EFFECT ON STUDENT ACHIEVEMENT FOR MIDDLE SCHOOL MATH STUDENTS

USING BLACKBOARD, CANVAS AND SCHOOLOGY IN THE STATE OF VIRGINIA

by

Rosa Ann Woodley-Richard

Liberty University

A Dissertation Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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ABSTRACT

The purpose of this quantitative, causal-comparative research was to compare the differences in middle-school student achievement for grade 7 math students among three different learning management systems: Blackboard, Canvas, and Schoology. The instrument was the Virginia Grade 7 Math Standards of Learning test. The population included students in the 7th grade attending a public school in the state of Virginia. The participants were the individual school districts. The study examined the means between the pass rates of the three learning management systems to see if there was a significant difference. The independent variable included the three learning management systems: Blackboard, Canvas, and Schoology. The dependent variable was the student pass rates that were reported to the school districts. The sum of one pass proficient and one pass advanced pass rate for each district was calculated and organized in an excel spreadsheet. The Statistical Package for the Social Sciences (SPSS) was used to run a one-way ANOVA. The results revealed that there was no significant difference between the means thus supporting the hypothesis. The study increased the understanding of the difference between the means of three different learning management systems. Finally, it is suggested that future investigations focus on students in K-12 educational settings, face-to-face instruction, and post COVID-19 instruction.

Keywords: learning management system, Blackboard, Canvas, Schoology

Copyright Page

Dedication

This manuscript is dedicated to my mother, Ms. Doris M. Williams-Woodley, may

she rest in peace, my father, Mr. John W. Woodley, and my daughters, Ms. Johnessa L.

Richard, and Ms. Jaylyn L. Richard.

Acknowledgments

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List of Abbreviations

Arizona State University (ASU)

Distance Education (DE)

Information and Communication Technology (ICT)

Individualized Educational Plan (IEP)

Institutional Review Board (IRB)

Interactive Mathematics Program (IMP)

Learning Management System (LMS)

Online Student Engagement Survey (OSES)

Professional Learning Community (PLC)

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)

Standards of Learning (SOL)

Technology Based Learning & Research (TBLR)

Virginia Department of Education (VDOE)

Virtual Learning Environment (VLE)

World Health Organization (WHO)

United Nations Education, Scientific, and Cultural Organization (UNESCO)

CHAPTER ONE: INTRODUCTION

Overview

The purpose of this quantitative, causal-comparative research was to compare the differences in middle-school student achievement for grade 7 math students among three different learning management systems (LMS): Blackboard, Canvas, and Schoology. Chapter one provides a background for the circumstances leading to the wide-spread use of learning management systems, learning management systems parameters, and the purpose of the study. Included in the background is an overview of the theoretical framework for this study and how LMS have transformed over time. The problem statement examines the scope of recent literature on this topic. The purpose of this study is followed by the significance of the current study and the research question. The chapter concludes with an introduction of the research question and a list of key terms and their definitions.

Background

The heightened use of LMS makes this study more important than ever. It is projected that by 2025, there will be a 15% increase of online learners in the post-secondary setting (Williams et al., 2019). With this new virtual world, learners will be afforded the opportunity to interact with other learners and participate in constructivist activities (Girvan & Savage, 2019). According to the Virginia Department of Education (2020b), Virginia has more than 1.2 million students enrolled in public schools. Overall, there are 124 out of 132 school systems that implemented virtual learning in Virginia, or 93.9% (Alba, 2020) There were 8 out of 132 or approximately 6.1% of Virginia's school systems that opted not to implement virtual learning (Alba, 2020). Six-point seven percent of Virginia Region 2 public schools used Blackboard. Sixty percent of Virginia Region 2 public schools used Canvas. As more and more schools and

students transition to e-learning or virtual learning environments for extended periods due to COVID-19, the necessity for understanding student achievement will become increasingly important (Hillmer et al., 2021; Huggins et al., 2020). Helping to understand how achievement is affected by learner's connectedness during virtual instruction (Chennamsetti, 2020) will provide focus for future investigations.

Historical Overview

Learning management construction began in 1924 with the creation of the first automated teaching machine by Sidney Pressey (Petrina, 2004, 2019; Webdesign, 2020). Pressey created a typewriter-like machine with a video window. This machine could be used to administer questions (Petrina, 2004, 2019; Webdesign, 2020). Specifically, the machine used one display for the question and the other to display the answer (Petrina, 2004, 2019; Webdesign, 2020). As time went on, other inventors saw a need to create technology-based instruments to enhance learning outcomes. Another inventor included M. E. Lazerte who invented the problem cylinder in 1929. The problem cylinder presented questions to students and validated that their responses followed the correct procedures (Webdesign, 2020). In 1956, Gordon Park and Robin McKinnon-Wood invented the Adaptive Teaching System, SAKI, which adjusted questions based on the performance level of the learner. Now, this system is being implemented on the Virginia Standards of Learning Tests and is called CAT or Computer Adaptive Testing (VDOE, 2020c).

As technology evolved with the invention of the first desktop in 1970 by Hewlett Packerd (HP) (Packard, 2007; Webdesign, 2020), the role of LMS took on a new appearance. Robert Elliot Kahn and Vint Cerf designed the first interface that allowed users to communicate with the Internet. This communication has transformed how LMS work and the ability of learners to use

them. In 1990, SoftArc created the first software for use by MacIntosh (Webdesign, 2020). In 2002, Martin Dougiamas introduced Moodle, an open-source internal network. Moodle was designed to have three levels of users: administrators, teachers, and students. At the time, it was recorded that Moodle had over 60 million users in many countries. One of the most influential changes occurred in 2008, when the private cloud was designed by Eucalyptus. With this innovation, LMS could exist online. In 2012, several companies transitioned to the LMS and made use of cloud-based technology. As the dynamics of the e-learning environment has changed, there has been an increased need for adequate LMS. Now that companies can provide cloud-based learning, the focus has shifted to perfecting the components of each LMS. According to Oliveira et al. (2016), seven parameters for an effective LMS have been identified: Administrative Support, Communication/ Interaction, Coordination, Didactic Resources, Evaluation, Interface, and Navigation. LMS in education could not exist without the on-going innovation of researchers and advances in technology.

Society-at-large

With the onset of COVID-19, the use and implementation of LMS has become more popular with so many students learning from home (Kuhfeld et al., 2020). On March 13, 2020, the announcement from Governor Ralph Northam to close all Virginia schools for a minimum of two weeks (Silva et al., 2020; Yarmosky, 2020) sent over 1.2 million students home to learn virtually. The increased use of e-learning or a Virtual Learning Environment (VLE) has sparked the implementation of various LMS , such as Blackboard, Canvas, and Schoology (Oliveira et al., 2016).

In addition to implementing LMS in the field of education, other societal changes occurred. According to Silva et al. (2020) there have been numerous psycho-emotional changes

due to the social isolation caused by COVID-19. The study conducted by Silva et al. (2020)

consisted of undergraduate dentistry students who were socially isolated. The study revealed that

there was an increased use of social media outlets, cell phones, and the Internet. The largest

effect was noted in the psychological domain. The researchers further noted that increased

distance education activities improved the students' quality of life (Silva et al., 2020). Though

this study does not aim to analyze psycho-emotional changes, it will look at the effect of student

achievement due to the implementation of distance education (DE).

Other key societal changes included physical health issues, family conflicts, stress, and

long-term mental health disorders (Garfin et al., 2018; Silva et al., 2020). Wang et al., (2020)

pointed out that, due to social isolation, students may display prolonged affects. These

researchers highlighted stress factors, like lack of personal space at home and accurate

information, alarm of infection, forfeiture of family income, reduced contact with friends, and

apathy, may lead to prolonged effects for children (Silva et al., 2020; Wang et al., 2020). Based

on this information, some of these factors may play a key role in student achievement, which will

be examined in this study.

Theory

The Engagement Theory is relevant to the study of the effects of LMS on student

achievement because the Engagement Theory suggests that students using a technology-based

learning system must be meaningfully engaged in learning activities through interaction with

others while completing worthwhile tasks (Bayrak et al. 2009; Huang, 2010; Kearsley, 1997;

Kearsley & Shneiderman, 1998; Shneiderman, 1994). The Engagement Theory correlates and

directs the focus of the study by delving into how achievement is affected by the virtual

environment. Researchers and theorists agree that, with increased engagement, there will be an increase in achievement. This study will evaluate these claims (Gasiewski et al., 2011).

Walberg's Theory of Achievement proposed that student achievement is affected by four factors: motivation, ability, the quantity of instruction, and quality of instruction (Haertel et al., 1983; Walberg, 1986). Walberg's Theory of Achievement is related to this study because this study examines student achievement. Walberg's Theory of Achievement will help to guide the research of this study by focusing on the quality of instruction presented using the LMS. Moreover, the implementation of this study and the data collected will further the understanding of student achievement and provide support for Walberg's Theory of Achievement.

Problem Statement

Since the beginning of the formal education system, researchers have sought to understand the factors that affect student achievement. Literature has addressed the need to improve student achievement and the factors that play a role in student achievement, such as socioeconomic status, testing disparities, student motivation, and delivery methods (Au, 2009, 2016; Hanushek, 2016). There are many studies on the effect of LMS in higher education (Al Meajel & Sharadgah, 2017; Eom, 2019; Ugwoke et al., 2018). However, there is a gap in the literature about student achievement at the middle school level in mathematics using a LMS (Panahi et al., 2019). These unexamined populations have not been studied. Research on flipped classrooms at the collegiate level has shown the potential of increasing students' interest in learning and meeting their learning needs (Phillips & Trainor, 2014; Ugwoke et al., 2018).

Thus, the general problem that needs to be investigated is student achievement using an LMS with middle school students in a mathematics course. Ugwoke et al. (2018) suggested that achievement is dependent upon several factors, such as the learning environment, instructional

methods, the learners, and motivation for stimulating students' interests in learning. Furthermore, minimal empirical research has been done in the field of teaching mathematics, and most research has been in other fields of study (Panahi et al., 2019). The specific problem is the effectiveness of LMS such as Blackboard, Canvas, and Schoology on student achievement. The focus of the research is to analyze how students who are exposed to LMS score on standardized tests. The population sample will consist of middle school math students from the state of Virginia who have learned using an LMS. The problem is that the literature has not fully addressed the effect on student achievement for middle school math students using Blackboard, Canvas, and Schoology in the state of Virginia.

Purpose Statement

The purpose of this quantitative, causal-comparative research was to compare the differences in middle-school student achievement for grade 7 math students among three different LMS: Blackboard, Canvas, and Schoology. Researchers define LMS as an online platform used in a virtual environment in which students learn utilizing an LMS that maintains, records, and reports assignments. Using a quantitative causal-comparative research design, this study investigated the effect LMS has on student achievement in 7th grade math courses in Virginia. Based on the description of the ex-post facto research provided by Gall et al. (2007), this study highlighted observations based on the variations between means of the independent and dependent variables. Likewise, Kerlinger (1964, 1972), Lord (1973), Salkind (2010) and Sharma (2017, 2019) described *ex-post facto* as research in which the independent variable has happened, and the research will establish a relationship between that independent variable and the dependent variable. McLeod (2019) described the dependent variable as the tested variable. The dependent variable is student achievement on the Virginia Grade 7 Mathematics Standards

of Learning test, as reported to each school district as a mean of the pass proficient and pass advanced rate. Students are classified as Proficient with a scaled score of 400-499. Students who score 500-600 are labeled as Passed Advanced (VDOE, 2020a). McLeod (2019) defined the independent variable as the variable that changes. The district receives a pass rate based on how many students scored between 400-600. The independent variables for this study were one of three LMS: Blackboard, Canvas, or Schoology. Data was collected about which LMS were being implemented in school systems in the state of Virginia. The focus of the study was student achievement based on standardized test data during the pandemic. A quantitative statistical analysis using One-way ANOVA was used to determine differences between student achievement among the various LMS. The population consisted of public middle school students who were participating in a virtual learning environment and learning the current Virginia State Math Standards of Learning through Blackboard, Canvas, Schoology, or no LMS. The students were randomly selected from middle schools in Virginia.

