race and social class as the most controversial points about testing. The No Child Left Behind Act brought the controversy over standardized testing to a climax. At its inception, standardized testing was a way to identify students who would benefit from further studies in a subject. These ability-based tests were designed as an entrance into tracks of education that would benefit students who were deemed able. Tests such as the Scholastic Aptitude Test (SAT) model this type of examination. In the 1960s, states introduced more achievement-based tests which were designed to evaluate schools and their instructional methods. The intent was to ensure that all students had access to quality education in an effort to prepare them for the workforce. Advocates of standardized testing label the tests as reliable and objective measures of student achievement (Phelps, 2002).

Conversely, dissenters of standardized testing inevitably refer to the biases in standardized tests as a negative point to English language learners (Menken, 2008). Students are often required to take standardized tests regardless of their proficiency in the English language or the length of time enrolled in a public school. Only special education students have the option to "opt-out" of standardized tests as prescribed in their IEP (Mitra, Mann, & Hlavacik, 2016).

Data collected from standardized tests has been used to determine teacher effectiveness as prescribed by state laws in Colorado and Florida (Colorado Department of Education, 2013a; Florida State Government, 2013). Furthermore, countries with high performing students, such as China, have a long history of standardized testing (Dillon, 2010). The result of students performing well suggests to proponents that standardized testing leads to high levels of student performance.

According to Blazer and Miami-Dade County Public Schools (2011), both advocates and dissenters of standardized testing are correct. These performance-based assessments have both positive and negative consequences. Teachers feel pressure to teach to the test to ensure students' success because their job performance will be evaluated based on the students' performance. Students, likewise, feel pressure and test anxiety associated with the high stakes that are tied to the outcome of the test. Also, schools whose students do not perform well are forced to change instructional methods to ensure that the needs of all students are met. By bringing low scores to the attention of the public, low performing schools feel pressure from administrators and the public to make the necessary changes.

Because government funding is tied to the performance of students on standardized tests, schools are coerced to take all the steps necessary to raise the level of performance of their students to meet the standards. This includes embracing instructional methods that are data-driven and proven effective, while discontinuing strategies that do not meet the needs of students. Studies that determine whether a curriculum delivery method is more effective than another method serve to help schools make decisions that will benefit their students' performance on the standardized tests. After NCLB was passed in 2002, despite its initiatives which focused on ensuring that student groups were reached, the United States fell from 18th in

the world in math on the Programme for International Student Assessment (PISA) to 31st place in 2009, with a similar drop in science and no change in reading (PISA 2015, 2016). This indicates that further research and investigation is necessary to accomplish the task of raising student test scores.

In 2016, a report by the National Research Council indicated that, "despite using them for several decades, policymakers and educators do not yet know how to use test-based incentives to consistently generate positive effects on achievement and to improve education" (Hout, 2011, p. 5). This stems in part from the fact that standardized tests measure only a small portion of what makes education meaningful. According to education researcher Gerald Bracey (2009), qualities that standardized tests cannot measure include: creativity, critical thinking, resilience, motivation, persistence, curiosity, endurance, reliability, enthusiasm, empathy, self-awareness, self-discipline, leadership, civic-mindedness, courage, compassion, resourcefulness, sense of beauty, sense of wonder, honesty, and integrity.

While these learning styles can be addressed in the online classroom, it is important to note that many skeptics of online education point to the integrity of student work as a problem that needs to be addressed. Critics of online education point to cheating as a cause to abandon online education as a viable option. However various studies have shown that learning is not compromised in the online educational environment. For example, Bata-Jones and Avery (2004) studied nursing students to determine if there was a difference in midterm scores between students who took the course online versus students who took the course in a face-to-face setting. The result of their study showed that there was no significant difference in the test scores.

In addition, Ridley and Husband (1998) sought to compare the grade point averages (GPAs) of students who completed traditional and online classes to determine the level of

academic integrity in the online learning environment. The researchers proposed that "remote learners connected to the faculty only through computer networks may have greater opportunity than ever to turn in work that was not their own" (p. 185). The researchers thought that cheating would be detectable by students in the online learning environment having higher GPAs than students in the face-to-face setting. They concluded that the concern for cheating was unfounded.

In contrast, Keefe (2003) measured student learning with three exams given during the semester of an organizational behavior course in which students either took in a face-to-face setting or online. In this study, Keefe found that students in the face-to-face setting did better than those in the online learning environment. It is important to note that the focus of this study is not to determine whether cheating happens or not, but rather, to determine that if cheating is a viable option in the online environment does it affect the performance of online students on state-mandated exams.

It is important to understand what constitutes cheating as it applies to the educational learning environment. Harkins and Kubik (2010) found that a traditional view of cheating in institutions has opened a greater use of collaboration and tools which make the sharing of ideas more prevalent. Within the realm of online courses, cheating has become high tech. According to Young (2012), students are able to cheat with little to no effort and still receive high grades in the course. This includes the use of Google products to share test answers in hopes of beating the online test bank of questions for multiple choice tests.

With the ever-growing population of online course delivery systems, institutions are forced into rethinking how they may prevent cheating and stay ahead of the curve on this issue. Students cheat in class by submitting papers which are written by others. Many times,

these papers are found or purchased on websites. Schools attempt to minimize this level of cheating by using websites, such as Turnitin.com, which use search features to identify cheating. Other levels of cheating are present when students have an individual other than themselves complete assignments such as labs, quizzes, or exams. If these exams are given online, the cheating becomes more difficult to detect. Currently, the burden lies with the curriculum team of the institution to design assessments that feature rigor and creativity to deter students from using a simple search to find the answers.

Does this mean that all students in online courses are cheating? According to research by Ladyshewsky (2014), there is no significant increase in mean test scores over time among students who complete supervised in-class multiple choice tests versus students who complete unsupervised online multiple-choice tests. Additional research can be found to indicate that cheating is more likely to occur in an online course when compared to a traditional course offered in a brick and mortar setting (Grijalva, Nowell, & Kerkvliet, 2006).

Fask, Englander, and Wang (2014) concluded that cheaters are present in any format of learning, whether conventional or online. Their research admitted that asking students to self-report the extent to which they cheat causes problems with the validity of the results. Ladyshewsky (2014) found that unsupervised exams can be delivered within the correct framework and that the fears concerning cheating on these exams may not be as overwhelming as was first suspected. Cheating is assumed in the online environment, but does the cheating hurt the student in the proctored exam setting? The research seems to indicate a mixed message whether cheating is done in the online learning environment in a way that benefits the student. Further research is needed to comprehend this issue completely.

Proctored assessments can take on two forms. First, the students may be asked to complete an assessment with a deemed credible person in a face-to-face setting. The second form may include the student using a remote proctoring service in which the student completes the assessments in the presence of a remote proctor or through video recording. Proctoring has become a best practice in online courses because most educators feel that cheating is more prevalent in the online setting than in the traditional brick and mortar learning environment. Educators in general believe that when assessments are completed online, students will exhibit more cheating behavior than their peers who must complete their assessments in a proctored setting (Kennedy, Nowak, Raghuraman, Thomas, & Davis, 2000). While this information is difficult to validate, it is important to note the results of research in this arena.

Because cheating in the online learning environment is many times detected by surveys which ask students to self-report, there have been mixed results. While some studies such as Fask, Englander, and Wang, (2015) have reported cheating, others such as Greenberg, Lester, Evans, Williams, Hacker, and Halic (2009), have indicated no cheating was present. When compared with students in the brick and mortar learning environment, over 70% of students say that they have received questions and answers from a student who took the same class in the past as well as saving questions and answers to help another student in the future (Moberg, Sojka, & Gupta, 2008). Miller and Young-Jones (2012) reported that students admitted that cheating in an online learning environment was easier. However, this study was criticized because it was based on data collected through survey only.

The most commonly reported challenge in distance education is how to maintain academic integrity. The Higher Education Opportunity Act (HEOA) of 2008 requires institutions to design ways and develop plans to reduce cheating as a way to maintain academic

integrity. One step of this process is to confirm student identification before conducting an assessment online. Primarily this is done using a username and password which allows access to the learning management system in the online setting. However, with proctored assessments, the student is required to provide identification usually through a government issued identification card. Accredited institutions must adhere to the standards of accrediting agencies, such as the Southern Association of Colleges and Schools (SACS), which mandates that courses offered online must maintain the "integrity of student work and the credibility of degrees and credits" (McGee, 2013, p. 1).

One option to uphold academic integrity is to offer proctored exams. Exams can be proctored in a variety of ways including: (a) testing in-person, (b) requiring students to physically attend a testing session at the institution or an approved testing site apart from the institution, or (c) utilizing online real-time proctor services. These real-time proctor services require the use of a webcam throughout the duration of the testing session to ensure that a student is not cheating. Companies such as ProctorU have contracted with schools to provide real-time, online proctoring services. Beck (2014) stated that validating identification was a key factor in limiting cheating with online testing. Research by Milone, Cortese, Balestrieri, and Pittenger (2017) found that the use of online proctoring services such as ProctorU did influence the educational experience for the student.

