

Proctored Versus Non-Proctored Testing: A Study for Online Classes

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## Abstract

Research-based consensus about the about the connection between proctored and non-proctored assessments in online mathematics classes at the post-secondary education as related to success, retention, and final exam scores, provides instructors and administrators with little guidance when creating policies for online classes due to the lack of research. The purpose of the quantitative research design, using a series of logistic generalized linear mixed models (GLMM) were conducted to examine the relationships between proctor status and all the dependent variables, final exam scores, success (passing the semester with a 70% or higher), and retention of online mathematics students in the areas surrounding Baltimore, Maryland. Final exam scores, success, and retention were compared between students who were given proctored versus non-proctored tests during the semester to determine if there was a relationship between the test data in relationship to proctored versus non-proctored tests in online mathematics classes. A relationship status was determined by examining five different online mathematics classes with about 1900 students over a three-year period (2016-2018).

The results indicated students who took assessments during the semester in a proctored class were more likely to fail the final exam. Proctoring semester assessments meant students were 1.49 times more likely to fail the final exam. White and other races were more likely to pass the final exam than African-Americans. With final grades, students who were proctored were less likely to succeed. The result suggests students who attended the non-proctored assessments during the semester were 1.53 times more likely to succeed in the course. Results predicting retention demonstrated proctoring was not associated with retention. The only significant finding showed Whites were more likely to be retained than African-Americans.

## Dedication

This dissertation is dedicated to my three daughters who have supported and encouraged me throughout this journey. Each one of my girls has dealt with me working and researching over the years during “their time.” I look forward to seeing Payton, Skylar, and McKenna achieve professional and academic success, and make a difference in this world as we know today.

I also dedicate this research to all the men and woman in online education. In this ever changing world, more men and women are now able to follow their dreams and be successful due to online courses and program offerings. I have created online courses, taught online courses, and worked with people who were only able to be successful in the completion of their degree due to the opportunities of online classes and programs.

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## Chapter 1: Introduction

Online courses are increasing in popularity due to convenience and plasticity of not having to go to a class (Gregory & Lampley, 2016). At a Mid-Atlantic community college (MACC), the Mathematics Department aspires to work on raising the success and retention in online courses. The mathematics faculty debated if proctored testing versus non-proctored testing is affecting online students. With community colleges offering classes at a lower financial rate than four-year colleges, there is an influx of part-time online students from the community, four-year colleges, and military personnel who are stationed abroad. Community colleges are having the highest growth rate in online courses in higher education (Ashby, Sadera, & McNary, 2011). Gender and age difference can even make a difference when electing online classes (Haynie, 2015), which are discussed in Chapter 2.

The study conducted was designed to contribute to the body of knowledge about the connection between proctored and non-proctored assessments in online mathematics classes. Chapter 1 introduces the quantitative research study where a series of logistic generalized linear mixed models (GLMM) are conducted. The background of the study provides the research situation, including a review of some literature relating to online courses and topics surrounding proctored assessments in education. Chapter 1 presented the background of the problem, the problem, purpose of the study, significance of the study, research questions and hypotheses, theoretical framework, definition of terms used, assumptions, scope and delimitations, and limitations to provide additional information about the study's methods and procedures within the literature.

## Background of the Study

The struggle by the mathematics department at a junior college located in the Mid-Atlantic region of the United States, to implement rules about proctored and non-proctored testing may be attributed to the mixed outcomes found in the literature research. Online institutions and instructors have found strong evidence of a relationship between proctored and non-proctored assessments. The final exam scores are a good indicator regarding the success and retention of students. Research conducted on proctored and non-proctored testing has been done in different parts of the country, with different content areas, at community colleges, and four-year colleges. A number have shown high correlations with proctored and non-proctored assessments having different outcomes (Nash, 2015), and others have shown to have approximately the same scores (O'Connell, 2018).

When the first online degrees became available, computers were in more of an infancy state, and government financial aid was not allowed to be applied. In the early 2000s pioneer colleges of online education helped students' complete degrees, and eventually, Federal financial aid was being offered for online students (Ferrer, 2019). There is an estimate of four million students who are taking online courses annually, and the number is expected to rise well into the future (Ferrer, 2019). Although no one can put an exact number on online courses, there is no telling where the courses are going, so institutions have to research the best methods for success and retention in these now extremely popular classes. Despite the knowledge, the profession has largely still concluded different results on the relationship between proctored versus non-proctored assessments in relation to success and retention, due to mixed research. For instance, Harmon and Lambrinos (2008) concluded in the study, cheating took place more often in non-proctored assessments than proctored assessment which could affect success, while Watson and

Sottile (2015) found there was no more evidence of cheating behaviors in the non-proctored group than in a proctored setting, and Fask, Englander, and Wang (2104) determined the difference was in the testing environment which produced a disadvantage for online student test taking, which counterbalanced the advantage of cheating when the exam was non-proctored. For example, the stress of going to an unfamiliar environment to test causes anxiety.

Online courses are increasing in popularity due to convenience and plasticity of not having to go to a class (Gregory & Lampley, 2016). In fact, community colleges are having the highest growth rate in online courses in higher education (Ashby, et al., 2011). In the decade prior to 2011, online course enrollment in community colleges increased 18.5% on average, while the total U.S. enrollment in higher education increased 2.1% (Mitchel, 2017). The table below shows the increases in two-year colleges in the United States. The growth of students taking online courses, show the importance of studying online courses and instruction for improvement (Mitchel, 2017).

Table 1

*Educational Enrollment Data for Students in Degree-granting 2-year Higher Education*

*Institutions in the United States* (U.S. Department of Education, 2014, 2015, 2016, 2017)

	Total Percent taking any online course(s)	Percent taking at least one online course, but not all of a student's classes	Percent exclusively taking online courses
Fall 2014	27.9	17.3	10.6
Fall 2015	28.8	17.6	11.2
Fall 2016	30.7	18.6	12.1
Fall 2017	32.0	19.2	12.8

### **Statement of the Problem**

The problem to be investigated was how students are failing online mathematics courses, in which tests are proctored or non-proctored, at a higher rate than face-to-face courses. There have not been standards put into place about proctoring assessments during the semester in online mathematics courses, and the number of online classes the MACC is offering has increased. Since learning and success of all students is what the school system is about, the problem is of great importance. Perhaps more studies regarding online mathematics classes would provide further insight as to how online mathematics courses can be taught in an electronic venue in order for the academic achievement of students to be measured. Those impacted by the problem of students not being as successful in online mathematics classes, are the students in the online mathematics classes each semester, the instructors, those in charge of college finances, and community businesses who hire students with an associate's degrees.

The Mid-Atlantic community college serves over 62,000 students with about 45% of the students being white, and 33% African American, 6% Hispanic or Latino, 6% Asian, 2% multicultural, and 8% unknown. In addition, there are over 35% of students who are Pell Grants recipients. Furthermore, the community college has about 29% of students who take an online course, which has seen an increase each year.

The gap in the literature is between proctored and non-proctored assessments and the relationship with success and retention in online mathematics classes specifically. Knowing if proctoring assessments in online classes is affecting success and retention, and if so, what type of proctoring and technology is best for the school and these classes, is important. The information needs to be known for the financial view of the college and the success of the students. The gap was closed by looking at multiple online mathematics classes and student test scores which have

proctored assessments throughout the semester as well as those without proctored tests. Data were collected from instructors on experiences with proctoring, the technology, and student responses experienced.

A lack of understanding about the impact of proctoring assessments in online mathematics education classes affects students, institutions, and communities. Non-proctored, online assessments promise a low-cost opportunity to reach a large, heterogeneous, and geographically diverse population (Gosling, Sandy, John, & Potter, 2010). In recent years, non-proctored, online testing has become the main assessment mode in the academic field (Allen & Seaman, 2014). The advantages of non-proctored testing can come at the cost of the lack of supervision, less standardized test taking conditions, and less control over the student's behavior. The question may arise about dishonest behaviors in non-proctored assessments leading to unfair scores and threats of the usefulness of online tests as a whole (Steger, Schroeders, & Gnams, 2018). The individual institution can be responsible to look into the needed information to make a determination.

### **Purpose of the Study**

The purpose of the quantitative correlation research design was to examine the relationship of the following final exam grades (pass/fail), percent of success (passing the semester with a 70% or higher), and percent of retention of online mathematics students. Final exam scores, percent of student success, and percent of student retention were compared among proctored versus non-proctored tests during the semester. The comparison determined if there was a relationship in online mathematics classes. The proposed study was necessary for the MACC and the mathematics department, to determine if the college can increase online success and decrease dropout rates through the type of assessments given to students during the semester.

Research indicates, online assessments are a challenge when determining a student's performance (Hollister & Berenson, 2009). Studies have found the percent of success in online classes are lower than in the comparable face-to-face classes (Borzewski, 2016). If the research was not conducted, there would not be a conclusion as to whether proctoring tests affect the success of online students to meet or exceed those in face-to-face classes. The study contributes to the knowledge base by determining if proctored assessments affect successful education in online mathematics classes for students in at MACC.

Success is achieved for students by earning 70% or higher as the final grade in the course. Cumulative final exam grades (pass/fail) were analyzed for students who had a proctored test during the semester, and those who had not. Retention is upheld when students have passed a mathematics course, signed up for the subsequent course needed in the student's program of study in order to earn a degree, certificate, or to transfer. Online student retention needs to be looked at in each higher education institution as a wholistic, complete program approach in order to prepare the students for a job after graduation (Kalinski, 2015). Data were sourced from secondary data sources the Program Research and Evaluation Department has on file about students at MACC. The study was designed to provide the Mathematics Department, online departments, and administrators at MACC with information about how proctoring tests in online mathematics classes are related to success, retention and final exam scores. The completed research study was shared with the Mathematics Department, the online departments, and administrators of the college.

### **Significance of the Study**

This research study has been designed to be specifically applicable to instructors and administrators. Administrators, instructors and students at MACC in online mathematics classes

may benefit from research. Information was gained about possible effects of proctoring or not proctoring assessments in online mathematics classes when determining success, retention, and final exam scores. Decisions may be influenced by what percentage of assessments need to be proctored to benefit the students, school, community, and ultimately attain a degree.

Alignment of the data shows how the items can all work together in order to achieve the desired goals. Results of the data give information on research, and recommendations to educational institutions, administrators, and instructors who are interested in a more in-depth examination of online assessments in other geographic locations or cultural settings outside of the study (Enago Academy, 2019). Failing to do the study may leave the community college uninformed about the future of proctoring assessments in online mathematics classes while valuing success and retention. Research designed to contribute to the body of knowledge in online higher education as a predictor to effects of proctored and non-proctored assessments is of importance.

Additional information with specific data focusing on the areas of success and retention of students in online classes compared to traditional face-to-face students as well as gender and age. Online success and retention remain a problem at the higher educational level which needs to be addressed. For students, dropping out may typically mean unrealized possibility and lower earnings over the course of a career, but the success of the university ends up being intertwined with student success as well (Millea, Wills, Elder, & Molina, 2018). In addition to focusing on success and retention, student integrity was considered, insuring credibility for students and the institution. As online classes and programs have blown up in numbers, the academic integrity issue has taken center stage with program design (Wagner, Enders, Pirie, & Thomas, 2016). The study addressed issues important in online mathematics classes at the community college level.

## Research Questions

The following research questions guided the study based on the theoretical framework. Research questions were developed to address the problem. To achieve the purpose of the study, the following research questions were used for the quantitative study:

Research Question 1: What is the relationship between student final exam scores, (pass/fail) for students with proctored versus non-proctored online math tests?

Research Question 2: What is the relationship between the percent of student success for proctored versus non-proctored online math tests?

Research Question 3: What is the relationship between the percent of student retention for proctored versus non-proctored online math tests?

## Hypotheses

The following hypotheses were developed based on the research questions for the study. Hypotheses were written based on the quantitative research design using a series of logistic generalized linear mixed models for the statistics for analysis. To achieve the purpose of the study the hypotheses were as follows:

$H_{I0}$ : There is no relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

$H_{IA}$ : There is a relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

$H_{20}$ : There is no relationship between the percent of student success with proctored versus non-proctored tests.

$H_{2A}$ : There is a relationship between the percent of student success with proctored versus non-proctored tests.

H3<sub>0</sub>: There is no relationship between the percent of student retention with proctored versus non-proctored tests.

H3<sub>A</sub>: There is a relationship between the percent of student retention with proctored versus non-proctored tests.

### **Theoretical Framework**

This research study was based on the theoretical framework of the Theory of Planned Behavior, which was developed by psychologist Icek Ajzen. The Theory of Planned Behavior is a cognitive theory which aims to predict and understand the relationship between human behavior and motivation (Peters, & Templin, 2010). Based on the theory of belief, people use information and reasoning to guide personal behavior. A key component to the model is behavioral intent, which is influenced by the likelihood a behavior has an expected outcome as well as the risks and benefits of the outcome (Boston University, 2018). Variables are used to predict an individual's behavioral intention, which in turn is used to predict actual behavior. Weight of an individual variable may vary depending on the behavior and the population (Boslaugh, 2013). Researchers have found a student's likelihood of cheating depends on the degree to which the students can rationalize cheating in a given circumstance (Eisenberg, 2004). Development of new behaviors and practices is key when leaders are considering to what extent factors like motivation and technology are impacting students cheating problem within each individual institution (Bolman & Deal, 2008).

Research questions and hypotheses in the study were focused on the theoretical framework in which proctored and non-proctored assessments were the independent variable. Performance measures such as final exam scores, success, and retention were the dependent variables. Chapter 2 offers evidence of relationships between online learning and assessments,

success, retention, and possible integrity issues higher education institutions need to consider. Additionally, Chapter 2 recaps research and information which exists within the same framework.

### **Definition of Terms**

Definitions are provided below for the study's dependent and independent variables. Additional terms used in the research study having multiple meanings or may be ambiguous are listed below as well. Definitions of terms for the study are:

***Course ID.*** The name of the online mathematics course in the study (Community College of Baltimore County, 2019).

***Grade.*** Dependent Variable. The study had letter grades representing final exam scores. A: 90%-100%, B: 80%-89%, C: 70%-79%, D: 60%-69%, F: 0% - 59%. The grades are on the student's transcript for the class (Community College of Baltimore County, 2019).

