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Introductory Mathematics and STEM Persistence: Examining the Differences between Online and In-Person Performance at a HBCU

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INTRODUCTORY MATHEMATICS AND STEM PERSISTENCE:
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PERFORMANCE AT A HBCU

BY

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BY

WENDY D. DIXIE

Submitted to the Faculty of the Graduate School of
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2021

DEDICATION

This dissertation is dedicated to my family, those who are living and those who are deceased; for it is because of their faith, prayers, hard work, and perseverance that I am who I am today.

"Greatness is not measured by what a man or woman accomplishes, but by the opposition, he or she has overcome to reach his goals. "

Dr. Dorothy Irene Height

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ABSTRACT

The United States is losing its position as an innovative global leader because of a shortage of skilled workers in STEM. This decline is due in part to the US producing a lower number of graduates from STEM related fields. One reason for the shortage is that US students are selecting or graduating with STEM majors at a lower rate than those of competing countries. As a result of these shortages, the US has undertaken several initiatives to increase public awareness of and training in STEM that will ultimately produce STEM degrees.

The purpose of this research was to examine the performance differences that exist between web-based introductory math courses and classroom-based introductory math courses at an HBCU over 3 academic years. The research questions that guided this study were:

1. What differences, if any, exist between an online introductory math class and a classroom-based introductory math class as it relates to grades, race, gender, age, and major?
2. What difference, if any, exists between STEM majors in an online introductory math class and classroom-based introductory math class?

To discover answers to the research questions, I conducted a non-experimental descriptive comparative study utilizing quantitative methods and found that when using independent sample *t* tests, student performance in the introductory mathematics course significantly differed according to gender, race, and academic major. This demographic difference in academic performance were specifically seen with female students, White

students, and students of non-STEM majors as they outperformed their respective counterparts.

The end result is that HBCUs are a relevant solution to the STEM challenge in the United States. The outstanding institutions of higher learning can not only address the global shortage of innovative STEM workers, but can also lead the way for an even more diverse and inclusive workforce and community.

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CHAPTER ONE: INTRODUCTION

Problem Statement

Once considered a global innovative leader, the US is now falling behind other countries in producing a skilled STEM workforce (Casey, 2012; Weiner, 2018). This decline is due in part to the US producing a lower number of graduates from STEM related fields (Atkinson et al., 2007; Hassan, 2018; Lamb, 2019; McCarthy, 2017), especially as it relates to US domestic students (Herman, 2019; Herman, 2018). In particular, bachelor degrees in engineering, technology, and math are obtained at a lower rate as opposed to the biological/life sciences (Chen & Soldner, 2013). In 2017, the National Science Board reported Science and Engineering degrees were 9% of all associates degrees, 34% of all bachelor's degrees, 25% of all master's degrees and 64% of all doctoral level degrees obtained in the US. It is important to note that while there is a shortage of STEM workers in private, government and other sectors, higher education is experiencing a surplus of doctorate level workers in certain career paths of STEM such as Biology due in part to the level of doctoral degrees obtained in that area (Xue & Larson, 2015).

This global crisis is persisting as the US is struggling to adequately develop and retain qualified STEM talent (Chen & Soldner, 2013). Specifically, US students in elementary and secondary schools perform at a lower rate in mathematics and science than students in several other countries; US undergraduates select STEM majors at a lower rate than those of many competing countries; the US ratio of STEM to non-STEM bachelor's degrees is one of the lowest globally; and US students, who have a higher probability to become great scientist or technologist are not pursuing careers in

STEM areas (Chen & Soldner, 2013). As a result of these concerns, there are national initiatives to develop a larger quantity of STEM degrees and careers from a diverse background of students (Chen & Soldner, 2013).

Because this is such a global and important issue, the government has pursued multiple avenues to increase the number of STEM graduates (Handelsman & Smith, 2016; National Science Board, 2018; U.S. Government, 2016, 2018). In particular, there has been an emphasis on supporting HBCUs and assisting them to graduate more STEM degrees (National Academies of Science and Medicine, 2019; U.S. Government, 2018). Additionally, increasing offerings in STEM related courses, such as mathematics can be beneficial in encouraging students to pursue a degree in STEM (Herbert & Clark, 2020). Moreover, the flexibility of online STEM or mathematics courses can also attract a diverse set of students who may not have taken the course in person. As such, the purpose of this dissertation is to examine the differences that exist between web-based introductory math courses and classroom-based introductory math courses at an HBCU.

Background

The two previous federal administrations had initiatives to enhance and expand STEM training and awareness in the US (Campisi, 2019). During the Obama administration, several councils, programs, and legislation that would improve and expand funding, training and education for STEM were implemented. From the 2009 Educate to Innovate campaign, the America Competes Reauthorization Act of 2010, to the 2016 Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5 - Year Strategic Plan (U.S. Government, 2016). Over 3.4 billion dollars was dedicated to over 14 Federal programs dedicated to STEM education programs. The goal of these programs was to improve teaching of STEM, support active learning, expand access to STEM courses that were rigorous, and take on the bias and increase opportunities for underrepresented students in STEM (Handelsman & Smith, 2016).

In 2018, the Trump Administration created the *Charting A Course for Success: America's Strategy for STEM Education* to address the STEM crisis. This 5-year strategic plan was to demonstrate the Federal government's dedication to enhancing and expanding STEM training and awareness and to continue strategies as set forth in the America Competes Reauthorization Act. This objective of the plan was to set forth a road map centered around the vision the US will be an international leader in all components of STEM and that every American will have continued access to a rigorous STEM education. (U.S. Government, 2018). The plan highlighted three areas of focus which included developing a sound STEM education infrastructure, "Increase Diversity, Equity, and Inclusion in STEM" and lay the foundation for the future STEM Workforce. The Trump Administration dedicated over $200 million a year toward STEM (U.S. Government, 2018).

The initiatives of both administrations, recognized that in order to fill the STEM workforce shortages, increasing STEM graduates, especially among African-Americans or Blacks and other underrepresented populations, is essential for diversity and equity (U.S. Government, 2016, 2018). The Obama Administration acknowledged that involving Historically Black Colleges and Universities (HBCUs) was vital in assisting the U.S. in meeting the overall challenges with STEM. The administration established policies over $800 million over 10 years to HBCUs to "renew, reform, and expand programs to ensure students have the opportunity for educational and career success at HBCUs" (U.S. Department of Education, 2016, para. 2). The Trump Administration also created federal STEM related initiatives to promote quality and creativity at HBCUs. With the "Presidential Executive Order on The White House Initiative to Promote Excellence and Innovation at Historically Black Colleges and Universities.", the Trump Administration made funding and supporting HBCUs a priority (U.S. Department of Education, 2017).

The Biden Administration has also committed to supporting HBCU's and other minority-serving institutions in order to ensure future workforce needs. During Biden's signing of an Executive Order on Racial Equity, he stated, "Just imagine if more incredibly creative and innovative — how much more creative and innovative we'd be if this nation held — held the historic black colleges and universities to the same opportunities — and minority-serving institutions — that had the same funding and resources of public universities to compete for jobs and industries of the future," (Biden, 2021, para. 17).

Partnering and supporting HBCUs in order to increase a diverse STEM workforce, is a desirable strategy due in part because of HBCUs impact on the degree completion of African-Americans and other underrepresented populations. Although HBCUs represent a smaller number of institutions; there were 101 in 2018, HBCUs have been shown to graduate a high proportion of STEM graduates. For example, HBCUs make up 3% of the institutions in the U.S., but they graduated 25% of the bachelor's degrees in education awarded to African-Americans or Blacks in 2011, 27% percent of African-American or Black graduates with STEM bachelor degrees, 46% of

African American or Black women graduates in STEM disciplines between 1995 and 2004, 30% of African American or Black graduates of science and engineering doctorate programs; placing 21 HBCUs in the midst of 50 top institutions for graduate doctorates in science and engineering. Additionally, between 2008 and 2012, eight of the 20 institutions that conferred the most bachelor degrees in science and engineering were HBCUs while one HBCU, Xavier University, has awarded African-Americans or Black more undergraduate degrees in biological and physical sciences in the U.S. (U.S. Department of Education, 2016). By design, HBCUs provide a supportive, nurturing, diverse and inclusive environment for students (Jett, 2013). This allows for all students, especially those participating in STEM, to receive a holistic experience that includes academic support, mentoring, and unique networking and career development (Lee et al., 2019). As such, support for STEM majors and courses at HBCUs can help to increase the number of STEM graduates on a national level.

There is also emphasis placed on gaining experience of science, technology, engineering, and mathematics as distinct disciplines as well as gaining experience by integrating all the disciplines into one curriculum (Shaughnessy, 2013) as a way to improve STEM interest and education. As a result, another way to promote an increase in STEM graduates is to ensure introductory math courses are a part of standard curriculum. An incorporation of mathematics is essential to the foundation of developing the skills for problem solving, learning, and reasoning that draws on "concepts and procedures" (Lefkowitz, 2018; Shaughnessy, 2013, p. 324). As the desire for a more highly skilled STEM workforce grows, without the development of these skills, higher education programs that are pathways to careers in STEM will not be of interest or will result in a low skilled workforce (Lefkowitz, 2018).

There is also belief that increasing interest in mathematics will not only help the US by increasing mathematics majors but for students who wish to attend graduate school, being a mathematics major will improve their applications. By increasing mathematics majors or by adding a mathematical curriculum, Mathematic departments could increase the involvement in STEM (Velez, 2020). Introductory college mathematics courses are considered gateway courses to many majors, as a result passing those classes is essential to student success and persistence toward STEM degrees (Brakke & Helpern, 2014). Additionally, introductory mathematics, among other courses, are often mandatory or a prerequisite for other courses as part of degree completion. (Small, 2006).

Lastly, another way to increase access to STEM degrees is to consider offering STEM courses in an online format. There are multiple benefits of online courses. From lower costs to learning in a customizable learning environment (Dumbauld, 2020). While cost is often a top factor in determining whether or not to attend classes in an online format, it is not the only factor. In the 2020 Online Education Trends Report created by Best Colleges, for the past four years, over 47% of students take online classes because of the flexibility the format offers as work and family obligations are barriers for attending in-person (BestColleges, 2020). Additionally, 77% of online learners were attempting to reach career goals which concludes that students taking online classes are looking for the fastest pathway to graduation (Magda et al., 2020).

As a result of student academic goals, if an institution did not have an online offering for a 52% of the students would look at other institutions who may offer the program (Magda et al., 2020). Institutions look at program demand from students as one of the three reasons for offering online courses. The top reason for offering online courses is to expand an already online program and the third highest reason for offering online courses is to meet employee demands (BestColleges, 2020).

In summary, the focus of this dissertation is to explore how the outcomes of an online mathematics course differs from an in-person mathematics course. Given these three ways to promote STEM graduates (e.g. emphasis on HBCUs, exploration into introductory math classes, and utilizing the flexibility of online courses), the underlying results should demonstrate academic guidance to assist with this global crisis.

Purpose and Research Questions

The purpose of this quantitative study is to examine the demographics and academic outcome differences between web-based introductory math class and classroom-based introductory math class at an HBCU over 3 academic years. Therefore, this dissertation is guided by the following research questions:

- What differences, if any, exist between an online introductory math class and classroom-based introductory math class as it relates to grades, race, gender, age, and major?
- What difference, if any, exists between STEM majors in an online introductory math class and classroom-based introductory math class?