High student enrollment is common in online distance education courses. The purpose is to maximize the accessibility of the instructor to as many students as feasibly possible. In order to manage the workload associated with a high enrollment, institutions and instructors feel obligated to use multiple-choice exams. Harmon, Lambrinos, and Buffolino (2010) found that 46% of students felt that students cheated regardless of proctoring when given a multiple-choice

exam. Gikani (2013) claimed that online courses continue to use the same assessment tools that face-to-face courses use to assess student learning. He further concluded that these assessment tools focus on the lower levels of learning in Bloom's taxonomy. Speck (2002) explained that these tools cannot assess the higher-order thinking skills of evaluation and synthesis. These lower level assessments are easier for students to cheat on than an assessment tool that strives to assess higher-order thinking skills.

To assess these thinking skills, standardized testing originated in the early twentieth century when the College Entrance Examination Board, later renamed the Scholastic Aptitude Test (SAT), was first offered to students (Jacobsen, 2013). The SAT was first offered as a benchmark to determine whether students should be admitted into a particular college. In stark contrast, the federal government began to advocate the administration of achievement tests in public schools as a way to evaluate specific instructional methods in use (Alcocer, & NEA, n.d.). In 2001, the revolutionary No Child Left Behind (NCLB) act mandated that all states be required to use standardized testing as a means of evaluating school performance. While each state gives their version of an achievement test, schools are evaluated on the performance of their students. Students are generally tested in math and reading each year beginning in third grade. In an elaborate process, data from standardized testing is used to determine whether a school has met Adequate Yearly Progress (AYP). Failing to meet AYP could lead to restructuring of the school or even a redistribution of students to nearby schools that have met AYP.

Another application of standardized testing is to collect data and assess a school's administration and teacher effectiveness. Because a student's performance on a subject exam such as reading can be linked to the teacher who teaches that subject in a particular grade level, teacher performance is evaluated at a district and school level. Much debate centers on using

standardized testing data in this manner because many factors could affect the performance of students, including test anxiety and past performance. In addition to this, NCLB required that schools be held accountable for the performance of students in all subgroups, i.e. students with low socio-economic status, minorities, and special education. The performance of these subgroups on standardized tests has historically been low. Thus, the emphasis on the performance of these students has caused many districts and schools to rethink the instruction and resources that are provided to these students.

Virtual Schools and K-12 Education

A virtual school is defined as a school that delivers curriculum through an online format and is accredited (Barbour & Reeves, 2009). In order to allow easier access to education for all learners, institutions first offered correspondence classes, and then classes over the internet to eliminate the barriers of time and space to reach a student population outside the traditional setting. However, these classes are primarily offered to adults seeking to further their education while continuing to raise a family and pursue their career. Because of this, the workplace underwent change as more employees were able to gain access to higher education. In 1993, districts in California began to offer online programs for students. These programs were organized at the district level and sought to supplement the current classes offered in the brick and mortar setting.

The following year, CalCampus introduced the concept of a complete online curriculum. In this, schools are able to eliminate the need for students to be in close proximity to the school in order to take classes that are offered. This was the first opportunity for secondary students to receive all instruction delivered in a virtual setting instead of in combination with a brick and mortar classroom. Further progress was made when the Utah eSchool opened in the 1994-95

school year for students to attend full time. Also, the Florida Virtual School and the Virtual School Global Consortium began accepting students for enrollment in the 1996-97 school year.

Picciano and Seaman (2010) suggest the five most common reasons schools are currently offering online courses are defined as: (a) meeting the needs of specific groups of students, (b) offering courses not otherwise available, (c) offering advanced placement or college level courses, (d) permitting students who failed a course to take it again, and (e) reducing scheduling conflicts for students. In addition to this, parents have sought to find an alternative way to educate their children. Currently, students can enroll full-time with schools and complete their required coursework for a standard high school diploma in their state at a fully virtual school. Parents also seek out virtual schools out of concern for their child's safety. With the recent influx of school shootings, parents feel the urgency to find a safe schooling option for their student without compromising the quality. Online school provides the opportunity for children to engage with other students in a safe environment.

The addition of virtual schools to compete for students with the traditional brick and mortar schools has changed the face of secondary education in the United States. According to the International Association for Online K-12 Learning (2012), approximately 1.8 million students were enrolled in a distance education course by 2009-2010 while an additional 200,000 students were enrolled in a completely virtual school the same year. The online learning initiative in America received a large boost in 2009 when President Obama pledged $500 million to fund online courses and materials.

Virtual learning is required for many students. For these students, their state education agency has mandated that all students seeking a high school diploma must experience at least one class through a virtual learning environment. The first state to require virtual learning as a

component for graduation was Michigan in 2006 (Marrotte-Newman, 2009). As of 2014, five states required virtual learning as a part of graduation requirements, which speaks to the importance of virtual learning in the United States (Watson, Pape, Murin, Gemin, & Vashaw, 2015). It is difficult to say whether this trend will continue to include more states. Much of the success of virtual learning at the secondary level hinges upon further research in the field. This research will also help to educate administrators, teachers, and families on virtual learning's benefits and challenges.

For-profit corporations have also joined the virtual education landscape, meaning that several corporations have designed curriculum and contracted with local school districts to provide curriculum for virtual public high schools. In 2005, private company K-12, Inc. reported that thirteen states had purchased their curriculum to serve their distance education needs for students (Gartner, 2004). Just ten years later, the Evergreen Education Group's annual 2015 report, "Keeping Pace with K–12 Digital Learning," reported that 31 states had completely virtual high schools in their state. In 25 of these states, the virtual schools function as charter schools (Watson, Pape, Gemin, & Vashaw, 2015).

In the 2009-2010 school year, fully virtual schools served approximately 450,000 students (Ferdig & Kennedy, 2014). According to Watson et al. (2015), 46% of students enrolled in virtual schools are in grades 9-12, 28% of students are enrolled in grades 6-8, and 26% are in grades K-5. These figures speak to the growing popularity of virtual schools as a viable learning option for students. In addition, states are making strides to remove the barriers that would prohibit students from enrolling. In the case of charter virtual public schools, students must reside within the state where the sponsoring school exists. Because it is a public

school, students can attend the virtual school for free. Students attending the virtual school can earn a standard high school diploma in the state where the sponsoring school district resides.

These virtual schools have raised questions in the minds of administrators as well as researchers. Should virtual schools be held to the same standards as brick and mortar schools? Do they present more difficult challenges than the traditional school? If so, how much of these differences can be attributed to the learning platform? Administrators and teachers in both types of schools have questions. Pennucci (2016) found that superintendents in Pennsylvania had questions about policy regarding online schools. Three issues were identified: "who is responsible for handling truancy, the type of student that is transferring, regular education students being diagnosed as special education … (Pennucci, 2016)". Only with further research can these issues be resolved.

Virtual School as a Learning Program

Other studies have investigated aspects of the growing learning program that is virtual schools. Montgomery (2014) investigated the relationship between students labeled as socio-economically disadvantaged in South Carolina. In her research, she compared those who attended a fully online school and other socio-economically disadvantaged students who attended a brick and mortar school. In the study, no statistical difference in the test scores was found between the two groups of students.

Cavanaugh, Barbour, and Clark (2009) indicated that much research with regard to virtual schools focuses on administrative issues while little research has been done with regard to the performance of students in virtual schools. Philipp (2014) looked at the performance of students in a virtual school in the state of Georgia. In the correlation study, Philipp focused on

the relationship between course grades that were assigned by the teacher and the performance of students on the standardized tests in five core end-of-course exams.

In a study like this one, Wrenn (2016) found that there was no statistical difference between the traditional and online students based on the standardized North Carolina End-of-Course exam scores. In this study, the researcher deemed that online instructional practices were just as effective as instructional models found in the traditional classroom. Also, Chancey (2017) discovered that there was no statistical relationship between math scores and a specific delivery of curriculum - traditional, blended, or fully online. In the same study, similar results were found regarding reading scores in that there was no statistical relationship between the scores and the delivery method of the curriculum.

Another breakthrough came in 2004 as research into online learning environments continued. Cavanaugh, Gillan, Kromrey, Hess, Blomeyer, and Learning Point Associates / North Central Regional Educational Laboratory (2004) explored the effectiveness of distance learning for K-12 students. Upon analyzing 14 different studies, they found that distance learning can be as effective as brick and mortar classroom learning. The study concluded that "policy-makers and practitioners should continue to move forward in developing and implementing K-12 distance education programs when those programs meet identified needs and when they are designed and managed as carefully as traditional education programs" (Cavanaugh et al., 2004, p. 23). This study confirms what proponents of virtual schooling have previously claimed, that the education a student receives in a virtual school is comparable to the education a student might receive in a brick and mortar school.

Harris-Packer and Ségol (2015) explored the instruction in online delivery systems in 10 states to determine how virtual instruction affected student achievement, as measured by the

percent of K-12 students proficient in mathematics and reading. While some virtual schools appeared to achieve results at or above the results of brick and mortar schools, the 10 states in the study did not show evidence that online students performed greater than the students in a traditional setting (Harris-Packer & Ségol, 2015).

In the United States, people often hide their inadequate reading skills as it is considered a societal faux pas. Approximately 15% of the world's population fall into this category of not being able to read or write (Odekon, 2015). However, individuals proudly proclaim their lack of mathematical skills. A numerate person has more than just mathematical skills; instead, they can analyze a situation and apply the appropriate knowledge in its context (Willis, 1998). This has pushed administrators and teachers to make every effort to improve math instruction in schools. To elevate the levels of numeracy in students, teachers and schools have used various interventions and resources.