***Higher Education.*** Education past (after) the high school level (Kirkman, McNees, Stickl, Banner, & Hewitt, 2016). Represented in the research and study as education at the community college level.

***Proctoring.*** Independent Variable. The study provided two different proctoring states, which are represented by a dichotomous variable ("Proctored" or "Not Proctored"). The coding used in the analysis has presence of proctoring or the absence of proctoring. A challenge to consider with online classes is the perception associated with academic integrity, and compromised testing due to undetected cheating with testing, which yields artificial high grades. To address concerns, proctoring and proctoring software has been developed in hopes of preventing academic dishonesty (Alessio, Malay, Maurer, Bailer, & Rubin, 2017).

***Retention.*** Dependent Variable. The study provided two different retention states, which are represented by a dichotomous variable ("Retained" or "Not Retained"). Retention continues to

be an issue for colleges as the number of students taking an online course continues to increase. Not only is the student who dropped affected, but so are other parties such as the college and eventually the community (Cochran, Campbell, Baker, & Leeds, 2014).

**Success.** Dependent Variable. The study provided two different success states, which are represented by a dichotomous variable (“Successful” or “Not Successful”). Success is when a student earns a 70% or above as a final semester average for the given online mathematics class at the Mid-Atlantic community college. As the popularity of online education continues to grow, so do concerns about student success. Online students typically withdraw more often and receive lower grades, compared to face-to-face students, and institutions need to have the goal of improving online learning (Gregory & Lampley, 2016).

**Term.** The semester and year of the online mathematics course (Community College of Baltimore County, 2019).

### **Assumptions**

This study involved the collection of online mathematics student’s final exam scores, percent of student success, and percent of student retention at the study site. The collection of data were completed by the Program Research and Evaluation Department at the school. Online mathematics classes used in the study are institutionalized, which means the students take the same assessments during the semester, with the possibility of appropriate random numbers inserted into each question. The assumption is, the instructors in each class told the truth about whether proctored or non-proctored assessments were given during the semester. A questionnaire was sent to each instructor in an email with each class in the study listed in a chart form. Instructors checked the appropriate box with as to whether proctored or non-proctored

assessments were given for each individual class. The assumption is necessary as there is no other documentation about how the tests were given.

### **Scope and Delimitations**

This study focused on a large community college in the Mid-Atlantic region of the east coast. The sample consisted of about 1900 students who took institutionalized online mathematics courses at the Mid-Atlantic community college. Standardizing online courses in the mathematics department as well as final exams started in the fall of 2016. Due to evaluation and assessment instruments across the same courses having multiple variables prior to 2016, the focus is restricted to the study of the classes starting in 2016. Generalizing of the findings to other community college online mathematics courses beyond the study site is likely limited, due to the scope of the study.

A three-year period, from the fall of 2016 to the fall of 2018, was covered in the study. A longer time period has not been selected due to time constraints associated with data collection. MyOpenMath (2018) was the free online homework and assessment system used in all of the classes in the study. All online classes were institutionalized and used by all instructors during the three year period, so students were getting a similar experience.

### **Limitations**

This study focused on success and retention as a measure of proctored and non-proctored assessments throughout each semester. The given process is the only method of possible grade differences which determine success, and ultimately possible retention differences and relationships at the community college during the three-year period of 2016–2018. Low completion rates are a problem for colleges who seek to serve students, employers who are reliant on a workforce and economic prosperity (Levesque, 2018). A three-year period has been selected

for the focused research to include a variety of instructors, both full time and adjunct, as well as a variety and diverse population of students. During the time frame, the classes were institutionalized, online, and included similar assessments, giving the students as close to the same experience in each class as possible. These students were in five different levels of math to help alleviate any potential student and instructor bias. More students were in the study due to data which states students at community colleges during the given time, were more likely to sign up for at least one online course than in four-year institutions (Lederman, 2018).

The study focused on proctored and non-proctored assessments as the independent variable. Lurking variables having the potential to impact the student's performance within the research sample may have existed. Other demographic variables which could have a potential impact on students' performance include age, having to take care of family members, and the number of hours students need to work outside of an education commitment (Glazier, 2016). The research sample was diverse in these and students of all demographics in the study had an equal opportunity to sign up for an online mathematics course in place of a traditional face-to-face course.

### **Chapter Summary**

Chapter 1 provided an introduction and overview of the research study. The purpose of the quantitative study was to determine the degree to which proctored versus non-proctored assessments were related to success and retention in an online mathematics class. Measuring the data were accomplished by comparing the final exam scores (pass/fail), success and retention of online mathematics students for a three-year period (fall 2016-fall 2018) in a large-sized community college in the Mid-Atlantic region. The problem to be addressed was, there has been minimal research-based consensus about the benefits of proctored assessments in online classes.

There are benefits of researching the problem and relating student success and retention, leaving community colleges with little guidance when establishing criteria for assessments in online mathematics classes.

Chapter 1 introduced the study's research questions, hypotheses, the theoretical framework, and the methodology which was used to address these questions and hypotheses. Chapter 1 included the research study's definitions, assumptions, scope, delimitations, and limitations. The study's significance and importance are described and included contributions to the existing body of knowledge relating proctored and non-proctored online testing to success and retention with online mathematics students. Chapter 1 provided a background of literature relevant to the research study. Chapter 2 provided a more in depth and comprehensive review of the literature related to online classes, success, retention, proctored and non-proctored testing, integrity, and the relationships compared amongst themselves and to face-to-face traditional classes.

## Chapter 2: Literature Review

Online classes are becoming more popular amongst students across the United States, and more colleges are offering online classes in significantly increasing numbers. The popularity of online courses is partly due to convenience and plasticity (Gregory & Lampley, 2016). The Mid-Atlantic community college (MACC), for example, increased online courses by 20% in just the spring of 2018 (Community College of Baltimore County, 2018). Many students who enroll in online courses have families and work responsibilities which make attending a class in person difficult, in turn rendering online courses more appealing (Gregory & Lampley, 2016). Online instruction is an area in which MACC needs to be prepared to make students as successful as possible.

Neuman (2003) identified purposes of a literature review to be varying in capabilities of, for example, finding gaps in knowledge on a topic, demonstrating a flow in the literature, and showing the topic in a broader yet relevant context in order for the chosen topic to be credible. The chosen topic determines whether proctored versus non-proctored assessments affect final exam scores, success, and retention of online mathematics students. MACC is experiencing the issue of students failing online mathematics courses at a higher rate than students who are enrolled in face-to-face courses which are solely proctored. The background of the problem is, the number of online classes MACC offers has been increasing, and the faculty does not necessarily agree on the amount of proctoring for each online mathematics class. The problem is important, considering students' success and gained knowledge is the focus behind a school system (U.S. Department of Education, 2015a). Those affected by the problem are the students enrolled in the online mathematics classes each semester, the instructors, those in charge of college finances, and community businesses who hire students with associate's degrees.

This study contributes to the literature with specific data in online mathematics classes. The contributions are accomplished through observations of the online mathematics classes and analysis of students' final exam scores, success (passing with a 70% or higher), and retention. The data were then be compared with those who received proctored assessments throughout the semester, those who did not receive proctored tests, and those in traditional face-to-face classes. About 29% of the total community college student population is enrolled in one or more online courses—a percentage which increases each year. In the fall of 2018, 4% of the online students were full time, while 96% were part time. While 67% of online students were female, 33% were male. Regarding ethnicity, 6% were Hispanic or Latino, 43% were Caucasian, 39% were African American, 7% were Asian, 4% were multi-racial, and 1% were unknown. 21% of the online students were aged between fifteen and nineteen years, 47% between twenty and 29 years, 19% between 30 and 39 years, 12% between 40 and 59 years, and 1% were aged 60 years or more (Community College of Baltimore County, 2018).

The MACC has a student body of over 62,000 students who are eligible to take online courses, while roughly 45% of the students are Caucasian, 33% are African American, 6% are Hispanic or Latino, 6% are Asian, 2% are multicultural, and 8% are unknown (Community College of Baltimore County, 2018). In addition, over 35% of students are Pell Grants recipients. The total enrollment at MACC has been gradually decreasing over the past four years. In 2018 alone, enrollment decreased by 3% overall (Community College of Baltimore County, 2018).

The purpose of the quantitative research design was to determine the following variables of online mathematics students at MACC: final exam scores, success, and retention. Quantitative research was used to pose hypothesis constructs and frame the research questions (Waruingi, 2013). Correlational research attempts to quantify a relationship between combinations of

variables for which analysis methods have been made available (Creswell, 2005). The study determined whether there was a relationship in online mathematics classes between proctored assessments, success, and retention. Retention occurs when students pass a mathematics course and sign up for the subsequent course required in the program of study in order to earn a degree or certificate or to be eligible for transfer.

A research study, as described, can contribute to the literature by determining whether the proctoring of tests affects the success of online students by meeting or exceeding those in face-to-face classes. Cumulative final exam scores were analyzed for students who have and have not received proctored tests during the semester. These final exams are the same tests students in face-to-face classes receive. Results of the study have been shared with the mathematics department, the online departments, and administrators of the college.

The framework is based on the theory of planned behavior, which focuses on understanding the relationship between human behavior and motivation (Boslaugh, 2013). The theory includes variables believed to contribute a significant influence on outcomes related to cheating behaviors in cases such as the taking of non-proctored assessments in online classes (Madara, Namango, & Katana, 2016). The theory of planned behavior can be applied to the major sections of the literature review, which discusses online classes, students' success, students' retention, proctored and non-proctored testing, and integrity in online classes. The data firstly compares students who have received proctored exams with those who have not received proctored exams during the semester, and secondly analyze how success and retention may be related.

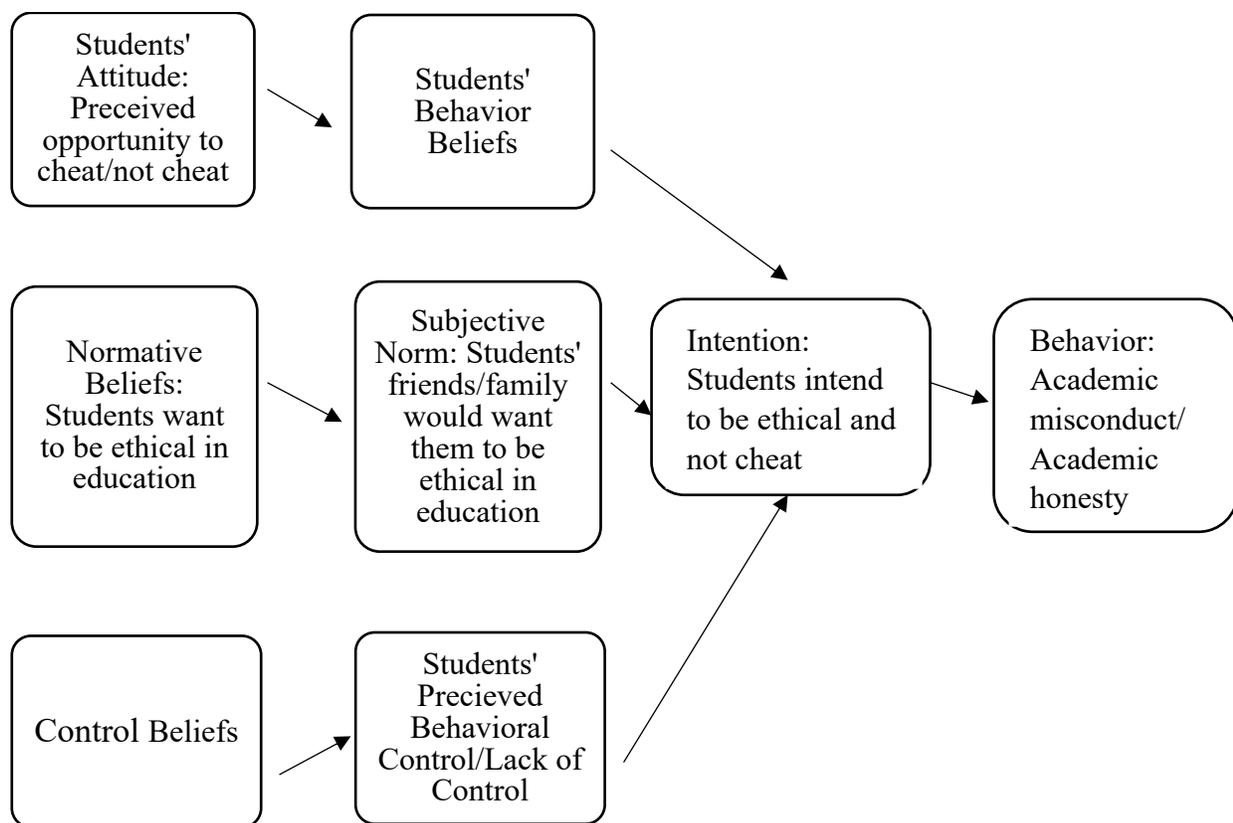
### **Literature Search Strategy**

Literature search strategies for the study were used continuously throughout the research process. The main strategies involved searching online databases through EBSCO Library Information Services from the American College of Education, searching the internet for scholarly literature through Google Scholar, and visiting a library to search books and the online system. The results returned reliable and credible databases, e-journals, magazines, and e-books, all of which produced viable peer-reviewed literature. Research studies were identified by searching key words such as: *online classes, online courses, online education, online classes in higher education, proctored versus non-proctored assessments, proctored versus non-proctored, assessments in online classes, online assessments, success in online courses, success and retention in online classes, retention in online courses, cheating in online assessments, and integrity in online classes*. Simple key word searches should not be expected to always lead to optimal results listed in order of relevancy (Haigh, 2006). The library and librarians were accustomed to locating research books on topics such as quantitative research, research methods, data collection, and data analysis. Literature search strategies can somewhat easily provide knowledge of what research has been conducted, what results were found, how the information may be of assistance, and what still needs to be completed (University of Leeds, 2018).