Significance of the Study

Due to the increased use in LMS (Al-Fraihat et al., 2020), educators need to understand the effects of LMS on student achievement (Bartholomew & Reeve, 2018). Blackboard is known for its ease of use because the course material is readily available (Baig et al., 2020). Blackboard provided users with a way to organize, administer, and collect data about learners. Canvas LMS is used across the United States, in thousands of universities, as well as internationally, with a powerful and flourishing presence in the K-12 and higher education markets (Marachi & Quill, 2020). Another LMS that has enhanced student learning is Schoology (Masyhudianti et al., 2018). Schoology provides educators a way to interact with students and present learning content that students can complete in a student-paced format. This study will build on the study

conducted by Eom (2019). Eom utilized the virtual learning environment (VLE) theory to analyze the effectiveness of e-learning systems. Eom recommended future research on self-regulatory learning strategies. In this study, the self-regulatory learning strategies are the LMS: Blackboard, Canvas, and Schoology. Ease of use, accessibility, and ability to manage assignments are key parameters when considering which LMS to use (Al Meajel & Sharadgah, 2017). Currently, there are limited studies on the use of a LMS (Bradley, 2020) with middle school math students in Virginia. There are many studies on the effect of LMS in higher education (Al Meajel & Sharadgah, 2017; Eom, 2019; Ugwoke et al., 2018). However, at the conclusion of this study, there will be a greater understanding of the effect of LMS on student achievement (Almrashdeh et al., 2011; Kostaris et al., 2017) in middle school mathematics.

Research Question

RQ1: Is there a difference in middle-school student achievement as measured by the Virginia Grade 7 Mathematics Standards of Learning test and reported as pass rates per school district among students using Blackboard, Canvas, and Schoology?

Definitions

1. *Blackboard*- allows faculty and students to log in and view learning materials conveniently inside and outside of class time (Al Meajel & Sharadgah, 2017).

2. *Canvas*- an online platform used to present online courses and degrees (Marachi & Quill, 2020).

3. *Distance Learning*- Distance learning may be a combination of methods used to learn when teachers and students are separated. Learning may take place on the computer, with packets that are mailed to the students, or a combination (VDOE, 2020e).

4. *E-learning*- is the use of technology, such as the Internet, web applications, and computing equipment, to facilitate teaching and learning (Yakubu & Dasuki, 2018).

5. *LMS*- Learning Management System- a set of software tools and Web-based technology that support planning, implementation, delivery, tracking, and managing of online education and training (Nair & Patil, 2012; Rahman et al., 2010; Ugwoke et al., 2018).

6. *Schoology*- free web-based education application that allows teachers to give a lesson to students digitally (Irawan et al., 2017)

7. *Standardized Testing* – used as a tool for accountability (Au, 2016).

8. *Student Achievement* – the level at which students perform compared to their peers (Xuan et al., 2019).

9. *Virtual Learning Environment Model*- postulates that two antecedents (human dimension and design dimension) determine the effectiveness of e-learning systems (Eom, 2019).

CHAPTER TWO: LITERATURE REVIEW

Overview

The purpose of this literature review is to present the existing literature on student achievement of students who learn via an online learning management system. The chapter opens with the theoretical framework. This study is grounded first in Walberg's Theory of Achievement and is further supported by Engagement Theory. The related literature on Blackboard, Canvas, and Schoology is included. Understanding the key components in each learning management system and how to better improve them to increase student achievement will further the field of education. A thorough review of the literature pertinent to student engagement, student achievement, and learning management systems is highlighted. Chapter Two will end with a summary that synthesizes the literature related to the study and demonstrates why this study should be conducted.

Theoretical Framework

The underlying theories that focus on student engagement while promoting student achievement are supported by the Engagement Theory and Walberg's Theory of Academic Achievement.

Engagement Theory

The Engagement Theory is a theory that evolved from the increased use of online or virtual learning (Kearsley, 1997; Shneiderman, 1994, 1998; Shneiderman et al., 1995). Theorists, Kearsley and Shneiderman (1998) proposed that, in this conceptual framework, students using a technology-based learning system must be meaningfully engaged in learning activities through interaction with others while completing worthwhile tasks (Bayrak et al. 2009; Huang, 2010; Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994). Since virtual learning has

become increasingly necessary in American's educational system (Watson et al., 2014), studies must be conducted to analyze the success of the LMS being utilized.

The Engagement Theory is composed of three basic components: Relate, Create, Donate (Kearsley & Shneiderman, 1998). The first principle, *relate*, addresses the need for teamwork and collaboration. The focus on management and communication builds planning and social skills. Students are afforded the opportunity to work with various groups of students, which leads to diverse understanding and respect for others' perspectives (Kearsley, 1997; Shneiderman, 1994, 1998; Shneiderman et al., 1995).

In this study, the focus will be on student achievement using various LMS. Researchers believe that when teachers provide quality communication, student achievement will improve (Böheim et al., 2021; Resnick et al., 2018). Böheim et al. (2021) found that, when 19 teachers participated in a one-year discourse development program, teachers improved their verbal discourse among the students, which lead to increased motivation. Being able to relate knowledge, skills, and information to the students' pre-existing knowledge will increase student engagement, thus increasing student achievement.

The second component, *create*, allows the students to garner ownership of the project because they design and create the activities. The students' ability to contribute on a higher- level opens the door for exploration. Through this exploration, the students gain a meaningful understanding of the topic being studied. Professional education fields and the medical profession have implemented this type of Project-Based Assessment for many years (Barrows & Tamblyn, 1980; Kearsley, 1997; Shneiderman, 1994, 1998; Shneiderman et al., 1995).

Within this study, the students were expected to create and complete assigned tasks using a LMS with online or virtual access. The learning platforms allow teachers to upload

assignments, interface with students, and provide feedback on completed tasks (Juhaňák et al., 2019). As a result, students can view the feedback and monitor their progress within the course. The students' unique ability to create their responses allows them more ownership and promotes engagement. The purpose of this quantitative, causal-comparative research was to compare the differences in middle-school student achievement for grade 7 math students among three different LMS: Blackboard, Canvas, and Schoology.

The third component, *donate*, is grounded in the intention of providing knowledge to a group or individual that did not exist before the completion of the project (Kearsley & Shneiderman, 1998). The increased ownership of the project drives student motivation, which yields greater student achievement and satisfaction (Kearsley, 1997; Shneiderman, 1994, 1998; Shneiderman et al., 1995). The fundamentals of this component are supported by service or school-to-work programs provided by many school systems (Jacoby et al., 1996; Kearsley, 1997; Shneiderman, 1994, 1998; Shneiderman et al., 1995).

This study will incorporate the donate aspect of the Engagement Theory by evaluating the student's achievement on a state-mandated assessment. The students are donating to the efforts of the educational system to evaluate the teachers, curriculum, and successful implementation of the curriculum (Kearsley, 1997; Shneiderman, 1994, 1998; Shneiderman et al., 1995). Once the student's achievement has been analyzed, recommendations for future studies will be made.

The Engagement Theory has advanced the literature on virtual learning by addressing the need for collaboration while students are working in a virtual environment (Cayubit, 2021; Walberg & Greenberg, 1997). According to Cayubit (2021), social qualities aid in the learning process (Cayubit, 2021; Walberg & Greenberg, 1997). Engagement Theory has established the

components necessary for the successful incorporation of learning activities into the curriculum that promotes student achievement. Moreover, the Engagement Theory has provided guidelines that will stimulate student achievement through the interaction of online platforms (Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994, 1998; Shneiderman et al., 1995).

Researchers discovered students have meaningful interactions while participating in virtual learning activities which are linked to physical interactions (Christopoulos et al., 2018). According to Lei et al. (2018), student engagement refers to the students' ability to be directly involved in the learning tasks. Research has shown how instructors are collaborators or subject matter experts who design the lessons to be learned, while virtual learners manipulate the content being presented and formulate their own understanding and learning (Anasol et al., 2012; Schrader, 2008).

Francis (2018) examined how students, who were presented with a performance task, did at various levels of engagement. This study on student engagement found that when students were engaged, provided with a rubric and additional learning resources, achievement increased . Francis' study evaluated whether the rubric improved student achievement or engagement. The study revealed that students who were engaged with discussion about the rubric earned an average of 63%, whereas students who were less engaged earned an average score of 55.7%. Additionally, students who were involved in the discussion and applied related resources demonstrated an average of 70.2%. This study provided support for the implementation of performance tasks that promote student engagement through rubrics and additional resources.

According to Gasiewski et al. (2011), engagement improves student learning when students are actively participating in their learning. Their study demonstrated that students participating in entry level college STEM courses were less successful in lecture formatted

courses. Instead, students need the opportunity to create questions, actively answer them, and reflect on those answers (Thalheimer, 2003). Further, engagement may be affected by many outside factors. Hofer (2002) suggested that students who are motivated by extrinsic rewards may faulter in concept mastery. Whereas Ryan and Deci (2000) believed that students who are intrinsically motivated may have an increased learning experience due to their own admiration and zeal for learning. Engagement Theory offers one explanation of students' accusation of knowledge and concepts, but there is much to learn about the achievement of students who learn in a virtual or online environment.

Studies on Engagement Theory have yielded a plethora of opportunities for colleges and school systems alike to allow students to work in a collaborative environment (Bayrak et al., 2009; Bond et al., 2020; Huang, 2010; Payne, 2016). The Engagement Theory has been utilized to examine student engagement within collaborative groups (Francis, 2018; Huang, 2010; Payne, 2016). Additionally, the Engagement Theory has been used to investigate the level of academic achievement of students based on their amount of engagement in learning activities (Francis, 2018; Huang, 2010; Payne, 2016). Tseng et al. (2016) found that higher achievement was based on the ability of the performer. Shi et al. (2017) discovered that boys traditionally have a higher self-esteem, thus yielding greater achievement. Further, Engagement Theory has been applied to evaluate the innovative value of student collaboration on various levels (Francis, 2018; Huang, 2010; Payne, 2016).

Bond et al. (2020) examined 243 studies that referenced the Engagement Theory. These studies were conducted between 2007 and 2016. The studies focused on mathematics, natural sciences, statistics, arts, and humanities. Various statistical methods were used with quantitative being the most widely used. Less than 50% were guided by theoretical framework and a limited

number of studies provided the definition of student engagement. The studies focused heavily on behavioral engagement which was derived from educational technology. The studies relied on undergraduate students. Most courses implemented text-based tools (i.e., discussion boards) and blended learning. Research by Bond et al. recommended further research on discipline specific use of technology to foster student engagement.

There have also been studies of the effect of engagement on adult learners as well. According to Reder et al. (2020), adult learners have an increased motivation to learn. With the increased motivation to advance literacy and numeracy skills, these adults have increased sustainability. They are more likely to be lifelong learners with better incomes, lifestyles, and socioeconomic health. Engagement continues to be an ongoing process in motivating learners of all ages.

Today, stakeholders need to understand how students are motivated at all ages. Since math is one of the critical areas in which students spend a substantial portion of their time learning (Lemieux et al., 2017), it is instrumental that researchers understand student levels of motivation. Arens et al. (2017) surmised that achievement and self-concept are closely related, especially in the study of mathematics. Due to the complexities of student engagement (Ben-Eliyahu et al., 2018), the study of the relationship between engagement and achievement is essential.

The proposed research on student achievement while using a LMS in a virtual environment is related to the Engagement Theory because it looks at how students learn in a virtual environment. Kahu and Nelson (2017) conducted research on the correlation of student engagement and achievement. Based on their research, student engagement is integral to student achievement. Furthermore, other studies revealed an increased student login yielded increased

total student engagement and increased student achievement (Salmela-Aro et al., 2021). The Engagement Theory also looks at ways to increase student achievement through the LMS. The research will identify the effect of a LMS in a virtual learning setting on student achievement.

Walberg's Theory of Academic Achievement

Student academic achievement and learning outcomes can be affected by determinants in the learning environment. Some aspects, such as school environment and student attitudes toward learning, can positively or negatively affect student achievement (Fraser & Walberg, 1991; Mazana et al., 2019; Nguyen et al., 2014). Research from the past 35 years revealed a positive correlation between student achievement and classroom environments (Dorman & Fraser, 2009; Nguyen et al., 2014). Walberg's Theory of Academic Achievement (1986) will be advanced through the investigation of academic achievement within a virtual learning environment.

The major theorist for the Walberg Theory of Academic Achievement is Herbert J. Walberg (1986). He proposed that there are nine parameters that affect student achievement: media exposure, home environment, age/developmental level, classroom climate, amount of teaching, teaching quality, motivation, peer group, and student ability/previous achievement (Bruinsma & Jansen, 2007; Galizty & Sutarni, 2021; Walberg, 1986). Walberg proposed students' educational outcomes are driven by their environment and psychological characteristics (Reynolds & Walberg, 1992).