According to Doig (2001), "every reported program and strategy implemented to improve numeracy teaching and learning reports at least some success (p. 31)." Success in math hinges on moving from the concrete concepts to the abstract. For example, students are generally taught computational mathematics at the beginning of the school experience. This often involves the four basic operations, addition, subtraction, multiplication, and division. Then, a conceptual understanding is deepened as students begin to link a new concept with a previous concept (Miller & Hudson, 2007). For instance, a student understands that addition and subtraction are inverse operations. A procedural understanding of mathematics is often developed next as a student hones the ability to solve a mathematical problem following a step-by-step procedure (Bottge, 2001). Both a conceptual and procedural understanding are required in order to improve math understanding among students but especially students experiencing difficulties in math

(Schneider, Rittle-Johnson, & Star, 2011). By having a working knowledge of these levels of understanding, teachers can address deficiencies by working with students to fill gaps in understanding.

Students often struggle to develop a conceptual understanding of mathematical concepts when those concepts are taught with abstract mathematical symbols such as variables (McNeil and Alibali, 2000). However, the use of these symbols is an important component of learning math and should not be avoided. Many students struggle to grasp abstract concepts in math because it requires visualization and more than just a procedural level of understanding of a concept. In the virtual classroom, this problem is extenuated as the concrete nature of the brick and mortar teaching environment has now moved to a disconnected mode of delivery. This intuitively places the already abstract concepts of a mathematics class even further out of reach.

Because online education is an ever-changing field due to its infancy, the challenge of delivering meaningful curriculum while engaging students is a reality across all subjects in virtual schools. Even the mode of delivery, the internet, changes rapidly due to concerns over privacy, security, protection of intellectual material, and the introduction of new applications. In response, the internet's shifting climate makes it difficult to settle on an instructional method for the online classroom. Ten years ago, online schooling did not incorporate as much of the personalization that it does now. Now, schools and teachers are challenged to provide an individualized curriculum that is both relevant and engaging for each student.

With math in particular, teachers face many challenges with helping students to visualize the concrete examples. Often, math curriculum is most effective through demonstration and video. However, to be effective, students either must attend the virtual demonstration synchronously with the teacher or view a recording. This optional attendance component gives

students the opportunity to miss out on meaningful instruction that help most brick and mortar classroom students. According to Francescucci and Foster (2013), a synchronous component of distance education was found to increase the level of perceived instruction among students. There are many forms of synchronous interactions, such as video conferencing and instant messaging (Martin & Parker, 2014). Cao, Griffin, and Bai (2009) found that when synchronous interaction was made during a virtual course, student satisfaction increased. In addition, synchronous interaction has been shown to help students stay on task, feel more connected to the teacher and other students in the class, and increase completion rates (Hrastinski, 2010, Skylar, 2009; You, 2007).

In the secondary setting, virtual schools are bound to the same standards for intervention as brick and mortar school. Response to Intervention (RTI) programs exist at both brick and mortar schools and virtual schools to help students at-risk of failure for all subjects. These interventions are more effective at a brick and mortar school because students can be required to utilize these resources through face-to-face interactions. However, when attending a virtual school, students have interventions available to them but must choose to engage with them. The systems in place at a virtual school, as well as the distance component of the delivery, provide a setting where students can opt out of using the prescribed interventions. In this, students at a virtual school have more free-will, which often results in not utilizing the intervention made available and thus hindering their performance.

Virtual schools recently have reported weak performance in math. Studies by Woodworth, Raymond, Chirbas, Gonzalez, Negassi, Snow, and Van Donge (2015) and Ahn (2017) have reported a lower average on state test scores by virtual students when compared to their peers in brick and mortar schools. Virtual schools as a whole do not generally perform well

on state assessments. For example, the number of virtual schools which receive an acceptable rating has increased from 33% to 41% over a three-year period (Barbour, 2015).

Summary

Modern education offers multiple options for students of all abilities and ages. Among these options, traditional public schools, private schools, and online schools each provide students with the opportunity to choose a schooling environment that addresses their specific learning needs. Online schools, specifically, provide opportunities for students who cannot attend traditional schools for reasons such as illness or geographical limitations. In the early stages of development, distance education began with limited enrollment. In its infancy, distance education's participants included males from affluent backgrounds but has since expanded to include minorities, women, and those with disabilities. Distance education has now been extended to include high school students with demanding schedules who pursue athletic and other professional endeavors.

Beginning with the postal service as its main delivery platform, distance education courses were delivered to students through the standard mail service but have since evolved to interactive software which is used to engage students while adapting the curriculum they encounter to meet their specific needs. In the early stages of development, the curriculum development process for online courses began at the institution level and changed very little while the student interacted with the course. Initially, assessments focused heavily on reading and writing. Synchronous components were added to online courses to foster community building and accessibility to the instructor. The use of adaptive software has made teaching math more conducive to the online learning platform.

With any new format of learning, educators and administrators face challenges. Cheating is just one of these challenges that online educators face to maintain academic integrity. To combat this issue, proctored exams are often implemented as well as the requirement of student identification before curriculum materials can be accessed.

CHAPTER THREE: METHODS

Overview

Chapter Three will explain the methods and design of this study. While describing the participants for the study, further details will be provided for why these participants were included. In addition to this, descriptions will be provided for the collection of data and the statistical analysis which is planned for the data once it is collected.

Design

This study will use a causal-comparative design of quantitative data in order to determine if there is a difference between scores on the State of Texas Assessment of Academic Readiness Algebra I End-of-Course Exam for students in Algebra 1 while attending a full time virtual high school and those of students attending a brick and mortar school in Texas. In addition, the study will also seek to determine if there is a difference between scores on the State of Texas Assessment of Academic Readiness Algebra I End-of-Course Exam for males versus females in Algebra 1 while attending a full time virtual high school for one school year and those attending a brick and mortar high school for one school year in Texas. No experiment will be conducted for this study, but the study will be conducted ex-post facto. This study strives to answer three research questions.

Research Questions

The first research question of the study is to determine whether there is a difference between the scores in Algebra 1 End of Course Exam at the ninth-grade level between the two types of full time schools, both virtual and brick and mortar. Data will be collected from a database of standardized test data on the Texas Education Agency (TEA) website for ninth grade first time testers at a large urban high school in the state of Texas taking the STAAR Algebra I

EOC in the 2018 spring administration as well as all ninth grade first time testers taking the STAAR Algebra I EOC while attending a full time virtual high school. The data will be downloaded from the TEA website and uploaded into the SPSS statistical software program for study.

RQ1: Is there a difference between high school students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for Algebra 1 after attending a virtual high school for the previous school year as compared to those students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a brick and mortar high school for the previous school year?

RQ2: Is there a difference between the performance of high school males on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a virtual high school for the previous school year as compared to those males' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a brick and mortar high school for the previous school year?

RQ3: Is there a difference between the performance of high school females on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a virtual high school for the previous school year as compared to those females' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a brick and mortar high school for the previous school year?

Hypotheses

The null hypotheses for this study are:

$H_0$1: There is no statistically significant difference between high school students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for

Algebra 1 after attending a virtual high school for the previous school year as compared to those students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a brick and mortar high school for the previous school year as shown by analysis of covariance.

H_02: There is no statistically significant difference between the performance of high school males on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a virtual high school for the previous school year as compared to those males' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a brick and mortar high school for the previous school year as shown by analysis of covariance.

H03: There is no statistically significant difference between the performance of high school females on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a virtual high school for the previous school year as compared to those females' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for after attending a brick and mortar high school for the previous school year as shown by analysis of covariance.

Participants and Setting

The participants for the study will be drawn from a convenience sample of ninth grade student who attended a virtual public high school located in the state of Texas during the 2017–2018 school year. These students will be taking the End of Course Algebra 1 exam for the first time. The school district will be an urban school located in southeastern Texas. Because the school is virtual, students can choose to enroll with the school district if they reside in the state of Texas while remaining geographically across the state of Texas. Data will be collected after the

school year from the school district. The number of participants from this sample will be 700 which again exceeds the required minimum for a medium effect size. In addition, participants will also be drawn from a convenience sample of ninth grade students who attended a traditional brick and mortar high school located in the southeast portion of Texas. The high school has approximately 2000 students. Data will be collected for the students who are in ninth grade and attempting the STAAR Algebra 1 EOC for the first time. The number of participants from this sample will be 400.

Instrumentation

The data for student performance on the STAAR EOC exams for Texas high schools from the spring 2018 administration will be recorded from the Texas Education Agency Report Card and organized by student performance on the Algebra 1 EOC exam. According to Zucker (2003), "criterion-referenced tests are intended to measure a level of mastery according to a specific set of performance standards" (p. 6). The STAAR EOC exams for Texas are criterion-referenced tests. The purpose of the STAAR EOC exam is to measure how well students understand the stated objectives of the Texas Essential Knowledge and Skills. Scores are typically reported as a raw score representing the number of questions answered correctly as well as a scaled score. The scale score is based on the raw score which assessed reporting categories. The five reporting categories for Algebra 1 are: (1) Number and Algebraic Methods, (2) Describing and Graphing Linear Functions, Equations, and Inequalities, (3) Writing and Solving Linear Functions, Equations, and Inequalities, (4) Quadratic Functions and Equations, and (5) Exponential Functions and Equations (Texas Education Agency, 2014).