### **Theoretical Framework**

The theoretical framework for the research study is based on the theory of planned behavior, which was developed by psychologist Icek Ajzen. The theory of planned behavior is a cognitive theory aimed to predict and understand the relationship between human behavior and motivation (Peters & Templin, 2010). The theory is based on the belief, people use information and reasoning to guide behavior. A key component to the model is behavioral intent, which is

influenced by the likelihood a behavior has an expected outcome as well as the risks and benefits of the outcome (Boston University, 2018). Variables are used to predict an individual's behavioral intention, which in turn are used to predict the individual's actual behavior. The weight of an individual variable may vary depending on the behavior and the corresponding population (Boslaugh, 2013). Figure 1 provides a visual representation of how the principles of planned behavior relate to a student's characteristics in regard to ethical behavior in an online assessment.



*Figure 1.* Left-to-right view of planned behavior concerning students and ethical behavior in regards to cheating. Students' attitudes, normative beliefs, and controlled beliefs come together.

Empirical researchers have confirmed the validity of the theory of planned behavior in regard to predicting human behaviors (Chu, Chen, & Sung, 2016). Per the theory, there are three predictors of human behavior. *First*, there is an attitude toward behavior, which is the extent of

positive or negative appraisal a student would possess regarding a given behavior. *Second*, there are subjective norms, which are a student's perceived social expectations or pressure to conform to the given behavior. The *third* predictor is perceived behavioral control, which is a student's perceived ability to carry out the behavior based on past experience (Yang, Choi, & Lee, 2018).

The theory of planned behavior includes demographic variables believed to contribute to a significant influence on outcomes related to cheating behaviors in situations such as the taking of non-proctored assessments (Madara et al., 2016). Some of these behaviors are factors of gender, discipline, and education level (Whitley & Keith-Spiegel, 2002). Some concepts students typically manifest within themselves to justify behavior are: "It was not my fault," "It was not a big-deal," "You were just as bad when you were my age," and "My friends needed me. What was I going to do?" (McQuillan & Zito, 2011). The concepts listed present justification as to why students may violate ethical codes which would otherwise be supported (McQuillan & Zito, 2011).

Bolman and Deal (2008) declare most effective leadership in theories such as the theory of planned behavior establish meaning and predictability in what is considered a disordered world. Researchers have found, a student's likelihood of cheating depends upon the degree to which the student can rationalize cheating in a given circumstance (Eisenberg, 2004). Curtis, et al. (2018) have determined both self-control and perceived behavioral control, when contributing to the prediction of plagiarism and cheating, are the best fit in the event which direct paths from perceived norms to plagiarism behavior are specified. The information suggests schools which set strong anti-plagiarism norms, such as honor codes, and pursue the enhancement of students' self-control may reduce student engagement in plagiarism and cheating. The need for the development of new behaviors and practices is key when leaders are considering to what extent factors such as

motivation and technology affect the student cheating problem within the institutions (Bolman & Deal, 2008).

There are several limitations and undetermined factors of the theory of planned behavior in regard to integrity and cheating. The theory of planned behavior assumes, regardless of the intentions, the involved students have attained opportunities and resources with which may be used to become successful while practicing the desired behavior. While the theory does consider normative influences, the theory does not account for all environmental or economic factors, which may influence a student's intention to perform a behavior (Boston University, 2018). In the future, researchers may want to investigate additional factors of theory, such as the role of religion. Religion may increase the variance explained in any model of cheating (Al-Dossary, 2017). Finally, research found men were more likely to cheat than women, which may lead to varying behaviors of men versus women (Al-Dossary, 2017).

The research questions and hypotheses in the study were focused on the theoretical framework in which proctored and non-proctored assessments were the independent variable. Performance measures such as final exam scores, success, and retention were the dependent variables. Chapter 2 offers evidence of relationships between online learning in regard to assessments, success, retention, and possible integrity issues, higher education institutions should consider. Research and information which exist within the same framework is reviewed in Chapter 2.

### **Research Literature Review**

Instructors and administrators in education throughout the United States must make informed decisions when creating and establishing criteria for online mathematics courses. The problem is, there is minimal research-based consensus about proctored and non-proctored testing.

The literature review examined some of the debated topics of online courses, like integrity, retention, and proctoring.

### **Online Courses**

As online course offerings evolve, more strategies have been researched for the purpose of improving the online learning experience for students and instructors alike. Woods and Bliss (2016) believe increasing students' engagement in online discussions and the assessment process, providing feedback, and overcoming some challenges in the facilitation of online course discussions are all the best practices for online education. Reflective assessments and grading rubrics are recommended for students' learning, as well (Woods & Bliss, 2016). Martin, Wang, and Sadaf (2018) verified, instructors need to establish presence, connection, and engagement in order to achieve the most effective learning. The more thoroughly the students are involved, the more strongly the students want to remain in the class in order to learn in future classes (Martin et al., 2018).

Reddy and Andrade (2010) recommended course rubrics for assignments and assessments, along with a timely instructor grading system included for students' satisfaction in online courses as well. With these recommendations, not only may students' learning and engagement increase, but the exceptional instructors using these methods could become mentors who may help enhance other teachers' instruction and online classrooms (Reddy & Andrade, 2010). Student capabilities in online classes are different than those needed to succeed in face-to-face classes, and instructors need to determine what increases students' satisfaction, self-motivation, and the ability to manage time wisely in order to become successful, independent learners based on the course requirements (Lee, Stringer, & Jianjun, 2017).

Jayaratne and Moore (2017) conducted a research study at North Carolina State University to determine students' perceptions toward online classes. With about 90% of students possessing experience taking an online class, a student's decision to take an online course or a face-to-face course seemed to be based primarily on class scheduling. Platt, Raile, and Yu (2014) concluded, students in higher education settings felt there were fewer opportunities to interact in online courses with instructors and classmates, which made students believe slightly less knowledge was gained. Despite this, students claim online courses possess the same rigor as face-to-face courses. The most helpful online instruction methods students believed may help close the gap, according to Jayaratne and Moore (2017), were instructional videos, PowerPoints with recorded narratives, video recordings of face-to-face courses, instructional audios, and reading materials. The information encourages instructors to find ways to replace visual and verbal instruction used in face-to-face classes. The materials may assist older students who feel online courses are more difficult in general (Jayaratne & Moore, 2017).

Beck and Milligan (2014) indicated positive effects on a student's persistence and success have been recognized for quite some time in face-to-face programs, and more studies need to be conducted with online students. Institutions need to investigate students' family backgrounds, reasons for attending online courses, demographics, and experiences in order to improve online learners' institutional commitment and success (Beck & Milligan, 2014). Ouzts (2006) claimed online courses designed to promote a sense of community may address many of these concerns.

Ouzts (2006) suggested, concerning online courses and the continuous, rapid growth, there is still considerable concern among educators in regard to the quality of the learning experience. Students themselves have expressed concerns regarding the lack of contact with faculty and peers, which has made the students sense isolation in cyberspace as well. These feelings of isolation and

disconnect may contribute to negative learning outcomes and lower retention. Regardless, students are choosing online courses because of the flexibility, convenience, and accessibility (Sanford, Ross, Rosenbloom, & Singer, 2017).

Distance learning models have evolved over the past few decades. Social media and technologies, according to Friedman and Friedman (2013), encompass a wide variety of learning strategies which can enhance online learning, such as blogs, wikis, online social networking, and virtual worlds. Knowing many students are not retained and quit college because courses were uninteresting, requires educators to more actively motivate success. Over 80% of chief academic officers believe massive open online courses (MOOCs) are an important factor in helping teachers learn about online pedagogy and improve online classes, according to Allen and Seaman (2014). Online education is being used as an alternative to the violent schools to which some students are assigned, and thus becoming important for institutions to improve online classes when many disadvantaged children are being taught online and need help achieving success (Friedman & Friedman, 2013).

Peslak, Kovalchick, Wang, and Kovacs (2018) studied students enrolled in computer information systems courses at three colleges during the 2016–2017 academic year. The students comprehensively preferred the face-to-face course delivery method over the online method. Sole online course delivery was considered moderately effective according to the surveyed students. As reported by Kovacs, Peslak, Kovalchick, Wang, and Davis (2017), when asked which option students would select if given the choice between online or face-to-face presentation, 54% of students preferred the latter, while 46% preferred the former. Hybrid courses were found to be effective by 84% of students. Contrary to solely online courses, neither age nor gender differences

were found to be significant regarding the effectiveness of hybrid courses. The fact of online courses being perceived as less favorable, is a call for improvement in online delivery methods.

Various cultures may perform differently in online classes, as well. Tucker (2014) identified conditions within and outside online class environments which supported academic success among male college students of color. Some of these factors within online environments support academic success, and are convenience and flexibility, a colorblind environment, faculty support and immediate interactions, and institutional support (Tucker, 2014). Beyond the online environment, factors such as self-efficacy and educational resilience affect online classes. In addition, Moore (2014) noticed some African American students withdrew from online courses and specified the decisions were associated with inadequate technology, computer skills, and support as well as perceived course difficulty.

Students of color preferred in-person social supports, which may lessen the feelings of isolation and alienation often experienced by students in online classes (Tucker, 2014). Economic factors may influence academic underachievement among African American male college students. According to the National Center for Educational Statistics (2015), 50% of African American male students are raised by single mothers. Single-parent families in which African American males are usually raised are typically associated with a greater incidence of poverty (United States Census Bureau, 2015). Greater incidences of poverty and lower incomes are associated with subordinate educational outcomes (Child Trends Databank, 2015). Travers (2016) believed African American male students as well as others stemming from lower socioeconomic populations with lower standards in grade school need to keep up with employment obligations while remaining motivated in school. Due to the outside factors affecting these students, the

pursuance of higher education online is not only appealing, but necessary for the goal of a degree or certificate.

In the United States, there have been some challenges faced in online courses. For instance, various institutions considered different levels of online classes as being “online”. Online courses have now been defined as having at least 80% of the course material delivered online (Allen, Seaman, Babson Survey Research Group, & Quahog Research Group, 2015). Online and distance education studies have faced challenges due to the content being reported and not reported, especially in regard to blended, hybrid, and fully online courses. The content is something leadership may be able to develop more affluently while providing additional innovations for long-term success. According to Allen and Seaman (2014), another issue involves comparing retention in online courses to those of face-to-face courses. Due to there being online students who may have never attended a college class if there were exclusively traditional classes, the comparisons may not match. If students drop out of an online course due to the environment, the dropout may be a reflection not of the class, but of the student’s nature.

### **Success of Students in Online Classes**

Success is the goal of education. Studies have found success in online classes are lower than those in the comparable face-to-face classes (Borzewski, 2016). Researchers have delved into demographic issues, academic concepts, enrollment, and environmental factors surrounding success. Online courses offer convenience and flexibility, although many of these students who want to sign up for online courses possess characteristics which may lead to high risk of academic failure (Gregory & Lampley, 2016). Not only was success in online classes at the community college level lower than those in face-to-face classes, there were significant differences in success rates based on the types of instructional methods used (Gregory & Lampley, 2016). Borzewski

(2016) explains how higher education professionals need to be educated on instructional methods and potential impacts of students in online classes in order to achieve the greatest success.

Shotwell and Apigian (2015) surveyed students to determine potential impacts which affect online students. The impacts covered student insight, academic resources, and core motivating factors which lead to success in class. For instance, students mainly used homework as the first tool to learn a new topic. Instructors should be aware, and tailor approaches toward student learning and behaviors which are associated with success in regard to online testing (Shotwell & Apigian, 2015). Matika (2012) concluded, in an online study of mathematics courses at a community college, the difference in the lower success rates and retention rates in these courses compared to face-to-face courses may be a result of student self-efficacy, communication, and presentation on the instructors' part. The findings both conclude the instructors can make a genuine impact and a worthy difference on student success.

Research reveals students who learn in online classrooms may be affected by self-efficacy and success academically, however a higher success can be reached than with students in traditional classrooms who do not utilize technology (Ozerbas & Erdogan, 2016). The incorporation of digital-based activities can increase students' motivation and result in higher success rates. Many students can relate to technology and be comfortable communicating through it, which can promote connections between everyday life and the courses themselves (Ozerbas & Erdogan, 2016). Success and technology in online classes are becoming even more important with the expansion of online classes, even among on-campus and typically traditional students (Murphy & Stewart, 2017). All online student success among community college students and four-year college students cannot be generalized in all cases. There may be too many variables, such as the student diversity, or type of assessments given, which vary within each type of college

and should be considered, and thus individual colleges may wish to conduct research individually (Ashby et al., 2011).

If higher education continues to grow with online offerings, there should be an expansion of support for students and instructors alike. Rey (2010) described how the online modality of teaching is gaining ground at such a rapid rate, but without guidelines for quality and merit, there are too many unknown factors for students and instructors. Betts, et al., (2013) focused on student success in online classes and explained how accessibility is one support which should be a priority when designing a course for the purpose of increasing success. Accessibility and online courses are a collective responsibility which requires a commitment from the institution and instructors alike. Many institutions have used online education as a way to reduce costs and increase enrollment, which students have bought into for alleged ease and convenience (Rey, 2010). Institutions should maintain student and instructor support as a priority for future success.

Although many success rates have been lowered in online courses than in comparable face-to-face classes, clarity is still needed as to whether other variables such as student demographics and history are related to the issue as have been in some remedial math classes in higher education (Borzewski, 2016). Friedman and Friedman (2013) suggested the issues in online education are raising the standard and making the classes interesting for a diverse group of students—a feat instructors have tried to accomplish in face-to-face classes over the years. Hybrid classes, according to the study, may be the best method to teach courses for college students while maintaining interest and connection. The business world is implementing like strategies in stores such as Wal-Mart and Target. Wal-Mart and Target sell an abundance of products both in store and online, and both options possess particular benefits. Friedman and Friedman (2013) believed online learning, to some degree, should be taught as early as kindergarten in order for students to

understand the valuable tools of discipline and persistence, which could ultimately help students acquire a degree, and in order for institutions to understand how many variables are related.

California community colleges, according to Johnson, Cuellar Mejia, and Cook (2015), believed in giving instructors new pedagogical tools and ways to track students in order to implement a more data-driven, integrated, and systematic approach geared toward improving online learning. Online education has allowed for increases in enrollment without the requirement of additional classroom space. The setting of standards and provision of tools for instructors contributes toward the increased availability of online courses to those who could not reach a brick-and-mortar classroom—with just as much success—and may close the gap in success for all students. Bernard, et al. (2014) determined there is a strong association between the strength of communication and success in online courses compared to face-to-face classes. Teaching standards, provisions of tools, and strong communication skills to instructors, may increase cognitive engagement and may be promoted by strengthening interactions and success in online courses.