Walberg's Theory of Academic Achievement (1986) originated out of the necessity to understand student learning and student achievement. Walberg researched the effect of student achievement to determine if it was based on student motivation or the quantity of instruction. (Haertel et al., 1983; Walberg, 1971, 1986). Walberg proposed that student achievement was

related to students' need to feel connected (Walberg & Greenberg, 1997). In addition, Cayubit (2021) suggested that variables, such as level of engagement, academic motivation, and learning strategies influenced student achievement. Cayubit demonstrated that college students' academic motivation was related to the students' learning environment. The study consisted of 1002 college students who completed four standardized scales. These scales measured environment, motivation, engagement, and motivational strategies. The study found a positive correlation between student achievement, motivation, and learning environment . Other such studies have been conducted about environment and class climate as well with the same findings (Khine, 2021; Rathmann et al., 2018).

There is an abundance of literature on student achievement that looks at gender, ethnicity, school environment, efficacy, and many other factors that affect student achievement (Kahu & Nelson, 2017), but there is a limited amount of research on student achievement and learning management systems in the middle school grades (Steinmayr et al., 2019). One such study looked at student attitudes towards mathematics as compared to their achievement. Mazana et al. (2019) examined 419 primary, 318 secondary and 132 college students from Tanzania. The researchers compiled and analyzed the data of students from a survey about their attitude towards mathematics using one-way ANOVA, standard deviations, means, percentages, regressions, and thematic analysis. Their results showed that students start out with positive attitudes towards learning mathematics. However, as they progressed through school, their positive attitudes and motivation decreased.

Multiple theorists have proposed learning theories (Bennett, 1978; Bloom, 1976; Bruner, 1966; Carroll, 1963, 1989; Cooley & Leinhardt, 1975; Gagne, 1977; Glaser, 1976; Walberg, 1981; Wiley & Harnischfeger, 1974), which strive to explain the influences on students'

academic achievement or learning. These models are composed of four key components that are essential to student achievement: motivation, ability, the quantity of instruction, and quality of instruction (Haertel et al., 1983; Walberg, 1986). Variables, direct and indirect, prevalent in these common models have been under-tested in empirical investigations (Keith & Benson, 1992). To adequately assess student achievement, there needs to be an interpretation of learning outcome variables (Haertel et al., 1983; Walberg, 1986). The examination of student achievement while utilizing a LMS relates to the Walberg Theory of Academic Achievement by comparing the achievement of middle school students using various online learning platforms. The goal is to highlight the difference between the means of seventh grade mathematics' students using one of three LMS in a virtual environment.

The study of student achievement while learning virtually and accessing a learning management system may advance Walberg's Theory of Achievement (1986) by adding to the body of knowledge about student achievement. Student achievement at the middle school level has little research. The literature review will look at various aspects of student achievement through a technical, virtual environment. Furthermore, the literature review will explain what COVID-19 or severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is and how it affected the learning environment. The literature review highlights the directives disbursed by the Virginia Department of Education to school districts to mitigate virtual learning and combat some of the issues schools and teachers had to face during virtual learning. Also, the literature review will discuss the LMS: Blackboard, Canvas, and Schoology.

Related Literature

COVID-19 Driven Adoption

According to the World Health Organization (WHO) (2020a) and Cao (2020), COVID-19, or severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is a contagious disease. The first known case was reported on December 31, 2019, by the Wuhan Municipal Health Commission (WHO, 2020b). Fast forward to March 11, 2020, COVID-19 was then classified as a worldwide pandemic (WHO, 2020a). It met the criteria of a worldwide pandemic after more than 114 countries were affected over a three-month span. As of December 26, 2021, there had been approximately 280,129,759 cases with 5,415,926 deaths (Coronavirus cases: Worldometer, 2020). COVID-19 has significantly transformed the learning communities around the world.

According to the United Nations Education, Scientific, and Cultural Organization (UNESCO), COVID-19 greatly impacted the world-wide educational system. UNESCO reported that the pandemic affected approximately 87% of students learning across the world. Purportedly, 1.5 billion students in 195 countries were affected by the closing of schools (UNESCO, 2020b). Due to this pandemic, UNESCO had to take creative measures to ensure that students were still learning (Tadesse & Muluye, 2020; UNESCO, 2020a). Thus, the recommendation for digital or virtual learning, self-directed learning, and the use of online learning platforms (UNESCO, 2020a).

The effects of COVID-19 on the educational system are far-reaching. Not only were students affected, but teachers, parents, and school systems were affected as well (Tadesse & Muluye, 2020). Tadesse and Muluye reported multiple disorders, leading to increased stress, anxiety, and depression in students. Additionally, disadvantaged students were overwhelmingly impacted by not having access to the infrastructure necessary for virtual or distance learning (Di

Pietro et al., 2020; Zhang, 2020). Many public-school teachers and students did not have access to the technology necessary to participate in virtual or distance learning (Kuhfeld et al., 2020; Tzifopoulos, 2020).

Virginia Department of Education Expectations for School Districts during COVID-19

Most of the school districts in the United States transitioned from face-to-face instruction to distance learning in a virtual environment (Kuhfeld et al., 2020). Furthermore, this remote learning was provided during the last few months of the fourth quarter grading period (Lake & Dusseault, 2020). Many of the parents were unable to assist their children because they were still expected to work (Harris, 2020). These issues posed some educational strains on all stakeholders. According to Kuhfeld et al. (2020), the lasting effects on student achievement may never be fully documented or understood.

According to the Virginia Department of Education records, there are currently 134 school districts in the state of Virginia (Miller & Reynolds, 2022). Almost 100% of these districts established or fully implemented an online LMS. When implementing the LMS, districts had to account for equity issues. VDOE tasked each district to think of a way to provide continuity and structure. Districts had to differentiate between the equity versus equality of the LMS. Furthermore, districts had to guarantee equal access and support for students with diversified needs. VDOE suggested that school districts consider various learning groups: students with disabilities, early learners, students from low socio-economic backgrounds, English learners, and homeless students. Stakeholders had to be sure not to increase the achievement gaps within these groups (VDOE, 2020e). When implementing an LMS, it is essential that stakeholders implore guidelines like those described by the Engagement theory that

will increase student achievement and minimize the achievement gap (Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994, 1998; Shneiderman et al., 1995).

The districts were given specific advice from the Virginia Department of Education (VDOE). First, districts were advised to meet students' immediate needs. Second, they needed to provide equal access to learning resources. Thirdly, provide clear, concise, and consistent communication to all families. Fourth, they were told to create an equity plan that addressed returning to learning. Lastly, districts were advised to design a plan that addressed the continuity for learning and incorporated a local philosophy (VDOE, 2020e). As explained by the Engagement theory, each guideline was tailored to increase student engagement and promote achievement (Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994, 1998; Shneiderman et al., 1995).

The focus of the VDOE was to meet the needs of the students first (VDOE, 2020e). Districts were directed by VDOE to spotlight the social emotional and physical needs of the most defenseless students. It was suggested that districts establish procedures to assess the needs of these defenseless students. VDOE included students lacking health care, food, and housing, immigrant students, English learners, students with disabilities, and students receiving state care. Additionally, districts were instructed by VDOE to provide training or guidance to school staff on culturally diverse outreach programs availability. VDOE also advised school districts to consider the impact that COVID-19 would have on student members of Virginia's tribes (VDOE, 2020e). As documented by Mazana et al. (2019), various aspects of school environment and student attitudes toward learning can positively or negatively affect student achievement.

Districts were tasked with providing equitable access to resources. VDOE reminded each district that equitable access not only provides resources but also provides adequate support to

families and students. Other caveats that districts needed to consider were the alignment to state and federal civil rights laws and the influence their model would have on students of need (VDOE, 2020e). Districts were also tasked by VDOE with gathering data about the students' availability to technology. Districts also had to evaluate and ensure that instructional and distance learning models would promote student success and not deter or increase achievement gaps. The incorporation of an LMS meant that districts had to consider the adequacy of the LMS and incorporate the seven parameters for an effective LMS (Oliveira et al., 2016). Oliveira et al. defined the seven parameters for an effective LMS: administrative support, communication/ interaction, coordination, didactic resources, evaluation, interface, and navigation.

VDOE expected all districts to communicate with families. Districts were expected to establish and maintain a communication system germane to their district. The system was expected to have communication abilities with families in their native language. Furthermore, districts were expected to establish partnerships with community wrap-around services. These services would include media outlets, faith-based organizations, and civil rights organizations, further supporting the communication pathways with families. These partnerships would ensure that districts were communicating with families frequently and that the families had access to local and state resources when necessary (VDOE, 2020e). To align with the Engagement theory, districts needed to keep parents and students engaged in the learning process using the LMS and other community resources (Jacoby et al., 1996; Kearsley, 1997; Shneiderman, 1994, 1998; Shneiderman et al., 1995).

Districts were also expected to design a return to learning equity plan (VDOE, 2020e). According to the VDOE, the reason for such a plan was to monitor the disparities in learning and ensure that the school closures did not exacerbate previously existing gaps in student

achievement. VDOE suggested that districts develop a system for monitoring student progress, growth, and align accountability outcomes. VDOE invited all districts to create a return to learning team that represented stakeholders from the community, state partners from hospitals, detention facilities, and the foster care system. VDOE suggested that districts disaggregate current data to highlight students and groups of students who would be disproportionally affected by school closures. The actions and directives of the VDOE aligned with Walberg's theory of achievement by monitoring the students' level of achievement and achievement gaps (Haertel et al., 1983; Walberg, 1986).

Lastly, districts were tasked with creating and implementing a local philosophy and approach for Continuity for Learning (VDOE, 2020e). VDOE suggested three models that teachers could use interchangeably. These models were the Learner Centered, Teacher Centered, or the Hybrid Model. Each model incorporated various activities, such as sample agendas, recommended resources, and suggested strategies. However, it was most interesting that the VDOE reiterated that teachers should select the model most closely aligned to their comfort level given previous professional learning experiences combined with current circumstances. The suggested use of the model that teachers were most familiar with supported Walberg's Theory of Achievement. According to Walberg (1986) students' level of achievement could be affected by the environment and quality of teaching.

Questions for Administrators

With all these suggestions and directives from the VDOE, there were many questions that needed to be answered by administrators. The VDOE (2020e) posed 12 questions to the administrators and gave them possible answers and solutions for each. These questions offered school districts the opportunity to monitor student engagement and achievement. As Walberg

(1986) researched, all variables had to be monitored to ascertain the students' level of achievement.

The first question was, "What can administrators do to support the social and emotional needs of students, families, and teachers?" (VDOE, 2020e). VDOE suggested that districts garner the awareness of Maslow's hierarchy of needs to mitigate the students' uneasiness. VDOE further detailed that students' safety and physiological needs must met. Also, students needed to feel a sense of belonging and being loved. VDOE further suggested that districts partner with faith-based organizations and foodbanks to assist families in securing food. Expectations were set and criteria developed for students and guidance counselors to connect with students and collaborate with families on a weekly basis to achieve academic success by planning. The parameters of this question would facilitate student engagement. As described by Kearsley and Shneiderman (1998), the focus on management and communication builds planning and social skills.

Next, administrators were asked, "How do divisions prevent learning gaps from expanding during school closures" (VDOE, 2020e). It was recommended that school divisions provide hot spots to allow students to have Internet access throughout the school closure (VDOE, 2020e). Moreover, VDOE suggested that learning activities be differentiated so that students can have a better chance of success. Also, VDOE mentioned that paper copies of assignments should be made available with the distribution of meals. Therefore, students who did not have Internet access would still have access to learning activities. Providing additional resources would mitigate the increase in learning gaps (Francis, 2018).

Another question posed by the Virginia Department of Education (2020e) was, "How can administrators take care of staff during extended school closures?" VDOE suggested that

administrators acknowledge the needs of teachers, as well as the students. It was the recommendation by VDOE that administrators make teachers feel supported and happy. Additionally, VDOE advised that administrators remind teachers to focus on their home activities and allow for self-care. VDOE suggested shout-outs to teachers who were being innovative and holding virtual meetings, just to check-in on the staff members. As mentioned in the Engagement theory, attending to the teachers' social qualities (Cayubit, 2021; Salam & Farooq, 2020) would continue to foster student achievement.

Next, VDOE (2020e) asked, "What expectations for learning should be communicated to teachers?" VDOE entrusted administrators with the task to set clear expectations for teachers in a timely fashion. Also, the expectations set for the students by the teachers would be abridged and simplistic in nature. Students would be afforded the opportunity to complete tasks in multiple ways. Most importantly, learning goals were to be realistic and attainable. As grounded in the Engagement theory, students would be able to relate, create, and donate (Kearsley & Shneiderman, 1998).