Significance

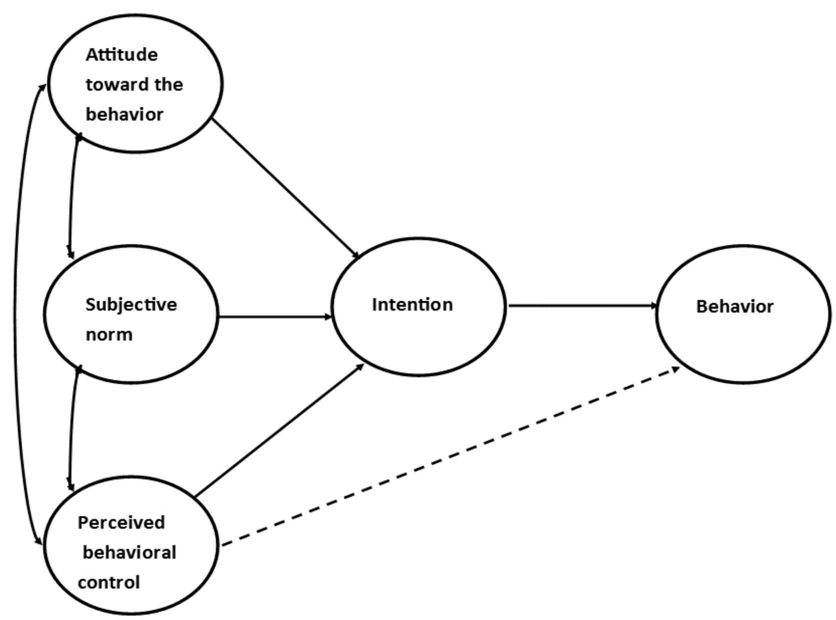
Not only is there a decrease in STEM graduates, but there are large and consistent gender and racial gaps when it comes to STEM graduation rates (Lloyd-Jones et al., 2011). For undergraduates in the US, going to college has improved over the last 30 years (Lloyd-Jones et al., 2011). However, the gap in STEM graduates is large, 24 percent of African Americans or Blacks graduate with a STEM degree in comparison to 40 percent of white graduates (Lloyd-Jones et al., 2011). Also, while women earned 57 percent of bachelor’s degrees in all fields, they only earned 19 percent of degrees in computer science, 22 percent of degrees in engineering, 40 percent of degrees in physical sciences and 42 percent of degrees in mathematics (National Science Board, 2017).

The findings of this study should help to understand the gaps between students of color and white students and between women and men. Additionally, it can help to highlight whether or not online courses can be a beneficial and cost-efficient way to promote STEM graduates. By attracting more students, especially in STEM, universities can expand online offerings and conserve academic standards and rigor while also reducing cost to the organization (Hartman, 2012; Schwartz, 2019). Over 68% of institutions decided to offer online courses as a way to expand enrollment into their organization (BestColleges, 2020).

Theoretical Framework

Increasing the number of STEM graduates will assist in the STEM workforce shortage that the US has and will continue to have (Moore & Burrus, 2019). Being able to determine if a student will major in STEM or a STEM gateway course could be determined by the usage of multiple behavioral or cognitive theories. One behavioral theory that has been used to anticipate behavior is the Theory of Planned Behavior (TPB). This theory has been used to predict behavior and explain behaviors that an individual can control. This theory is a derivative of the 1980's Theory of Reasoned Action (Ajzen, 1991). The Theory of Planned Behavior suggests that behaviors can be predicted based on certain elements as illustrated in Figure 1.

Figure 1. Elements of TPB.



Source: Icek Ajzen, "*The Theory of Planned Behavior*." *Organizational Behavior and Human Decision Process* Vol 50, pp. 179-211.

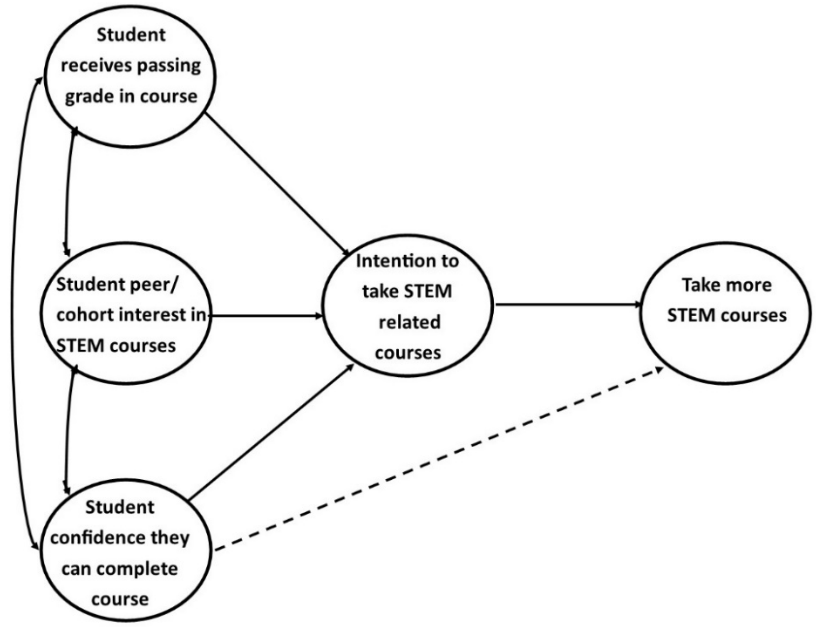
Central to TPB is the intention of an individual. According to TPB, particular activities will be completed based on a person's intentions (Ajzen, 1991). Additional aspects of TPB that assist in predicting behavior are: (1) Attitude: This factor associates a person's attitude toward the behavior. With TPB, an individual's behavior can be forecasted by an enthusiastic or unenthusiastic assessment of a certain behavior. (2)

Subjective Norm: This factor of TPB describes how an individual discerns the social pressure he or she gets to accomplish or not accomplish a particular action. (3) Perceived behavioral norms: This factor describes how an individual discerns how difficult or easy it will be to conduct a certain act. This factor uses prior circumstances and expected weaknesses (Ajzen, 1991).

For example, if a student has a passing grade in introductory math, his attitude toward the experience of taking the class and perceived behavioral norm will be favorable and thus the student may continue to take further classes in STEM. TPB reveals that a planned behavior is not necessarily driven by an individual's intention to perform (as in this study, take an introductory mathematics class) but can be decided by an individual's attitude or subjective norms (Ajzen, 1991). Figure 2 illustrates the relation between TPB and persistence in taking STEM related courses.

Additionally, TPB can be used to explore how a student's attitude, subjective norms, and perceived behavior controls toward learning online can influence their intentions to take courses online (Ajzen, 1991). Using this model, for example a student's attitude toward taking classes online (flexibility), subjective norms (pressure to take class online vs in-person) and perceived behavior control (ease of use) can determine a student's intention to take online classes.

Figure 2. TPB and STEM Related Course Persistence



Source: Adapted from Icek Ajzen, "*The Theory of Planned Behavior*." *Organizational Behavior and Human Decision Process* Vol 50, pp. 179-211.

Key Terminology

The following definitions are being provided for consistency and understanding of key terminology relied upon throughout this dissertation.

HBCU: Historically Black Colleges and Universities. The definition of HBCUs according to the Higher Education Act of 1965, is "institutions of higher learning established before 1964 whose principal mission was then, as is now, the [higher] education of black Americans." (LeMelle, 2002, p. 11). While that definition still exists, it is important to understand that not all institutions that service minorities are HBCUS and not all HBCUs of today primarily educate African Americans or Blacks (Palmer et al., 2010).

In Person Course: For the basis of this study, this may also be referred to as classroom course, face-to-face class, classroom-based or traditional classroom. This type of course involves meeting at a planned time face-to-face (Miller, 2015). These classes, while in-person, can be conducted in many different formats. Examples are "lectures, studios, or workshops or other traditional face-to-face activities, such as laboratories, field trips, or internships" (Miller, 2015).

Introductory Mathematics: For this dissertation, introductory mathematics is MAT 115- College Algebra. Per the Kentucky State University, 2018-2019 Catalogue, the objective of this course is to provide the necessary knowledge in algebra so that students who may need to advance their studies in mathematics. "Topics include the algebra of functions; graphing techniques; quantitative and qualitative analysis of polynomial, rational, exponential and logarithmic functions, including limits at infinity and infinite limits; and appropriate applications" (Kentucky State University, 2019, p. 209).

Online Course: For the basis of this study, this may also be referred to as online class, web-based, e-learning, or virtual learning. Online courses are classes that do not meet in-person. All of the course work and "student interactions with content, the instructor and other students" are conducted online. Location of the student nor the institutions is not a consideration in this platform (Miller, 2015, para. 13). IDEA describes online courses as a "directed learning process, comprised of educational information (articles, videos, images, web links) communication (messaging, discussion forums) and some way to measure students' achievement (IDEA, 2012, para. 12).

STEM: Science Technology Engineering and Mathematics. STEM, in full science, technology, engineering, and mathematics, field and curriculum centered on education in the disciplines of science, technology, engineering, and mathematics (STEM). The STEM acronym was introduced in 2001 by scientific administrators at the U.S. National Science Foundation.

Conclusion

In conclusion, this chapter introduced the problem of the US falling behind other countries in producing a skilled STEM workforce. Additionally, the chapter explained the purpose, significance, research questions and theoretical framework in support of the research. In Chapter 2, a review of existing scholarly sources was conducted to develop the theoretical groundwork for research. Chapter 3 outlined the research design and methodology used for the data collection and analysis. In Chapter 4 the results of the research were presented. To conclude, Chapter 5 included a summary of the findings, discussions and offer suggestions for future research.

CHAPTER TWO: LITERATURE REVIEW

Overview

The purpose of this dissertation was to better understand the differences between online and in-person introductory math courses at an HBCU. As such, this chapter will first discuss research regarding STEM degrees and challenges with gender and race gaps within STEM. This chapter will also discuss the importance of introductory mathematics and its role as a gatekeeper course for STEM. Additionally, a brief overview of HBCU's and not only their overall significance but also their significance in assisting with solving the STEM workforce issue. This chapter concludes with a review of online courses and their effectiveness, why and who are choosing these types of courses.

Research About STEM Degrees

As highlighted in research by Redmond-Sanogo et al., the President's Council of Advisors on Science and Technology stated that the US will need to produce larger than "one million additional workers in STEM fields each year" over the next 10 years. This is alarming because there is a decreased interest in some STEM areas and the number of STEM degrees for underrepresented minorities has decreased even more (Redmond-Sanogo et al., 2016; Sadler et al. 2012).

The US is not the leader of graduates in all areas of STEM; engineering graduates in the US remained the lowest in the world (National Research Council, 2011). The US ranks twentieth internationally in the number of students who received degrees in science and engineering (Moomaw, 2013). There are also shortages in cybersecurity and there are not enough students graduating to meet the growing demand in that discipline (National Research Council, 2011).

Without an increase in the number of students pursuing careers in STEM areas, the United States (US) may not be able to tackle the major obstacles it faces. This shortfall will challenge the US' position as an international leader and make it difficult to address issues such as "clean energy, stewardship of natural resources, and advances in Medicine" (Obama as cited in Sadler et al., 2012, p. 412). Rice and Alfred (2014) state that a country's "intellectual capital" (p. 40) is closely associated with how the country innovates and progresses in STEM.

There are multiple ways that the US is attempting to increase the interest in STEM, one way is to have students from other countries study abroad in the US. Also, the US hopes these individuals will stay in the US and train individuals native to the US. The Department of Defense (DOD) wants to increase public awareness of STEM careers through recruiting and educating. The DOD plans to retain top STEM talent by offering competitive salaries and a constructive work environment. One issue faced is that the DOD has been unable to compete with the salaries that companies pay in the private industry.

In summary, the US is expected to have a shortage of qualified workers in the STEM industry. The US needs to produce more graduates in order to remain a global competitor. Also, this shortage will also put the US at a disadvantage as it relates to innovative solutions needed to address global issues or advancements in areas such as technology, medicine, and the environment. The US government, by way of recruitment and education, hopes to raise public awareness of STEM professions and the advantages of pursuing one.

Gender and Racial Gaps in STEM Degrees

In addition to the decline in STEM degrees in the U.S., there are large and consistent gender and racial gaps when it comes to STEM graduation rates (Lloyd-Jones, et al., 2011). Improving the number of underrepresented minorities in the STEM field has sparked attention in the US (Lloyd-Jones et al., 2011). For undergraduates in the US, going to college has improved over the last 30 years (Lloyd-Jones et al., 2011). However, the gap in STEM graduates is large; 24 percent of African Americans or Blacks graduate with a STEM degree in comparison to 40 percent of white graduates (Lloyd-Jones et al., 2011). This educational gap also relates to a persistent gap in wages (Wilson, 2007). Out of every bachelor degree recipient, African Americans or Blacks still make up a smaller number of individuals with bachelor degrees (Perna et al., 2009).

In order to meet the STEM demands, targeting women and non-Asian minorities should be the goal (National Research Council, 2011). According to the National Research Council study, women consist of 57 percent of the Bachelor degrees awarded. Of these degrees earned by women, 10-11 percent are in STEM, while men graduating with STEM degrees consist of 23-25 percent. Another interesting percentage is that 2.7 percent of STEM degree recipients are African American or Black (National Research Council, 2011).