California community college students enrolled in online developmental and traditional courses over a four-year period were studied by White (2013) as well. The study sought to determine whether gender had an impact on success. Overall, women were found to be more successful than men in any modality of course taking (White, 2013). There existed no difference in success in online classes versus face-to-face classes. Gregory and Lampley (2016) agreed, women outperform men on average, but went a step further. The study looked at non-Pell Grant-eligible students and nontraditionally aged students in online classes. The study determined these students had higher success rates, even though there was typically more work-related, financial, and personal responsibilities and burdens. Another point noted was, students who are not Pell

Grant eligible receive alternative financial aid and are only able to continue receiving financial aid if a certain GPA is maintained as well as a full-time student status, which often determines if students can stay in college or not.

Shea and Bidjerano (2014) analyzed data to compare degree completion rates of community college students enrolled in online courses during the first year enrolled, to students enrolled in all face-to-face courses the first year. The conclusion of the study noted, students who registered for online classes during the first year of college had higher rates of attaining a degree than those who did not take online courses during the first year. Researchers often agree, the most successful students who earn degrees in online courses are self-disciplined, goal-oriented, responsible, and organized (Johnson & Berge, 2012). These students are abreast in time management, multitasking, and critical thinking, and tend to take responsibility for learning, and are capable of working independently. These are typically characteristics of an adult learner, who is often considered a nontraditional student. The students are usually more mature and possess prior knowledge and life experiences to which can be related to education and have effectively introduced these elements back into online education classes (Johnson & Berge, 2012).

A data analysis of online students and face-to-face students was conducted with more than twelve years' worth of studies, and Means, Toyama, Murphy, Bakia, and Janes (2009) determined online students generally performed better than face-to-face students. Understanding how students succeed in online courses may lead to even far greater success. Such an understanding may significantly contribute to initiatives which could double the number of American college graduates. Effective practices for engaging and motivating students to persist toward success can be most effectively tackled through collaboration with other online learning organizations (Moore & Fetzner, 2009). Together, instructors and institutions can achieve more in less time.

Quality education is a goal for all means of instruction, the Online Learning Consortium (2015) explained, and included satisfaction, fairness, and rigor for students, as well as instructor and peer interaction. Effective professors help students achieve learning outcomes and require the support of a technical infrastructure and training in online skills in order to achieve these goals. Although learning effectiveness is focused on ensuring online students are provided with a high-quality education which is at least equivalent to traditional students, there is no implication online learning experiences should duplicate what occurs within traditional classrooms (Online Learning Consortium, 2015). Xu and Jaggars (2014) suggested, although gaps persevere between online and traditional classes in persistence and course grades, in order to ensure positive and effective online learning experiences, the traditionally underserved students should be truly supported in each case. If these students are not, the continued expansion of online learning may strengthen rather than diminish educational inequity (Xu & Jaggars, 2014).

Shea and Bidjerano (2014) suggested students do not achieve degrees or certificates in online programs at the community college level when enrolling during the first year. Contrary to preexisting expectations, the study additionally noted, students with certain background characteristics who take some online classes early on do have a better chance of obtaining credentials as opposed to solely traditional peers. Institutions should find importance in determining the characteristics of the student population, as the proportion of a diverse group of higher education students taking one or more online course is at an all-time high, with online enrollment growing more than five times faster than the total enrollment (Bailey, Barton, & Mullen, 2014). In fact, 16% of higher education students are now registering and learning primarily through online classes (Bailey et al., 2014).

In order to direct students to the correct classes, community colleges may consider requiring the completion of an assessment prior to enrollment (Xu & Jaggars, 2011). The assessment may be tailored to each student by directing the student to a specific college session if claiming basic technology skills. Furthermore, students may be advised to look into face-to-face courses if the student scores poorly on the assessment, or the student may be asked to schedule an appointment with an advisor if those classes do not fit availability wise. Western Governors University, which is solely based online, has adopted the strategy of trying to provide a personalized education by allowing students to forego formal courses and directing the student to take only the courses required for the degrees the student is trying to earn, which leads to the possibility of earlier graduation (Western Governors University, 2018).

### **Retention of Students in Online Classes**

Success and retention can go hand-in-hand with education. Elam (2013) discussed some of the issues faced in online classes and introduced ways to increase retention. For instance, the study determined, demographics often make a difference in retention, and an orientation class for a school's online classes improves retention and success. Students who are educated on how these classes work, operate, and are organized, possess the ability to improve retention and success (Elam, 2013). James, Swan, and Daston (2016) added, although learning outcomes in online courses are similar to those in face-to-face courses, retention and success are larger issues in online classes and should be addressed. Students who took online classes early on at the community college were significantly less likely to return to school for subsequent terms, while those who took a high proportion of online credits were significantly less likely to graduate or earn a certificate (James et al., 2016)

Since student retention is an issue in higher education, Black (2018) conducted a study which provided educators strategies to implement and improve retention rates. The study determined how critical and pivotal instructors working toward improving students' attendance and success in order to improve retention can be. Retention strategies found by Cochran, et al., (2014) for online classes include student engagement activities, learning communities, learning-centered environments, and readily available information on student services. Engagement in the first year of college and the method by which tests are conducted online are crucial for student retention. Cochran et al. (2014) have identified prior student performance (GPA) and class standing (freshman, sophomore, junior, senior) as important characteristics associated with student retention in online courses, which may be used to identify at-risk students early on in the coursework process. When a student drops a class, the student loses time, money, and the self-confidence necessary to complete the program. Multiple parties are affected when a student drops a course and fails to return to a class or school in general.

Research, proven strategies, and theoretical models have been implemented to increase student retention (Gomez, 2013). Obtaining information on students' backgrounds, past academic achievements, socioeconomic statuses, and personal characteristics are habitually collected by institutions and may be used for research purposes. The readily available student data from a specific institution can be an effective predictor for student retention. The information can provide administrators and educators with what is necessary to create strategies and models which inspire and motivate degree and/or certificate completion. These strategies and models can help students overcome weaknesses and encourage greater persistence and retention (Gomez, 2013). The integration of supports and strategies for students and instructors alike in online courses not only

improves retention rates but enhances the role community colleges play as a whole (Travers, 2016).

To increase retention in online courses, models need to be continuously reviewed, such as models in modern literature. The review allows for the understanding of changing behaviors in online students and faculty. Institutions can then determine how student characteristics fit together in an online educational unit and how retention and success can be upheld namely as online enrollment rises (Papia, 2016).

In Virginia community colleges, almost half of the students are enrolled in an online course, and the data were used for a study conducted by Jaggars and Xu (2010) at Columbia University. Regardless of preparation, online students were more likely to withdraw or fail than face-to-face counterparts. Some students reported frustration with typing skills, course navigation, and the learning management system. To empower students, the study suggests, online courses be explicitly designed around the unique content of the online class rather than by the pedagogy and materials of the comparable face-to-face class. Educators need to remove the barriers of time and space which are experienced in the traditional educational system by offering uniquely designed courses at learners' doorsteps (Gul, Shafiq, Mahajan, Shafi, & Shah, 2018).

An additional item which can affect issues relative to retention rates, according to Richardson (2018), is the lack of financial resources at historically black colleges and universities, which primarily affects online classes. The research cites, these institutions serve a positive societal purpose as well as an instrumental role in the education of lower socioeconomic classes which other colleges do not offer. Components are able to be preserved of the African American ethnic identity in both online and face-to-face classes. Salvo, Shelton, and Welch (2017) believe

online education can possibly offer a color-free environment in which students are less likely to be judged by race and more likely to be treated equally.

According to Moore (2014), African Americans as a whole are more likely than other demographic groups to take entire undergraduate programs online. Ironically, historically black colleges and universities are typically slower to create online programs for students than are other universities. In fact, only 18% of historically black colleges offer online degrees (Flowers, White, Raynor, & Bhattacharya, 2012). Certain cultures and socioeconomic classes such as the African American community can build connections, support one another, and improve retention rates (Blue, 2018). Other important concepts to consider in regard to online classes, African Americans, and the improvement of retention and dropout rates are mentors' responsibilities and higher education preparation for student success. Mentoring and building connections are actions considered so important, and potentially even save money can be saved for students in regard to retention rates (Blue, 2018).

### **Proctored Tests and Non-Proctored Tests in Online Classes**

The use of online exams as part of the evaluation process has been studied and researched to some extent. In the study conducted by Ardid, Gomez-Teiedor, Meseguer-Duenas, Riera, and Vidaurre (2015), students were given online proctored exams, online non-proctored exams, and an online training homework task. The analysis reveals students' online grades depended on the way the online exam was administered. For instance, in the non-proctored setting, the results were biased toward higher ratings, while a greater dispersion of results was observed in the proctored environment. The study noted, non-proctored assessments can have security and honesty concerns. Advances in technology, according to Weiner and Hurtz (2017), have spurred innovations in the security of assessments and the delivery process. Online testing has become

increasingly sophisticated even with an absence of published research. Results of the study conducted by Weiner and Hurtz (2017) supported the equivalence of kiosk-based, remote online proctored exams and proctored onsite assessments in test centers. With the given research, a community college may choose to implement the cheaper option within the institution.

Non-proctored online assessments promise a low-cost opportunity to reach a large, heterogeneous, and geographically diverse population (Gosling, et al., 2010). The pessimistic viewer might conclude, some participants cheat every time if given the opportunity, regardless of countermeasures or expected consequences (Diedenhofen & Musch, 2017). Those with a more positive outlook believe students do not cheat if the opportunity is not given. Whatever the case may be, administrators and instructors of non-proctored assessments are encouraged to adopt strategies to identify potential cheaters with information on reaction times or non-reactive behavioral data (Diedenhofen & Musch, 2017).

Since non-proctored online assessments are often compromised by the lack of control over students' test-taking behavior, Steger, et al., (2018) examined mean score differences and correlations between proctored and non-proctored assessments. Perceived consequences of the assessments, countermeasures against cheating, and the susceptibility to cheat were considered. Standardized mean differences indicated higher scores in non-proctored assessments. The results demonstrated, non-proctored assessments are biased by cheating. Some studies found no statistical differences between proctored and non-proctored assessments (Ihme et al., 2009), while others reported much higher scores for non-proctored tests or, infrequently, for proctored tests (Carstairs & Myers, 2009).

Varying results were reported in regard to how often students were cheating, which ranged from below 2.5% to 7.0% (Tendeiro, Meijer, Schakel, & Maij-de Meij, 2013). In an online

survey, 25% of students reported, cheating on a problem may be most appropriate when the problem is difficult to search online (Jensen & Thomsen, 2014). A reason for the varied results may be the diverse educational settings in which non-proctored assessments are often administered (Allen & Seaman, 2014). No significant effects were found with other variables, which suggests the score differences between proctored and non-proctored assessments are not affected by students' expected consequences of assessment results. In cases when solutions to problems were not easily found on the internet, mean score differences were roughly zero (Allen & Seaman, 2014).

The findings validate previous research, suggesting, some tasks are more susceptible to cheating than are others (Diedenhofen & Musch, 2017). For example, Bloemers, Oud, and van Dam (2016) examined cheating strategies for various online assessments. Cheating was determined to be most often present for problems which could be tampered with through online searches. Cheating did not affect problems in online non-proctored tests for which complex reasoning was required (Bloemers et al., 2016).

Recent technological developments have changed the way researchers collect data in general (Miller, 2012) and conduct assessments in particular (Harari et al., 2016). In recent years, non-proctored online testing has become the main assessment mode in the academic field (Allen & Seaman, 2014). The advantages of non-proctored testing can incur the cost of lack of supervision, less standardized test-taking conditions, and less control over students' behaviors. The issues of dishonest behaviors in non-proctored assessments is then leading to unfair scores and threats of the usefulness of online tests as a whole may arise (Steger et al., 2018). Proctoring choices may be considered the responsibility of each individual institution to look into.

At one institution, characteristics including students' efforts and performances were examined in regard to online assessments versus assessments administered in a classroom proctored setting in the Spivey and McMillan (2014) study. The researchers measured students' efforts by tracking the number of times students accessed the study resources in the university system, and the study determined, students' efforts and course performance were not influenced by testing differences. Instead, success and students' efforts in the classroom showed a strong correlation with success on assessments. Mozes-Carmel and Gold (2009) determined the modality used to administer the final exams in online courses did not have a significant difference. The study indicated, sophisticated online software was a viable alternative to in-person proctored exams as long as the academic rigor was taken into consideration and institutions minimized the ability for students to access other online information (Mozes-Carmel & Gold, 2009).

According to Hollister and Berenson (2009), some instructors have been reluctant to teach online because there is a concern about who is working on assessments. In a higher education computer course study conducted by Hollister and Berenson (2009), the students' scores in proctored versus non-proctored exams were no different. The study concluded, the lack of variation is due to the administration of questions in a simulated Microsoft Office environment which is not conducive to cheating behavior. In another information systems course, Hollister and Berenson (2009) analyzed the differences in online proctored versus non-proctored exams and determined the non-proctored students had a significant amount of variation in performance, although there was no significant difference in the mean overall performance. The researchers determined the activity-based online exams graded by the computer were the determining factor; hence, implying using these types of questions may help alleviate instructor concerns in regard to online assessments.

Administering the correct type of test is important to Brallier and Palm (2015), who studied proctored and non-proctored tests in higher education online and face-to-face beginner psychology classes. Although students scored 6% higher on the non-proctored online tests, the course grades were ultimately not higher. Daffin and Jones (2018) conducted a study in psychology classes with proctored and non-proctored tests and found the non-proctored tests were 10–20% higher, and students took twice as long to complete them. Test scores were similar for the face-to-face and online courses for both proctored and non-proctored tests. So learning outcomes in well-designed online courses are similar to those achieved in traditional courses (Daffin & Jones, 2018). Due to the possible occurrence of misconduct during a non-proctored test, one suggestion may be, the instructors should design the tests with the potential for misconduct in mind and create questions which require far more than memorization (Brallier & Palm, 2015).