Another question raised was, "Which priorities should administrators focus on to ensure continuity for learning?" (VDOE, 2020e). Administrators were told to focus on relationship building and attending to students' social and emotional learning needs. Further, VDOE tasked administrators with providing effective communication regarding the learning management system or other communication tools. Administrators were also expected to ensure that plans focused on key knowledge and skills. Likewise, teachers were tasked with providing non-technological assessments and assignments. The plans for continuity for learning is directly related to the Engagement theory because of the expectation to enhance students' learning and thus maintaining their achievement (Kearsley & Shneiderman, 1998).

VDOE (2020e) asked, "How can administrators promote and support deeper learning?" Administrators could promote and support deeper learning by implementing programs that allowed students access to these rich learning experiences. Also, VDOE suggested that administrators could support the efforts of the teachers by creating communities for learning. Administrators were allowed to network beyond school walls and form partnerships within their districts. They had the infrastructure necessary to support learning through technology. Using technology, administrators were expected to provide differentiated learning experiences and provide resources for teachers. Just as described by the Engagement theory, deeper learning is derived from the incorporation of varied activities and students' ownership of activities (Kearsley & Shneiderman, 1998).

Questions for Teachers

The first question posed to teachers by the VDOE was, "How can teachers focus on the social and emotional needs of students?" Suggestions offered included: prioritizing students' emotional and social needs over work. Teachers were expected to regularly host virtual meetings to check the well-being of students. Further, it was suggested that teachers collaborate with other school officials to meet the needs of students. Teachers were expected to inquire about student activities (i.e., which activity was fun?) (VDOE, 2020e). These activities would measure the level of engagement of the students while working in the LMS. According to the Engagement theory, students need to perform activities that are engaging (Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994, 1998; Shneiderman et al., 1995).

Secondly, teachers were asked, "How do teachers support students to prevent learning gaps from expanding during extended school closure?" (VDOE, 2020e). Teachers were tasked with identifying students who may have needed additional resources. These students were

underrepresented groups identified as students with disabilities, socio-economic disadvantaged, and English learners. Then, the teachers were encouraged to provide outside resources from the community, such as faith-based organizations. Also, it was recommended that teachers supply students without Internet access with physical copies of classroom activities. The actions of these teachers are directly related to the Engagement Theory. Based on research by Kearsley and Shneiderman (1998), achievement is related to conceptual framework. Students using a technology-based learning system must be meaningfully engaged in learning activities through interaction with others while completing worthwhile tasks (Bayrak et al. 2009; Huang, 2010; Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994).

VDOE asked, "What guidelines for learning are available to teachers?" Professional Learning Communities (PLC) were suggested as a way for teachers to acquire the essential knowledge and skills the students needed to be successful. It was also recommended that teachers incorporate *cross-curricular* activities that would integrate lessons from multiple subjects concurrently. The lessons were to focus on the 5C's of learning: citizenship, creativity, communication, collaboration, and critical thinking (VDOE, 2020e). These cross-curricular activities would tie in with the Engagement theory because it would allow students to be more engaged, thus increasing achievement (Bayrak et al. 2009; Huang, 2010; Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994).

VDOE posed another key question, "What are the teacher priorities to ensure continuity for learning for students?" Most importantly, teachers were directed by VDOE to concentrate on emotional and social learning instead of curriculum. Another directive was to implement the LMS provided by the district and interact with students and parents using the designated platform. Plus, teachers were instructed to communicate deadlines, expectations, and learning

goals. For students with an Individualized Educational Plan (IEP), teachers were asked to collaborate with other stakeholders to monitor and adjust the IEP to accommodate the student's learning environment (VDOE, 2020e). This virtual environment demonstrated how students can learn via LMS (Bayrak et al. 2009; Huang, 2010; Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994) with proper monitoring and communication.

Implementation of LMS Training and PD

According to the VDOE (2022a) website, there was a plethora of Virtual Learning resources made available to school districts, teachers, and staff during the school closure period. Some of the key features included the differentiation between synchronous and asynchronous learning, instructional models, preparing students for virtual learning, and how to design virtual learning classrooms. Contained in the preparation for virtual learning tab, resources were offered for learning modalities, best practices for online learning, and resources for families, students, and teachers. Under the professional learning tab, there was a virtual learning support toolkit. The toolkit contained nine modules on various aspects of virtual learning. Some topics presented in the toolkit included planning for the virtual classroom, instructional models, feedback, effective assessments, and voice choice. Within the VDOE (2020e) Virginia Learns Anywhere document, there were links available to teachers. These links included access to instructional models, as well as resources. However, based on the VDOE Virginia Learns Anywhere document, there were no links for the students. All the resources provided on the VDOE website demonstrated how important resources are when implementing an online learning platform. As shown by Haertel et al. (1983) and Walberg (1986), the VDOE covered the four key components that are essential to student achievement: motivation, ability, the quantity of instruction, and quality of instruction.

Multiple studies on Information and Communication Technology (ICT) revealed that instructors tend to have positive experiences (Gamage & Tanwar, 2018; Janssen et al., 2019; Torres Martín et al., 2021) with online learning. These instructors referenced the ability to use these tools to motivate students and provide them with active ways to collaborate (Torres Martín et al., 2021). According to Janssen et al. (2019) teachers who participated in training had a better perception of teaching critical thinking and thus were more capable of identifying issues in the vignettes studied. Therefore, teachers who received training about teaching using a virtual learning platform demonstrated improved implementation and were more equipped to manage student behaviors (Dawson & Lignugaris/Kraft, 2017; Peterson-Ahmad et al., 2018). These studies reinforced the need for appropriate training for the instructors as did the studies by Walberg (1986) and Galizty and Sutarni (2021) to promote increased achievement. They found that student achievement was affected by teacher quality.

Student Achievement using Online Learning

According to Hwang et al. (2021), students who opt to learn mathematics online have access to self-paced learning and the support of the learning community. In their study, they suggested the use of social regulation-based online learning. They described social regulation-based learning as learning in which the students monitor each other and utilize similar strategies of their peers. They studied two groups of high school math students. One group utilized the social regulation-based learning, while the other group used the conventional self-regulated study method with no interaction with peers. Based on their findings, students who used the social regulation-based learning method had increased achievement. Thus, the implementation of such a social regulation-based study method with middle school math students may prove to increase their student achievement as well.

Conversely, some students are not necessarily having the same positive interactions with online or virtual learning as their instructors. One study conducted by Torres Martín et al. (2021) found that students on the collegiate level felt ill prepared to learn virtually. They responded that they did not have the skills necessary to learn effectively. Also, they felt that resources provided by instructors were not satisfactory. As described by Galizty and Sutarni (2021) and Walberg (1986), student achievement can be affected by self-motivation and attitudes toward their learning environment.

Likewise, a literature review compiled by Efriana (2021) revealed similar problems and offered some solutions for online learning. Efriana found that there were problems with students understanding the curriculum presented, and a lack of technology, including enthusiasm to learn online. Also, Efriana offered that the inability of teachers to effectively utilize the technology necessary to facilitate online learning was a hinderance. The researcher offered these solutions for the identified problems: lesson preparation should be interesting, use LMS platforms that have simplistic features, contact the students who demonstrate less inactivity, and solicit the assistance of guidance counselors.

Math Curriculum in Various Environments

Cichon and Ellis (2020) described Math Connections as a math program designed to increase student achievement. Even though the program is not virtual, it is technologically enhanced. Interactive Mathematics Program (IMP) implemented the same fundamental principles that are embedded within the Virginia Standards of Learning. The researchers tracked the students' engagement and found that, students who learned using this program were more successful. Thus, implying that middle school math students with increased engagement time will demonstrate greater student achievement. Furthermore, they found that classes that

implemented the Math Connections program had increased student on-task behavior. Additionally, the curriculum was designed to provide students with the resources necessary to think critically, solve problems, communicate, and apply mathematical reasoning. This IMP fostered increased student achievement in the areas of statistics and probability (Cichon & Ellis, 2020). Even though the program focused on students in grades 9- 12, these reporting categories are taught at all levels (VDOE, 2022b), as referenced in the Blueprints provided by the VDOE. The Blueprints indicated that students in middle school mathematics in the state of Virginia learn the same material as taught using this online program. Cichon and Ellis described a program that incorporated the principles of Engagement theory. These same principles of the Engagement theory would apply to students learning middle-school mathematics in Virginia. Based on the research by Gasiewski et al. (2011), the more time that students spend on tasks or engaged, the greater their achievement.

Studies on students' mathematical achievement in various environments have been conducted (ASU TBLR, 2022; Lekwa et al., 2019). Lekwa et al. (2019) researched students in urban environments. They found that, when teachers implemented evidence-based instructional and behavior management strategies, students made significant gains in mathematics and reading. Likewise, in rural Arizona, the Arizona State University Technology- Based Learning and Research (ASU TBLR) Center found that students who were exposed to an interactive online learning program outperformed their peers. Walberg (1986) and Galizty and Sutarni (2021) proposed that there are nine parameters that affect student achievement: media exposure, home environment, age/developmental level, classroom climate, amount of teaching, teaching quality, motivation, peer group, and student ability/previous achievement. These studies model how important these parameters are in achievement.

In a study conducted by Arizona State University's (ASU) Technology Based Learning and Research (TBLR) Center, it was determined that students learning with a state-of-the-art math curriculum called Adaptive Curriculum achieved better on standardized tests. The program was designed by Sebit Inc., a global e-learning company. The program offered real-world applications, groundbreaking graphics, and the latest technology for lesson planning (ASU TBLR, 2022). According to the TBLR Center, over 95% of the teachers using Adaptive Curriculum had students that demonstrated a 5% achievement over teachers who did not expose their students to the Adaptive Curriculum. As demonstrated by this study, achievement is directly related to appropriate planning and implementation, as is in Walberg's theory of achievement (Galizty & Sutarni, 2021; Walberg, 1986).

Middle School Student Learning

Research on student achievement is vast and multidimensional (Bruce & Singh, 1996; Fu et al., 2020; Nguyen et al., 2014). Researchers have been researching student achievements since Horace Mann, John Dewey, and Lev Vygotsky. In the 1930s, Mann was unsettled with the number of children that were being educated, the level of effectiveness of the instructors, and the lack of resources in deprived communities (Gutek, 2011; Mudge, 1937). The constructivists of 1938, Dewey, and Vygotsky, dabbled in the theory of engagement to explain social interaction and collaborative learning (Dewey, 1938). In the 21st Century, these learning models, learning environments, and learning platforms continue to be researched (Bruce & Singh, 1996; Fu et al., 2020; Haertel et al., 1983; Nguyen et al., 2014; Walberg, 1986). Student motivation is one of the key components to increasing student achievement (Bruce & Singh, 1996; Eom, 2019; Fu et al., 2020). The researchers have all contributed to the field of student achievement and some of their findings are grounded in Walberg's theory of achievement.

Fazal and Bryant (2019) conducted a study with 413 6th grade students and found that there were advantages to implementing blended learning. Teachers were able to harness the ingenuity of technology and scaffold learning to meet students at their learning level. According to Fazal and Bryant (2019), students typically scored higher on standardized assessments than their counterparts, who were taught using only face to face instruction. Similarly, a study conducted by Ghazel et al. (2018) found that certain factors influenced students' ease of use and usefulness of LMS and therefore lead to their satisfaction. Furthermore, Ghazel et al. discovered that student characteristics, like computer self-efficiency, technology experience, and computer anxiety were essential properties for creating a positive usage experience with the LMS. Other key factors, such as course and classmates' characteristics contributed to increased LMS satisfaction. A study conducted by Chaw and Tang (2018) revealed that 123 students on the collegiate level demonstrated greater learning effectiveness when LMS service quality and system quality was adequate. Each study demonstrated the benefits of using technology and implementing online learning.

An abundance of initiatives has been implemented over the recent decades to increase student achievement (Lumpkin, 2016), however research of virtual learning on student achievement has only begun to be studied. Most of the studies on student achievement via online or virtual settings have taken place on the collegiate level (Cunha et al., 2016). Phungsuk et al. (2017) found that college students who were taught using problem-based learning via a virtual learning environment (VLE) achieved better than their counterparts who were taught in a traditional classroom. Exposing the students to VLE empowers them and gives them control over their learning experiences (Zepeda et al., 2015). These studies are tied to the Engagement theory because they focus on students learning virtually (Kearsley, 1997; Shneiderman, 1994, 1998;

Shneiderman et al., 1995). It further demonstrated how online learning can increase student achievement (Francis, 2018).