These differences or declinations are related to the challenges that underrepresented minorities face when entering STEM degrees in college while persisting to graduate with a STEM degree (Lloyd-Jones et al., 2011). When a member of an underrepresented group leaves a STEM career, it is often for non-academic reasons. As a result of this information, it is important to understand the challenges that underrepresented minorities face. According to Lloyd-Jones et al. (2011), the barriers or challenges are summarized into three categories: 1. insufficient pre-college preparation for STEM; 2. Perceptions of STEM careers and scientists that are negative; 3. Environments that are not welcoming or supportive in STEM majors and classrooms.

As it relates to women, Robnett and Thoman (2017) state that while women have overcome many obstacles as it relates to STEM, there are still many barriers that exist. These barriers may add to the reason why interest in STEM diminishes for young girls. Robnett and Thoman's research relates the challenging factors of "negative stereotypes", "gender bias" and "wavering confidence" (p. 91) as the reason why there is a decrease of women in STEM related fields. Heilbronner (2013) quoted The National Academies Press when researching this issue as it relates to women:

> While the representation of women among those receiving bachelor's degrees in all fields from US universities exceeds 57 percent, less than 20 percent of the degrees in engineering are award to women – with the most recent trend slightly worsening (p. 39).

Sadler et al. (2012) believed that the US is being placed in a disadvantaged position because of the decline in women in STEM related fields. This disadvantage is due in part to the theory that having a diverse workforce, who can contribute different ideas and experiences will promote “scientific and technological progress” (p. 413); not having a diverse workforce will have the opposite effect.

Research by Lloyd-Jones et al. (2011) indicated that many underrepresented minorities are not properly prepared for STEM majors prior to college. This is related to this group not having the appropriate ability to receive the mathematics and science courses that are needed. Also, if the courses are available, performance in the courses is not as high as it needs to be. Adams et al. (2017) refer to research led by the National Center for Education Statistics, where it was discovered that while 60 percent of white students who perform in the upper the percentile of math, will continue on to take Algebra I before the eighth grade: only 26 percent of African American or Black students will do the same.

In summary, aside from the drop in STEM degrees in the US, there are significant and consistent gender and ethnic disparities in STEM graduation rates. In the US, increasing the number of underrepresented minorities in STEM fields has sparked interest. The National Research Council states (2011) the goal should be to target women and non-Asian minorities in order to meet the STEM demands. These disparities or declinations are due to the difficulties that underrepresented minorities face in pursuing and completing STEM degrees in college. These obstacles can contribute to young girls' lack of interest in STEM fields. According to Robnett and Thoman's (2017) study, the challenges of "negative expectations", "gender inequality", and "wavering trust" (p. 91) are the reasons for the decline of women in STEM fields.

The decline in women in STEM-related fields, according to Sadler et al. (2012), has placed the US in a disadvantageous position. This weakness stems in part from the belief that having a diverse workforce with a range of ideas and perspectives will foster "scientific and technical progress" (p. 413); not having a diverse workforce will have the opposite impact.

Persistence in STEM

Perceptions of STEM careers and of scientists according to Lloyd-Jones et al. (2011), play a significant role in the persistence in STEM. Research has shown that not only underrepresented groups, but other students believe that careers that are non-STEM related provide for a fundamentally higher interest. Also, the research shows that across the board, there is a decrease in the interest in STEM fields due in part to the dismissal of the type of life that individuals who work in STEM fields live. Ultimately there are negative stereotypes of the science industry. Lloyd et al. (2011) indicated in their research that students perceive being a scientist as "unhappy, unfulfilling work" (p. 215) and that scientists are unfriendly and are usually a white man. Additionally, when high school students were surveyed, the women thought of a man and African Americans or Blacks perceived scientists as being white when asked their opinions of scientists. Lloyd-Jones and colleagues referenced a 1957 study by Mead and Met stated that high school students perceived scientists as:

> A man who wears a white coat and works in a laboratory. He is elderly and middle aged and wears glasses…he may have a beard…he is surrounded by equipment.

Robnett and Thoman (2017) also discussed how experiences an individual has as they go to college, examination of educational goals, and future job interest can have a big impact on the career that an individual pursues. Research by Sadler et al. (2012) supports the experience theory as well. Sadler et al. state that many times experiences in colleges can change ones' aspirations for persistence in STEM fields. However, Sadler et al. also stated that many women will enroll in higher education with the predetermination not to enter the STEM fields at a higher rate than men. The reason that Sadler et al. believed that women do not enter STEM fields is related to Ceci and Williams theory that women choose to enter majors or careers where the focus is on people and that do not interfere with their individual and "family" requirements (as cited in Sadler et al., p. 413).

Griffith's (2010) theory on experiences relating to women persisting or not persisting STEM fields, stemmed from her research on the college experience. Griffith states that when a student enters college they have already had different academic experiences. When these individuals go through their college years, they will also have different academic experiences. Students will enroll in "different classes, with different professors and with different peers" (p. 912). Also contributing to the different experience will be the gender or race of their professors. Women and other underrepresented populations will have a lower number of professors of the same race and gender; this factor impacts the college experience as well. The college experience may also be different as colleges or universities will have differing STEM programs and focuses on STEM. Rice and Alfred's (2014) research discussed how the positive experience of African American or Black engineers was stronger in K-12 and pre-college and helped to develop skills needed to thrive once they entered a sometimes "unwelcoming" (p. 44) college environment.

Challenges relating to an unwelcoming environment, relate to negative racial stereotypes and the lack of encouraging role models in STEM fields to push or direct the student toward graduation (Lloyd-Jones et al., 2011). This lack of peers or mentors contributes to the environment being unwelcoming or "chilly" for underrepresented students in STEM, especially in primary white institutions (PWI). Research by Swali, Redd and Perna (as cited by Lloyd-Jones, 2011, p. 216) stated:

> underrepresented minorities face obstacles to persistence [such] as racism, hostility, prejudice, discrimination, a 'chilly' climate, instructional bias, negative stereotypes, self-doubt, alienation, isolation, and cultural insensitivity.

Johnson's (2011) research highlighted some of the challenges that women of color have experienced in STEM majors. Women of color have indicated that their college experience left them feeling secluded especially when it came to selecting or being selected for "informal study groups" (p. 80), networking opportunities, working on team homework or laboratory assignments. The challenges that Perna et al. (2009) identified that African American or Black women in STEM face are "academic, psychological, social, and financial" (p. 10). Chen et al. (2014), also indicate that isolation and alienation are reasons that individuals leave college.

Robnett and Thoman's (2017) study focuses on the "expectancy-value theory" (p. 92) which discusses how individuals who believe that they will have success in a certain area will follow that particular area and dodge areas in which they believe there will not be any success. This theory is supported particularly for those who are interested in STEM related fields. When individuals expect to be successful in STEM fields, these individuals believe that they should be in the field, these individuals will take more STEM classes and are more than likely to indicate that they have a curiosity for STEM fields. Robnett and Thoman firmly believe that the expectation of success is a greater indicator of high educational performance.

Through Robnett and Thoman's (2017) research, they discovered how Wigfield and Eccles (as cited in Robnett & Thoman, p. 92) determined that an individual's expectations are based upon cultural stereotypes. For women, these stereotypes as they relate to the STEM fields are mostly negative. As a result of these deleterious stereotypes, women are more likely to not perceive themselves as being successful in STEM fields. The lower confidence in success for women occurs regardless of how a woman excels in the classroom. Their research demonstrated how women were least likely when compared to men to be described as having high levels of expectations for success and high levels of academic attainment. Self-Efficacy is equally important to the success of African-American male students in STEM (Lloyd-Jones, et al., 2011).

Rice and Alfred's (2014) research explained how the challenges are greater and expectancy for success varies for African American or Black and Hispanic women. In fact, Rice and Alfred's research on African American or Black female engineers showed how these women were determined to persist in the STEM field. These women strongly believed that "quitting was not an option" and they were "destined to become engineers" (p. 43) despite the many challenges that were faced. The women in Rice and Alfred's study used their willingness to not give up as the factor in their persistence in

STEM major. Johnson (2011) also stated in her research that although women of color are faced with many barriers, these women still persevered to finish college successfully.

As Griffith (2010) examined the reason why women do not continue in STEM fields, she researched how the college experience plays a major factor. Griffith's research indicates how colleges or universities that focus on STEM can have an impact on the major that the student selects. Griffith's research demonstrated how post-secondary institutions that focus more on undergraduate "teaching and research" (p. 922) and less on graduate will have students who are more likely to persist in a STEM major.

In summary, perceptions of STEM occupations and scientists play a major role in STEM persistence. According to research, students in general have a greater interest in non-STEM based occupations. Furthermore, research indicates that there is a decline in interest in STEM fields across the board, owing in part to a dismissal of the type of life that people who work in STEM fields lead. Additionally, researchers addressed how an individual's college experiences, as well as an analysis of educational aspirations and potential work interests, may have a significant effect on the career path taken.

Negative racial stereotypes and a lack of encouraging role models in STEM fields are two challenges related to an unwelcoming climate that drive or steer the student away from graduation. Also facing challenges, Johnson's (2011) study shed light on some of the barriers that women of color have faced in STEM fields.

The expectancy-value theory, which discusses how individuals who believe that they will have success in a certain area, will follow that particular area and dodge areas in which they believe there will not be any success. When compared to men, women were less likely to be described as having high levels of performance standards and academic attainment, according to their findings. Self-efficacy is equally critical for African-American male STEM students' performance.

HBCUs and STEM Degrees

Increasing the number of underrepresented individuals in STEM is a challenge that Historically Black Colleges and Universities (HBCU) is equipped to take on (Jett, 2013). The involvement of HBCUs is instrumental in creating and graduating more STEM majors more particularly for underrepresented groups. HBCUs are uniquely engineered to assist with educating issues as they relate to African Americans or Blacks and other minorities, women included.

Since the establishment of Cheney State University in 1937 (LeMelle, 2002), HBCUs have "championed access, opportunity, and cultural empowerment for African Americans" (Ableman, 2014, p. 1). The definition of HBCUs according to the Higher Education Act of 1965, is "institutions of higher learning established before 1964 whose principal mission was then, as is now, the [higher] education of black Americans." (LeMelle, 2002, p. 11). While that definition still exists, it is important to understand that not all institutions that service minorities are HBCUs and not all HBCUs of today primarily educate African Americans or Blacks (Palmer et al., 2010).

While HBUCs are characterized as being small in enrollment, having a larger number of students who have low entrance SAT and ACT scores and having a larger number of students who come from lower socioeconomic status, HBCUs are also known for having lower resources than many PWI, these resources consist of academic programs and facilities (Kim & Conrad, 2006; LeMelle, 2002; Palmer et al., 2010). Each HBCU has its own set of unique tuition and fee structures, admission criteria, academic programs, financial endowment, and missions. Many HBCUs have high graduation rates, while many have high graduation rates that are lower than 30 percent (Wilcox et al., 2014).

Additionally, HBCUs have since the early 1960s experienced a decline in enrollment of African-American students (Kim & Conrad, 2006) as PWIs are using their greater resources to recruit and retain the best and brightest African American or Black students (Wilcox et al., 2014). As of 2014, only twelve percent of African Americans or Blacks intend to enroll in bachelor programs at HBCUs that is a large difference from 1968 when approximately 80 percent of African Americans or Blacks attended HBCUs.

Public HBUCs, while never funded at the same level as PWIs, have realized a large decrease in state funding over the years. Despite limited resources, declining enrollments and only consisting of three percent of higher education institutions (Wilcox et al., 2014), HBCUs are responsible for educating many African American or Black professionals, doctors, lawyers, and political leaders (Kim & Conrad, 2006; LeMelle, 2002) who may not have come from elite economic or social status. Providing this type of education remains at the core of mission for HBCUs. HBCUs have graduated: 75 percent of all African Americans or Blacks with Ph.Ds, 46 percent of African American or Black business executives, 50 percent of African American or Black engineers, 80 percent of African American or Black federal judges, and 65 percent of African American or Black doctors (LeMelle, 2002, p. 12).

While Jett's (2013) research focused on African American or Black males, his findings indicate that HBCU's can also assist with persistence in STEM careers. Lundy-Wagner (2015) states that HBCUs ability to improve the quantity of African Americans or Blacks in STEM is noteworthy.