The instrument was developed by the state of Texas, which has deemed the instrument to be reliable. The Texas Education Agency reported the reliability of all exams in its State of

Texas Assessment of Academic Readiness to be between 0.79 and 0.91 (Human Resources Research Organization, 2016). Both the Texas Education Agency and the federal government credit the exam as being valid and reliability as a tool to determine the Annual Yearly Progress status. The state of Texas refers to validity as "the legitimacy or acceptability of the interpretation and use of ascribed test scores" and reliability as "the repeatability of test scores" (Human Resources Research Organization, 2016)

Procedures

The researcher will request data from the school district for each of the two high schools. Student identifying information will be removed by the school district before sending it to the researcher. The data will then be disaggregated to separate the data for virtual high schools only and brick and mortar high schools only. This separation will create two groups of data gleaned from the data for all schools and this data will be used to determine if there was any statistically significant difference between students' performance on a state assessment after attending a virtual high school as compared to those students' performance on a state assessment in math after attending a brick and mortar high school.

Data Analysis

The researcher will use Microsoft Excel and the statistics software program SPSS to analyze the data in this quantitative study. Descriptive statistics will be used to determine measures of central tendency including mean, minimum and maximum scores, and standard deviation for both samples. Independent *t*-tests will be performed to determine the difference in the means of the scores of the brick and mortar students and the online students. Independent *t*-tests will be calculated to determine if there is a statistically significant difference at the $p < .05$ level in the scores on the State of Texas Assessment of Academic Readiness End of Course

Exam in Algebra between students who attend a brick and mortar high school and students who attend a virtual high school.

Summary

Chapter Three outlined the methodology used to perform this quantitative study including detailed descriptions of the participants, instruments, and procedures used. Demographic data for the participants, validity and reliability data for the instruments, as well as procedures for collecting data were also explained. Finally, the procedures for conducting the study were detailed.

CHAPTER FOUR: FINDINGS

Overview

This chapter details the results of the analysis, which were compiled using SPSS version 22 for the causal-comparative study to determine if there is a statistically significant difference between the performance of students on the State of Texas Assessment of Academic Readiness (STAAR) End-of-Course Exam for Algebra 1 during the 2017–2018 school year. The independent variable in this study was the learning environment, a traditional brick and mortar classroom versus a completely virtual classroom. The dependent variable, which was affected by the learning environment, was the score on the state assessment. The research questions and null hypotheses were designed to determine whether there was a statistically significant difference in the performance of students who attend a brick and mortar, traditional high school and their peers who attend a virtual high school.

Research Questions

RQ1: Is there a difference between high school students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for Algebra 1 after attending a virtual high school for the previous school year as compared to those students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year?

RQ2: Is there a difference between the performance of high school males on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to males' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year?

RQ3: Is there a difference between the performance of high school females on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to females' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year?

Null Hypotheses

$H_0$1: There is no statistically significant difference between high school students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for Algebra 1 after attending a virtual high school for the previous school year as compared to those students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year.

$H_0$2: There is no statistically significant difference between the performance of high school males on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to males' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year.

$H_0$3: There is no statistically significant difference between the performance of high school females on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to females' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year.

Descriptive Statistics

A total of 1087 scores were analyzed for students who completed the STAAR End-of-Course Exam in Algebra 1. Scores from 1087 students were included of which 368 were from students who attended a traditional, brick and mortar high school (n = 368, M = 3927, SD = 416) while 719 were students who attended a virtual high school (n = 719, M = 3802, SD = 455). See Table 1.

Table 1

Descriptive Statistics on STAAR Algebra 1 End-of-Course Exam Student Outcomes

	Sample Size	Mean	Standard Deviation
Traditional	368	3927	416
Online	719	3802	455

In the whole sample, the gender was 57% female (n = 643) and 43% male (n = 494). For students attending the traditional high school, the gender distribution was 48% female (traditional female n = 176) and 52% male (traditional male n = 192). In contrast, the gender of online students was 60% female (online female n = 432) and 40% male (online male n = 287).

Students who take the STAAR Algebra 1 End-of-Course Exam receive a scaled score based on the number of questions answered correctly. These scaled scores then place students in one of four categories to denote proficiency of the test objectives – did not meet standards, approaches standards, meets standards, and masters standards. For students whose scaled score places them in the did not meet standards category, their performance indicates that they are unlikely to be successful in the next grade level without ongoing intervention. Students who score into this category are considered as not passing. The approaches standards category

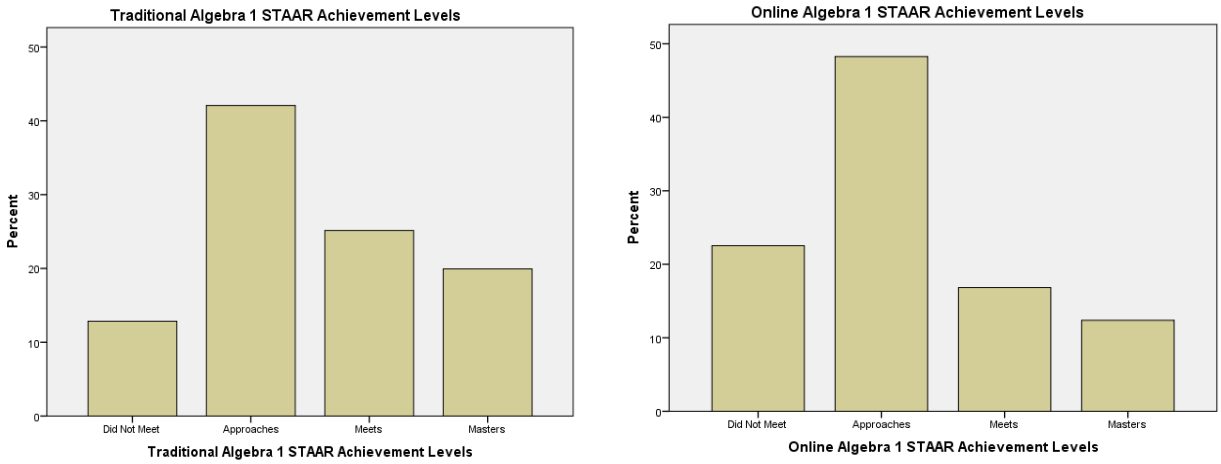
indicates that the students can be successful in the next grade if they receive targeted intervention and support. This category is considered to have passed the exam. The third category, meets standards, includes students who are likely to be successful in the next grade level, but who may need short-term academic support. These students also have received a passing score on the exam. The final category, masters standards, contains students who are expected to successfully complete the next grade level with little to no academic support. Table 2 shows the scale scores required for each of the four categories for the spring 2018 administration of the STAAR Algebra 1 End-of-Course Exam. Figure 1 shows the STAAR achievement levels for both the online students and the students of the traditional high school in this study.

Table 2

Subject	Did Not Meet	Approaches	Meets	Masters
Algebra I EOC 2018 Spring	< 3499	3500 – 3999	4000 – 4299	> 4300

Figure 1

Achievement Levels for Traditional and Online Student Performance on Algebra 1 End-of-Course Exam



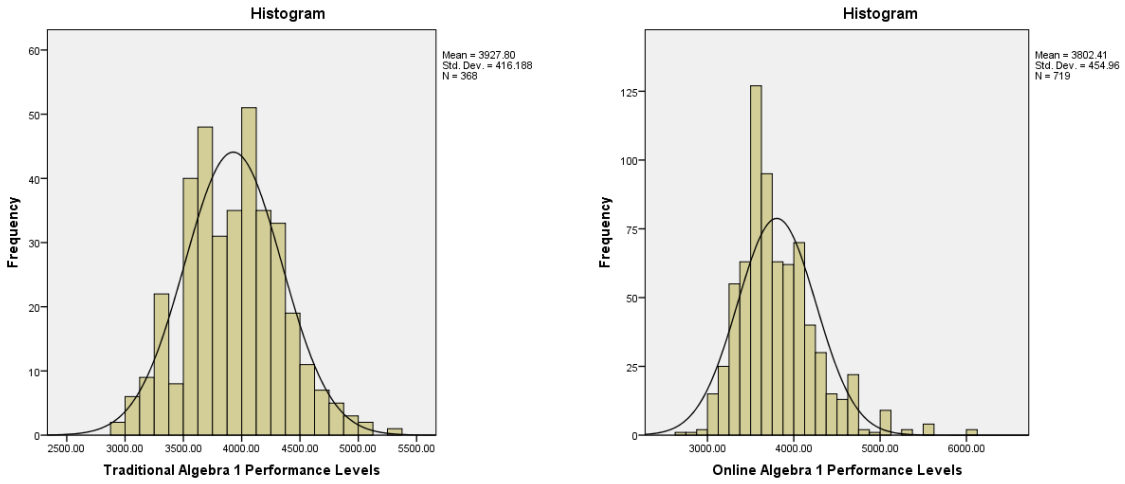
Assumption Testing

For testing Null Hypothesis $H_0$1, Levene's Test of Equality of Variance was used to satisfy the assumption of homogeneity of variance. The variance of the two populations are assumed to be approximately equal based on the results of Levene's Test, $F(1085) = 0.425$, $p = 0.515$ since the significance is not less than 0.05. Because of these results, standard *t*-tests results were used.