It has long been the belief that increased student engagement yields higher achievement levels (Lei et al., 2018) thus combating high unemployment rates (He et al., 2021). According to Olivier et al. (2018), student self-efficacy, emotional engagement, and behavioral engagement are key components in student achievement. Furthermore, student achievement and student engagement may not be as closely related as once suggested (Pekrun et al., 2017). Some researchers believed that they are bidirectional in nature (Hughes et al., 2008; Pekrun et al., 2017). Student achievement heavily relies on the way in which engagement is recorded and reported (Lei et al., 2018). Also, student achievement is closely related to self-efficacy (Assouline et al., 2020; Aydin, 2016). The goal of this study is to delve deeper into how achievement is affected when students participate in a virtual or online learning environment.

The worldwide pandemic (COVID-19) is still being studied (Al-Nofaie, 2020). COVID-19 was declared a worldwide pandemic on March 11, 2020, by the World Health Organization (WHO, 2020a). The proposed study will add to the understanding of students' learning via an LMS during COVID-19 school closures and their performance on a mathematical Standards of Learning assessment. It will also provide a better understanding of the students' engagement with the LMS and student achievement.

Virtual Learning Environment in General

The use of digital or online learning has increased in recent years (Bond et al., 2020; Faber et al., 2016; Hwang & Tsai, 2011; Keeley, 2015; Sung et al., 2016). With this increased integration of digital learning, there is also a centralized focus on student experience (Barak, 2018; Henderson et al., 2017). Key factors, such as motivation and homework (Bruce & Singh,

1996; Suárez et al., 2019), have been analyzed to see if they affect the virtual learning environment. Suárez et al. (2019) discovered that there was a link between student behavioral engagement and students who were more internally motivated. Also, they found evidence that supports the link between student engagement and achievement. The level of success while in a virtual learning environment has brought on studies about social and emotional concerns (Taylor & Dymnicki, 2007).

Barak (2018) studied 679 undergraduate collegiate students by administering a questionnaire. The questionnaire pertained to their expertise in information and communication technology (ICT). Barak found that when students are open to new learning experiences, they are more inclined to be focused, are less emotional, and do not need routines. The study showed that students who are technology savvy were more flexible and demonstrated a more open thought process. Based on this study, a researcher may assimilate that middle school students who are technology proficient may engage more with the LMS, thus improving their achievement.

Henderson et al. (2017) investigated what 1,658 undergraduate students suggested as digital benefits. They were more interested in what the students found to be beneficial versus the use of digital technology to improve student learning. The feedback from the students revealed that digital technology may not be improving collegiate teaching and learning. Therefore, it was suggested that institutions of higher learning find out the true benefits of digital integration. Investigations by Lei et al. (2018) demonstrated how students directly involved in the virtual learning experience performed better; hopefully similar measures can be implemented in the K-12 learning environment.

The effects of not participating in a face-to-face setting in middle schools have not been explored often (Poirier et al., 2019). Other factors, like distractions at home or lack of

engagement while in the virtual environment, need to be considered (Al-Fraihat et al., 2020). Also, there are numerous studies on college-level students (Barak, 2018; Henderson et al., 2017) but very few for K-12 learners. According to Bond et al. (2020), in general there is much to be studied to foster student engagement in the digital age.

Understanding virtual learning is still evolving because researchers recommended other studies to be conducted (Olpak et al., 2018; Saygili & Çetin, 2021) to look at the students' gender and ethnicity (Bruce & Singh, 1996). Bruce and Singh found that there was a significant difference between the level of motivation of girls and boys on the eighth-grade level. Further, researchers concluded that there are significant achievement differences in students' ethnicity and therefore recommended additional studies to be conducted.

The proposed study can fill the gap in literature about student achievement and improve understanding in the field of virtual learning environments because the study will analyze the difference between the means among Blackboard, Canvas, and Schoology. Furthermore, data will be collected from the VDOE website about student achievement on the seventh-grade standardized test. Lastly, the analysis of these two parameters will support the null hypothesis, thus increasing the knowledge about student achievement while using a LMS in a virtual learning environment.

Learning Management Systems

Formal LMSs have been gaining implementation since the early 20th century (Khan & Qudrat-Ullah, 2021; Petrina, 2004, 2019; Webdesign, 2020). With the movement of most schools to virtual learning in March 2020 (Yarmosky, 2020), educators had to implement a learning platform where teachers could interact with their students and provide feedback, collect data, and organize coursework (Bradford et al., 2007; Khan & Qudrat-Ullah, 2021; Oliveira et

al., 2016). Based on a study by Kuhfeld et al. (2020), it was found that students in K-12, including teachers, had substantial gaps in technology and limited experience with virtual instruction. LMSs have provided software that permits teachers to interact with their students outside of the classroom (Akay & Koral Gumusoglu, 2020). This makes learning material readily available to all students (Bogarín et al., 2018). LMSs have become an integral part in the achievement of students and teachers (Khan & Qudrat-Ullah, 2021).

LMSs are composed of software that organizes material, collects data, tracks students' responses, records their grades, and reports the completed tasks (Khan & Qudrat-Ullah, 2021). There are many LMSs, like eCollege, GNU General Public License/Linus, Angle/ LMS, and Learning Space (Bradford et al., 2007). Other systems exist that work as open-source, like uPortal, Open-Source Portfolio Initiative, The Sakai Project, and Moodle. Each LMS has its own components and offers various tools for teachers and administrators to incorporate into teaching and learning. LMSs offer access to learning materials, the ability of the students and teachers to communicate and interact with those materials, organizing materials, documenting progress, and allowing the instructor to provide feedback (Bulut Özek, 2018; Jovanovic & Jovanovic, 2014; Kaya & Özel, 2014). However, little has been done to examine the effects of virtual LMS on student achievement (Han & Shin, 2016; Kraleva et al., 2019; Saygili & Çetin, 2021). This study aims to look at Blackboard, Canvas and Schoology.

Researchers are calling on learning management companies to solicit feedback from the users and integrate their views for future functionality designs (Song & Luan, 2020). Further, studies show there is a gap in research in the quality of the LMS and the actual usage by the students (Yakubu & Dasuki, 2018). Yakubu and Dasuki called for more research on the quality of the LMS and the correlation between increased student usage and improved student

achievement. This study will investigate the difference among student achievement of students using one of three LMS: Blackboard, Canvas, or Schoology.

Blackboard

Blackboard, the LMS, has been used since 1997 (Bradford et al., 2007). Research about Blackboard extends in many directions (Al Meajel & Sharadgah, 2017; Al-Nofaie, 2020; Baig et al., 2020; Bradford et al., 2007; Nkonki & Ntlabathi, 2016; Sultana, 2019). Researchers have examined the factors, barriers, and effectiveness of Blackboard (Al Meajel & Sharadgah, 2017; Baig et al., 2020; Sultana, 2019). Blackboard has been analyzed and evaluated (Bradford et al., 2007; Nkonki & Ntlabathi, 2016). Al-Nofaie (2020) even questioned the effectiveness of Blackboard with college students who were learning English.

Since Blackboard was marketed as an online learning management system for higher education markets and college professors (Bradford et al., 2007; Khan & Qudrat-Ullah, 2021; Murshitha & Wickramarachchi, 2016; Nagy, 2016), there is limited research on Blackboard in use with K-12 settings (Marachi & Quill, 2020). Blackboard has been touted as an e-learning system for students to use while online or on campus (Murshitha & Wickramarachchi, 2016; Nagy, 2016). According to researchers, there is a lack of literature on the use of Blackboard; one study on university-level medical students who used Blackboard (Baig et al., 2020), and one focused on the students' learning experiences during the COVID-19 pandemic (Al-Nofaie, 2020).

Understanding the effects of Blackboard as a LMS is still developing because researchers are calling for further investigations (Al-Nofaie, 2020; Baig et al., 2020). Even though research shows that, with the usage of Blackboard, student achievement is higher, researchers agree that their studies have been limited to understanding how much time the students' study and the

limited usage. Additionally, the developments about online or virtual learning during COVID-19 are new and still evolving (Al-Nofaie, 2020).

Based on the current research, there is a gap in research about the usage of Blackboard in middle school environments. Also, the study of the effects on math achievement will add to the field of education and assist future researchers to understand how to meet the needs of virtual or online learners. The study will seek to identify the difference in means between students utilizing Blackboard, Canvas and Schoology. The data may be used to indicate which LMS yields higher student achievement.

Canvas

Many studies have been conducted about Canvas (Çelik, 2019; Fathema & Akanda, 2020; Gambari & Fagbemi, 2008; Marachi & Quill, 2020; Shepherd et al., 2019; Song & Luan, 2020; Yakubu & Dasuki, 2018). These studies have addressed the success factors necessary for student acceptance of a LMS (Yakubu & Dasuki, 2018). Marachi and Quill (2020) studied the datafication of Canvas. Other factors, such as instructors' prior experience (Fathema & Akanda, 2020) and the optimization of Canvas from the students' perspective (Song & Luan, 2020) were examined. Another study looked at the plausibility of using Canvas to collect and organize data for the accreditation process (Shepherd et al., 2019). Most importantly, studies have been conducted on the effects of Canvas on mathematics achievement (Çelik, 2019; Gambari & Fagbemi, 2008).

Due to the increased use of Canvas during the COVID-19 pandemic (Al-Nofaie, 2020), many topics have not been examined. The search for studies of student achievement at the middle school level using Canvas revealed a gap in literature. There are studies on mathematics student achievement using Canvas at the primary level (Çelik, 2019; Gambari & Fagbemi, 2008).

Additionally, searches of other databases, like ERIC and Research Gate, did not reveal any studies on the effects of Canvas on student motivation to learn in a virtual setting.

Understanding the topic of using Canvas as a viable LMS is still developing because this platform is one of the newer systems (Marachi & Quill, 2020). Canvas has been used in many universities and colleges, but now, with the need for additional learning management options, Canvas is growing in usage in K-12 education, as well as higher education environments.

Research has been conducted on the correlation of mathematics achievement and the use of LMS (Olpak et al., 2018; Saygili & Çetin, 2021). According to Saygili and Çetin (2021), most research has been conducted at the collegiate level. However, a study of the effects of Canvas on the achievement levels of middle school mathematics standardized tests will enhance the knowledge of LMS usage to improve student achievement. The study will compare the difference between means among students learning using Canvas and other LMS, Blackboard and Schoology. These studies showed an increased level of mathematics achievement with the use of LMS in general (Olpak et al., 2018; Saygili & Çetin, 2021). Thus, further research needs to be conducted to understand students' achievement levels on the middle school standardized tests while using Canvas.

Schoology

Student achievement has been researched using Schoology as the LMS (Apriliani, 2020; Azmi et al., 2018; Barikhlana et al., 2019; Irawan et al., 2017; Masyhudianti et al., 2018; Saiful et al., 2019; Wardono, & Mariani, 2018). Researchers have examined the mathematics literacy of students who participated in virtual learning with the Schoology LMS (Azmi et al., 2018; Wardono, & Mariani, 2018). Barikhlana et al. (2019) studied student achievement based on learning motivation. Also, blended learning at the high school level has been investigated

(Irawan et al., 2017). Further, the effectiveness of teaching writing while using Schoology as a LMShas been examined (Apriliani, 2020; Masyhudianti et al., 2018; Saiful et al., 2019).

However, the topic of mathematics achievement with middle school students who use Schoology as an LMS has limited research (Lapinid, 2021). The Liberty University Database and Google Scholar did not reveal any specific articles on this topic. However, Suryati et al. (2019) examined the effects of Schoology on cognitive skills, but not mathematics achievement. There is a combination of research on the topics, but not a difference among means study on the effectiveness of Schoology on mathematics achievement on a standardized test of middle school students.

The topic of maintaining student achievement while implementing Schoology as a LMS is still developing. Also, the increased use of Schoology as a LMS with the onset of COVID-19 research is still developing (Lapinid, 2021). The research into student achievement in mathematics will help the understanding of how well students achieve while learning in a virtual environment using Schoology (Azmi et al., 2018; Wardono, & Mariani, 2018). Studies on student achievement in mathematics demonstrated that Schoology was a valid and reliable LMS .