Jett (2013) discusses how HBCUs have been instrumental in educating African Americans or Blacks for decades. While HBCUs may lack resources and other characteristics of PWIs, they compensate by providing a more "collegial and supporting learning environment for students and faculty" (Kim & Conrad, 2006, p. 401). Chen et al. (2014) supports this theory as they stated that HBCUs offer a more "positive, social and psychological environment" (p. 565). This type of environment encourages African Americans or Blacks to perform better academically and set greater occupational goals. Wilcox et al. (2014) believed the importance of HBCUs on student success reside in HBCUs: (1) offering educational opportunities to students with financial, social, cultural, motivational, and other challenges; (2) awarding a significant portion of undergraduate, law, and medical degrees to African Americans or Blacks; (3) and providing an opportunity for elite African American or Black students to study in a majority-Black institution that seeks to build self-confidence, efficacy, and leadership skills (p. 569).

Chen et al. (2014) believe that students attending HBCUs will feel as if they are in a better supportive environment and have a greater feeling of being accepted. This experience causes for the student to become more engaged. Additionally, Jett's (2013) research indicated that the objectives of HBCU's include:

> to continue the historical and cultural tradition of teaching and research about the black condition, (2) to serve the black community in various leadership roles, (3) to supply an economic function in the black community, (4) to provide black role models who examine social, political, and economic issues endemic to the black community, 95) to produce graduates who engage in tackling race-related issues in society, and (6) to produce black scholars who disseminate scholarly research and teaching to the black community (p. 191).

These objectives offer support and increase the expectancy for success for students who attend. Jett (2013) states that HBCU's discredit many traditional beliefs related to STEM by demonstrating a diverse population of peers and faculty members who are scholarly and optimistic images, especially as it relates to mathematics. Lundy-Wagner (2015) stated that HBCU's have inexplicably added to the broadening of a more diverse workforce by not only being a place of employment for African Americans or Blacks but also being a place of education for them as well.

Jett (2013) as well as Rice and Alfred (2014) refer to a study by Perna et al. at Spelman College, an all-female HBCU. Spelman College has been very successful in graduating African American or Black females in the STEM field (Rice & Alfred, 2014). Jett (2013) discussed how the students who participated in the study believed that Spelman had successfully given them what they needed to meet their goals and achieve success in STEM careers. The participants received "peer support, faculty encouragement and involvement, academic support and undergraduate research opportunities" (p. 192). HBCUs offer advantages that only grow when full-time faculty who care "form mentoring relationships with students" (Wilcox et al., 2014).

Rice and Alfred (2014) pointed out in their research that Spelman's success was in part due to the supportive infrastructure that had been put in place to ensure attainment. The infrastructure consisted of "(a) the school's rich legacy positively impacts Black women in STEM (b) the institution supports the student's solid foundation and future goals, as related to STEM areas, (c) there is a general understanding of the barriers and challenges for Black women pursuing STEM fields, and (d) as a counter to the third finding listed, the institution has systems in place to address the challenges and barriers that Black women face in STEM fields" (p. 41). Johnson (2011) indicated in her research that programs and services that have been geared toward supporting women of color on college campuses contribute to the persistence toward achieving a degree. In addition to the factors mentioned, the research of Perna et al. (2009) determined that the collaboration of the African American or Black women and their STEM faculty was due in part to the small number of students in the classes and the readily accessibility of the faculty. The students believed that the chance to engage directly with faculty and fellow classmates was very beneficial.

The study by Perna et al. (2009) showed the advantageous impact that a culture of compassionate faculty can have at HBCUs. Perna et al. state that the faculty at Spelman believe that their STEM students can persist and reach educational attainment. The faculty also instilled a mindset of self-efficacy in their STEM students. The Perna et al.'s (2009) research discusses how the faculty at the HBCU endorse curriculum that supports positive student learning outcomes and attainment and they also change their method of instruction to ensure success. Research by Kim and Conrad (2006) also suggested that regular student-faculty interaction had a positive outcome on a student's academic progress.

Spelman as well as many HBCUs, support student success by implementing achievement alert systems that will allow for the early intervention of support if a student is not progressing or having challenges (Perna et al., 2009). Perna et al. also demonstrated how Spelman prepares and encourages their STEM students to pursue advanced degrees.

As a result of his and others' research, Jett (2013) believes that because of the mission and objectives of HBCU's the higher education institutions are distinctively qualified to successfully provide access to educational attainment especially as it relates to STEM related degrees. Copeland stated that "It is apparent that many black institutions provide a different milieu, an environment that promotes access and fosters retention and graduation" (as cited in Jett, p. 192).

HBCUs around the nation have developed programs that assist with the recruiting, retention, and ultimate graduation of underrepresented minorities in STEM related fields. There is a statistically significant increase in the graduation rates of underrepresented students who major in STEM related fields at HBCUs that have a specific focus on NSF-funded STEM programming. Currently, 2 of the top STEM programs at HBCUs are implemented at North Carolina A&T University and Florida

A&M University. These universities remove the barriers underrepresented minority STEM majors' face and assist in the students' graduating with a STEM degree.

The STEM program at North Carolina A&T University (NCAT) is recognized for graduating the largest number of African American or Black engineers at the undergraduate and graduate levels in the US. NCAT also offers high school students access to a pre-college STEM curriculum through the STEM Early College program. This pre-college program prepares students by exposing students to a diverse environment that incorporates real-world and problem-based techniques to help students in the program to develop critical and "unique" thinking skills. The program is located on the campus of NCAT and has a small "close-knit" group of faculty and administrators who are committed to the success of each student. The pre-college curriculum consists of 3 pathways, Biology, Engineering, and Renewable Energy Sustainability (North Carolina A&T University [NCAT], n.d.).

Additionally, NCAT has created an environment that is supportive for students in STEM majors. The university has a residential living and learning community for STEM students that is called the STEM Theme House. Objectives of this living and learning community is to "assist students in achieving academic and personal success while fostering university and STEM retention and to support the expansion of the nation's STEM workforce by equipping graduates to assume positions in industry, the academy beyond". The community offers academic programs that encourage academic, personal development and career planning activities with the goal to gain a better appreciation of STEM majors. There are two academic staff assigned to the community (NCAT, n.d.).

The core of the NCAT STEM academic program is the College of Science and Technology (CoST). The program governs the education and research of STEM at NCAT. The college has over 1,300 undergraduate and 300 graduate students. These students are in academic programs of Applied Engineering Technology, Biology, Built Environment, Chemistry, Computer Systems Technology, Energy and Environmental Systems, Graphic Design Technology, Mathematics and Physics. The college hosts a series of seminars and workshops that relate to STEM. In April 2018, the college hosted as part of the North Carolina Science festival, a community forum titled "Hidden No More: STEM Women of Color". NCAT also hosted a Science and Technology (SciTech) Week where North Carolina high schools, community colleges and organizations were educated regarding STEM career options by CoST faculty and students. The SciTech week was themed, "STEM: Prepare, Learn, Succeed" (NCAT, n.d.).

Based on 2016-2017 data, NCAT graduated 341 students from the CoST. This total consisted of bachelor's degrees (198), master's degrees (107), doctoral, research/scholarship (16), underrepresented (243), non-underrepresented (7), male (177) and female (144) (NCAT, n.d.).

The college recently expanded its Ph.D. program to include applied physics, bioscience, applied chemistry, data science and analytics, and information technology and technology management. The University also has the Engineering Research and

Innovation Complex (ERIC) which will be a state-of-the-art interdisciplinary and multifunctional facility for academics, research and community engagement, which will provide the technology, environment and education to be designed to meet the global challenges of tomorrow (NCAT, n.d.).

The STEM program at Florida A&M University (FAMU) received a four-year, $1.6 million grant in 2013 from the National Science Foundation's (NSF) Historically Black College and Universities Program (HBCU-UP). The funded project was entitled "Student Centered Active Learning and Assessment Reform (SCALAR)" and was intended to enhance the overall quality of the STEM educational experience at FAMU by revamping the institutional approach for educating STEM students in lower-division courses. The goals of SCLAR were to: 1) An increase in the number of FAMU students who pursue STEM careers. 2) Improvement in the academic preparedness of FAMU students so they are better equipped for the rigor of upper-division STEM major courses, graduate school, and the global marketplace. 3) An increase in the retention rate of students in STEM programs. 4) An increase of student engagement with the educational experience in lower division STEM courses. 5) An increase in professional development opportunities provided to STEM faculty to learn about teaching best practices (Florida A&M University [FAMU], n.d.).

In addition to SCALAR, FAMU has the STEM programs of Florida-Georgia Louis Stokes Alliance and the Florida Information Technology Career (FITC) Alliance, which provides internship and job placement support for computer science and IT majors (FAMU, n.d.).

The College of Science and Technology offers undergraduate degrees in Biology, Chemistry, Information Technology, Computer Information Technology, Computer Science, Mathematics, and Physics. The following graduate degrees are offered Biology, Chemistry, Physics, Software Engineering Science/Computer Science, and a doctorate in Physics. The College of Science and Technology also has community events such as STEM Day which is considered a STEM outreach event for middle and high school students. The goal of the day was to increase in pursuing STEM related careers and showcase the STEM activities that take place on FAMU's campus as well as a STEM Summer Program (FAMU, n.d.).

In summary, HBCUs are well-equipped to meet the challenge of increasing the number of underrepresented individuals in STEM fields. The involvement of HBCUs is critical in the creation and graduation of more STEM majors, especially for underrepresented groups. HBUCs have "championed access, opportunity, and cultural empowerment for African Americans" since the founding of Cheney State University in 1937 (LeMelle, 2002). HBCUs are responsible for educating many African American or Black professionals, physicians, lawyers, and political leaders (Kim & Conrad, 2006; LeMelle, 2002), despite scarce funding, decreasing enrollments, and only accounting for 3% of higher education institutions (Wilcox et al., 2014). Researchers also suggest that HBCUs will help students stay in STEM fields longer. Researchers believe students who attend historically black colleges and universities will feel more supported and welcomed due to the support services and culture of compassionate faculty that HBCUs can have.

Research on Introductory Mathematics

For centuries, mathematics has been considered essential to society (Li & Schoenfeld, 2019; Stanic, 1986). A report by the US Department of Education (1997) reported the probability of attending college is higher for students who take more demanding mathematics courses versus students who do not take more demanding courses. This same report indicated that students who take more challenging mathematics courses also have greater mathematical success. Even for high school students, the US Department of Education believe that students who take advanced mathematics were at an "advantage" (p. 12). Over the years, there has been research related to who should take mathematics and how it should be taught (Deangelis, 2017; Li & Schoenfeld, 2019; Stanic, 1986; Tezer, 2019).

Also often debated is the role of mathematics in STEM. Since the rigor of coursework related to STEM majors includes the requirement to have a level of proficiency in mathematics at a college level (Fitzallen, 2015), mathematics has a large role in STEM. By the definition of STEM, mathematics is a part of the discipline (Fitzallen, 2015). While mathematics is often considered to be an ancillary part of STEM (Tezer, 2019), researchers and mathematics advocates have stated that mathematics needs to be considered an important part of STEM (Deangelis, 2017; Herbert & Clark, 2020; Stohlmann, 2018). Stohlmann (2018) notes the analysis of integrating the disciplines of STEM vary from the "STEM enhanced model" where the STEM classes are independently enrolled in and not connected or offered as discretionary STEM courses to the "integrated STEM model" where two or more science, technology engineering and mathematics focused courses are intentionally combined into one course.

Lefkowitz (2018) contends that mathematics is the most important part of STEM and should have a more integral role especially in order to appreciate or recognize the other parts of STEM. Lefkowitz asserted:

> Math is the language needed to Engineer new Technologies, as well as understand, model and make new Science discoveries, just as English is the language needed to Read and Write books. Math literacy goes hand in hand with English literacy. An education without a solid footing in mathematical thinking will not result in a successful solution to the problems we face (para. 3).

Bowman (2010) suggested that mathematics provides the foundation for the skills needed for the 21st Century workforce. Bowman described the skills as needing to include problem-solving and using numbers among others. The top skill set according to a 2014 study from the Bayer Corporation from 150 Fortune 1000 companies indicated that these organizations prefer to hire individuals with leadership skills (50), conflict resolution skills (47), complex problem solving skills (37), team building skills (36), communication skills (29), advanced operating, maintenance, repair and troubleshooting skills (28), critical thinking skills (27) and advanced system analysis and evaluation (27); however, their new hires are lacking these skills. Furthermore, Shaugnessy agrees to the importance of STEM (2013). Shaugnessy (2013) found that a substantial level of mathematics should be contained within STEM instruction. “Otherwise the M is silent" (p. 324).