Different subject areas in higher education may be questioned as to whether different results would be achieved in a particular topic of study. Yates and Beaudrie (2009) studied mathematics classes at the community college level, and determined the test results of proctored and non-proctored online students had no significant difference with regard to grades. The study included over 800 students, where approximately 400 students were administered proctored tests and the rest were administered non-proctored tests online. A community college in New York studied by Trenholm (2009) suggested, contrary to the proctored and non-proctored scores, there may be a high correlation in online math test grades with institutional affluence, socioeconomic status with computer accessibility, and student ability. Furthermore, each institution may be looking at different concepts in regard to online courses.

## **Integrity in Online Classes**

The proctoring of tests may be a requirement for some who believe there are integrity issues associated with taking a test online in the convenience of a student's home. According to Moore, Head, and Griffin (2017), some of the problems with online exams lie in the identification of the test taker, the prevention of test theft, students' use of unauthorized notes, cell phones, and/or Bluetooth devices, and the determination of intentional computer crashes. If one question becomes compromised, the integrity of the exam is affected. If the whole test becomes compromised, then all the efforts put into the test as well as the test problems become damaged (Moore et al., 2017). Instructors should note, Microsoft Word automatically creates a copy of these tests on students' computers when the documents are opened without any additional action taken by the students. Ladyshevsky (2015) suggested the test design, the value of the test, student age, and student maturity are the most important factors to consider when designing an unsupervised online test. Ladyshevsky found cheating may not be as problematic as some individuals fear. Rather, cheaters seem to cheat regardless of the testing modality.

Cifuentes and Janney (2016) explained, integrity concerns not only the students, but the school as a whole. The promotion of integrity should be a foundational principle to which the use of learning management system (LMS) preventive technologies should be applied; authentication of students should be required, proctored exams should be in place, and students should be required to submit individual work for each test. The Center for Innovation in Mathematics (2011) concluded in a study, the proctoring of two exams (out of three or four) in addition to the semester final exam provided enough motivation for students to ensure the learning outcomes were met. Proctoring some assessments was the option used after data were analyzed because, logistically, the proctoring of all tests might not be an option for many colleges. Since final exam

grades were found to have a high correlation in overall average scores and knowledge of the course, researchers determined the students needed to achieve 60% or higher on the final exam in order to pass the class (The Center for Innovation in Mathematics, 2011).

Due to the elevated faculty concerns as well as more online classes and assessments being offered, Varble and Haute (2014) conducted a study focused on reducing online cheating opportunities, which compared online classes to traditional classes. In both cases, the last two tests were proctored on campus along with the final exam. The data analysis results indicated traditional students performed better when taking the proctored assessments and when there were no aids available. A study conducted by Fask, Englander, and Wang (2015) in regard to proctored and non-proctored testing in online statistics classes suggested, even though cheating in non-proctored environments facilitates much higher levels of cheating, there are different inclinations associated with student cheating. The study suggested the different disciplines, different levels of courses (undergraduate, graduate, and professional), and different modes of interaction among students and teachers can make a significant difference with integrity in online classes.

Alessio, et al., (2017) addressed the challenge of online testing and the compromising of tests due to undetected cheating which can produce inappropriate higher grades. Tests of 147 students in multiple sections of online courses were compared with half of the students who received no proctoring, while the other half utilized online proctoring software. On average, students scored seven points lower and utilized a significantly smaller amount of time to take online tests when the tests were proctored. Another challenge and concern, according to Alessio et al. (2017), is the attrition rate, since 7% of the students with non-proctored tests dropped classes, while 19% of the students with proctored tests dropped classes. Samavati, Stumph, and Dilts (2012) determined the students who scored higher on tests had a negative correlation with

time and score, which suggests, in online environments, the allocation of extra time does not necessarily help improve a student's grade. Hence, to improve online assessment outcomes, instructors are recommended to consider reducing the allotted time to about 75% of what is allowed for a comparable in-class proctored test (Samavati et al., 2012).

Unethical behavior and dishonesty are widespread in the public and private sectors, which cause not only integrity issues, but large financial losses (Ayal, Gino, Barkan, & Ariely, 2015). In education, reminding students to refrain from cheating can be an effective practice. The reminders may increase salience while decreasing the ability to justify. Self-engagement, which increases students' motivation to maintain a positive self-perception, can bridge the gap between moral values and behavior. With all the above in place, Fask, Englander, and Wang (2014) stated, if a difference in online versus traditional test scores are observed, establishing whether the variance is due to cheating or the modality of the test (in class versus online) is still important.

Online cheating internet companies who support academic dishonesty by writing papers, completing homework assignments, and enrolling on behalf of students pose a significant challenge (Moten, Fitterer, Brazier, Leonard, & Brown, 2013). Due to these challenges, the study recommended online assessments and courses to be designed, knowing students use textbooks and notes in order to ensure more comprehensive courses. The assistance from the internet in regard to cheating has been a game changer compared to years ago, according to Watson and Sottile (2015). Programs such as Turnitin.com have assisted with plagiarism; due to proctoring programs, instructors may place more weight on projects and papers versus tests taken for online classes (Watson & Sottile, 2015).

Other suggestions given by Moten et al. (2013) included the creation of multiple versions of assessments, the randomization of questions, or a requirement to have online students sign and

return an academic dishonesty statement. Cheating among freshmen and graduate students was found to be the highest though the study, according to the Moten et al. (2013), and need to be looked into. Some people may claim, the freshmen dropped out, but dropping out is not an excuse to be considered viable in the case of graduate students. More research should be conducted on online assessments (Watson & Sottile, 2015).

Due to the growing popularity of online courses, tech-savvy students can still find ways to cheat, which allows the student to pass online classes without much effort while remaining difficult to detect. The phenomenon was described by one student surveyed in the Miller and Young-Jones (2012) study, who received an “A” grade in his online course because four friends shared a Google Document online, which all students could read and add to simultaneously. Due to the surveys administered in the study, companies were suggested to work on developing new and improved anti-cheating software, and researchers and schools alike need to join forces and share work. Unless sharing occurs, schools and instructors are going to continue playing the catch-up game (Miller & Young-Jones, 2012). Some technologies, according to Karim, Kaminsky, and Behrend (2014), have already been examined to determine effectiveness regarding cheating, although have not determined whether there even exist unintended effects on students’ reactions, performances, and/or selection procedures.

Karim et al. (2014) conducted a study in which students were assigned randomly to a webcam-proctored or honor system condition for two online tests. Regarding the 295 students who participated, the researchers determined remote proctoring may have reduced cheating rates, although unintended student reactions may have increased, which might differentially affect a test-taking experience. Institutions who test both anxiety increases and coping skills are needed.

The data invites the opportunity for instructors to incorporate material into online courses to help students become calmer while taking proctored online exams (Kolski & Weible, 2018).

Companies who have started to offer proctoring services for online classes are faced with an uphill battle in persuading skeptics, as cameras remotely peer into a student's home, seize control of the computer, and stare at the student for the duration of the test to determine whether there are any signs of impropriety (Kolowich, 2013). Each company has an individual approach, such as using webcams, sharing computer monitors, recording a student, and installing software which makes using other browsers or chat platforms impossible. Stack (2015) conducted a study with 287 online criminology students who took assessments either proctored at the college or proctored at home using the Respondus Lockdown Browser. The study determined, there was no significant difference between student exam scores in either sections, which suggests, online proctoring systems may begin to level the playing field. Kolowich (2013) claimed the real question revolves around how much proctoring is enough in higher education where institutions certify academic achievement. In general, the study concluded, online proctoring needs to be at least as effective as what one would witness in a large lecture classroom (Kolowich, 2013).

Because higher education learning management systems, such as Blackboard and Canvas, are becoming the norm, computerized testing has made testing not only easier for instructors, but more convenient for students (Tao & Li, 2012). For instance, the cost of delivery is cheaper, there is improved efficiency of administration, the time-consuming scoring is completed by the computer, and more time can be saved for interactions with the instructors. When students know they are going to be proctored during an online assessment, the assessment is taken more seriously and frequently more studying is involved. Stowell (2015) studied a biological psychology class for three semesters to delve into the effects of open-book non-proctored online

testing for students and instructors. As expected, students scored higher, but the effect was only temporary and did not last throughout the semester.

Trends in increasing online courses at institutions suggest the need for further research on cheating and academic integrity in comparison with those of face-to-face classes. The Miller and Young-Jones (2012) study surveyed 639 students in each type of course. Although students felt cheating was easier in online courses, those who only took online classes were less likely to cheat than students who only took face-to-face courses. For students taking both online and face-to-face courses, cheating did occur more frequently in online courses. Older students tended to cheat less frequently, as well, but in regard to female versus male students, no significant differences were identified. In the Swartz and Cole (2013) study in which undergraduate and graduate students were surveyed, the majority of students believed academic integrity possessed the same degree of issues in online environments as students did in face-to-face courses when taking an exam, writing a paper, or completing a project. Additionally, the students noted, if someone wants to cheat, students are going to find a way to cheat no matter the type of environment (Swartz & Cole, 2013).

### **Chapter Summary**

Chapter 2 literature review examined possible effects on assessments, success, and retention in online mathematics classes through the literature search strategies and frameworks. Topics discussed in the research were online classes in higher education, success of students in online classes, retention, the number of students passing proctored versus non-proctored tests, and integrity in online assessments. The theoretical framework for the research study is based on the theory of planned behavior, which aims to predict and understand the relationship between human behavior and motivation (Boslaugh, 2013). Demographic variables, included in the theory, are

believed to contribute a significant influence on outcomes related to cheating behaviors (Madara et al., 2016). Planned behavior theory presents a reason as to why students may violate ethical codes under these circumstances people would otherwise support (McQuillan & Zito, 2011). A gap in the literature lies specifically in the data from online mathematics classes, as other subject areas do not apply for proctored and non-proctored testing. The proposed study is necessary should colleges hope to increase online success and retention.

A common theme emerged, which suggested integrity in online assessments should be researched within individual institutions. Integrity is essential to the flexibility, consistency, reputation, and overall survival of higher education and online education so the reduction may lead to shocking consequences for the future of higher education (Farnesea, Tramontanob, Fidaa, & Paciello, 2011). Many students perceive a college degree as being a pass needed to enter into the attractive middle- or upper-class lifestyle, and the pressures to succeed may lead to academic dishonesty when the achievement of the goal is put at risk (Farnesea et al., 2011). The presence of academic dishonesty is indisputably present in all cultures and should be minimized as much as possible in the education field as a whole. The observable differences lie in the scope of dishonesty, the attitudes toward dishonesty, and the penalties which result from dishonesty (Blachnio & Weremko, 2011).

Murdock, Hale, and Weber (2001) reported an increase in cheating over the last few decades, as well as a diminished trend in students' perceived seriousness of dishonest behavior. The Mathematics Department at the Mid-Atlantic community college is concerned about the integrity of students who are taking all assessments online in the mathematics department. Integrity can equally affect the students and the institutions. The study was aimed to determine whether final exam scores, success (passing with a 70% or above for the semester), and retention

(signing up for the subsequent math course) are affected when assessments are proctored versus not proctored during the semester. Chapter 3 addresses the research methods used in the study.

### Chapter 3: Methodology

The purpose of the quantitative research design was to examine the relationship of final exam scores (pass/fail), percent of student success (passing the semester with a 70% or higher), and percent of student retention of online mathematics students at the Mid-Atlantic community college (MACC). Final exam scores, percent of success, and percent of retention were compared between proctored versus non-proctored tests during the semester to determine if there is a relationship between the data. The data was also broken up according to age and gender. The study was necessary in order to determine if the college can increase online success and decrease dropout rates through the type of testing given to students during the semester.

Percent of student success in online math courses with proctored testing were compared with the percent of student success in online math courses with non-proctored testing. A series of logistic generalized linear mixed models (LGMM) compared the percent of student retention in online math courses with tests proctored during the semester versus those who had non-proctored testing. Final exam scores in online math courses with proctored testing were also compared with final exam scores in online math courses with non-proctored testing. Data were collected from the Program Research and Evaluation (PRE) Department and organized for accurate research. Statistical analysis started with descriptive statistics to describe percentages of variables. Continuous variables were reported using mean and standard deviation.

A series of logistic generalized linear mixed models examined the relationship demographics and variables. The tests were conducted to examine the relationships between proctor status and all the dependent variables. Mixed models were used in order to account for the random effect of courses and subjects who attended different terms multiple times. Proctor was

used as a predictor for all outcomes controlling for gender, race, and age. Data were managed and analyzed using IBM SPSS version 25.

The tests were used to determine whether there was a significant difference between what is expected in online courses and the observed frequencies among the variables. The test were then used to determine if the null hypothesis should be rejected (University of Pennsylvania School of Arts & Sciences, 2008). In the study, the variables are success, retention, and final exam scores. Materials collected are kept in a password-protected folder on a personal computer for three years after the completion of the study.

### **Research Questions and Hypotheses**

The following hypotheses were developed based on the research questions for the study. Hypotheses were written based on the quantitative research design using a series of logistic generalized linear mixed models for the statistics for analysis. The following research questions and hypotheses guided the study:

Research Question 1: What is the relationship between student final exam scores, (pass/fail) for students with proctored versus non-proctored online math tests?

Research Question 2: What is the relationship between the percent of student success for proctored versus non-proctored online math tests?

Research Question 3: What is the relationship between the percent of student retention for proctored versus non-proctored online math tests?

$H/0$ : There is no relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

$H/A$ : There is a relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

H2<sub>0</sub>: There is no relationship between the percent of student success with proctored versus non-proctored tests.

H2<sub>A</sub>: There is a relationship between the percent of student success with proctored versus non-proctored tests.

H3<sub>0</sub>: There is no relationship between the percent of student retention with proctored versus non-proctored tests.

H3<sub>A</sub>: There is a relationship between the percent of student retention with proctored versus non-proctored tests.

### **Research Design and Rationale**

The research study used final exam scores (pass/fail), success, and retention of students in mathematics classes. The research design included a series of logistic generalized linear mixed models to determine whether there was a significant difference between the expected occurrences and the observed occurrences. A series of logistic generalized linear mixed models (GLMM) were conducted to examine the relationships between proctor status and all the dependent variables. Mixed models were used in order to account for the random effect of courses and subjects who attended different terms multiple times. Proctor was used as a predictor for all outcomes controlling for gender, race, and age. Hypotheses for the study determined if there were relationships between final exam scores, the percent of success, and the percent of retention with students who have assessments proctored and non-proctored throughout the semester. Quantitative research and hypotheses questions rely specifically on directional language, and focus on the variables under investigation, the relationship to each other, and affect different groups (Leavy, 2017).