With the use of histograms, normality was tested. The scores for the traditional students on the Algebra 1 End-of-Course Exam were found within the normal, bell shaped curve (see Figure 1). Normality assumption is satisfied. Likewise, the scores of the online students fell within the normal, bell shaped curve. Therefore, the normality requirement was satisfied for this group as well.

Figure 1

Histograms for Traditional and Online Student Performance on Algebra 1 End-of-Course Exam



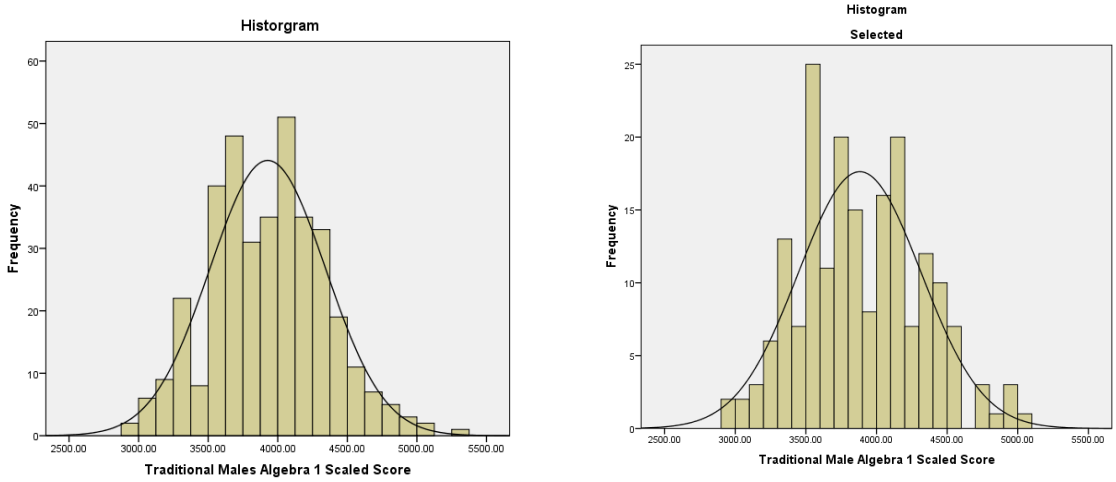
Levene's Test of Equality of Variance was again used to satisfy the assumption of homogeneity of variance for the male students in each population. Considering only the male students, the variance of the two populations are assumed to be approximately equal based on the

results of Levene's Test, $F(477) = 0.159$, $p = .690$. The assumption of homogeneity of variance is satisfied since the significance is not less than .05, and the results of an independent *t*-test are used.

Normality was tested with histograms. The scores for the male students who attended a traditional high school lie within the normal, bell-shaped curve (see Figure 2).

Figure 2

Histograms for Traditional and Online Male Student Performance on Algebra 1 End-of-Course Exam

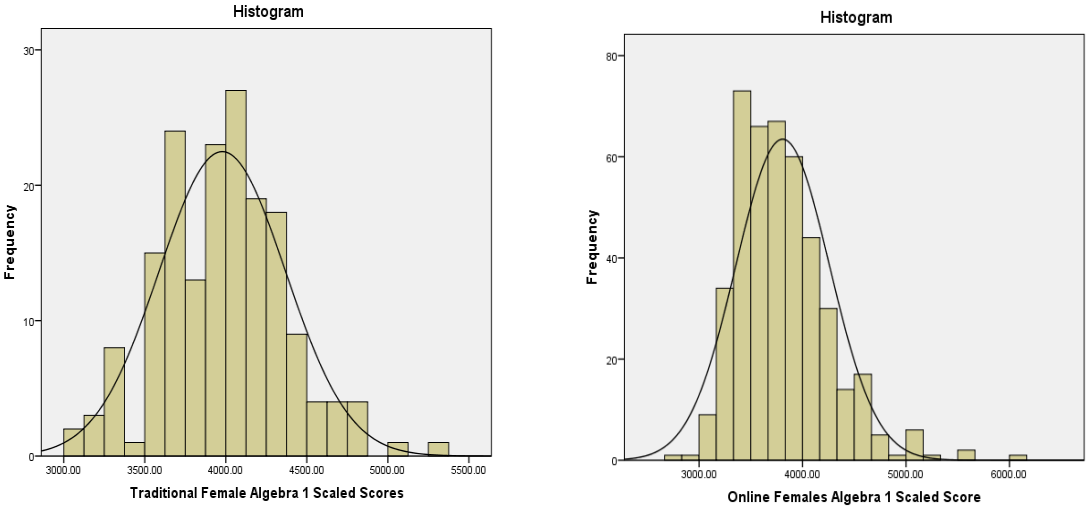


Levene's Test of Equality of Variance was again used to satisfy the assumption of homogeneity of variance for the female students in each population. Considering only the female students, the variance of the two populations are assumed to be approximately equal based on the results of Levene's Test, $F(606) = 2.706$, $p = .100$.

Normality was tested with histograms. The scores of the females who attended a traditional high school fell within the normal, bell shaped curve (see Figure 3).

Figure 3

Histograms for Traditional and Online Female Student Performance on Algebra 1 End-of-Course Exam



Results

Null Hypothesis $H_0 1$

There is no statistically significant difference between high school students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for Algebra 1 after attending a virtual high school for the previous school year as compared to those students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year.

An independent sample *t*-test was conducted to determine if there was a statistically significant difference between the mean of the Algebra 1 scores for the virtual and brick and mortar high schools on the State of Texas Assessment of Academic Readiness End-of-Course Exam.

Hypothesis Testing $H_0$1

The independent sample *t*-test determined that there is a statistically significant difference between the means of student scores on the STAAR End-of-Course Exam in Algebra 1 between the students who attend a traditional high school (n = 368, M = 3927, SD = 416) and those students who attend a virtual high school (n = 719, M = 3802, SD = 455). The p level was less than .05; therefore, the researcher can reject the null hypothesis.

Table 3

$H_0$1 Independent Sample *t*-test

		Levene's Test for Equality of Variances		*t*-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Algebra I Scaled Score	Equal variances assumed	.425	.515	4.424	1085	.000011	125.39008	28.34463	69.77358	181.00657
	Equal variance not assumed			4.553	800.213	.000006	125.39008	27.54216	71.32665	179.45350

Null Hypothesis $H_0$2

There is no statistically significant difference between the performance of high school males on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to males' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year.

An independent sample *t*-test was conducted to determine if there was a statistically significant difference between the mean of the Algebra 1 scores for the male students who attended virtual and brick and mortar high schools on the State of Texas Assessment of Academic Readiness End-of-Course Exam.

Hypothesis Testing $H_0$2

The independent sample *t*-test determined that there is a statistically significant difference between the means of male student scores on the STAAR End-of-Course Exam in Algebra 1 between the students who attend a traditional high school (n = 192, M = 3881, SD = 434) and those students who attend a virtual high school (n = 287, M = 3794, SD = 459). The p level was less than .05; therefore, the researcher rejected the null hypothesis.

Table 4

$H_0$2 Independent Sample *t*-test

		Levene's Test for Equality of Variances		*t*-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Algebra I Scaled Score	Equal variances assumed	.159	.690	2.082	477	.038	87.27610	41.92013	4.90516	169.64703
	Equal variance not assumed			2.105	424.819	.036	87.27610	41.45917	5.78546	168.76674

Null Hypothesis $H_0$3

There is no statistically significant difference between the performance of high school females on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to females' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year.

An independent *t*-test was used to determine whether a statistically significant difference existed between the performance of high school females who attended a traditional high school

and those who attended a virtual high school on the State of Texas Assessment of Academic Readiness Algebra 1 End-of-Course Exam.

Hypothesis Testing $H_0$3

The independent sample *t*-test determined that there is a statistically significant difference between the means of female student scores on the STAAR End-of-Course Exam in Algebra 1 between the students who attend a traditional high school (n = 176, M = 3978, SD = 390) and those students who attend a virtual high school (n = 432, M = 3807, SD = 452). The p level was less than .05; therefore, the researcher rejected the null hypothesis.

Table 5

$H_0$3 Independent Sample *t*-test

		Levene's Test for Equality of Variances		*t*-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Algebra I Scaled Score	Equal variances assumed	2.706	.100	4.375	606	.000014	170.34806	38.93431	93.88550	246.81063
	Equal variance not assumed			4.655	373.622	.000005	170.34806	36.59515	98.38979	242.30634

Summary

Chapter Four provided a detailed report of the statistical processes and results used to analyze the data and evaluate the null hypotheses for this study. Statistical calculations and analysis were conducted using SPSS Version 22. The researcher found a statistically significant difference between the performance of students on the State of Texas Assessment of Academic Readiness who had attended a traditional, brick and mortar high school versus their peers who attended a virtual high school. The researcher rejected null hypothesis one as evidence was found to validate a statistically significant difference in the scaled scores of students who attended the traditional high school and students who attended the virtual high school.