Many studies have been conducted using Schoology to deliver other learning models (Apriliani, 2020; Azmi et al., 2018; Barikhlana et al., 2019; Irawan et al., 2017; Masyhudianti et al., 2018; Saiful et al., 2019; Wardono, & Mariani, 2018). One such study looked at the Just in Time Teaching method on student learning achievements (Barikhlana et al., 2019). In this study, approximately 64 middle school students were provided physics learning material using Schoology LMS. The researchers looked at three areas: differences in Physics students who used Just in Time on Schoology and those who did not; differences in high motivation versus low motivation student achievement; and the effect of Just in Time on Schoology with learning

motivation towards learning achievement. They found that there are differences in using Just in Time with Schoology and the conventional learning methods, there are differences between students with high motivation and student with low motivation; and lastly, there is no interaction effect when implementing Just in Time with Schoology on motivation toward learning (Barikhlana et al., 2019).

The proposed study of the effect of LMS on student achievement of middle school mathematics students will provide a comparison of math scores among three LMS. Azmi et al. (2018) studied mathematics literacy and found that using Schoology to present Creative Problem Solving was effective in improving students' mathematical literacy. Likewise, Wardono and Mariani (2018) studied mathematical literacy in Indonesia with middle school students and found that there was a 30% increase in student achievement when Schoology was implemented. However, there needs to be further studies to see if student achievement on standardized tests will be improved while using Schoology to present the current middle school mathematical curriculum (Mendoza & Lapinid, 2021). The study examined districts who implemented Blackboard, Canvas or Schoology in a virtual learning environment. Further, the study examined the students' achievement levels on middle school mathematics standardized tests. Once the statistical analysis was completed, the researcher compared student achievement among three LMS, adding to the literature on student achievement for middle school math standardized test scores.

Summary

The literature review demonstrated that there are differences between means among the use of LMS. Saygili and Çetin (2021) presented research that revealed a low correlation between LMS and mathematics achievement. Additional studies showed that when students are more engaged, they tend to engross in the system more, thus increasing their productivity (Olpak et al., 2018). Based on the studies conducted by Walberg, achievement is related to environment and student attitudes. However, there are still questions surrounding the use of various LMS. There is a lack of literature on the effects of LMS on middle school students (Saygili & Çetin, 2021). Also, there is an insignificant supply of literature on the students' ability to achieve on standardized tests after participating in an online learning or virtual environment. The focus on virtual learning with emphasis on achievement is supported by Engagement theory and Walberg's theory of achievement. The study will add to the body of knowledge about student achievement, learning management systems, and the virtual learning environment.

CHAPTER THREE: METHODS

Overview

The purpose of this quantitative, causal-comparative research was to compare the differences in middle-school student achievement for grade 7 math students among three different Learning Management Systems: Blackboard, Canvas, and Schoology. Chapter three begins by introducing the design of the study, including full definitions of all variables. The research question and null hypothesis follow. The participants and setting, instrumentation, procedures, and data analysis plans are presented in that order.

Design

Creswell and Guetterman (2021) defined causal-comparative research as research that compares the outcomes from groups without experimental manipulation of the participants by the researcher. A more in-depth explanation by Gall et al. (2007) described causal-comparative research as a "type of non-experimental investigation in which researchers seek to identify cause-and-effect relationships by forming groups of individuals in whom the independent variable is present or absent-or present at several levels-and then determining whether the groups differ on the dependent variable" (p.306). Another major characteristic of causal-comparative research is that the independent variable is composed of categorical groups.

The independent variables for this study included the three LMS: Blackboard, Canvas, and Schoology. The dependent variable was student achievement on the Virginia Grade 7 Mathematics Standards of Learning test, as reported to each school district as a sum of the pass proficient and pass advanced rate. One major limitation of using causal-comparative research design is the inability to manipulate the phenomenon. Creswell and Guetterman (2021) agreed that one disadvantage of causal-comparative research is that researchers have less control over

the study, therefore, they must carefully interpret results. The researcher must accept the participants after the variable has been applied. Joyner et al. (2018) described ex post facto research as a study where the participants have already received the treatment. Further, the current study was limited by the participants who were in the seventh grade. Other limitations included factors in the testing environment, the platform the school district implemented, students' access to the online platform, and how much they used the platform.

The purpose of this quantitative, causal-comparative research was to compare the differences in middle-school student achievement for grade 7 math students among three different LMS: Blackboard, Canvas, and Schoology. The quantitative causal-comparative research design was the most appropriate for this study because the study sought to compare differences between categorical groups (Creswell & Creswell, 2018). In this study, there were three groups, Group B were the school districts who implemented Blackboard; Group C were school districts who implemented Canvas; Group S were school districts who implemented Schoology.

Further, Joyner et al. (2018) described the causal-comparative design as *ex-post-factor* because "the causes are usually studied after they have affected another variable" (p. 84). The research for this study qualified as *ex-post-facto* because the research was conducted after the school districts had already been taught using one of the learning management systems (Kerlinger, 1964, 1972; Lord, 1973; Salkind, 2010; Sharma, 2019). In addition to *ex-post facto*, the study involved non-experimental categorical groups in which the independent variable depended on which LMS was used (Johnson & Christensen, 2000; Salkind, 2010), and no experimental manipulation was implemented.

Research Question

RQ1: Is there a difference in middle-school student achievement as measured by the Virginia Grade 7 Mathematics Standards of Learning test and reported as pass rates per school district among students using Blackboard, Canvas, and Schoology?

Hypothesis

The null hypothesis for this study is:

$H_0 1$: There was no significant difference in student achievement for math 7 standardized test scores among virtual students using Blackboard, Canvas, and Schoology.

Participants and Setting

Population

The population consisted of public-school districts located in the state of Virginia. Virginia has 134 school districts and most of them reported pass rates for the Standards of Learning test. The data was collected and organized by district. However, only the scores for math 7 was included in the analysis. The pass rates that were reported to each school district represented student achievement on the Virginia Standards of Learning grade 7 math test and were classified as middle school students in the seventh grade attending public school.

Participants

The participants for this study were the individual school districts. The school districts for the study were grouped based on the LMS implemented in their school district. There were 134 school districts located in the state of Virginia during the 2020 and 2021 school years. The school districts varied in socio-economic status because data was collected from all over the state. Various districts implemented Blackboard, Canvas, and Schoology learning management systems. The standardized test scores were obtained from the VDOE website.

The study consisted of 94 school districts which used either Blackboard, Canvas, or Schoology LMS and reported pass rates. The sample consisted of 9 Blackboard, 62 Canvas, and 23 Schoology from multiple districts located in Virginia teaching seventh-grade math using a virtual learning environment. There were 40 districts that did not report pass rates, used a different LMS, or the researcher was unable to attain the LMS implemented. The sample size of 94 school districts does not exceed the required minimum of 126 suggested for a one-way ANOVA when assuming a medium effect size with statistical power of 0.7 and alpha level α = .05 (Gall et al., 2007, p.145.) Each year, students are expected to pass the Virginia Standards of Learning grade 7 math test that measures the following strands: number, number sense, computation, estimation, measurement, geometry, probability, statistics, patterns, functions, and algebra (VDOE, 2016).

The setting consisted of districts located in the state of Virginia. There were 134 school districts located in the state of Virginia during the 2020-2021 school year. However, not all school districts reported pass rates, some implemented other LMS, and information could not be attained from others. Therefore, only 94 school district pass rates were included in this study. According to the National Center for Education Statistics (2018), there were approximately 1,846 operating schools in the state of Virginia with 1,281,866 students. Furthermore, 429 schools were labeled as *city* equating to 23.2%, 580 were classified as *rural* equating to 31.4%. 676 public schools in Virginia were classified as *suburban* equating to 36.6%. The other 161 schools or 0.087% were classified as *town*. Additionally, of the 1, 281,866 students, 23% attended *city* schools, 45.4% attended *suburban* schools, 7% attended *town* schools, and 25.4% attended *rural* schools.

Instrumentation

The three LMS; Blackboard, Canvas, and Schoology represented the independent variable. The dependent variable was student achievement on the Virginia Grade 7 Mathematics Standards of Learning test as reported to each school district as a sum of the pass proficient and pass advanced rate. The middle-school Virginia Grade 7 Math Standards of Learning assessment is a multiple-choice test that contains 50 items and is presented in a Computer Adaptive Testing (CAT) format. CAT means that the students cannot go back to a question during the test and based on the student's responses, they will receive increasingly more difficult questions. If they get the answer wrong, they will receive a lower-level question. One issue with the SOL tests is that they are secure tests and secure test items that cannot be shared until they are released by the Virginia Department of Education. The use of this instrument was to measure student achievement. Students who score between 400-600 on the Virginia Mathematics Standards of Learning test signify that the student has successfully attained 70% of the information taught for that course. A student scoring 399 or less denotes that they did not meet the level of achievement expected. A student is labeled *Pass Proficient* if they score between 400-499. A student is labeled *Pass Advanced* if they score between 500-600. For the purpose if this study, one pass proficient and one pass advanced SOL pass rate was summed to attain one pass rate for each school district. The instrument was used in numerous studies, such as Kostaris et al. (2017), Shechtman et al. (2019) and Ugwoke et al. (2018). On their website, the Virginia Department of Education claimed the 7th Grade Math SOL is valid and reliable. According to the Virginia Standards of Learning Assessments 2013-2014 Technical Report, Cronbach's Alpha for Grade 7 Mathematics was 0.91 for Core 1 and 0.92 for Core 2 (VDOE, 2013). A few studies have used the Virginia Standards of Learning Tests for their research. The validity and reliability of the

Virginia Mathematics Standards of Learning test is further accounted for through the
disaggregation of data. The scores are scaled based on the results of the number of students
taking the tests.

Procedures

After IRB (Institutional Review Board) approval (See Appendix A for IRB approval),
the 2020-2021 data was collected from the Virginia Department of Education (VDOE) about
the Virginia Grade 7 Math Standards of Learning test by district. The study did not need to
elicit consent by the parent/guardian because only public data was used. The use of public
data from the Virginia Grade 7 Math Standards of Learning pass rates provided the information
necessary to identify the differences between the groups. No pilot study was conducted, as it was
not necessary. There was no training of individuals implemented, treatment or administration
provided by the researcher. Faculty, staff, and teachers were trained in the implementation of the
SOL test, however that happened at the school level using the attached training manual (VDOE,
2022c) (See Appendix B for Spring 2022 Test Implementation Manual).

Each year, districts in Virginia are tasked with administering Standards of Learning Tests
to attain students' achievement levels. The data from the 2020-2021 Grade 7 Math Standards of
Learning pass rates are then displayed on the Virginia Department of Education's website
(VDOE, 2022d). The data was collected from the website (VDOE, 2022e) and organized using
an excel spreadsheet. The researcher transcribed the data into an excel spreadsheet, the
researcher clicked on the correct key to ascertain the data by district and selected the correct
toggle keys for each district. In order to ascertain the data needed for this study, or to further this
study, the researcher went to the referenced website for the Test Results Build a Table and
selected SOL Test Results to build a table. The researcher selected the school year and report

level. She was sure to select all races, all genders, and grade level 7. Including reporting categories: Disadvantaged, English Learner, Migrant, Homeless, Military Connected, Foster Care, and Disabled, the researcher selected all students. The researcher included the Test Source, which was SOL, for Subject Area was Mathematics, and for Test selected Mathematics. The researcher included the Statistics to Display on the Report, therefore, Pass Proficient rate and Pass Advanced rate were selected. The spreadsheet displayed columns listing each of the established criteria. While going through and creating a table for each district in Virginia, the researcher transcribed the data into an excel spreadsheet. The usage of this spreadsheet organized all the 2020-2021 mathematics 7 SOL scores for each district. Then, the data was used to find the difference between the means using a Statistical Package for the Social Sciences (SPSS) program. Ultimately, the purpose of this quantitative, causal-comparative research was to compare the differences in middle-school student achievement for grade 7 math students among three different LMS: Blackboard, Canvas, and Schoology.

Data Analysis

Statistical analysis was conducted utilizing the Statistical Package for the Social Sciences (SPSS). The one-way ANOVA was used to analyze data. The rationale for using the one-way ANOVA was to determine if there were any differences between the three groups: Blackboard, Canvas, and Schoology. Also, if there was a difference, to determine if the difference was significant. Basically, it tested the null hypothesis. The independent variable was the LMS in which the participants received instruction. The dependent variable was the student achievement based on the sum of the district's pass proficient and pass advanced pass rate on the Virginia Grade 7 Mathematics Standards of Learning test as reported to each school district.

The One-Way ANOVA was the best statistical model because the goal of the study was to examine the differences between the means of standardized test scores for groups using Blackboard, Canvas, or Schoology. The one-way ANOVA statistical analysis can be used to determine the differences between means of groups of 3 or more (Guillén-Gámez & Mayorga-Fernández, 2020; Kim, 2017a; Kim & Cribbie, 2017b; Mrkvička et al., 2020). In this study, the groups included students learning using Blackboard, Canvas, or Schoology. The one-way ANOVA is a statistical test, but it did not show any statically significant differences between the groups. In order to determine which groups were statically different, a post-hoc test was conducted. The null hypothesis indicated that there was not a significant difference in standardized test scores among LMS groups.