Quantitative research design is the appropriate design for the study because the design focuses on the following variables under investigation, including final exam scores, success, and retention, which are under investigation with proctored and non-proctored testing. Logistic generalized linear mixed models (GLMM) were used to determine if proctoring student tests during the semester would be better practice. Given the variables are independent, some call the test a "goodness of fit" statistic, because the test measures how well the observed distribution of data fits with the distribution expected (Deshpande, 2011). The results helped explain how future test in online mathematics courses should be given. Quantitative research design is used to advance knowledge in education by identifying relationships between two variables (Creswell, 2017).

### **Research Procedures**

The discussion of research procedures includes population and sample selection, instrumentation, data collection, and data preparation. Population, which entails all online mathematics students at MACC, is a collection of elements and data in a specific region at a certain point in time, which are considered the subject in the study. A student, for instance, in an online math course is a unit of the population. The sample design is specifically online math classes in the past three years.

These classes were chosen because each one was an institutionalized online mathematics class MACC offered. The classes included uniformed online assessments and finals, where the only difference was the randomly assigned numbers (of the same difficulty level) which were inserted into the tests. The instrumentation section explains how the PRE Department collected all of the data for the study and describes how the data were used to benefit the research. Research

indicates readily available student data within institutions can be an effective predictor for student retention and success (Gomez, 2013).

### **Population and Sample Selection**

The Mid-Atlantic community college serves over 62,000 students with about 40% of the students being white, 40% African American, 6% Hispanic or Latino, 8% Asian, 4% multicultural, and 1% unknown. MACC students who take at least one online course make up about 31% of the whole population. There are approximately 43% white, 39% African American, 6% Hispanic or Latino, 7% Asian, 4% multicultural, and 1% unknown students in online classes. In addition, there are over 35% of students who are Pell Grants recipients. The population of the study was approximately 1,900 online mathematics students which MACC serves yearly. The data in the study were a comprise of data from students in online institutionalized mathematics courses at MACC in the past three years. These classes are created by a team of faculty members, approved by the administration, and Quality Matters (2018) approved. The course is then given to each instructor to teach for consistency.

Secondary data from students in each of these online mathematics classes was collected as numeric and non-numeric data which can answer new research questions on data already collected (MacInnes, 2017). Any student who dropped the class (no longer registered) early enough to be taken off the roster in the first week, was not be included. Any students who receive a withdraw (W) grade, were included and recorded as failing for the semester with a 0% final exam grade. Permission was given from the administration (see Appendix A), and data were collected from the PRE Department. The data came from 10 different instructors who teach online mathematics courses. There were about about 300 students each semester, for three years, which totals about 1900 students. Within these classes, there are sections which have no proctored tests

during the semester, and only the final exam is proctored, and other sections which do have proctored tests along with the final exam.

A sample is a subset of the population and is important to ensure the sample size is appropriate to make inferences about the results of the study (Hoy & Adams, 2016). The predictors in the model are proctoring status (proctored tests for online classes, non-proctored test for online classes, and traditional proctored test for face-to-face classes) combined with gender, age, and five different math classes in which students could have taken proctored tests in. When analyzing data, the representing sample should have a well-defined population. The intent is to be able to make a generalization from the sample to the population (Creswell, 2017).

In summary, after getting permission from administration, a sample of the population of online mathematics classes was used in the study. Data were collected from the classes in the past three years, on final exam scores, success, and retention to see if there was a relationship with students having proctored versus non-proctored tests during the semester. With the data, a series of logistic generalized linear mixed models tests were conducted with an effective sample size for the research, which is necessary to obtain a desired level of statistical power (Anderson, Kelley, & Maxwekk, 2017). The percent of students who achieved passing exam scores, end of semester success, and retention were compared in charts. After the research was complete, what should happen could be extrapolated from the entire population in reference to online mathematics courses and proctored tests.

### **Instrumentation**

Final exam scores (pass/fail), success, and retention were categorized into chart form according to students who had proctored versus non-proctored testing during the semester. Data were collected from the PRE Department on students in face-to-face math courses to compare

percentage of success as well. Then, by using a series of logistic generalized linear mixed models tests on the collected data, the determination was made if proctored versus non-proctored testing during the semester, in online mathematics courses, makes a difference in final exam scores, success, and retention, in order to answer the research questions.

Final exam scores, success, and retention were dichotomous data written as Pass/Fail and Retained/Not Retained as well as percent of passing and retained. To establish reliability, there was internal consistency. The online mathematics courses each instructor uses were designed by a team, approved by the administration, and Quality Matters Certified. Quality Matters Certification (2018) is obtained when the company has reviewed the course, and certified the course as well-designed, engaging for learners, and has met standards for the disabled. These courses have all the homework, tests and final exams in the same format, with the same questions, and randomly assigned numbers of the same difficulty level inserted into each question. The Mathematics Department and administration have determined, students who are successful on the final exam in online mathematics courses are prepared for the subsequent mathematics course, which is an educational goal for all.

### **Data Collection**

Data collection according to Zozus (2017) include identifying data to be collected, defining the data elements, measuring values or acquiring secondary data, processing data in electronic forms to prepare for analyzing. In order to prepare for correlational quantitative research, data were collected from MACC instructors and the schools Planning, Research and Evaluation (PRE) Department after approval has been given. Access was given to the data for the study and the data were emailed from the PRE department to conduct the study. Only online mathematics classes in the past three years were a part of the data collection. The data were

collected from 16 different instructors for three years, totaling approximately 1900 students.

There were classes with only a proctored final exam, and others with proctored tests as well as the final.

The test scores, passing percentages, and retention were given to the instructor in the form of a student ID. These were then converted to a randomly assigned and anonymous numbering/coding system. These identification numbers ensured confidentiality to all involved. The data is housed on a computer in a password-protected folder. Researchers need to remember validity relies on accurate and truthful data collected without fear of disclosure of sensitive information (Adinoff, Conley, Taylor, & Chezem, 2013).

Mid-Atlantic community college instructors use an open educational online assessment system called MyOpenMath (2018). All final exams are taken in the system and stored here online. Once the college approved the process, an administrator allowed the access to the final exam scores in the system. The success percentages of online students and face-to-face students were collected through the PRE department at the college. PRE was told to ignore any one credit online courses, which occur when students only need to finish one portion of a course.

The PRE department provided a spreadsheet of data on each of the original students in the study who signed up for a subsequent mathematics course. The original students were tracked by PRE to see if the students signed up for another course after being successful in the previous course. To ensure participant confidentiality, students were coded with an identification number to ensure confidentiality. Even when data is collected using standardized procedures and tools, the data still needs to be checked for possible inaccurate or missing data to ensure the findings are clear and conclusions can be validated, and verified (Peersman, 2014). Any problems which arose in the process of data collection should be noted along with how the problems were

overcome, in order to keep a transparent nature for anyone who would want to review the process (Best, 2014).

The student's mean and median final exam grade were determined with given standard deviations, and the percent of student success at a 70% semester average or higher, given the type of online class signed up for. The series of logistic generalized linear mixed models determined if the variables had a relationship. These tests allowed inferences about means to be made by analyzing variances to find out if there was a relationship between proctored testing, non-proctored testing and student success.

### **Data Preparation**

During the data preparation period, there was the collection of data, consolidation of all data, and putting the information into tables to be analyzed (Zozus, 2017). The data entailed coding, entering data into the computer for analysis, checking and verifying all elements are accurate (Cohen, Lawrence, & Morrison, 2017). First, final exam scores were recorded in chart form from highest to lowest and organized by students who had proctored or non-proctored non-final assessments during the semester. Second, to determine success, the students needed to have a 70% or higher as a final average for the course. At MACC, a 70-79% is a C, an 80-89% is a B, and a 90-100% is an A. A chart was designed to list students who were successful versus unsuccessful in face-to-face classes, which have all proctored testing, online classes with proctored tests, and online classes without any proctored assessments during the semester. There is a concern for success in online higher education classes because students are often unable to socially interact with peers and instructors, as face-to-face peers do, which ultimately helps in the learning and engaging process (Struble, 2014). The third step, to determine retention percentages

among given groups, is a chart to classify students who did or did not sign up for the subsequent mathematics course.

### **Data Analysis**

Data analysis is about asking questions, developing explanations, and testing hypotheses based on logic. Data analysis is multidisciplinary, and combines artificial intelligence, statistics, math, and business (Cuesta & Kumar, 2016). Data analysis has been discussed below with reference to each research question of the study. Each separate discussion of data analysis includes the rules for hypothesis testing. A series of logistic generalized linear mixed models was performed to determine if there was a relationship between variables in the research questions. The significance of the results was then calculated. If the calculated value is larger than the critical value, the null hypothesis was rejected, which suggests a significant relationship (Statistics Solutions, 2013). In order to analyze the data correctly, there needs to be screening procedures. Initially, data had to be checked for mistakes, and abnormalities, since data can easily be entered incorrectly. Outliers need to be taken into consideration as well, because outliers can have a high impact on statistical analysis. Being very familiar with the data collected and understanding the distribution of each variable through the examination of descriptive statistics, in order to easily detect if anything appears to be out of the ordinary, the research may be highly benefit (DeSimone, Harms, & DeSimone, 2015).

#### **Data Analysis, Research Question 1**

The first research question of the study is as follows: Is there a statistically significant effect of proctoring status on the scores of students' final exams in online mathematics courses? The independent variable, according to the University of Connecticut (2018), is a factor which is selected by the experimenter to determine the relationship in a study. In the study, the variable is

reliant on a student in a test proctored or non-proctored online class, and the dependent variable is a student's score on the final test. RQ1 data analysis contained categorical variables to track each student's gender, age, and the exact class the students took. The classes were also be compared with percentages and letter grades.

The dependent variable of final score, the independent variable of proctoring status, and the covariates of gender, age, and math class determined how proctoring effects final exam scores. There are two different proctoring states, the presence of proctoring during semester tests or the absence of proctoring during semester tests, on the final score (final). The tests determined if there is a difference in final exam scores in proctored versus non-proctored tests for students.

### **Data Analysis, Research Question 2**

The second research question of the study is as follows: Is there a statistically significant effect on the proctoring environment on students' success? The purpose of data analysis for Research Question 2 (RQ2) was to determine whether the proctoring environment might be associated with better overall class performance for community college mathematics students. In RQ2, the independent variable is proctoring, and the dependent variable were reliant on a student obtaining a C or better (>70%) in the class. RQ2 data analysis contained categorical variables to track a student's gender, age, and the exact class the student took. The test determined if there is a difference in success with proctored versus non-proctored tests for students.

### **Data Analysis, Research Question 3**

The third research question of the study is as follows: Is there a statistically significant effect of proctoring status on the retention of students in online math courses? The purpose of data analysis for Research Question 3 was to determine whether proctoring might be associated with better retention for community college mathematics students. In Research Question 3 (RQ3),

the independent variable was reliant on a student being proctored in the online class, and the dependent variable was reliant on a student being enrolled at MACC in another math class, the semesters after taking proctored tests during the semester. Data analysis for RQ3 was restricted to those students who were eligible for retention in the semesters after taking an online math course with proctored testing; thus, students scheduled to graduate in the first semester after a proctored test were excluded from the data analysis for RQ3. Finally, RQ3 data analysis contained categorical variables to track a student's gender, age, and the exact class the student took, and percentages of retained students.

### **Reliability and Validity**

When selecting and evaluating an assessment tool, one needs to consider reliability and validity. Reliability refers to consistency (Jackson, 2015). When an assessment is reliable, a consistency of scores is demonstrated. A consistency of scores occurs when scores obtained are the same after the data is reexamined and approximately the same score is reached. Validity determines if the research measures what was intended to measure and how true the results are (Jackson, 2015). In statistical tests, both reliability and validity are dependent on the normality of the distribution of the dependent variable (Jackson, 2015).

Potential threats to internal validity include items such as maturation, and evaluation anxiety (Houser, 2015). Threats such as these can often be reduced or eliminated by choosing certain research designs. Possible threats to quantitative research and internal validity can compromise assurance in stating a relationship exists or does not exist with the dependent and independent variable (Houser, 2015). A threat to internal validity was ultimately be an influence on the results as well and generalized cannot be made (Cotrell & McKenzie, 2011). In the study, dealing with students at the community college level, maturation could affect the study. Students

can change over the course with physical or mental maturation changing scores Evaluation anxiety affects students' scores when students know they are being evaluated on a test and feel uneasy.

External validity threats occur when incorrect inferences from data, settings, and past or future situations are made. A threat could be population validity, which is generalizing the results of a study of a specific group to another group or a larger group (Creswell, 2017). Using the results of the study is important to all present and future online mathematics courses at MACC. Ecological validity can become a threat if the study is not sufficiently described and conducted, because of the difficulty in determining if the results apply to any other settings or groups, like all online math classes in the study. Another threat could be interaction of history and treatment, which occurs since studies are time bound, and the past and future cannot always be generalized. The threat can be resolved by replicating a study at a later date. In the study, the final exam scores, success, and retention of online mathematics courses could be studied again to verify the results obtained (Creswell, 2017). Mathematics can be difficult for students, so looking at the subject specifically in face-to-face classes is important, where an instructor is going through examples together with the class, versus online where there are videos for only some examples, is important. Another way to think about validity and to ensure threats are limited, is to understand the validity of tests is a combined judgment of empirical evidence and theoretical rationales which support the adequacy and appropriateness of implications and actions based on test scores (Khemakhem, 2016).

### **Ethical Procedures**

There are legal and ethical obligation to keep all the human subjects involved, protected and confidential. As Bain (2017) acknowledged, ethical approval should be a moral reflex for all

researchers, and ethical training should be provided when needed. The data collected is housed on the researcher's computer in a password-protected folder. The students are coded by giving identification numbers to ensure participant confidentiality is protected. To increase the credibility of the data, and validity, all online mathematics courses which fit the criteria were used. Multiple full-time online instructors, adjunct online instructors, and administrators were contacted to determine if proctored or non-proctored tests during the semester were given in each class. Researchers need to keep perspective of others for ethical practice as instructors of a university. Even though instructors/researchers may be given access to data like grades and test scores for a specific reason, permission is still needed to use part or all of the data for any research purpose (McGinn, 2018).