In addition, evidence was found to solidify a statistically significant difference in the scaled scores of male students who attended a traditional high school and male students who attended a virtual high school. The research rejected null hypothesis two.

Furthermore, the researcher rejected null hypothesis three because evidence was found to confirm a statistically significant difference between the performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam in Algebra 1 of female students who attended a traditional high school versus their female peers who attended a virtual high school.

CHAPTER FIVE: CONCLUSION

Overview

This chapter serves to summarize the outcomes of the study and discern how its results are applicable. While the overarching goal of this study was to examine the difference in student performance between traditional and online school, the differentiation between male and female student performance was also observed and included in the results. Lastly, this chapter seeks to discuss several implications of this study in education that could help many educators who are continuing to seek out new ways to improve both in traditional school and in its online counterpart.

Discussion

The purpose of this study was three-fold. First, this study sought to provide analysis of student performance data with both the traditional school setting as well as the online learning environment for secondary level students. Secondly, this study sought to add to the research available for online students at the secondary level. Thirdly, this study wanted to equip administrators, teachers, parents, and other stakeholders with the research to make informed decisions to benefit student learning. With the growth of online learning opportunities for students of all ages, the types of schools offering (whether wholly or in part) some component of virtual learning include charter schools, hybrid programs, and traditional schools. Many students have come to require at least one online class for graduation.

Online learning has grown exponentially. However, it has struggled to erase the initial perceptions that stakeholders have had regarding comparable learning and student performance outcomes of the traditional schooling method in a brick and mortar setting. Allen and Seaman (2013) found that 23% of leaders in academic settings felt online instruction was inferior to

instruction delivered in a traditional, brick and mortar environment. In addition, traditionally trained teachers must be trained to meet the challenges of the online environment with students who are not geographically present with them as they were in the past. Attention, likewise, must be given to curriculum design and adaptive resources to meet the unique challenges of students.

It is important to note that students who enroll with a publicly funded online school at the K-12 level are held to the learning outcome standards as their peers in the traditional school setting. With this in mind, this study proposed to provide further research to aid administrators, teachers, and stakeholders to make decisions on how to improve student learning as well as performance on the compulsory state exams. Specifically, this study was designed to determine if the public online high school and the traditional public high school were equitable in student performance. This equity was defined by student performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam in Algebra 1.

Null Hypotheses

Null Hypothesis $H_0 1$

Null hypothesis one stated, **"**There is no statistically significant difference between high school students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam for Algebra 1 after attending a virtual high school for the previous school year as compared to those students' performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year". There was a significant difference between the means of student scaled scores on the State of Texas Assessment of Academic Readiness End-of-Course Exam for Algebra 1 between the online and traditional high schools, $t(1085) = 4.424$, $p = .000011$. Therefore, the researcher rejected null hypothesis one.

Null Hypothesis $H_0$2

Null hypothesis two stated, “There is no statistically significant difference between the performance of high school males on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to males’ performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year.” A significant difference was found between the means of the student scaled scores on the State of Texas Assessment of Academic Readiness End-of-Course Exam for Algebra 1 between the male students who attended online and traditional high schools, $t(477)= 2.082$, $p = .038$. Therefore, the researcher rejected null hypothesis two.

Null Hypothesis $H_0$3

Null hypothesis three stated, “There is no statistically significant difference between the performance of high school females on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a virtual high school for the previous school year as compared to females’ performance on the State of Texas Assessment of Academic Readiness End-of-Course Exam after attending a brick and mortar high school for the previous school year.” The means of the scaled scores of females students differed significantly on the State of Texas Assessment of Academic Readiness End of Course Exam in Algebra 1 based on the traditional or online learning environment, $t(606)= 4.375$, $p = .000014$.

A study done by Stanford University in 2015 found comparable results with regard to student academic growth in mathematics when comparing the traditional public school with similar students at an online school. This study found that online students had weaker growth in

math overall and estimated that they were 180 days behind in learning when compared to their peers at a traditional public school (Woodworth et al., 2015).

Conclusions

Several conclusions can be made from this study. First, virtual classrooms are not as effective as traditional classrooms with math instruction when viewing student performance of learning objectives. Secondly, significant differences were found between the means of male and female students who attended a traditional public high school and the means of their comparable peers who attended a virtual public high school. These both speak in support of the growing concern for the quality of public online instruction particularly in math as it compares to the quality of instruction found in a traditional public school.

Female students performed slightly better in the traditional classroom than the online classroom. Female students may perform better in learning environments where relationships are fostered, and concepts are communicated in both verbal and written words. Male students also performed better in the traditional classroom. This may be attributed to the structured learning environment provided by the teacher who is in the same geographical location with the student. While each student has unique needs for learning, the researcher concluded that these needs may not be met for all students in the online learning environment.

Implications

The findings of this study support implications for stakeholders in education. First, administrators of virtual schools must strive to provide teachers with the resources to support the individual academic needs of the students in the online learning environment. These academic needs may include adaptive software which can identify gaps in learning as well as prescribe activities to bridge these learning gaps. In the same way, administrators can brainstorm with

teachers to plan actions to support student learning and performance. These actions may need to be different than the actions of teachers in the traditional public school environment as the needs of online students may be different than their peers in the traditional learning environment.

In the same way, online teachers must commit to making decisions based on the data available in the online learning environment to move students towards increased performance. Virtual teachers may need to research and learn proven strategies that will engage online learners. Because pre-service teacher programs train teachers for traditional learning environments, educators may need to seek out additional training on the specific needs and challenges for the online learning environment. Based on the results of this study, parents must realize that the online learning environment is not a good fit for every child. To ensure that the specific needs of their child are met, parents must actively monitor the learning of their child.

Limitations

The limitations of this study stem from the casual-comparative design. While the researcher employed every precaution possible to ensure accurate results, investigations of this nature should be completed using an experimental design. Studies in the K-12 setting should be conducted with random-assignment or controlled-experiment design (Cuban, 2013). However, public high school processes make it difficult to conduct a controlled, randomly assigned study because students and families most often self-select to be in an online class or in a traditional face-to-face class.

Recommendations for Future Research

Given the fact that this study is inevitably not all-encompassing, there are several subdivisions of the topic that are lacking in development. For advancements to be made in this area of research, the following are suggestions for further research.

- Exploration in the effects of different online learning platforms to improve online learning outcomes
- Ways that online learning can be beneficial in other areas, such as technical skills and time management
- Creating educational experiences that form a hybrid of both online and traditional school learning.

These areas of further research will pave the way for the advancement of the educational system, both in online and traditional platforms.

REFERENCES

Ahn, J., & McEachin, A. (2017). Student enrollment patterns and achievement in Ohio's online charter schools. *Educational Researcher, 46*(1), 44–57. https://doi.org/10.3102/0013189X17692999

Alcocer, P., & NEA. (n.d.). History of standardized testing in the United States. Retrieved from http://www.nea.org/home/66139.htm

Allen, I. E., & Seaman, J. (2013). Changing course: Ten years of tracking online education in the United States. Babson Park, MA: Babson Survey Research Group and Quahog Research Group. Retrieved from http://www.onlinelearningsurvey.com/reports/changingcourse.pdf

Barbour, M. K. (2015). Section II: Limited evidence, little guidance: Research to guide virtual school policy. In A. Molnar (ed.). *Virtual Schools in the U.S. 2015: Politics, Performance, Policy, and Research Evidence*. Boulder, CO: National Education Policy Center. Retrieved from https://nepc.colorado.edu/sites/default/files/publications/RB%20Section%20II%20with%20blurb.pdf

Barbour, M. K., & Reeves, T. C. (2009). The reality of virtual schools: A review of the literature. *Computers and Education*, *52*(2), 402–16. https://doi.org/10.1016/j.compedu.2008.09.009

Beck, V. (2014). Testing a model to predict online cheating--Much ado about nothing. *Active Learning in Higher Education, 15*(1), 65–75. https://doi.org/10.1177/1469787413514646

Bottge, B. A. (2001). Reconceptualizing mathematics problem solving for low-achieving students. *Remedial and Special Education*, *22*, 102–112. https://doi.org/10.1177/074193250102200204

Boulton, C. A., Kent, C., & Williams, H. T. (2018). Virtual learning environment engagement and learning outcomes at a 'bricks-and-mortar' university. *Computers & Education*, *126*, 129–142. https://doi.org/10.1016/j.compedu.2018.06.031

Bracey, G. W. (2009). *Education Hell: Rhetoric Vs. Reality*. Alexandria, VA: Educational Resource Service.

Buggey, T. J. (2000). Accommodating students with special needs in the online classroom. *New Directions for Teaching and Learning*, *2000*(84), 41–46. https://doi.org/10.1002/tl.846

Cao, Q., Griffin, T. E., & Bai, X. (2009). The importance of synchronous interaction for student satisfaction with course web sites. *Journal of Information Systems Education*, *20*(3), 331–338. Retrieved from https://pdfs.semanticscholar.org/9816/aa78248dc4b6009acc369a2937b6e79edfed.pdf

Capozzi, D. (1998). *Technology access by citizens with disabilities.* Speech presented at the Microsoft Accessibility Summit. Redmond, WA.