The National Research Council (2011) set three central objectives to meeting STEM: 1) Expand the number of students who ultimately pursue advanced degrees and careers in STEM fields and broaden the participation of women and minorities in those fields. 2) Expand the STEM-capable workforce and broaden the participation of women and minorities in that workforce. 3) Increase STEM literacy for all students, including those who do not pursue STEM-related careers or additional study in the STEM disciplines (p. 6).

Stohlmann's (2018) comments to address these objectives, an emphasis on mathematics needs to be a part of the integrated STEM model. Stohlmann rebranded the STEM abbreviation to "steM" to show the focus on mathematics (p. 310). This type of emphasis builds a learning outcome that is significant and concentrated for students because mathematics to be incorporated with the other focuses of STEM. In addition to providing job skills, especially related to STEM, undergraduate students with a solid foundation in mathematics are placed in an advantageous position when pursuing STEM related majors in graduate schools (Velez, 2020).

In summary, mathematics has been regarded as vital to society for centuries. According to a 1997 US Department of Education study, students who take more challenging mathematics courses have a higher chance of attending college than students who do not take more difficult courses. According to the same study, students who take more challenging mathematics courses have higher mathematical performance. Although mathematics is often considered an ancillary part of STEM (Tezer, 2019), researchers and math advocates have argued that it should be considered an integral part of STEM. According to researchers, mathematics is the basis for the

21st-century workforce's skill set. Problem-solving and numerical skills, among other skills that will be in demand.

Since mathematics is incorporated with the other focuses of STEM, this form of concentration creates a significant and focused learning outcome for students. In addition to providing job skills, especially in STEM fields, undergraduate students with a strong mathematical foundation have an advantage in graduate school when pursuing STEM-related majors.

Mathematics Anxiety

While mathematics is seen as important to society and to the STEM discipline, it is often one of the most dreaded courses a student can take (Lyons & Beilock, 2012). Dowker et al. (2016) asserts that although mathematics can be intellectually challenging for many individuals to learn and there are individuals who may suffer from an impairment when it comes to learning mathematics, not all mathematical challenges are intellectual. Ashcraft (2002) proclaimed that there is not a strong link between mathematics anxiety and cognitive ability. The dread or challenges that students and others feel may be what researchers have coined as mathematics anxiety (Ashcraft & Moore, 2009; Richardson & Suinn, 1972).

Mathematics anxiety, the sensation of pressure and nervousness, exists when a person is working with numbers or answering problems using mathematical methods (Ashcraft, 2002; Richardson & Suinn, 1972). This anxiety has been found to be prohibitive to students excelling in mathematics or desiring to enroll in more progressive classes in STEM. Additionally, this anxiety can exist with all persons, not just persons taking classes (Richardson & Suinn, 1972).

Mathematics anxiety can prevent a person from learning mathematics and negatively impact performance (Dowker et al., 2016; National Mathematics Advisory Panel, 2008). Dowker et al. (2016) states that this anxiety can happen in younger and older persons. Ashcraft and Moore (2009) discussed how mathematics anxiety did not have an impact on behavior when a person was solving elementary mathematics such as addition and multiplication. However, when a person was solving advanced mathematical problems, there was a slower response and a lower level of precision due to a higher level of anxiety. In their research they found that younger elementary school students did not appear to have math anxiety but by the later elementary school years, some level of anxiety started to exist.

Additionally, research by Ashcraft and Moore (2009) demonstrated how when a person, who is experiencing mathematics anxiety, especially when taking a standardized test, there is a decline in their response. Dowker et al. (2016) reports that mathematical achievement is impacted when mathematical anxiety exists, especially if the person is using “working memory” (p. 5). Ashcraft (2002) states that lower levels of anxiety are associated with simple mathematics because simple or basic mathematics does not tax working memory.

Lyons and Beilock (2012) asserted that mathematics anxiety does not necessarily always equal low performance. Palestro and Jameson’s (2020) research supported this finding. Lyons and Beilock (2012) separated the performances of individuals who have high levels of mathematics anxiety from individuals who have low levels of mathematics anxiety using the Mathematics Anxiety Rating Scale (Richardson and Suinn, 1972). They discovered that individuals with high levels of mathematics anxiety in general did not perform well with mathematics related activities however, some of these individuals with high levels of anxiety performed poorly but not because of their anxiety to mathematics. Lyons and Beilock (2012) contended that some individuals with high levels of anxiety may simply be more comfortable with mathematics than others or have a different attitude to handling the anxiety. Lyons and Beilock (2012) found that individuals who had lower levels of anxiety performed about the same on mathematical and non-mathematical activities.

A person's attitude toward mathematics is closely related to mathematics anxiety (Dowker et al., 2016). However, just because a person has a negative attitude toward mathematics, does not mean that the person has mathematics anxiety (Dowker et al., 2016). Additionally, Dowker et al. (2016) reported that when an individual rates themselves, especially in a low way, they tend to have mathematics anxiety. As part of the self-rating discussion, Dowker et al. (2016) discussed how self-rating is similar to self-efficacy. When describing how self-efficacy relates to mathematics anxiety, Ashcraft and Rudig (2012) described self-efficacy as "an individual's confidence in his or her ability to perform mathematics, and is thought to directly impact the choice to engage in, expend effort on, and persist in pursuing mathematics, such as taking further mathematics classes and excelling in them" (p. 249). Dower et al. (2016) explains the difference between self-rating and self-efficacy is that self-rating is more concerned with individual achievement and self-efficacy is associated with an individual's confidence in themselves to achieve in mathematics. Either way, Palestro and Jameson (2020) believe that self-efficacy can produce both encouraging and harmful outcomes to academic achievement. Dowker et al. (2016) questioned which if anxiety was the root cause of limited mathematics competency or was the limited mathematical competency the cause of the anxiety.

An individual's thoughts as to what they believe mathematics is also adds to mathematics anxiety (Dowker et al., 2016). If a person has a low impression of what mathematics is and how it is not useful in their daily lives but just in the classroom, this can lead a person to have mathematics anxiety because they may not perform well with one component of mathematics and thus they believe they are not good at mathematics.

Research has shown that individuals who have high mathematical anxiety avoid taking math classes (Dowker et al., 2016). Individuals who have high anxiety and ultimately lower mathematics performance take less mathematics classes or shun tasks or circumstances that may include mathematics (Dowker et al., 2016) and thus do not become familiar with mathematics (Ashcraft, 2002). This resistance of taking mathematics classes or the low exposure to mathematics adds to low confidence and high mathematics anxiety. Brown et al. (2008) found that students who received passing grades or were fond of mathematics had a higher probability to take or contemplate taking additional mathematics classes. Likewise, students who do not pursue additional mathematics courses reported did not do so because of their "perceived difficulty" or "lack of interest" (Brown et al., 2008, p. 15.). The Brown et al. (2008) study found ninety percent of students who had an "A" considered continuing with mathematics and 71% of these students intended continuing with mathematics. While 34 percent of students who obtained a “B” considered continuing with mathematics and 17% of these students intended continuing with mathematics. Finally, 13% of students who obtained a “C” considered continuing with mathematics and only four percent of these students intended to continue with mathematics.

Children experience math anxiety as early as second grade, (Justica-Galiano et al., 2017; Sorvo et al., 2017). Sorvo et al.’s research found that around a third of all children demonstrated fear of failing a mental calculation task, math homework, or something related to math in general. One-fifth of the children expressed fear of having to answer teachers' questions in math class, and one-tenth expressed fear of beginning math or stress about having to do math. In math class, more girls than boys showed anxiety about having to answer teachers' questions. Kesici et al. (2010) found that students who had low self-esteem had a significantly higher mathematics anxiety than students with high self-esteem.

Additionally, Justica-Galiano et al. (2017) found that elementary aged children who believe they do not have the skills necessary to complete math tasks have low expectations and this may lead to task avoidance or less effort and persistence. Research shows that as a person ages, the level of mathematics anxiety grows (Sorvo et al., 2017). As a result, as students’ progress to middle school, the mathematics anxiety and self-efficacy impact academic performance, however, Falco (2019) list items such as time management, study skills and the ability to seek help as other reasons for lower performances in mathematics. Other factors include the curriculum, teaching and learning, assessment techniques, social experiences, and students' relationships with others (Attard, 2010).

As a student transitions to high school, the same challenges persist. However, a study by a study by Moyer et al. (2018) indicated the type of mathematics curriculum a student participates in during middle school has a long-term impact on a student's attitude toward mathematics. The study found that of the students who participated in a non-traditional mathematics class in middle school, half of the students did not like mathematics because they believed the class to be hard. The other half of the students who did not like mathematics from the non-traditional group, did not like mathematics because it was boring. However, in the study, it found that all of the students who participated in a traditional mathematics class did not like the class because the students believed the class to be too challenging (Moyer et al., 2018). Moyer et al.'s study believed this to be in part due their findings that students who participated in the reform mathematics courses, were more independent learners in middle school and did not depend on their instructor as much. Students who participated in the traditional class were more dependent on the teacher.

In addition to attitude, self-efficacy and competency, research has linked mathematics anxiety to a person's genetic makeup. Dowker et al. (2016) mentioned how a mixture of previous adverse circumstances with mathematics and a genetic disposition to mathematical ability and general anxiety can result in mathematics anxiety. Additional mathematical research also has noted how gender does or does not play a role in mathematics anxiety. Dowker et al. (2016) has asserted that there is not a difference between men and women when it comes to mathematics anxiety and mathematics achievement (Dowker et al., 2016). On the other hand, Dowker et al.

(2016) asserted the self-rating of women was lower than men and their mathematics anxiety were higher.

In summary, despite its importance to society and the STEM field, mathematics is also one of the most feared courses a student may take. According to researchers, while studying mathematics may be mentally difficult for many people, and some people may have learning disabilities, not all mathematical difficulties are intellectual. When a person is working with numbers or solving problems using mathematical methods, they experience mathematics anxiety, which is a feeling of pressure and nervousness.

While many researchers found that anxiety about mathematics may prevent individuals from learning the subject and have a negative effect on their performance, there were a few researchers who asserted that mathematics anxiety does not necessarily always equal low performance. Individuals with high levels of mathematics anxiety did not do well with mathematics related tasks in general, according to researchers. However, some of these individuals with high levels of anxiety performed poorly but not because of their anxiety with mathematics. Mathematics anxiety is closely linked to a person's attitude toward mathematics, as well as a person’s thoughts about what mathematics actually is.

Mathematics as a Gatekeeper

Although individuals resist taking mathematical courses and high levels of mathematical anxiety may exist however, students who plan to major in one of the STEM disciplines or take STEM related courses, this is not an option. Mathematics is often added as a gatekeeper course for the most demanded majors, especially STEM related majors (Bleyer et al., 1981) or even educational privilege (Douglas & Attewell, 2017; National Research Council, 2011).

Additionally, as part of the general requirements for degree completion, many students are required to enroll and pass college mathematics as they begin their educational journey (Douglas & Attewell, 2017). Quattrociocchi (2002) stated that “Math is the gatekeeper that lets people into careers—or keeps people out of them” (p. 1).

Gatekeeper courses also often called “weed-out courses" (Mervis, 2011; Tyson and Spalding, 2010) are “the first or lowest-level college-level” course students take in a subject such as mathematics, reading, or writing, often following completion of one or more developmental courses in that subject (The Completion Arch, n.d.). Mathematics has been considered a gatekeeper course for centuries. Plato as cited by Stinson (2004) believed that mathematics was “virtually the first thing everyone has to learn” and that it was “common to all” (p.9). Stinson (2004) continued to discuss how Plato asserted that mathematics should be reserved for those that were “naturally skilled in calculation” (p. 9). Stinson believes this was the foundation of mathematics being considered a course for the advantaged or a gatekeeper course. To this day, mathematics is still considered to be a gatekeeper course and has continued to be considered one since then, especially for graduate and professional schools. (Douglas & Attewell, 2017). Stinson (2004) defined mathematics as “mathematics is an exclusive instrument for Stratification". Douglas and Attewell (2017) assert mathematics as a gateway course that impacts a “students’ educational and social mobility” (p. 648). The US Department of Education proclaimed in 1997 that students who have a level of competency in mathematics will have the opportunity to pursue careers with higher wages. Additionally, the US Department of Education's report indicated that "algebra is the 'gateway' to rigorous mathematics courses" (p. 3). Rigorous mathematics courses build upon the skills and concepts that students learn in earlier mathematics courses (p. 12).