### **Chapter Summary**

The purpose of the quantitative design was to analyze scores, percent passing, and percent of retention in online mathematics students at the Mid-Atlantic community college (MACC). Quantitative research focuses on the variables under investigation and the relationship each has to the other (Leavy, 2017). Data from the study determined if proctored assessments affect MACC students in online math courses when determining success, with a passing rate of a C or above. The results of the study were discussed in the Mathematics Department and decisions can be made about online mathematics classes, when determining regulations with assessments for the purpose of improving success and retention. Retention is upheld at the college when students who have successfully completed a mathematics course sign up for the subsequent course needed. Success in online education, as Young, Birtolo and McElman (2009) explained, is understanding who the customer is and understanding what the customer needs.

Discussed in chapter 3 are the research design, rationale, and procedures where the population and size are defined along with the sampling strategy. The chapter included who the participants were, and how consent was obtained. In the data collection techniques section, the data were collected from final exam scores, the percent of success, and the percent of retention. The appropriateness, reliability, and validity were discussed. The data section included the procedures for participation, data collection, gaining access to the data set, and permission. The data collection part of the chapter is described, how the dependent and independent variables are collected, and how the data is stored safely and confidentially even after the study. Even though there has been mention of education plans to make data collection inventory publicly available through a searchable web database, for some fields, the data is still all confidential (Scott, 2013). In Chapter 4, the data analysis section, which can study growth over time using the same variables provided explanations of data (Nese, Lai, & Anderson, 2013), and statistical tests used to test the hypotheses, rationale, and interpreted results. Describing reliability and validity has been done by identifying internal and external threats. The ethical procedures are then described how the human participants are protected ethically throughout the study and after. Ethical procedures are all upheld by making the data anonymous and confidential.

## Chapter 4: Research Findings and Data Analysis Results

The purpose of the quantitative research was to examine whether proctoring exams in online math courses is associated with final exam scores, the final course grade for success, and retention in the areas surrounding Baltimore, Maryland. To achieve the purpose of the study, three research questions were addressed:

Research Question 1: What is the relationship between student final exam scores, (pass/fail) for students with proctored versus non-proctored online math tests?

Research Question 2: What is the relationship between the percent of student success for proctored versus non-proctored online math tests?

Research Question 3: What is the relationship between the percent of student retention for proctored versus non-proctored online math tests?

H1<sup>0</sup>: There is no relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

H1<sup>A</sup>: There is a relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

H2<sup>0</sup>: There is no relationship between the percent of student success with proctored versus non-proctored tests.

H2<sup>A</sup>: There is a relationship between the percent of student success with proctored versus non-proctored tests.

H3<sup>0</sup>: There is no relationship between the percent of student retention with proctored versus non-proctored tests.

H3<sup>A</sup>: There is a relationship between the percent of student retention with proctored versus non-proctored tests.

### **Data Collection**

A total of 1909 cases (students) across five different levels of online mathematics courses at a Mid-Atlantic Community College (MACC) from 2016 to 2018 were included in the study. The largest population possible was collected of complete data (final exam scores and final course grades). In 2016 the community college implemented institutionalized online mathematics courses so students would have more of the same experience, with a course which met all of the school's standards and expectations. Each instructor teaches these courses which included uniformed online assessments and finals, where the only difference was the randomly assigned numbers (of the same difficulty level) which were inserted into the individual test items.

The Mid-Atlantic community college serves over 62,000 students with about 40% of the students being white, 40% African American, 6% Hispanic/Latino, 8% Asian, 4% multicultural, and 1% unknown. MACC students who take at least one online course make up about 31% of the whole population. There are approximately 43% white, 39% African American, 6% Hispanic or Latino, 7% Asian, 4% multicultural, and 1% unknown students in online classes. In addition, there are over 35% of students who are Pell Grants recipients.

Secondary data from students in each of these online mathematics classes was collected as numeric and non-numeric data which were used to answer research questions regarding the data already collected (MacInnes, 2017). Any student who dropped the class (no longer registered) early enough was taken off the roster in the first week and were not included. Any students who received a withdraw (W) grade was included and recorded as failing for the semester with a 0% final exam grade. When dealing comes to financial aid, a W is considered a fail (F). Permission was given by the administration (see Appendix A), and data were collected from the Planning Research and Evaluation (PRE) Department. The data came from 16 different instructors who

taught the online mathematics courses. For the previous three years, the total students with both pre- and post- test scores is about 1900. Within these classes, there are sections which have no proctored tests during the semester, and only the final exam is proctored, and other sections which do have proctored tests along with the final exam. The online instructors were surveyed to determine if the instructor had proctored assessments or non-proctored in each class.

At the time of the study, students attending the MACC were allowed to register for online courses. The study was conducted with five different levels of mathematics courses and over three years. Students who were in classes with proctored assessments during the semester were compared to those who did not have proctored tests during the regular semester. In order to do this, final exam scores (pass/fail), success rates (pass/fail) and retention rates were compared. The three years includes winter, spring, summer and fall online courses. Therefore, these approximate 1900 students are representative and proportional to the larger population. All online mathematics courses and future online mathematics classes would be included at the community college for external validity.

### **Data Analysis and Results**

Prior to analyzing the data, all data were cleaned: duplicates and impossible (extreme – disparate) values were examined first. The examination process found 282 cases were duplicated, meaning some subjects were included in the data multiple times at different terms for different or same courses. For instance, if a student failed one of these courses, the student was counted as being not successful in the course final grade. If a student signed up for the course again (possibly with another instructor), and passed the course, students were counted as being successful in the class for the semester. Another situation could be if a student passed one of these online math courses, and then signed up for another subsequent online class in the study, and passed, students

were counted in both situations. There were 2.2% of missing data, but the data *were missing completely at random (MCAR)*, which means there is no relationship between whether a data point is missing and any values in the data set (Sweet & Grace-Martin, 2012). Pairwise deletion was then used, missing and duplicates were removed prior to the statistical analysis. Statistical analysis started with descriptive statistics to describe frequencies and percentages of all categorical variables. Continuous variables were reported using mean and standard deviation. Next, cross tabulations using chi-square tests and independent t-tests were conducted to examine the relationships between demographics and independent/dependent variables in order to determine if any covariates needed to be included in the analysis. In the primary analyses, a series of logistic generalized linear mixed models (GLMM) were conducted to examine the relationships between proctor status and all the dependent variables. Mixed models were used in order to account for the random effect of courses and subjects who attended different terms multiple times. Proctor was used as a predictor for all outcomes controlling for gender, race, and age. Data were managed and analyzed using IBM SPSS version 25. Alpha levels were set at  $\alpha = .05$  and odds ratios (*OR*) were used as effect sizes.

**Descriptions of the Sample:**

A total of 1909 cases across five courses from 2016 to 2018 were included in the study. Frequencies and percentages for categorical variables are displayed in Table 2. Gender, course ID, Age, and race were all described.

Table 2

*Descriptive Statistics for Demographic Variables*

Demographic variable	<i>n</i>	%
<b>Gender</b>		
Female	1367	71.6
Male	539	28.2
<b>Race</b>		
African-American	776	40.6
American Indian/Alaska Native	6	.3
Asian	82	4.3
Hispanic/Latino	70	3.7
Multiple Races	93	4.9
Native Hawaiian or Other PI	3	.2
White	857	44.9
<b>Course ID</b>		
MATH081 (Pre-Algebra)	179	9.4
MATH082 (Introductory Algebra)	541	28.3
MATH083 (Intermediate Algebra)	517	27.1
MATH163 (College Algebra)	378	19.8
MATH165 (Pre-Calculus)	211	11.1
	<i>M</i>	<i>SD</i>
Age	29.0	8.2

*Note.* Frequencies not summing to 1909 reflect missing data.

A majority of cases were females (71.6%) with an average age of 29 years old. The largest percent of the students were White (44.9%), followed by African-American (40.6%).

Only 1227 cases provided proctor information, of which 68.2% (43.8% of total) were proctored. Most cases failed the final exam (68.9%), with mean final grade of 40.2 (SD = 34.7). However, nearly half of the sample succeeded for the course (48.2%) and nearly half of the sample retained in the math (49.6%). More details describing independent and dependent variables are in Table 3.

Table 3

*Descriptive Statistics for Independent and Dependent Variables*

Independent/Dependent variable	<i>n</i>	%
Proctor		
Not proctored	390	20.4
Proctored	837	43.8
Final exam		
Fail	1315	68.9
Pass	507	26.6
Course grade		
Not success	905	47.4
Success	921	48.2
Retention		
Not retained	879	46.0
Retained	947	49.6
	<i>M</i>	<i>SD</i>
Final exam grade	40.2	34.7

*Note.* Frequencies not summing to 1909 reflect missing data.

### **Proctor Comparisons for Final Exam, Course Grade, and Retention:**

Several logistic generalized linear mixed models (GLMM) were used to examine the relationships between proctor and outcome variables. The models account for the random effect of course and subjects who attended multiple terms. Logistic regression is used because the outcome is a binomial variable is determined (pass/not pass). From the preliminary analyses via cross-tabulation using chi-square tests, the data demonstrated African-American students were more likely to fail the final exam and had the lowest success rate. Males were more likely to succeed than females, and older participants were more likely to succeed and be retained. Therefore, the GLMM regressions controlled for age, gender, and race/ethnicity.

Final exam scores of 70% or above were considered passing. Therefore, the final exam grade was dichotomized into pass and fail. Results, shown in Table 3, and revealed students who took the exams in a proctored class during the semester were more likely to fail the final exam,  $OR = .669$  ( $CI = [.486, .920]$ ),  $p = .013$  while controlling for age, gender, and race as well as random effects for the course. The results indicate proctoring semester assessments was 1.49 (1/.669) times more likely to fail the final exam as compared to not proctoring semester assessments. Whites and other races had higher success rates on the final exam than African-Americans,  $OR = 1.775$  and  $1.930$ ,  $ps < .005$ . As seen in Table 2, with race distribution, most participants were White and African American. Although the other races are important, because the individual sample percentage is below 10%, students could not be included in the regression model, and were combined as “other.” Older participants were more likely to pass the final exam,  $OR = 1.026$  ( $CI = [1.010, 1.044]$ ),  $p = .002$ .

Table 4

*Logistic Regression Statistics with Proctor and Demographics Predicting Final Exam*

Predictor	<i>B</i>	<i>OR</i>	<i>p</i>	95% CI for OR	
				<i>LL</i>	<i>UL</i>
Proctor <sup>a</sup>	-.402	.669	.013	.486	.920
Race <sup>b</sup>					
Other races	.657	1.930	.004	1.234	3.017
White	.574	1.775	<.001	1.305	2.413
Male <sup>c</sup>	.136	1.146	.388	.841	1.561
Age	.026	1.026	.002	1.010	1.044

*Note.* <sup>a</sup> Compared to Not proctored. <sup>b</sup> Compared to African American. <sup>c</sup> Compared to Female.

When determining course grades for success, a participant who obtained a C or above letter grade was considered passing the course. Therefore, course grade was dichotomized into

success and not success. As seen in Table 5, students who were proctored were less likely to succeed,  $OR = .652$  ( $CI = [.494, .856]$ ),  $p = .002$  while controlling for age, gender, and race as well as random effects for course. The result suggests students who attended the non-proctored assessments during the semester were 1.53( $1/.652$ ) times more likely to succeed in the course than the student who attended the proctored assessments. In addition, White and other races were more likely to succeed than African-American,  $OR = 2.440$  and  $1.600$ ,  $ps < .05$ . Older participants were more likely to be successful for the course,  $OR = 1.022$  ( $CI = [1.007, 1.038]$ ),  $p = .004$ . Males were more likely to succeed in a course than females,  $OR = 1.321$  ( $CI = [1.006, 1.736]$ ),  $p = .045$ .

Table 5

*Logistic Regression Statistics with Proctor and Demographics Predicting Course Grade for Success*

Predictor	B	OR	p	95% CI for OR	
				LL	UL
Proctor <sup>a</sup>	-.428	.652	.002	.494	.859
Race <sup>b</sup>					
Other races	.470	1.600	.017	1.088	2.354
White	.892	2.440	.000	1.875	3.175
Male <sup>c</sup>	.279	1.321	.045	1.006	1.736
Age	.022	1.022	.004	1.007	1.038

*Note.* <sup>a</sup> Compared to Not proctored. <sup>b</sup> Compared to African American. <sup>c</sup> Compared to Female.

Finally, results predicting retention demonstrated proctoring was not associated with retention when controlling for the demographics. There is no relationship with proctoring. The only significant finding in Table 6 shows Whites were more likely to be retained than African-Americans,  $OR = 1.361$  ( $CI = [1.047, 1.769]$ ),  $p = .021$ .

Table 6

*Logistic Regression Statistics with Proctor and Demographics Predicting Retention*

Predictor	<i>B</i>	<i>OR</i>	<i>p</i>	95% CI for OR	
				<i>LL</i>	<i>UL</i>
Proctor <sup>a</sup>	.055	1.056	.698	.802	1.392
Race <sup>b</sup>					
Other races	.134	1.144	.496	.777	1.683
White	.308	1.361	.021	1.047	1.769
Male <sup>c</sup>	-.081	.922	.553	.704	1.207
Age	.004	1.004	.617	.989	1.019

*Note.* <sup>a</sup> Compared to Not proctored. <sup>b</sup> Compared to African American. <sup>c</sup> Compared to Female.

### Reliability and Validity

Ensuring there is reliability and validity in all research studies is important. Specifically, there needs to be internal validity, external validity and objectivity. No statistical tests conducted were researcher-conducted. Internal validity is the extent the researcher can conclude there is a cause and effect relationship between the variables. The conclusion can only be a correct inference if threats are accounted for in the study and design (Creswell, 2009). External validity, as Creswell (2009) described, is the extent the researcher can determine the results of the study can apply to a larger or extended population. If your research is applicable to other settings, students, and classes, high validity would be validated. If the research cannot be replicated in other situations, external validity is low. Scores used in research studies from participants (students) are consistent over time are considered reliable (Creswell, 2009). Due to using Inferential statistical tests have been used and determined to be valid and reliable over time (AllPsych, 2018). Statistically proven tests were used with collected data from the PRE department through college records of secondary data, and over 1900 students from five different

mathematics courses, to uphold reliability and validity.