Cavanaugh, C., Gillan, K. J., Kromrey, J., Hess, M., & Blomeyer, R. (2004). The Effects of distance education on K-12 student outcomes: A meta-analysis (Report No. ED489533). Naperville, IL: Learning Point Associates / North Central Regional Educational Laboratory (NCREL). Retrieved from https://pdfs.semanticscholar.org/bf44/876245b9d72f9030cd3ad0119ca87384d91f.pdf?_ga=2.173809188.685128036.1567565941-963047855.1567565941

Cavanaugh, C. S., Barbour, M. K., & Clark, T. (2009). Research and practice in K-12 online learning: A review of open access literature. *The International Review of Research in Open and Distributed Learning, 10*(1). https://doi.org/10.19173/irrodl.v10i1.607

Cavanaugh, C., Repetto, J., & Wayer, N. (2011, August). Virtual schooling for students at risk: Interventions for success. Paper presented at the 27th Annual Conference on Distance Teaching and Learning, Madison, WI. Retrieved from http://www.uwex.edu/disted/conference/Resource_library/search_detail.cfm?presid=46833

Cela, K., Sicilia, M., & Sánchez-Alonso, S. (2016). Influence of learning styles on social structures in online learning environments. *British Journal of Educational Technology.*, *47*(6), 1065–1082. https://doi.org/10.1111/bjet.12267

Colorado Department of Education. (2013a). District accountability handbook. Retrieved from http://www.cde.state.co.us/Accountability/Downloads/DistrictAccountabilityHandbook.pdf

Cuban, L. (2013). Does online instruction work? World Press. Retrieved from http://larrycuban.wordpress.com/2013/06/07/does-online-instruction-work-part-3/

Dick, T. P., & Hollebrands, K. F. (2011). *Focus in high school mathematics: Technology to support reasoning and sense making*. Reston, VA: NCTM.

Dillon, S. (2010). Top test scores from Shanghai stun educators. *New York Times.* Retrieved from https://www.nytimes.com/2010/12/07/education/07education.html

Doig, B. (2001). Summing up: Australian numeracy performances, practices, programs and possibilities. *Aust Council for Ed Research*. Retrieved from

https://research.acer.edu.au/cgi/viewcontent.cgi?article=1000&context=literacy_numeracy_reviews

Dreyer, B. (Spring 2013). Challenges in measuring online school performance. Retrieved from http://www.advanc-ed.org/source/challenges-measuring-online-school-performance

Dynarski, S. M. (2017, October 26). Online schooling: Who is harmed and who is helped? Retrieved from https://www.brookings.edu/research/who-should-take-online-courses/

ESSA (2015). Every Student Succeeds Act of 2015, Pub. L. No 114-95 114 Stat. 1177 (2015–2016).

Every Student Succeeds Act: Federal Elementary and Secondary Education Policy. (2017). *Congressional Digest, 96*(7), 4.

Fask, A., Englander, F., & Wang, Z.. (2014). Do online exams facilitate cheating? An experiment designed to separate possible cheating from the effect of the online test taking environment. *Journal of Academic Ethics, 12*(2), 101–112. https://doi.org/10.1007/s10805-014-9207-1

Fast Facts About Online Learning. (2012). *International Association for Online K-12 Learning*. Retrieved from https://gosa.georgia.gov/sites/gosa.georgia.gov/files/iNACOL_Fast_Facts_About_Online_Learning.pdf

Fernandez, H., Ferdig, R. E., Thompson, L. A., Schottke, K., & Black, E. W. (2016). Students with special health care needs in K-12 virtual schools. *Journal of Educational Technology & Society, 19*(1), 67–75. Retrieved from https://digitalcommons.kent.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1004&context=ldespubs

Florida State Government. (2013). Florida Senate Bill 736-Educational Personnel. Retrieved from http://www.flsenate.gov/Committees/BillSummaries/2011/html/0736ED

Flynn, P., Vermette, P., Mesibov, D. (2013). *Applying standards-based constructivism*. New York, NY: Routledge.

Francescucci, A., & Foster, M. (2013). The VIRI (virtual, interactive, real-time, instructor-led) classroom: The impact of blended synchronous online courses on student performance, engagement, and satisfaction. *Canadian Journal of Higher Education, 43*(3), 78–91. Retrieved from http://journals.sfu.ca/cjhe/index.php/cjhe/article/download/184676/184312

Gall, M., Gall, J., & Borg, W. (2007). *Educational research: An introduction* (8th ed.). Boston, MA: Pearson.

Garrison, D. R., & Shale, D. (1990). A new framework and perspective. D. R. Garrison & D. Shale (Eds.), *Education at a distance: From issues to practice* (pp. 123–133). Malabar, FL: Robert E. Krieger.

Gartner, J. (2004 April, 7). States rethinking virtual school. *Wired*. Retrieved from http://www.wired.com/politics/law/news/2004/04/62889

Gikandi, J. (2013). Synergy between authentic assessment activities and learner autonomy: How does this stimulate shared authenticity in online higher education? *International Journal on ELearning, 12*, 353. Retrieved from https://www.learntechlib.org/primary/p/38555/

Giossos, Y., Koutsouba, M., Lionarakis, A., & Skavantzos, K. (2009). Reconsidering Moore's transactional distance theory. *European Journal of Open Distance and ELearning, 2009*(2), 1–6. Retrieved from http://www.eurodl.org/?article=374

Grijalva, T., Nowell, C., & Kerkvliet, J. (2006). Academic honesty and online courses. *College Student Journal, 40*(1), 180–185. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.5777&rep=rep1&type=pdf

Harkins, A., & Kubik, G. (2010). Ethical cheating in formal education. *On the Horizon, 18*(2), 138–146. http://doi.org/10.1108/10748121011050487

Harmon, O. R., Lambrinos, J., & Buffolino, J. (2010). Assessment design and cheating risk in online instruction. *Online Journal of Distance Learning Administration, 13*(3). Retrieved from http://www.westga.edu/~distance/ojdla/Fall133/harmon_lambrinos_buffolino133.html

Harris-Packer, J. D., & Ségol, G. (2015). An empirical evaluation of distance learning's effectiveness in the K-12 setting. *American Journal of Distance Education, 29*(1), 4–17. https://doi.org/10.1080/08923647.2015.990768

Houst, M., & Elliott, S. W. (Eds.) (2011). *Incentives and test-based accountability in public education. (Panel Report).* Washington, DC: National Research Council.

Hrastinski, S. (2010). How do e-learners participate in synchronous online discussions? evolutionary and social psychological perspectives. *Evolutionary Psychology and Information Systems Research Integrated Series in Information Systems,*119–147. https://doi.org/10.1007/978-1-4419-6139-6_6

Human Resources Research Organization. (2016). *Independent evaluation of the validity and reliability of STAAR. independent valuation of the validity and reliability of STAAR.* Alexandria, VA.

IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

Jacobs, P. (2013). The challenges of online courses for the instructor. *Research in Higher Education Journal*, 1–18. Retrieved from https://digitalcommons.sacredheart.edu/cj_fac/8/

Jacobsen, E. (2013). A (mostly) brief history of the SAT and ACT tests. Retrieved from http://www.erikthered.com/tutor/sat-act-history-printable.html

Kennedy, K., Nowak, S., Raghuraman, R., Thomas, J., & Davis, S. F. (2000). Academic dishonesty and distance learning: Student and faculty views. *College Student Journal, 34*(2), 309–314. Retrieved from https://www.researchgate.net/profile/Kristen_Kennedy2/publication/236158886_Academic_dishonesty_and_distance_learning_Student_and_faculty_views/links/5e875c144585150839bcf476/Academic-dishonesty-and-distance-learning-Student-and-faculty-views.pdf

Ladyshewsky, R. (2015). Post-graduate student performance in 'supervised in-class' vs. 'unsupervised online' multiple choice tests: Implications for cheating and test security. *Assessment & Evaluation in Higher Education, 40*(7). https://doi.org/10.1080/02602938.2014.956683

LaFerrara, M. A. (2013, Summer). The conflict over standardized testing is a consequence of government-run schools. *The Objective Standard, 8*(2), 78+. Retrieved from https://www.theobjectivestandard.com/2013/04/the-conflict-over-standardized-testing-is-a-consequence-of-government-run-schools/

Linn, R. (2001). A century of standardized testing: Controversies and pendulum swings. Educational Assessment, 7, 29–38. https://doi.org/10.1207/S15326977EA0701_4

Marrotte-Newman, S. (2009). Why virtual schools exist and understanding their culture. *Distance Learning, 6*(4), 31–35.

Martin, F., & Parker, M. A. (2014). Use of synchronous virtual classrooms: Why, who, and how? *Journal of Online Learning and Teaching*, *10*(2), 192-n/a. Retrieved from http://jolt.merlot.org/vol10no2/martin_0614.pdf

Mazoue, J. G. (2013). The MOOC model: Challenging traditional education. *EDUCAUSE Review*, 1–9. Retrieved from https://er.educause.edu/articles/2013/1/the-mooc-model-challenging-traditional-education

McGee, P. (2013). Supporting academic honesty in online courses. *Journal of Educators Online*, *10*(1). https://doi.org/10.9743/JEO.2013.1.6

McIsaac, M., & Gunawardena, C. (1996). Distance education. In D. H. Jonassen (Ed.), Handbook of research for educational communications and technology: A project of the Association for Educational Communications and Technology (pp. 403–437). NY: Simon and Schuster.