Educational sorting (Eagen et al., 2012) or critical filters (Bleyer et al., 1981; Bryk & Treisman, 2010; Sells, 1973) is a practice that is debated among researchers and mathematic enthusiasts. Epstein (2006) quoted Daryl Chubin, director of the American Association for the Advancement of Sciences' Center for Advancing Science & Engineering Capacity as saying "The culture of science says, 'not everybody is good enough to cut it, and we're going to make it hard for them, and the cream will rise to the top.' (para. 13). However, critics of gatekeeper courses believe that poor experiences in gatekeeper courses relate to the high attrition rate of STEM students (Mervis, 2010, 2011; Tyson & Spalding, 2010). It is obvious that gatekeeper courses are added to the beginning of program curriculum intentionally to either directly or indirectly "weed out" students who are not high achievers in a certain discipline (Epstein, 2006). Tobias (1990) reported in his research that "scientists are born, not made". Bryk and Treisman (2010) believes that "Math should be a gateway, not a gatekeeper, to a successful college education (p. 2)".

STEM attrition happens for a number of reasons. Chen and Soldner (2013) reported how researchers have recognized that having an adverse experience in a gatekeeper or beginner mathematics or science related class, among other class related considerations as reasons for students being no longer attracted to STEM related majors. Researchers have found that students who leave or fail STEM leave at a higher rate during their first year (Chen & Soldner, 2013). This occurrence is even worse for underrepresented minority groups as they are adversely affected by these gatekeeper courses. (Chawla, 2020). In a 2012 study by Bayer, it was reported that 80% of department chairpersons stated that women and underrepresented minorities were underrepresented in their introductory and major/upper level STEM related courses.

In 2013, Chen and Soldner found that 48 percent of students who were seeking bachelor's degrees in a STEM major within the years of 2003 and 2009, had left the STEM major by the spring semester in 2009. The study illustrated how 20 percent of the students changed their major to a discipline that was not STEM, while 20 percent of the students dropped out of the college or university and did not complete the degree. As a consequence, research has determined the impact to be greater depending on gender, race, and socioeconomic status. Chen and Soldner (2013) reported that "women, underrepresented minorities, first-generation students, and those from low-income backgrounds leave STEM fields at higher rates than their counterparts" (p. 17). The Bayer (2012) study, which consisted of responses academic department heads or chairperson from 200 top colleges and universities, highlighted while 83% of the department chairpersons believe it's needed and are in full support of growing the number of underrepresented minorities and women in their areas for STEM and 46% of the department chairpersons consider difficult "weeding out" classes are detrimental and force out STEM undergraduate students who may have potential especially the underrepresented minority, 57% of the department chairpersons agreed that there was not a need to considerably transform their processes for introductory courses to ensure that additional STEM students, including women and underrepresented minorities stayed in their programs or in school.

In summary, while some people dislike mathematics courses and have high levels of mathematical anxiety, this is not a choice for students who choose to major in one of the STEM disciplines or take STEM related courses. Math is frequently added as a prerequisite or gateway course for the most sought-after majors, especially STEM-related majors. Mathematics as a gateway course, according to researchers, has an effect on a student's academic and economic progression. Educational sorting or the application of critical filters to courses in academic programs, is a controversial practice that is debated among academics and mathematical enthusiasts. The gatekeeper culture says that not everyone is cut out for it, so make it difficult, and the best will rise to the surface. Critics of gatekeeper courses, on the other hand, assume that bad gatekeeper course encounters contribute to the high dropout rate of STEM students (Mervis, 2010, 2011; Tyson & Spalding, 2010). Gatekeeper courses are clearly included in the beginning of a program's curriculum to either directly or implicitly "weed out" students who are not high achievers in a specific field.

Attrition in STEM fields occurs for a variety of causes. Researchers have identified having a negative experience in a gatekeeper or beginner mathematics or science related class, among other class related factors, as reasons for students no longer being attracted to STEM related majors, according to Chen and Soldner (2013). Researchers discovered that students who drop out or fail STEM classes are more likely to drop out. Students who drop out or fail STEM courses drop out at a higher rate during their first year, according to research (Chen & Soldner, 2013). This problem is exacerbated for underrepresented minority groups, which are harmed by these gatekeeper courses. The Bayer (2012) study found that although 83 percent of the department chairpersons in their study believe it is necessary and are fully supportive of increasing the number of underrepresented minorities and women in STEM fields in their regions and 46 percent of the department chairpersons believed difficult "weeding out" classes are counterproductive and force out STEM undergraduate students who may have potential, especially underrepresented minorities, but yet 57 percent of the department chairpersons believed there was no need to significantly change their introductory course processes.

Research on Online Education

Since the 1700's there have been various options to learning other than in-person or traditional learning. From the start of correspondence learning via postal mailings in 1728, learning by radio in 1894 and learning by television in 1927 there has been a desire to make learning more accessible (Kentnor, 2015). A number of authors have asserted the foundation of distance education is centered on the belief that learning could exist without the in-person interchange with the student and teacher (Dykman & Davis, 2008; Kentnor, 2015). This form of learning provides the opportunity for the disadvantaged to receive an excellent education (Dykman & Davis, 2008). While those modes of learning were introduced, an evolution of what is known as distance education, an actual two-way interchange of learning, is documented as being introduced by Isaac Pitman in 1840. Online learning over the internet that we know today was first launched in 1989. (Kentnor, 2015). Literature has successfully established how technological advances of the internet allow higher education institutions to go beyond boundaries and have the capacity to offer access to “anyone, anywhere at anytime” (Dykman & Davis, 2008, p. 14; Hiranrithikorn, 2019).

Although online education was available in the early 1900’s and utilized by many institutions, it did not take off in popularity until 1998. As of 2002, there were over 1.6 million students who were taking at least one online course (Allen & Seaman, 2008) and as of 2014, that number had risen to 6.4 million with 14 percent of the online students being totally online and 16.7 percent of the online students taking a combination of online and in-person classes (Allen et al., 2016). The number of students who preferred in-person courses are now intentionally switching to learning online. Online learning has grown at a rapid pace and has proven to be the fastest form of distance education (Ashby et al., 2011; Kentnor, 2015). As a result of the growth of online classes, it has proven to be a viable method of learning and considered a strategic part of higher education especially as higher education institutions look for ways grow their enrollment and remain competitive (Bonvillian & Singer, 2013; Dykman & Davis, 2008; Glazier, 2016; Kentnor, 2015; Schiffman et al., 2007).

As online learning became more popular, many creative thinkers predicted this type of learning would end traditional learning (Doyle, 2009). Peter Drucker is quoted as saying “Already we are beginning to deliver more lectures and classes off campus via satellite or two-way video at a fraction of the cost. The college won't survive as a residential institution. Today's buildings are hopelessly unsuited and totally unneeded” (Forbes, 1997, para. 72). Nguyen (2015) asserted the dominance that physical “brick and mortar” classrooms had on learning is weakening (p. 309). Doyle (2009) concludes that although online learning has certainly changed education, it has not been the educational upheaval that was predicted but instead it has become in his words an "important add-on" to the current learning environment (p. 58).

Research suggests that there are varying motivations for turning to online learning for organizations (Dykman & Davis, 2008; Schiffman et al., 2007). Prior and current research have highlighted how higher education institutions are working with tighter budgets and increased directives to perform (Dykman & Davis, 2008). Researchers have demonstrated how higher education officials are aware students who wish to take online classes will continue to grow (Allen et al., 2016; Nguyen, 2015) although enrollment in higher education across the nation has declined overall (Springer, 2018). The desire for and the increase in student enrolling in online classes has also been explored in studies by (Dykman & Davis, 2008; Glazier, 2016; Fink, 2007; Magda et al., 2020). Student demands and competitive strategies are not the only driving force for the increase in online offerings. Literature shows that higher education institutions also are being pressured by international and political demands for a skilled, culturally diverse workforce (Bach et al., 2007; Dykman & Davis, 2008; Fink, 2007). This pressure is forcing these institutions to change from the traditional ways of offering an education (Dykman & Davis, 2008). In light of this information, literature has shown how higher education institutions are having to not only compete for students but for faculty and resources to remain relevant and attractive. Research has acknowledged how higher education institutions have also had to adopt a new way of delivering curriculum, which has been supported through online learning. Many institutions have divided programs into modules and offered them online, which allows them to broaden their scope and provide a more tailored academic experience. These programs are attractive to older students, non-traditional students who appreciate the flexibility and intentionality of these programs (Dykman & Davis, 2008). Studies show how some universities have even embraced the massive open online courses (MOOC) as a way to attract and meet online delivery and enrollment targets (Allen & Seamen, 2013; Morris et al., 2020); although many higher education officials are not convinced that MOOCs are a maintainable technique for online learning (Allen & Seaman, 2013). In 2013, a study by Allen & Seaman found that only 2.6 percent of higher education institutions had operating MOOCs and 9.4 were preparing for them.

Likewise, recent research has found that institutions are outsourcing their online programs to online program management organizations (OPM) in order to meet the demands of online learning (Morris et al., 2020; Springer, 2018) without using internal resources and shoulder some of the risk associated with managing online programs. The organizations will not only create and deliver the curriculum for the program, but they will also market, recruit and enroll students, train faculty, and provide student and faculty support services (Springer, 2018). This is an attractive avenue for many instructions who want an online presence but may not have the financial, technological infrastructure or program development resources.

In research it has been found while instructional technology has advanced dramatically over the years, teaching, and learning practices have also changed (Dykman & Davis, 2008; Morris et al., 2020). There has been a transition away from traditional lecture-based teaching and a move toward student-centered instruction. This change helps the teacher to act as more of a guide or facilitator in a student's academic experience. Previous studies have shown that this form of facilitated learning works well in an online platform (Dykman & Davis, 2008; Morris et al., 2020). This differentiation places the focus on the student being self-driven and having their own discipline, and individual accountability (Dykman & Davis, 2008).

Online learning has prompted additional changes to the role faculty in online learning (Dykman & Davis, 2008). The “unbundling” of the conventional responsibilities of the instructor is another fundamental development driving the adoption of online technologies for teaching and learning (p. 12). This unbundling has been shown to reduce long-term educational expenses by achieving economies of scale by isolating and standardizing sections of the learning experience (Dykman & Davis, 2008). Instructors use technology platforms to provide online instruction. How the course is designed, distributed to, and communicated with students as well as the assessment of the students are components of teaching. These items are unbundled in the online environment and supported by technology systems (Dykman & Davis, 2008; Morris et al., 2020).

In summary, there have been different opportunities for learning outside the traditional classroom since the 1700s. This method of education allows all students, even the underprivileged, to obtain an education. Literature has successfully demonstrated how internet technological innovations allow higher education institutions to go beyond boundaries and provide access to all students at any location, whenever the student chooses.

Despite the fact that online education was available in the early 1900s and was used by a number of institutions, it did not become mainstream until 1998. As of 2014, there were 6.4 million online students, as a growing number of students who previously chose in-person courses are now choosing to learn online. Online learning has proven to be a viable method of learning and is considered a strategic part of higher education. As a result of its growth, higher education institutions search for ways to utilize it in order to meet student demands, increase enrollment and remain competitive. Student demand and competitive tactics aren't the only factors behind the expansion of online services. International and political demands for a professional, culturally diverse workforce are also putting pressure on higher education institutions, according to the literature.

Although instructional technology has improved significantly over the years, teaching, and learning habits have also changed, according to research. A shift has occurred away from conventional lecture-based instruction and toward student-centered instruction. This shift encourages the instructor to become more of a facilitator or guide in a student's learning experience. This type of facilitated learning has been shown to function well in an online environment in previous studies.

Effectiveness of Online Learning

There are well documented studies on both the benefits and disadvantages of an online education for students (James, 2002; Nguyen, 2015; Pearson, 2010). Advantages range from expanded access, cost savings, increased opportunities for professional development, convenience, access to current information, less apprehension, to a student having the ability to learn at their own speed (Hiranrithikorn, 2019; James, 2002; Nguyen, 2015; Pearson, 2010;). Disadvantages range from access to broadband internet and computing devices, limited communication with classmates, having discipline when completing coursework, lack of understanding coursework, controlling academic dishonesty, to the perception of limited rigor (Alexander et al., 2012; Hiranrithikorn, 2019).