SPSS was utilized to create a box-and-whisker plot to determine if there were any extreme outliers in each group. The data was visually screened for missing and inaccurate entries. The box-and-whisker plots showed the differences between the means. The Assumption of Normality used the Kolmogorov-Smirnov to test the overall shape of the frequency distribution (Aslam, 2019; Dimitrova et al., 2020; Warner, 2013). The assumption of equal variance was determined by Levene's test of equality of variance. The effect size was determined using eta squared. Additionally, eta squared was a useful measure to determine if the one-way ANOVA test was statistically significant. As reiterated by Beaudry and Miller (2016) and Bickman and Rog (2009), the null hypothesis should be rejected when p-value is less than the 0.05 critical value. The researcher used alpha, $\alpha = .05$ level to identify each statistical analysis technique.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this quantitative, causal-comparative research was to compare the differences between the means for student achievement bypass rates as documented by the Virginia Grade 7 Math Standards of Learning test among three different LMS: Blackboard, Canvas, and Schoology. The one research question asked is there a difference in middle school student achievement as measured by the Virginia Grade 7 Mathematics Standards of Learning test and reported as pass rates per school district among students using Blackboard, Canvas, and Schoology? The study analyzed three main LMS: Blackboard, Canvas, and Schoology. The Findings Section includes the research question, null hypothesis, data screening, descriptive statistics, assumption testing, and results.

Research Question

RQ1: Is there a difference in middle-school student achievement as measured by the Virginia Grade 7 Mathematics Standards of Learning test and reported as pass rates per school district among students using Blackboard, Canvas, and Schoology?

Null Hypothesis

H$_0$1: There is no significant difference in student achievement for math 7 standardized test scores among virtual students using Blackboard, Canvas, and Schoology.

The pass rate of each school district was examined by grouping the school districts into three categories: Blackboard, Canvas, and Schoology. To determine the academic achievement of nine school districts that implemented Blackboard, one pass proficient and one pass advanced pass rate was added together to obtain one overall pass rate for each school district that implemented Blackboard. To determine the academic achievement of 94 school districts that

implemented Canvas, one pass proficient and one pass advanced pass rate was added together to obtain one overall pass rate for each school district that implemented Canvas. To determine the academic achievement of 23 school districts that implemented Schoology, one pass proficient and one pass advanced pass rate was added together to obtain one overall pass rate for each school district that implemented Schoology. Data screenings were conducted on each group's dependent variable. The researcher sorted the data on each variable and visually scanned for inconsistencies. No data errors or inconsistencies were identified. Box and whiskers plots were used to detect outliers on each dependent variable. No outliers were identified. See Figure 1 for box and whisker plots, including data for the initial study among Blackboard, Canvas, and Schoology.

Figure 1

Box and whisker plot for Blackboard, Canvas, and Schoology
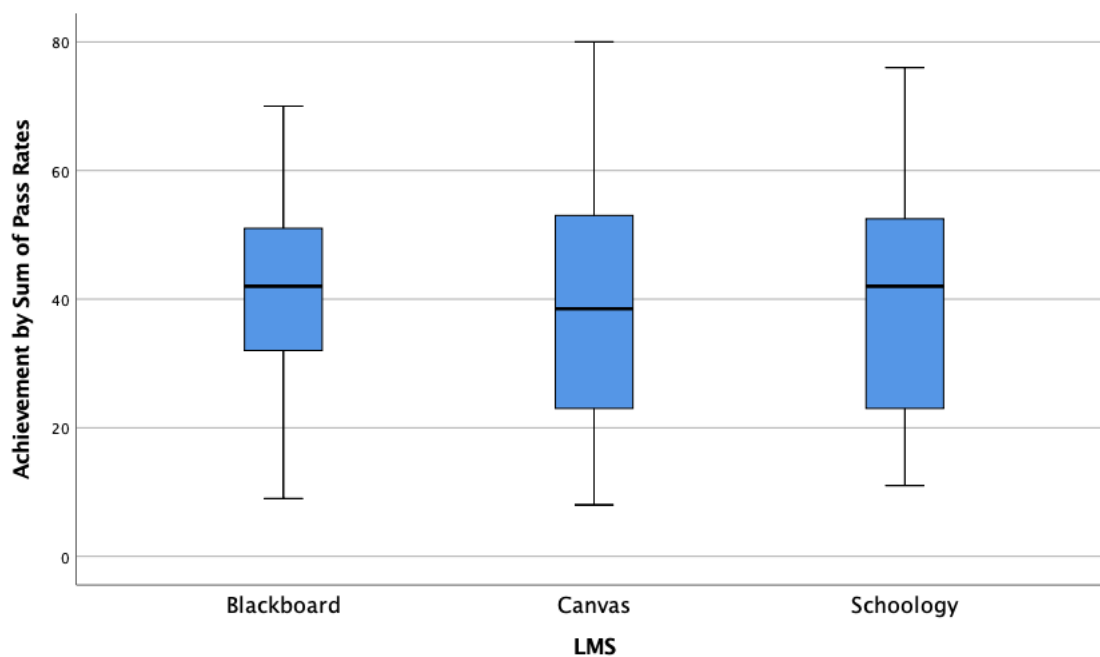
Descriptive Statistics

Descriptive statistics were obtained on the dependent variable for each group:

Blackboard, Canvas, and Schoology. The sample consisted of 94 districts. One pass advanced rate and one pass proficient rate from the 2020-2021 Virginia Grade 7 Math Standards of Learning test was collected from each district and added. The district pass rate is based on how many students passed the Standards of Learning test and can range from 0 - 100 percent. A high pass rate of 100 means that 100 percent of the students who completed the test scored in the pass proficient range of 400-499, whereas a student scoring 500-600 is considered pass advanced. Further, a low score of zero means that none of the students who took the test scored over a 400.

Blackboard had the smallest sample size with nine school districts. The means of the learning management systems were very close in value. The standard deviations were very close in value as well. Canvas had the largest sample size with 62 school districts. However, the standard deviation for Canvas was in the middle. Schoology had a moderate sample size with 23 school districts, but the greatest standard deviation. Blackboard maintained the highest mean, whereas, Canvas had the lowest mean. Overall, the descriptive statistics did not support a significant difference in the means. Descriptive statistics can be found in Table 1.

Table 1

Descriptive Statistics

LMS		N	Minimum	Maximum	Mean	Std. Deviation
Blackboard	Achievement	9	9	70	41.56	17.924
	Valid N (listwise)	9				
Canvas	Achievement	62	8	80	38.21	18.552
	Valid N (listwise)	62				
Schoology	Achievement	23	11	76	39.52	19.062
	Valid N (listwise)	23				

Assumption Testing

Assumption of Normality

The one-way ANOVA requires that the assumption of normality be met. The assumption

of normality test was conducted to demonstrate normality for the three groups. Normality was

examined using Kolmogorov-Smirnov because the sample size was greater than 50 participants

in this case, as each school district was considered to be one participant. The *p*-value for each

group was .200 . The assumption of normality was met because all populations from which

samples were taken had a *p*-value greater than .05. Since the *p*-value for each group is greater

than 0.5, all three groups were considered normally distributed. Therefore, if the value of interest

(the sum of the pass proficient and pass advanced SOL score per school district) was plotted, it

would create a bell-curve distribution function. See Table 2 for Tests of Normality.

Table 2

Tests of Normality

| | LMS | Kolmogorov-Smirnov | | |
		Statistic	*df*	Sig.
Achievement	Blackboard	.167	9	.200*
	Canvas	.084	62	.200*
	Schoology	.136	23	.200*

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Assumption of Homogeneity of Variance

The one-way ANOVA requires that the assumption of homogeneity of variance be met. The assumption of homogeneity of variance was examined using the Levene's Test. The Levene's test used an F test to test the null hypothesis that the variance is equal across the three groups. The Levene's test revealed that the assumption of equal variance was met ($p > .05$), signifying no difference between the variance of the three LMS: Blackboard, Canvas, and Schoology. The assumption of homogeneity of variance was met, where ($p = .753$). The sample size of the study was relatively large (N=94) even though the groups varied in school districts, making the one-way ANOVA a high-quality choice. See Table 3 for Levene's test of Equality of Error Variance.

Table 3

Levene's Test of Equality of Error Variances

		Levene Statistic	df1	df2	Sig.
Achievement	Based on Mean	.285	2	91	.753
	Based on Median	.272	2	91	.763
	Based on Median and with adjusted df	.272	2	90.505	.763
	Based on trimmed mean	.293	2	91	.747

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: Achievement

b. Design: Intercept + Status

Results

A one-way ANOVA was run to see if there was a significant difference in achievement among students taught via Blackboard, Canvas and Schoology. The independent variable was the learning management systems, and the dependent variable was the achievement level of 7th grade students in Virginia. The researcher failed to reject the null hypothesis at the 95% confidence level where $F(2, 91) = .147$, $p = .864$. Partial eta square equaled ($\eta^2_{part} = .003$). The effect size was very small. There was not a statistical difference in student achievement among Blackboard ($M = 41.56$ $SD = 17.924$), Canvas ($M = 38.21$, $SD = 18.552$), and Schoology ($M = 39.52$, $SD = 19.062$). Since the null hypothesis was not rejected, further analysis is not needed. See Table 4 for Tests of Between-Subjects Effects.

Table 4

Tests of Between-Subjects Effects

Dependent Variable: Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	101.679[a]	2	50.840	.147	.864	.003
Intercept	83350.016	1	83350.016	240.345	.000	.725
LMS	101.679	2	50.840	.147	.864	.003
Error	31558.236	91	346.794			
Total	173544.000	94				
Corrected Total	31659.915	93				

a. R Squared = .003 (Adjusted R Squared = -.019)

CHAPTER FIVE: CONCLUSIONS

Overview

This chapter summarizes the results of the analysis pertaining to the research question and null hypothesis. The chapter continues with a brief discussion, implications of the study, limitations, and recommendations for future research. The current quantitative, causal-comparative study found that there was no significant difference in the three learning management systems on student achievement of middle school students. The findings for this research show a relationship to previous research theories and studies, and it adds to the existing body of literature regarding the use of learning management systems in virtual environments.

Discussion

The purpose of this quantitative, causal-comparative research is to compare the differences in middle-school student achievement for grade 7 math students among three different Learning Management Systems: Blackboard, Canvas, and Schoology. The research question that was addressed, "Is there a difference in middle-school student achievement as measured by the Virginia Grade 7 Mathematics Standards of Learning test and reported as pass rates per district among students using Blackboard, Canvas, and Schoology?" This study is significant because the data used was based on students who learned in a virtual environment during a worldwide pandemic. The Virginia Standards of Learning test was used to ascertain the students' level of achievement. The pass rates were reported to each district as a pass proficient and pass advanced rate by grade level. These two data points were summed to attain the pass rate for each district. Determining if student achievement was affected by the learning management system implemented by each school district would give school districts the opportunity to utilize

the best LMS or focus their attention in other areas, such as socioeconomic status, testing disparities, student motivation, and delivery methods (Au, 2009, 2016; Hanushek, 2016) that would truly affect the student achievement. Additionally, this is one of the first studies conducted during the complete closure of the public-school systems in Virginia due to a worldwide pandemic. Since the results demonstrated that there was no significant difference between the means of the learning management systems, further research should be conducted on students in K-12 educational settings, face-to-face instruction, and post COVID-19 instruction.

Student achievement and how to improve it has always been a focus for educators (Au, 2009, 2016; Hanushek, 2016). The current study was designed to research the following question and corresponding null hypothesis related to student achievement for 7th grade middle school students attending a public school and learning in a virtual setting with a learning management system. The null hypothesis suggested that there are no significant differences in student achievement among three LMS: Blackboard, Canvas, and Schoology. The analysis was conducted using SPSS. The population included middle school students in public school in the state of Virginia.

RQ1: Is there a difference in middle-school student achievement as measured by the Virginia Grade 7 Mathematics Standards of Learning test and reported as pass rates per school district among students using Blackboard, Canvas, and Schoology?

Null Hypothesis $H_0$1: There is no significant difference in student achievement for math 7 standardized test scores among virtual students using Blackboard, Canvas, and Schoology.