Mcneil, N. M., & Alibali, M. W. (2000). Learning mathematics from procedural instruction: Externally imposed goals influence what is learned. *Journal of Educational Psychology*, *92*(4), 734–744. https://doi.org/10.1037/0022-0663.92.4.734

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). Evaluation of evidence based practices in online learning: A meta-analysis and review of online learning studies; Retrieved from http://www.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf

Menken, A. P. K. (2008). *English learners left behind: Standardized testing as language policy* (1st ed.). Buffalo, NY. Multilingual Matters Ltd.

Miller, A., & Young-Jones, A. D. (2012). Academic integrity: Online classes compared to face-to-face classes. *Journal of Instructional Psychology*, *39*(3/4), 138–145. Retrieved from

https://www.researchgate.net/profile/Adena_Young-Jones/publication/260969851_Academic_integrity_Online_classes_compared_to_face-to-face_classes/links/00b49532c4c5021bd8000000/Academic-integrity-Online-classes-compared-to-face-to-face-classes.pdf

Miller, S. P., & Hudson, P. J. (2007). Using evidence-based practices to build mathematics competence related to conceptual, procedural, and declarative knowledge. *Learning Disabilities Research and Practice, 22*, 47–57. https://doi.org/10.1111/j.1540-5826.2007.00230.x

Milone, A. S., Cortese, A. M., Balestrieri, R. L., & Pittenger, A. L. (2017). The impact of proctored online exams on the educational experience. *Currents in Pharmacy Teaching and Learning, 9*, 108–114. https://doi.org/10.1016/j.cptl.2016.08.037

Mitra, D., Mann, B., & Hlavacik, M. (2016). Opting out: Parents creating contested spaces to challenge standardized tests. *Education Policy Analysis Archives, 24*, 31. https://doi.org/10.14507/epaa.24.2142

Moberg, C., Sojka, J. Z., & Gupta, A. (2008). An update on academic dishonesty in the college classroom. *Journal on Excellence in College Teaching, 19*(1), 149–176. Retrieved from https://eric.ed.gov/?redir=http%3a%2f%2fcelt.muohio.edu%2fject%2fissue.php%3fv%3d19%26n%3d1 http://celt.muohio.edu/ject/login.php?page=issue.php%3Fv%3D19%26n%3D1

Moore, M. (1997). Theory of transactional distance. In D. Keegan (Ed.), Theoretical principles of distance education (pp. 22–38). New York, NY: Routledge

Moore, M. (2007). The theory of transactional distance. In Handbook of distance education (pp. 89–105). Mahwah, NJ: Erlbaum.

National Center for Education Statistics. Common Core of Data: America's Public Schools, n.d. Retrieved from https://nces.ed.gov/ccd/tables/201314_Virtual_Schools_table_3.asp

Odekon, M. (2015). Literacy and illiteracy rates. In *The SAGE encyclopedia of world poverty, 3,* 918–919. Thousand Oaks, CA: SAGE Publications, Inc. https://doi.org/10.4135/9781483345727.n480

Olejnik, S. F. (1984). Planning educational research. *The Journal of Experimental Education, 53*(1), 40–48. https://doi.org/10.1080/00220973.1984.10806360

Panigrahi, R., Srivastava, P. R., & Sharma, D. (2018). Online learning: Adoption, continuance, and learning outcome—A review of literature. *International Journal of Information Management, 43,* 1–14. https://doi.org/10.1016/j.ijinfomgt.2018.05.005

Pennucci, S. (2016). *Qualitative Case Study on the Perspective of Pennsylvania Superintendents on Distance Education in K-12 Public School Districts* (Doctoral dissertation). Retrieved from Digital Commons. (1204)

Phelps, R. P. (2002, February). Estimating the costs and benefits of educational testing programs. *Briefings on Educational Research, Education Consumers Clearinghouse*, *2*(2). Retrieved from http://www.education-consumers.com/briefs/phelps2.shtm

Philipp, J. (2014). *End of course grades and end of course tests in the virtual environment: As Study of correlation*. (Doctoral Dissertation). Retrieved from Digital Commons. (824)

Piaget, J. (1952). *The origins of intelligence in children*, 5, 18–19. New York, NY: International Universities Press.

Picciano, A. G., & Seaman, J. (2009). K-12 online learning: A 2008 follow-up of the survey of U.S. school district administrators. Boston, MA: Sloan Consortium. Retrieved from http://www.onlinelearningsurvey.com/reports/k-12-online-learning-2008.pdf

PISA 2015: U.S. students still in middle of the pack. (2016). *US Official News*. Retrieved from http://neatoday.org/2016/12/06/pisa-2015/

Roblyer, M. D., & Doering, A. H. (2013). *Integrating educational technology into teaching*, (6th Ed.). Boston, MA: Pearson.

Saiger, A. (2016). Homeschooling, virtual learning, and the eroding public/private binary. *Journal of School Choice*, *10*(3), 297–319. http://doi.org/10.1080/15582159.2016.1202070

Santelices, M. V., & Wilson, M. (2010). Unfair treatment? The case of freedle, the SAT, and the standardization approach to differential item functioning. *Harvard Educational Review, 80*(1), 106–133, 141–142. Retrieved from https://bearcenter.berkeley.edu/sites/default/files/Wilson%20%2322.pdf

Schneider, M., Rittle-Johnson, B., & Star, J. R. (2011). Relations among conceptual knowledge, procedural knowledge, and procedural flexibility in two samples differing in prior knowledge. *Developmental Psychology*, *47*(6), 1525. Retrieved from http://www.uni-trier.de/fileadmin/fb1/prof/PSY/PAE/Team/Schneider/SchneiderEtAl2011.pdf

Skylar, A. (2009). A comparison of asynchronous online text-based lectures and synchronous interactive web conferencing lectures. *Issues in Teacher Education*, *18*(2), 69–84. Retrieved from https://files.eric.ed.gov/fulltext/EJ858506.pdf

Speck, B. W. (2002). Learning-teaching-assessment paradigms and the online classroom. In R.S. Anderson, J. F. Bauer, & B.W. Speck (Eds.), *Assessment strategies for the on-line class: From theory to practice*. San Francisco, CA: Jossey-Bass.

Stack, S. (2015). Learning outcomes in an online vs traditional course. *International Journal for the Scholarship of Teaching and Learning, 9*(1), Article 5. Retrieved from https://doi.org/10.20429/ijsotl.2015.090105

Texas Education Agency. (2013, December). English I assessment eligible Texas essential knowledge and skills. Retrieved from http://ritter.tea.state.tx.us/rules/tac/chapter110/ch110c.html

The Nation's Report Card: A First Look: 2013 Mathematics and Reading (NCES 2014–451). Institute of Education Sciences, U.S. Department of Education, Washington, D.C.

Verschelden, C. (2017). *Bandwidth recovery: Helping students reclaim cognitive resources lost to poverty, racism, and social marginalization*. Sterling, VA: Stylus.

Vuopala, E., Hyvönen, P., & Järvelä, S. (2016). Interaction forms in successful collaborative learning in virtual learning environments. *Active Learning in Higher Education, 17*(1), 25–38. https://doi.org/10.1177/1469787415616730

Watson, J., Pape, L., Gemin, B., & Vashaw, L. (2015). Keeping pace with K12 digital learning. Mountain View, CA: Evergreen Education Group.

Willis, S. (1998). Which numeracy? *Unicorn, 24*(2), 32–42. Retrieved from https://search.informit.com.au/documentSummary;dn=990302341;res=IELAPA

Woodworth, J. L., Raymond, M. E., Chirbas, K., Gonzalez, M., Negassi, Y., Snow, W., & Van Donge, C. (2015). *Online charter school study*. Stanford, CA: Center for Research on Education Outcomes.

Wrenn, V. (2016). *Effects of traditional and online instructional models on student achievement outcomes*. (Doctoral dissertation). Retrieved from Digital Commons. (1135)

You, M. (2007). The differences between the influences of synchronous and asynchronous modes on collaborative learning project on industrial design. (pp. 275–283). Berlin, Heidelberg: Spring Berlin Heidelberg. https://doi.org/10.1007/978-3-540-73257-0_31

Young, J. R. (2012, June). Online classes see cheating go high tech. *The Education Digest, 78*(5), 4–8. Retrieved from https://www.chronicle.com/article/cheating-goes-high-tech/132093

Zhang, A. (2003). *Transactional distance in web-based college learning environments: Towards measurement and theory construction* (Doctoral Dissertation). Richmond, VA: Virginia Commonwealth University. UMI No: AAT 3082019

Zimmer, R., Gill, B., Booker, K., Lavertu, S., Sass, T., & Witte, J. (2009). *Charter schools in eight states: Effects on achievement, attainment, integration, and competition*. Santa Monica, CA; Arlington, VA; Pittsburgh, PA: RAND Corporation. Retrieved from https://www.rand.org/pubs/monographs/MG869.html

Zucker, S. (2003). Cross-correlation and maximum-likelihood analysis: A new approach to combining cross-correlation functions. *Monthly Notices of the Royal Astronomical Society, 342*(4), 1291–1298. https://doi.org/10.1046/j.1365-8711.2003.06633.x