### **Chapter Summary**

The purpose of the quantitative research was to examine whether proctoring assessments during the semester were associated with final exam scores, course grades for success, and retention for online mathematics students in the MACC area. The second purpose was to address the three research questions and hypotheses addressed in the study. A total of 1909 cases across 5 courses from 2016 to 2018 were included in the study. Taken together, the study looked at whether or not proctoring online math tests were significantly associated with final exam grades and students' success for the course.

Students who were proctored were less likely to pass the final exam and to succeed for the course. Specifically, proctoring semester exams was 1.49 times more likely to fail the final exam as compared to not proctoring semester exams. Worth noting, White and other races were more likely to pass the final exam than African-Americans. Students who were proctored were also less likely to succeed in the course. The result suggests students who attended the non-proctored assessments during the semester were 1.53 times more likely to succeed in the course than the student who had proctored assessments during the semester.

However, assessments being proctored was not related to whether or not a student was retained in a math course. The only significant finding was Whites were more likely to be retained than African-Americans. Therefore, the above findings reject the non-hypothesis for research questions 1 and 2, and accept the non-hypothesis for research question 3. Chapter 5 analyses findings of the study along with the study's implications, limitations, and recommendations for educators who are teaching online mathematics courses, and future researchers.

## Chapter 5: Discussion and Conclusion

The purpose of the quantitative research design is to examine the relationship of the following final exam grades (pass/fail), percent of success (passing the semester with a 70% or higher), and percent of retention of online mathematics students. Final exam scores, percent of student success, and percent of student retention was be compared among classes with proctored versus non-proctored tests during the semester. The comparison determined if there was a relationship in online mathematics classes. The proposed study is necessary for the Mid-Atlantic Community College (MACC) and the mathematics department, to determine if the college can increase online success and decrease dropout rates through the type of assessments given to students during the semester. Research indicates, online assessments are a challenge when looking at a student's performance (Hollister & Berenson, 2009). Studies have found the percent of success in online classes are lower than in the comparable face-to-face classes (Borzewski, 2016). If the research is not conducted, there would not be a conclusion as to whether proctoring tests affect the success of online students to meet or exceed those in face-to-face classes.

As seen in the literature review in Chapter 2, there is minimal research-based consensus about the proposed study, which contributes to the knowledge base. The knowledge base helps determine if proctored assessments affect successful education in online mathematics classes for students in at MACC. To achieve the purpose of the study, three research questions were addressed. Chapter 3 detailed the methods used to address the study's research questions and hypotheses. The quantitative design examined the relationship between a dichotomous variable ("Proctored" or "Not Proctored"). Proctored was the independent variable while the dependent variables were success rates, retention rates, and final exam scores. These were also broken up by demographics.

A generalized logistic mixed model (GLMM) was used to account for random effect of Course ID and Term. There were five different math course used in the study, and the Course ID was the name of the specific course, and the Term was the year and semester. Term indicates time. Term is mainly used due to the duplicate cases in order to control for Term (same subject took different courses for multiple terms).

In research question 1, while considering gender, age, race, course ID, and term, students who were proctored had higher rates of failing the final exam. White students pass rates for the final exam were higher than African-Americans. Older participants final exam passing rates were also higher. Gender and course ID were not associated with final grade.

In research question 2, while controlling for gender, age, race, course ID, and term, students who were proctored were less likely to succeed. Whites had higher success rates than African-American. Males showed higher scores than females. Older participants were more successful than younger ones.

In research question 3, while controlling for gender, age, race, course ID, and term, proctor was not associated with retention. There was no relationship with proctored tests and retention. Whites had higher retention rates than African-American. gender, age, and course ID were not associated with retention.

Chapter 5 includes a discussion of the findings in the study. Included is how the data may be interpreted and conclusions which may be drawn from the results found. Chapter 5 also discusses limitations in the study, recommendations for instructors of online mathematics courses at community colleges, and future researchers. The chapter then presented the implications for leadership at the community college level.

## Findings, Interpretations, and Conclusion

The results of the data analysis described in Chapter 4, give needed information to address the study's three research questions and hypotheses. Interpretations and conclusions from the study can be determined within the context of the study's theoretical framework. The outcomes related to the research questions and hypotheses, in order to achieve the goals of the study, are below.

Research Question 1: What is the relationship between student final exam scores, (pass/fail) for students with proctored versus non-proctored online math tests?

Research Question 2: What is the relationship between the percent of student success for proctored versus non-proctored online math tests?

Research Question 3: What is the relationship between the percent of student retention for proctored versus non-proctored online math tests?

$H1^0$ : There is no relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

$H1^A$ : There is a relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

$H2^0$ : There is no relationship between the percent of student success with proctored versus non-proctored tests.

$H2^A$ : There is a relationship between the percent of student success with proctored versus non-proctored tests.

$H3^0$ : There is no relationship between the percent of student retention with proctored versus non-proctored tests.

H3<sup>A</sup>: There is a relationship between the percent of student retention with proctored versus non-proctored tests.

To address the hypothesis and research questions, generalized linear mixed models were used to analyze the data. In research question 1, a participant was considered passing the final exam when the grade was a 70% or above. The final exam grade was dichotomized into pass and fail. Results revealed students who had proctored tests during the semester had higher rates of failing the final exam. Older students along with White students had higher passing rates on the final exam. Therefore, the above findings reject the non-hypothesis for research questions 1. H1<sup>A</sup> is then true, stating there is a relationship between final exam scores (pass/fail) of students with proctored versus non-proctored online tests.

In research question 2, the results suggest students who were assigned to non-proctored assessments during the semester were 1.53 times more likely to succeed in the course. As with success on final exam scores, Whites and older students had higher success rates in these online mathematics course. To no surprise, students who do better on the final exam have higher success rates in the class as well. The above findings reject the non-hypothesis for research questions 2. H2<sup>A</sup> is then true, stating there is a relationship between the percent of student success with proctored versus non-proctored tests.

In contrast, for research question 3, proctoring tests did not seem to determine if a student was retained or not. When looking at race though, Whites were retained at a higher rate than African-Americans. However, a greater proportion of participants who succeeded for the course were retained (62.5%) than those who did not succeed (41.0%). Hence, the above findings accept the non-hypothesis for research question 3. H3<sup>0</sup> is then true, stating there is no relationship between the percent of student retention with proctored versus non-proctored tests.

This research study is based on the theoretical framework of the Theory of Planned Behavior, a cognitive theory, which aims to predict and understand the relationship between human behavior and motivation (Peters, & Templin, 2010). Factors like motivation and technology are impacting students cheating problem within institutions (Bolman & Deal, 2008). Since the study determined students who were in online mathematics classes with non-proctored tests, did better on final exams, and were more successful in the course, there may be future studies needed. The studies may need to determine if the result is due to more students in the proctored tests not showing up for the final exam because the student did not believe they were going to be successful in the course. The study may also need to determine if due to the same concept, more students in courses with non-proctored tests were more successful.

As noted in Chapter 2, there is conflicting information from studies when looking at online courses. Demographics of who is being studied, could be influential on the research studies. The study determined males had higher success rates than females. There are conflicting results such as in the study done by White (2013), where overall, women were found to be more successful than men in online courses. However, when determining who is successful on the final exam or successful in the course for the semester, older students were determined to be the most successful in the study. Students who are abreast in time management, multitasking, and critical thinking, tend to take responsibility for personal learning, and are capable of working independently, are typically adult learners. The students are usually more mature and possess prior knowledge and life experiences and can relate to education and have effectively introduced these elements back into online education classes (Johnson & Berge, 2012).

Demographics can affect retention, according to Elam (2013). Students who are educated on how these classes work, operate, and are organized, possess the ability to improve retention

and success (Elam, 2013). Research Question 3 found proctoring tests did not have an effect on retention. However, White students were retained more often than African-American students. Future research could be conducted to determine if there is a connection between demographics at the MACC and student education in online mathematics courses.

The data analyzed in the study showed Whites had higher success rates on online mathematics final exams, in passing an online mathematics course, and being retained. Students in non-proctored online mathematics courses had higher success rates when looking at final exams and passing the course for the semester. Proctored assessments on the other hand, did not seem to have an effect on retention either way. The study contributed additional data to the growing body of research exploring the relationship between proctored and non-proctored tests in online mathematics courses at the community college level.

### **Limitations**

Lurking variables having the potential to impact the student's performance within the research sample may have existed. Other demographic variables which could have a potential impact on students' performance include age, having to take care of family members, and the number of hours students need to work outside of the education commitment (Glazier, 2016). The research sample was diverse in these and students of all demographics in the study had equal opportunity to sign up for an online mathematics course in place of a traditional face-to-face course.

A three-year period has been selected for the focused research to include a variety of instructors, both full time and adjunct, as well as a variety and diverse population of students. During the given three year time frame, the online classes in the study were institutionalized, which means each course was set up the same, and the assessments and homework's throughout

the semester were the same with only random numbers of the same difficulty changing in each problem. Common courses gave the students as close to the same experience in each class as possible. These students were in five different levels of math to help address any potential student or instructor bias. The scope of the study is generalizable because of the population the study was pulled from a large diverse population of 62,000 students with about 29% Pell Grant recipients, 45% of the students body is white, and 33% African American, 6% Hispanic or Latino, 6% Asian, 2% multicultural, and 8% unknown. Statistics here are comparable to the findings to other online mathematics courses at the MACC and possibly other community colleges with similar demographics.

The study was limited to five online mathematics courses which included Pre-Algebra, Introductory Algebra, Intermediate Algebra, College Algebra, and Pre-Calculus. Other online math courses offered at MACC were not used in the study due to lack of institutionalized courses which lead to many other variables which could contribute to results in the study. These courses can use other online homework and assessment systems, have individually created tests at multiply difficulty levels, and more.

### **Recommendations**

Instructors and administrators at community colleges continue to be given the responsibility of setting appropriate requirements and standards for online mathematics courses. The literature review in Chapter 2 showed the need for additional studies on the relationship between proctored and non-proctored assessments in online mathematics courses as related to success. Further research is recommended at the MACC as well as in other diverse settings throughout the United States.

Administration and leaders at the institution should consider further research as more online mathematics courses get institutionalized. Another study may be beneficial is to see how many students took the final exam in proctored settings versus non-proctored settings to determine if there is a possible relationship in success rates. A point of interest may also be to note how many students drop or no longer participate in proctored and non-proctored classes to compare the relationship.

This study contained about 1900 cases over three years and five different mathematics courses over a diverse population. Potentially the findings can be generalized to other community colleges with similar populations as the study. Future researchers may decide to consider different methodologies in order to address the relationship between proctored and non-proctored assessments in online math courses. For instance, the study did not include any qualitative data from students or instructors to better understand success and retention. Including qualitative data or mixed-methods study may serve to explain student performance and success characteristics found to be important by administration and instructors. Included qualitative interviews or surveys may provide additional insight into perceptions about the reasons for success and retention rates.

### **Implications for Leadership**

This study is significant to administration, educators, and instructors, as results are revealed for proctoring and not proctoring tests in online mathematics courses in reference to success and retention. There was evidence a relationship existed between students in classes with non-proctored assessments during the semester and being more successful on final exams and the course as a whole. As for retention, more studies have to be completed to determine what variables are effecting students and determining if students are going to sign up for the

subsequent math course or not.

Leadership can now determine based on the study, what is the most beneficial way to conduct online courses in the mathematics department. The study also leaves the door open for future research to be conducted to determine possible reasons for these conclusions. The community college administrators have looked into multiple online proctoring methods and taking the final exams for math classes with paper and pencil for instructors to see all algebraic work. As variables change, so may relationships, successes, and outcomes.

### **Conclusions**

Chapter 5 provided an overview of some of the previous chapters in the study. The problem researched, the purpose of the study, and the methods used to answer and summarize research questions and hypotheses. The study was to be determined whether or not proctoring online math tests were significantly associated with final exam grade and students' success for the course. Students who were given proctored assessments during the semester were less likely to pass the final exam and to succeed for the course. However, proctor was not related to whether or not a student retained in math course. Therefore, the above findings reject the non-hypothesis for research questions 1 and 2, and accept the non-hypothesis for research question 3. These conclusions can potentially be assumed for other institutionalized online math courses at MACC and other diverse community colleges.

Chapter 5 discussed the limitations of the study according to the study's research questions, the existing literature from Chapter 2, and the theoretical framework directing the study. Future research may focus on variables which cause retention, and the number of cases who may drop or no longer attend proctored classes and are given a 0% for the final exam and hence fail the course. Because community colleges continue to be tasked with setting appropriate

requirements and standards in online courses, further research examining relationships with proctored assessments was recommended. Chapter 5 also provided recommendations for future researchers choosing to contribute to the growing body of research and knowledge in the field. A better understanding of the relationship between proctored tests and non-proctored tests can now be understood.

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## Appendix A: Consent Form

Dear CCBC Administration,

As a Mid Atlantic Community College Professor, I am writing to request the opportunity to collect data for my dissertation in my doctorate program at the American College of Education, which is based out of Indianapolis, Indiana. I am requesting to be allowed to collect final exam scores, the percent of successful students, and the percent of students retained in the past three years (2016 – 2018) who have been in an online institutionalized mathematics course using MyOpenMath (2018) as the assessment/homework system. I will be comparing the noted scores and percents with students who had proctored assessments during the semester and those who did not. I will be comparing the percent of success with traditional classes as well. Therefore, I would also like to collect the percent of student success (success = C or above) of the above face to face classes during these same semesters.

The data would be specifically from the following online mathematics classes each semester (spring, summer, fall, & winter) and grouped by gender and age as well:

Math 081 Pre- Algebra

Math 082 Introductory Algebra

Math 083 Intermediate Algebra

Math 163 College Algebra (Pre-Calc I)

Math 165 Pre- Calculus (Pre-Calc II)

I look forward to your response, and the ability to add to the knowledge base of our students for continued success.

Sincerely,

Danielle Truskowski