While the research shows both advantages and disadvantages of online learning, its ability to produce the desired student learning outcome should be the most important factor (Swan, 2003). Research states that a student's class attendance is one factor for academic success (Nieuwoudt, 2020). It is believed that if a student attends class on a regular basis, then they will have better academic achievement (Nieuwoudt, 2020). However, with online learning, a student does not necessarily have to attend class. Nieuwoudt's (2020) study discussed how it is essential to understand the various methods students can access and engage in an online learning environment as a way of promoting learning and enhancing academic performance in online education. Authors have reported in their studies that asynchronous, synchronous and a combination of the two are learning modes that are popular methods used in online learning (Nieuwoudt, 2020). Asynchronous online learning allows the student to have a high degree of discretion over when and where they interact with course resources often through pre-created content and material. Synchronous online learning occurs when an instructor and students are online teaching and learning at the same time. Blended learning involves a mixture of the both asynchronous and synchronous (Richardson et al., 2014).

Notably, research has been mixed on the effectiveness of online learning, whether asynchronous, synchronous, or blended. Nieuwoudt (2020) found no distinction in performance was observed between students who attended synchronous virtual classes and students who watched captured virtual classes in this study.

Nieuwoudt (2020) argued that academic achievement is directly connected to the amount of time a student spends in online learning. The amount of time spent online, could be either in an asynchronous or synchronous mode. Either way, students who spent half the time online did not perform as well academically as students who attended class more often (Nieuwoudt, 2020). Additionally, in online courses, students with higher GPAs achieve higher grades and subsequently, in comparison to in-person classes, students who are close to or are failing, do worse in online courses (Cavanaugh & Jacquemin, 2015).

In addition to Nieuwoudt, a number of authors recognized the effectiveness of online learning in comparison to in-person learning. Based on grades, Cavanaugh and Jacquemin (2015), reported there is no difference in student learning outcomes between online and in-person classes. A 2009 report by the US Department of Education reported that students studying the same material online performed marginally better than those learning the same material in an in-person learning environment. Sitzmann et al. (2006) discovered that the learning outcomes were the same if the learning was done online or in the classroom. Sitzmann et al.'s (2006) study focused on the teaching process rather than the delivery method of instruction (2006). Likewise, Zhao et al. (2005) performed a meta-analysis study to assess the efficacy of distance education and in-person courses and discovered no significant gaps in total effectiveness between the two. Zhao et al. (2005) pointed out that the same variables that influence the efficacy of online learning also influence the effectiveness of in-person classes. Ni's (2013) research of an online graduate program found that a students' success is unchanged by the mode of learning, but some classes are more difficult for students who persist in simulated worlds rather than in the classroom. Additionally, Means et al. (2013) meta-analysis showed that blended online learning yields greater student learning outcomes than exclusively in-person learning. Means et al. (2013) also concluded that a fully online class proved to be comparable to in-person courses and blended online class also proved to be more successful than in-person.

Jaggars and Bailey (2010) agreed with the literature that online courses are just as effective as in-person courses, however, Jaggars and Baily pointed out that this is only the case when the students are "well-prepared and motivated" (p. 11). In a study with Xu, Jagger reported that online learning was most easily suited for people with knowledge of technology, understood how to manage their time, and had self-motivation (2013). Dutton (2002) concurred with prior computer knowledge being an important factor for higher achievement. Jaggars and Baily's study concluded online learning may not increase access but in fact jeopardize academic achievement and advancement for low-income and underrepresented students. Xu and Jaggars (2013) reported that in terms of perseverance and course score, men, African American or Black students, and students with lower standards of academic readiness had slightly higher negative relationship with online learning than their peers; although these achievement differences occur in both in-person and online classes, they are amplified in online courses and subsequently, African American or Blacks and Hispanics may have lower achievement in online classes. Likewise, Cavanaugh and Jacquemin (2015), asserted that female students who are not from a minority group and are older have higher grades than male students who are from a minority group and are younger. Xu and Jaggars (2013) were not surprised by a similar finding in their study. They reported that it's not shocking that women do better in online courses than men because women have better educational outcomes in a range of areas and timeframes.

Xu and Jaggars (2013) noted that online learning may make education inequality worse. Jaggars and Bailey (2010) recommended that online programs would need to address a few key issues prior to making the online classes available. Findings from the Moore et al. (2002) study indicate that first-time online students have misconceptions about online instruction, and that the less exposure they have with higher education, the less likely they are to excel online.

Literature reported other factors impacting a student’s performance as it relates to online courses. Age, according to some authors, is a factor. Xu and Jaggars (2013) found that younger students do not acclimate as well as older students in online classes. Sanchez-Gelabert et al. (2020), found that social conditions (situation at home and obligations outside the home) impacted performance (2020).

As it relates to literature on the effectiveness of online courses and mathematics, Jones and Long (2013) concluded there was no major disparity between the online and in-person mathematics classes. They conclude that students in both the online and in-person courses will gain equal knowledge in mathematics. Karr et al.’s (2003) research focused on a high-level mathematics course. The study found that students taking the online class performed well on the theoretical section of the course. Additionally, students, who took the traditional in-person class did marginally better on the in-class part of the tests. The study revealed all students performed well who had access to both in-person and online ways of learning. However, Dutton (2002) reported that online students performed better on test scores than students who attended in-person courses. Overall, the Karr et al.'s (2003) study highlighted there was no discernible variation between the achievement of the students taking the classes online or in-person. Hooft et al. (2010) reported that students believe online learning is a good way to study mathematics either in an asynchronous or synchronous mode. In contrast, Ferguson (2020) found that online mathematics classes added had higher levels of attrition. Ferguson (2020) stated that mathematics can be difficult to navigate in online learning settings, and learning mathematics, whether online or in-person, can be difficult for students.

As noted in literature, there are advantages and disadvantages to online learning. The objective of Hiranrithikorn's (2019) research was to identify the strengths and limitations of online learning, as well as the opportunities and challenges that higher education experiences. Though Hiranrithikorn's analysis finds similar benefits to researchers of many other studies, the study has limitations due to the sample size and lack of presenting of research questions. Furthermore, there appeared to be a misrepresentation in the results relating to the strengths and weaknesses of online learning.

Hiranrithikorn (2019) research found that the average students in online learning environments perform as well as or better than average students in conventional classrooms. The study also found that the main drawback to online learning stems from the outdated perception of online learning as being negative or insufficiently comprehensive. While Hiranrithikorn reported this in the findings, the author stated that this disadvantage has repeatedly been shown to be untrue. Additionally, Hiranrithikorn stated another disadvantage as being the lack of social contact especially for undergraduate students or young students who need friends and social contact with people their age. The third drawback found was the number of online courses is insufficient, and some courses require students to participate in activities, practice, and ability development in the classroom. While these items were listed as disadvantages, Hiranrithikorn did not mention in the methodology that students were interviewed. The researcher listed faculty and staff as the interviewees but not students. Also, Hiranrithikorn mentioned that the study would consist of a sample of 30, but later referenced a sample of 12. Future research discussing the advantages and disadvantages as they relate to students and online learning, should consist of data gathered on students and not faculty or staff (Hiranrithikorn, 2019).

In summary, there have been several researches performed on the benefits and drawbacks of online education for students. Expanded access, cost savings, improved opportunities for professional advancement, comfort, access to current knowledge, less apprehension, and the opportunity for a student to learn at their own pace are just a few of the benefits. Access to wireless internet and computing devices, insufficient contact with peers, maintaining consistency while completing coursework, a lack of comprehension of coursework, regulating academic dishonesty, and the impression of a lack of rigor are all disadvantages noted by researchers.

Although the research indicates that online learning has both benefits and drawbacks, the ability to achieve the desired student learning result should be the most important factor. According to research, a student's attendance in class is one factor in academic achievement. A student's academic performance will improve whether he or she attends class on a regular basis. With online learning, however, a student is not required to attend class. Asynchronous, synchronous, and a combination of the two learning modes are common methods used in online learning, according to researchers.

In particular, research on the efficacy of online learning, whether asynchronous, synchronous, or blended, has been mixed. Many researchers have discovered no difference in performance between students who attended synchronous virtual classes and students who watched captured virtual classes asynchronously. The amount of time spent online can either be asynchronous or synchronous. In any case, students who did not spend as much of their time online as those who spent a large portion of their time online, do as well academically as students who went to class more often. According to the literature, online classes are just as successful as in-person courses. However, Jaggars and Bailey (2010) pointed out that this is only true when students are "well-prepared and inspired." While these achievement gaps exist in both in-person and online classes, they are exacerbated in online classes, and as a result, men, African Americans or Blacks and Hispanics as well as students who are not academically prepared, may have lower achievement in online classes.

Characteristics of Online Students

In addition to student performance with and effectiveness of online learning, the literature also discusses the characteristics of students who are taking online courses. Sanchez-Gelabert (2020) classified students as (1) working, (2) having various obligations, (3) retired, (4) a foreign post-graduate, or (5) unemployed youth; a student could be a member of one or more of the classified groups. Notably, in Dutton’s (2002) study, online students tend to be older and Sanchez-Gelabert et al. (2020) agreed. Their study showed how in the traditional classroom environment, foreign post-graduates and young unemployed students are the most common student types because they often do not have family or job commitments (2015).

In addition to being older, Dutton (2002) also found that online students are also less likely to participate in conventional undergraduate programs and are more likely to be “lifelong” learners (p.17), they are also more than likely to have work and family obligations, they are more than likely to have experience with computers. According to Xu and Jaggars (2013), online learning is most appealing to non-traditional students.

In summary, the literature also addresses the characteristics of students who take online classes, in addition to their success and the efficacy of online learning. Students were categorized as (1) working, (2) having various responsibilities, (3) retired, (4) a foreign post-graduate, or (5) unemployed youth by the author; a student could belong to one or more of the categories. The literature highlighted that since they often do not have family or work obligations, international post-graduates and young unemployed students are the most popular student groups in the conventional classroom setting.

Conclusion

Although there is much research on increasing STEM degrees, the barriers to women and students of color in pursuit of STEM degrees, the effectiveness of HBCUs producing STEM degrees, online education, and characteristics of students who enroll online, additional research should be done to further deepen our understanding of the differences in academic performance between an online math class and in-person math class at an HBCU.

CHAPTER THREE: METHODS

Overview

This chapter presents the research methodology for this quantitative analysis regarding how the outcomes of an online mathematics course differs from an in-person mathematics course. This method will allow for a more in-depth understanding of how the study demonstrated three ways to promote STEM graduates (e.g. emphasis on HBCUs, exploration into introductory math classes, and utilizing the flexibility of online courses). As a result, the analysis demonstrated the academic guidance needed to assist with this global STEM crisis.

Additionally, the methods demonstrated how the research questions were presented. The research issue is reintroduced first and then followed by the research questions. The methodology will then be presented. The academic institution and its population are then identified. The research design will then be followed by the data collection process. A review of the chapter's contents completed the chapter.

Statement of the Problem

The United States, once known as a global innovator, is now falling behind other countries in terms of creating a skilled STEM workforce (Casey, 2012; Weiner, 2018). This decrease is due in part to the United States producing fewer graduates in

STEM fields (Atkinson et al., 2007; Hassan, 2018; Lamb, 2019; McCarthy, 2017), especially among domestic students (Herman, 2018, 2019). In comparison to the biological/life sciences, bachelor's degrees in engineering, technology, and math are earned at a lower rate (Chen & Soldner, 2013).

This global crisis persists as the United States struggles to cultivate and maintain skilled STEM talent (Chen & Soldner, 2013). In particular, US elementary and secondary school students perform worse in mathematics and science than students in several other countries; US undergraduates select STEM majors at a lower rate than students in several competing countries; the US ratio of STEM to non-STEM bachelor's degrees is one of the lowest globally; and US students, who have a higher chance of being great scientists, perform worse in math and science than students in several other countries (Chen & Soldner, 2013). As a result of these issues, there are national programs aimed at increasing the number of STEM degrees and professions available to students from a variety of backgrounds (Chen & Soldner, 2013).

The government has sought several avenues to increase the number of STEM graduates because this is such a global and critical issue (Handelsman & Smith, 2016; National Science Board, 2018; U.S. Government, 2016, 2018). Supporting HBCUs and assisting them in graduating with further STEM degrees has been emphasized in particular (National Academies of Science and Medicine, 2019; U.S. Government, 2018). Additionally, expanding STEM-related course offerings, such as mathematics, will help students decide whether or not to pursue a STEM degree (Herbert & Clark, 2020). Furthermore, the versatility of online STEM or math courses will appeal to a diverse group of students who may not have previously taken the course in person. As a result, the aim of this dissertation is to look at the differences between web-based introductory math courses and classroom-based introductory math courses at a historically black college or university.