The data for this study was collected for the Virginia Department of Education's website. The data was organized in an Excel spreadsheet. The researcher visually screened the data and there were no missing or inaccurate data entries. An additional table was created to organize

data. The data was then entered into SPSS statistical analysis program. The results for the research question indicated that there was no statistically significant difference in student achievement for middle school students who learn virtually with a learning management system Blackboard ($M = 41.56$, $SD = 17.924$), Canvas ($M = 38.21$, $SD = 18.552$), and Schoology ($M = 39.52$, $SD = 19.062$). This result supported previous research performed at the collegiate level that found that increasing students' interest in learning and meeting their learning needs (Phillips & Trainor, 2014; Ugwoke et al., 2018) will have a greater effect on student achievement.

The current study is credible based on the data collection methods, statistical analysis, and comparison to other like studies. Eom (2019) looked at student motivation and e-learning or virtual settings. Barak (2018) studied the thinking processes of students based on their level of technology abilities. The current study also studied the technology of learning management systems. Ugwoke et al. (2018) suggested that achievement is dependent upon several factors, such as the learning environment, instructional methods, the learners, and motivation for stimulating students' interests in learning. The current study does not address these outside factors that may influence achievement, but one seeking to further this study should be aware of such factors.

Eom (2019) conducted a study at Southeast Missouri State University with 372 student responses who had completed at least one course at the collegiate level. In contrast with the current study that studied student achievement in the K-12 setting. The Eom study examined the effects of student motivation and self-regulated learning strategies on students' perceived e-learning outcomes and satisfaction. Here, the current study looked at the effect of LMS on student achievement. Eom found that intrinsic motivation was the greatest indicator of learning in an e-learning environment. The current study aligned with the findings on LMS because the

outcomes showed that there was not a significant difference between the LMSs. Therefore, one can surmise that student achievement within Eom's study relied heavily on student intrinsic motivation. The current study relied on student achievement as documented by the Virginia Grade 7 Math Standards of Learning test.

The study conducted by Barak (2018) consisted of 679 undergraduates. The current study focused heavily on 94 school districts in the state of Virginia. The purpose of Barak study was to look at the students' thinking in reference to information and communication technology (ICT). The current study also looked at the possible effect of technology on student achievement as revealed by a school district's pass rates. Barak found that students who demonstrated an increased level of confidence in the use of technology were less resistant to change. Furthermore, students who were more proficient in the use of technology, showed an increase in the flexibility to utilize technology. This study aligns with the current study, in that both studies looked at the implementation of technology. The current study looked at the implementation of learning management systems which was a fairly new technical advance for students. Barak supported the findings in the current study that there is no statistically significant difference between the learning management systems and students' level of proficiency with technology that may assist students using a LMS. Therefore, there is no evidence that students who were more technically savvy would perform better while using the LMS.

Ugwoke et al. (2018) suggested that achievement is dependent upon several factors, suach as the learning environment, instructional methods, the learners, and motivation for stimulating students' interests in learning. The current study examined achievement as compared bypass rates reported by each school district. Ugwoke et al. focused on 168 first year students attending two public universities, whereas the current study looked at math achievement by pass

rates of 7th grade students in public schools. Ugwoke et al. studied the effects of the flipped classroom model on LMS and face-to-face learning environments on interest in accounting and students' achievement. Conversely, the current study focused on three LMS: Blackboard, Canvas, and Schoology. Ugwoke et al. revealed that the flipped classroom model on learning management system is more effective than face-to face instruction on improving students' academic achievement and students' interest in Elements of Accounting. In addition, the study by Ugwoke et al. showed that higher mean achievement among students taught Elements of Accounting when the flipped classroom model was implemented utilizing a learning management system versus the face-to-face method . Additionally, the current study revealed that there was no significant difference between the means of the three LMS. The study differed from the current study, as the Ugwoke et al. study focused on collegiate students. The current study focused on middle school students and was necessary because there needs to be an expansion on research conducted with K-12 students. The Ugwoke et al. study is similar to the current study in that both looked at achievement using a learning management system. Even though, the current study did not reveal a statistical significance, it can be inferred that achievement based on pass rates occurred while utilizing an LMS.

In addition to the Study of the Engagement Theory, digital technology has also become an area of specific concern (Bond et al., 2020). The current study supported the theories of Engagement and Wahlberg by demonstrating that learning takes places virtually despite the delivery platform, as evidenced by the statistical analysis presented in the current study. According to the Engagement Theory students who used a technology-based learning management system must be meaningfully engaged in learning activities through interaction with others while completing worthwhile tasks (Bayrak et al. 2009; Huang, 2010; Kearsley,

1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994). As referenced by the statistics in the current study, there is no significant difference between the means of the three learning management systems studied. Furthermore, Walberg's Theory of Achievement proposed that student achievement is affected by four factors: motivation, ability, the quantity of instruction, and quality of instruction (Haertel et al., 1983; Walberg, 1986). In total, student achievement is improved by addressing the students' motivation, ability, quantity of instruction, quality of instruction, and the interactions within the learning environment.

Implications

Virtual learning is a new area of focus for education. However, student achievement has been an ongoing area of concern for many years. Now, educators are going to have to implement the most meaningful ways to increase student achievement in virtual settings. According to Hillmer et al. (2021) and Huggins et al. (2020), understanding student achievement will become increasingly important. The focus of this study was examining student achievement for middle school students among three learning management systems. The implications of this study have demonstrated there is no statistically significant difference among the parameters of this study. However, other researchers who chose to set different parameters may discover differences. School systems can use Blackboard, Canvas, or Schoology and maintain student achievement at the levels presented in this study. Further, school districts may focus on other areas of education that may increase student achievement, such as socioeconomic status, testing disparities, student motivation, and delivery methods (Au, 2009, 2016; Hanushek, 2016). Another key implication is that students who learn in virtual settings may learn under any given conditions despite the use of Blackboard, Canvas, or Schoology.

Many studies have researched virtual learning on the collegiate level (Al Meajel & Sharadgah, 2017; Eom, 2019; Ugwoke et al., 2018). However, these studies have not focused on middle school students in public education. The current study identified school districts located in Virginia that implemented one of three LMS: Blackboard, Canvas, or Schoology. This study found no significant difference in the three LMS, thus reiterating that achievement is attained when students using a technology-based learning system are meaningfully engaged in learning activities through interaction with others while completing worthwhile tasks (Bayrak et al. 2009; Huang, 2010; Kearsley, 1997; Kearsley & Shneiderman, 1998; Shneiderman, 1994).

The findings from this study may lead policy makers in the development of policies surrounding the use of LMS. LMS have been described as web-based technology designed to improve the learning process through its proper application, evaluation, and program development in educational settings (Alias & Zainuddin, 2005). This definition may be expanded to include other LMS, like Google Classroom, Blackboard, Canvas, Moodle, Schoology, WebCT, and Desire2Learn (Iqbal, 2011; Waheed et al., 2016). The policies that address the implementation of LMS may allow for further implementation and not limit it to the need during a world-wide pandemic. According to Teo (2011), technology implementation is the preparedness of an individual to adopt the use of technology for enabling students to perform tasked-based projects, providing support. Most recently, the implementation of LMS and technologies are being investigated by researchers in different educational environments around the world, using different designs based on distinct parameters (Dečman, 2015; Raza et al., 2020).

Furthermore, educational leaders may consider various professional development opportunities for students, teachers, and parents. For example, the documents presented on the

VDOE website may be incorporated within the new teacher training. This study did not address professional development specifically. However, it did reveal there is no statistically significant difference among the means of achievement of students in middle school using Blackboard, Canvas, or Schoology. Therefore, districts need to establish reliable connections to online LMS in which educators can teach students without disruptions. Also, districts need to ensure that Information Technology teams and shareholders develop and present information to students and parents, which will attract them to online programs for extended periods of time. Moreover, it would behoove districts to implement online diploma programs, certification programs, international courses, regular courses, and short-course programs. Many students pursue educational opportunities with other distractions, such as jobs, relocation, and inadequate support, so, it is suggested that districts implement online learning opportunities for all students. Another advantage to using a LMS is the access to centralized information by all shareholders. The LMS allows users to record all information in one centralized location, and students and parents can access this information anytime, from anywhere, using devices with compatible programs or apps. The usage of the LMS diminishes distractions to administrators for maintaining learning resources in multiple areas. Conversely, the use of the LMS will save districts on the cost of education. Further, the implementation of LMS will help students understand the benefits of the technology versus being intimidated by the technology. Furthermore, the implementation of LMS is proof that educational programs can be successfully implemented through an online LMS. It is suggested to spread the usage of the online platform and start implementing various activities. Society is quickly moving toward technology-based learning and, therefore, it is time to fully implement an appropriate online learning environment in the educational society.

The data in this study highlighted that the pass rate per district was 40%, therefore, the failure rate was 60%. This data is not too far off from previous years of Virginia Standardized testing. Traditionally, the Virginia Math 7 Standards of Learning test is the most difficult SOL test. Also, the cut rate to determine if a student has passed is higher than on other standardized tests. During previous years, before COVID-19, the state pass rate for the same test was only a few percentage points higher.

Limitations

There are several limitations that need to be addressed regarding both the internal and external validity of the current study. The internal validity was threatened due to the use of a standardized test created by the VDOE. The students who took the tests were students who chose to return to school after schools reopened. Therefore, not all students were included in the district pass rate ascertained from the VDOE website. Furthermore, the data was archival and could not be manipulated by the researcher.

External threats to validity included the specific testing environments, limited population, and setting used for the research study. Testing environments may have varied based on the testing district, students' access to online platforms, and how much they engaged with the platform. Additionally, factors, such as socioeconomic status, testing disparities, student motivation, and delivery methods (Au, 2009, 2016; Hanushek, 2016) may limit a study of this nature. Due to the nature of the data collection, limitations exist in the number of students who were tested. The data was collected based on standardized test pass rates during the COVID-19 or severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic, which limited the number of student scores included in the district pass rate. The limited scores included in the pass rate could have skewed the district pass rate. However, every effort was made to ensure that

the data was accurate and gathered with integrity. Also, due to the lack of professional development for students, teachers, and parents, there were some stakeholders who did not use the LMS appropriately. Some students were unsupervised or did not have ample assistance in completing assignments. Any researcher seeking to further this research should keep the aforementioned limitations at the front of their study.

Recommendations for Future Research

The current research is significant because it showed that student achievement on the Math 7 Standards of Learning test was achieved among the three LMS. Student achievement is a very important aspect of education, therefore, researching the difference between the means of these three groups was important. Recommended future research studies include those that will add to the existing body of research related to virtual learning, learning management systems, and students in public K-12 settings which include the following:

1) Replicating this study with students in elementary settings.

2) Investigating the use of an approved instrument about attitudes toward achievement.

3) Conducting studies that look at the parameters of other theoretical constructs.

4) Collecting data from pre-COVID-19 or post-COVID-19 standardized tests and comparing the results.

5) Replicating this study with the use of student achievement data during the 2021-2022 school year, when the students returned to face-to-face instruction.

6) Replicating this study to include all LMS (Google Classroom, EduServ, and Moodle) and any new LMS that are developed and implemented in the future.

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APPENDICES

Appendix A- IRB permission

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

May 31, 2022

Rosa Richard
Hoiwah Benny Fong

Re: IRB Application - IRB-FY21-22-1113 EFFECT ON STUDENT ACHIEVEMENT FOR
MIDDLE SCHOOL MATH STUDENTS USING BLACKBOARD, CANVAS AND
SCHOOLOGY IN THE STATE OF VIRGINIA

Dear Rosa Richard and Hoiwah Benny Fong,

The Liberty University Institutional Review Board (IRB) has reviewed your application in
accordance with the Office for Human Research Protections (OHRP) and Food and Drug
Administration (FDA) regulations and finds your study does not classify as human subjects
research. This means you may begin your project with the data safeguarding methods mentioned
in your IRB application.

Decision: No Human Subjects Research

Explanation: Your study is not considered human subjects research for the following reason:

It will not involve the collection of identifiable, private information from or about living
individuals (45 CFR 46.102).

Please note that this decision only applies to your current application, and any modifications to
your protocol must be reported to the Liberty University IRB for verification of continued non-
human subjects research status. You may report these changes by completing a modification
submission through your Cayuse IRB account.

Also, although you are welcome to use our recruitment and consent templates, you are not
required to do so. **If you choose to use our documents, please replace the word** *research* **with
the word** *project* **throughout both documents.**

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

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

Appendix B- Training Manual
Spring 2022 Test Implementation Manual

https://www.doe.virginia.gov/testing/test_administration/manuals/test_implementation/sp

ring-2022-tim.pdf