Research Questions

As described in Chapter 1, the purpose of this quantitative study was to examine the demographics and academic outcome differences between web-based introductory math class and classroom-based introductory math class at an HBCU over 3 academic years. Therefore, this dissertation is guided by the following research questions:

- What differences, if any, exist between an online introductory math class and classroom-based introductory math class as it relates to grades, race, gender, age, and major?
- What difference, if any, exists between STEM majors in an online introductory math class and classroom-based introductory math class?

Quantitative Methods

Since this research will consist of quantitative and categorical variables that will not be manipulated nor randomly assigned to groups, this study will be a non-experimental descriptive comparative study. The goal of non-experimental or descriptive research designs is to address research questions about the current state of affairs, define variables and their relationships, and establish a concise quantitative overview of phenomena. As a result, it provides an overview of a selection of people's feelings, beliefs, practices, emotions, desires, or behaviors at a given time and place. (Lavrakas, 2008). Johnson and Christenson (2014) concludes that non-experimental research is crucial in the field of education because many essential educational variables cannot be manipulated or produced in the laboratory and designing many real-life environments using experiments is difficult, if not impossible. As a result, non-experimental studies provide the strongest research method available for an educational environment. Likewise, a study by Wells et al. (2015) found that over 70 percent of studies conducted in educational research were descriptive in nature. Wang et al. (2013), concurred that quantitative research methods reach across disciplines, including medicine, psychology, business, and education. Johnson and Christensen (2014) also found that researchers use descriptive research to learn about their subjects' attitudes, views, values, habits, and demographics. A descriptive analysis can, according to Johnson and Christensen (2014), be important in the study of education because it can provide an accurate description of the characteristics being studied. Wang et al. (2013) discussed in their study how quantitative research methods are relatively accurate when assessing the characteristics of people. Goertzen (2017) determined that quantitative research results show patterns and trends in behavior which will be useful in this study. Overall, the use of quantitative analysis for this study, will allow the ability to calculate and analyze results, support the goal of impartiality, and provide the ability to interpret findings using statistical analysis (Goertzen, 2017).

Research Site

Research was conducted at a historically black college or university that is accredited by the Southern Association of Colleges and Schools Commission on Colleges. This university has a rich history which is rooted in the tradition of educating and providing opportunity for underrepresented students who "enter to learn and go out to serve”. Although the university started as a small college for educating future African American or Black teachers, it has progressed to a major educational institution that prepares a diverse student body to succeed in a complex, dynamic globalized world. In 2020, Public University, a vibrant public land-grant and liberal arts university, was recognized by US News and World Report with the following rankings: 1) number one in terms of best value in its area, 2) number seven in terms of public institutions in its region 3) 12th best colleges for veterans in the country, 4) 29th best historically black colleges and universities, and 5) 36th best Southern Regional Institution and 6) 53rd in terms of social mobility.

According to the Public University’s 2019 fact book, the university enrolled 1,666 undergraduate and 115 graduate students in the fall semester of 2018 for a total of 1,781 students. Of the enrollment, 1,050 were women, 719 were men and 19 were non-reporting. Of the enrolled students, 925 belonged to an underrepresented minority group. The retention rate was 56 percent and the degrees awarded were 344 based on 2017-2018 data. The six-year graduation rate was 18 percent based on data from the years 2012-2018. Financial aid was disbursed to 91.9 percent of the enrolled students. Public University had 151 faculty; 18 of the faculty were from an underrepresented group. 67 were women and 84 were men. Of faculty, 61 belonged to an underrepresented minority group. The employment status of faculty consisted of 122 full-time and 29 part-time. According to Common Data Sets from fall 2016-sping 2019, an average of 45% of Public University’s faculty were reported as faculty who designate themselves as Black, non-Hispanic; American Indian or Alaska Native; Asian, Native Hawaiian or other Pacific Islander, or Hispanic.

The 2018-2019 Common Data Set reported that the university awards certificate, associate, bachelor's, master's and doctoral of professional practice degrees. Academic offerings include cooperative education programs, distance learning, double majors, dual enrollment, honors, independent study, internships, liberal arts/career combination and a teacher education certification program.

Data Source

The data for this dissertation was drawn from 2016-2017, 2017-2018 and 2018-2019 academic years. Research finds that mathematical information, methods, skills, and processes are essential for learning in all fields of science, as well as for the creation and practice of critical thinking and communication, data will be drawn from MAT 115 College Algebra and MAT 115A Accelerated College Algebras. The Public University offers both courses and describes MAT 115 in the 2018-2019 Academic Catalogue as the following:

> This course develops the algebraic skills necessary for further studies in mathematics. Topics include the algebra of functions; graphing techniques; quantitative and qualitative analysis of polynomial, rational, exponential, and logarithmic functions, including limits at infinity and infinite limits; and appropriate applications. Prerequisite: Successful completion of an Intermediate Algebra course with a grade of C or higher, an ACT math sub-score of 22 (or higher), SAT math sub-score of 510 (or higher), a KYOTE College Algebra Placement score of 14 (or higher), or COMPASS score of 50 (or higher). Credit: 3 semester hours (p. 209).

The course definition for MAT 115A in the 2018-2019 Academic Catalogue contains the following:

> This course is designed to be an efficient combination of Intermediate Algebra and College Algebra. Topics include manipulation of monomials, polynomials, rational and radical expressions; solving equations and inequalities, including linear, rational, quadratic, absolute value, exponential a logarithmic; developing problem solving techniques; and introduction to functions, variation, the algebra of functions and their graphs; study of properties and graphs of polynomial and rational functions, including use of a graphing calculator and regression analysis; reading/interpreting graphs of function and applications. Prerequisite: A grade of C or better in MAT 101, An ACT math sub score of 19 (or better), or an SAT math sub score of 460 (or better), or a KYOTE College Readiness placement score of 22 (or better). Credit: 4 semester hours (p. 209).

MAT 115 or MAT 115A is a requirement for completion of the Bachelor of Art Mathematics - Pure Mathematics, Bachelor of ART Mathematics - Applied Pre-Engineering (may be required based on ACT placement), Associates Degree Liberal Studies (STEM+ option) and for the concentrations of Mathematics, Biology, Computer Science, Science, A.A.S in Nursing, BSN Nursing, RN-BSN post licensure and Bachelor of Arts in Elementary Education and Teaching.

MAT 115 or MAT 115A is a prerequisites for the courses of Accounting, Advanced Research Agriculture, Food Sciences or Sustainable Systems, Economics and Marketing, Statistics for Behavioral and Social Sciences, Business Statistics, Chemistry, Survey of General Organic and Biochemistry, Statistics for Criminal Justice, Business

Statistics, Pre-Calculus, Business Calculus and Matrices, Mathematics for Elementary Teachers and Mathematics for Elementary Teachers II. Mathematics is listed as a Co-requisite for Math & Sciences Excel Laboratory and Algebraic Concepts.

Sample

The data analyzed consisted of all students who were actively enrolled in all sections of MAT 115 or MAT 115A from 2016-2017, 2017-2018 and 2018-2019 academic years. Students who withdrew or dropped from the MAT 115 or MAT 115A were not included in the sample. The data retrieved were demographic in nature and included age, grades, gender, race and major. The students were not identified personally. Students who participated in the online offering of the course were identified by the course section of V1 or D1 respectively. The sample size consisted of 2238 students.

Due to the sample size, a power analysis was not generated to determine if the sample size is too small. If the degree of significance does not exceed 0.80, the sample can be expanded by adding additional math courses or additional semesters. Ultimately, since the purpose of this study was to examine grades in one specific math course at an HBCU, a smaller sample size is justified. While a larger sample size may allow for more generalizability, a small sample may still contribute to the literature by revealing disparities between in-person and online courses for different subpopulations (women, non-whites, non-traditionally aged students, and STEM majors).

Data Collection and Management

After approval from the committee and institutional review board (IRB), I received approval to use data from the research site. After approval, I began the data collection process. For the purposes of the study, the data were retrieved from Public University's Student Information System, Ellucian Banner (Banner). The Banner system is the Public University's system of record where student demographic and official academic records (such as gpa, grades, courses, majors, and graduation status) are entered and maintained. The data were retrieved from the Banner System by personnel who work in the Institutional Research office using data generating tools of SQL Developer or ARGOS reporting. In order to obtain the secondary data, a request form was completed and submitted to the Public University's Institutional Research office (Appendix A). The request form contained the researcher's name and contact information, nature of the request, specific terms or academic years, details of the information requested and the purpose of the request. The request form was completed days in advance of retrieving the data.

Once the data was collected, all identifying information was removed. The data were stored in a secure location on a fully patched encrypted computer with anti-virus where the researcher was the only person with credentials to access. Additionally, the data collected were encrypted with a strong password and were managed according to information technology security policies.

Data Analysis Procedures

To better understand the differences between online mathematics and in-person introductory math courses at an HBCU, quantitative approaches were used to produce descriptive statistical data based on students enrolled in MAT 115 and MAT 115 A. The statistical process began with an identification of the descriptive statistics, such as means, frequencies, and standard deviations for the online course, in-person course, and each of the subcategories of demographic characteristics (i.e. major, gender, age, and race).

As a result of using descriptive comparative analysis, a *t* test was conducted. Researchers use *t* tests in experimental designs with categorical information (groups) on the independent variable and continuous information on the dependent variable (Creswell and Creswell, 2018). The objective of this test is to determine if the difference in two groups' means is statistically important (Johnson and Christensen, 2014). IBM SPSS was used to conduct the *t* tests on the descriptive data. The process for processing the *t* test with SPSS involved checking the homogeneity of variances and then examining the data to determine the significance of the test between the variables.. The purpose of my dissertation is to examine the demographics and academic outcome differences between web-based introductory math class and classroom-based introductory math class at an HBCU over 3 academic years. As such, the following hypothesis guided my data analysis procedures:

RQ1: What differences, if any, exist between an online introductory math class and classroom-based introductory math class as it relates to grades, race, gender, age, and major?

$H1_0$: There are no statistical differences between mean grades for an online introductory math class and classroom-based introductory math class as it relates to race, gender, and age.

$H1_a$: There are statistical differences between mean grades for an online introductory math class and classroom-based introductory math class as it relates to race, gender, and age.

RQ2: What difference, if any, exists between STEM majors in an online introductory math class and classroom-based introductory math class?

$H2_0$: There are no statistical differences between mean grades for STEM majors in an online introductory math class and classroom-based introductory math class.

$H2_a$: There are statistical differences between mean grades for STEM majors in an online introductory math class and classroom-based introductory math class.

In a descriptive quantitative analysis, *t* tests are an appropriate statistical test when the purpose is to assess differences in mean grades among two different groups. Literature has shown that differential grading standards exist between classrooms as well as different subpopulations (Gaha et al., 2018). Therefore, *t* tests are needed to determine if there are any statistical differences between two mean grades across different populations and the different courses (Gaha et al., 2018).

According to research, women, non-white students, and students of non-traditional ages must overcome stereotype threat and other barriers in order to succeed in introductory STEM courses, especially math courses (Robnett & Thoman, 2017). Additionally, although online courses have been shown to be more open and versatile for certain groups, such as women (Nguyen, 2015), they may hinder academic achievement for others, such as non-white males (Xu & Jaggars, 2013). Therefore, I was interested in investigating if there are any statistical differences among mean grades for women, non-white, and non-traditional aged students in an online course versus an in-person course. Finally, research has shown that introductory math courses are one of the gateway courses for STEM majors that cause students to either continue or drop out of the STEM pipeline (Douglas and Attewell, 2017). As a result, I was interested in understanding if there are differences between STEM majors in the online course versus the in-person course. As such, I used *t* tests to test my hypothesis.

Multiple *t* tests were conducted to compare different groups of students and their mean grades. First, the mean grades of MAT 115/MAT 115A offered as an online course was compared to the mean grades of MAT 115/MAT 115A offered as an in-person course. Second, a comparison was conducted of the mean grades of STEM majors in the online class compared to the in-person class in comparison to non-STEM majors and whether these are online or in-person students. Third, the mean grades of women taking the in-person courses was compared to the mean grades of women taking the online courses; this comparison will also be conducted between men taking online and in-person courses. Fourth, a comparison of mean grades of non-traditional aged college students was assessed in relation to the online course versus the in-person course. Finally, race was compared and the mean grades for non-whites was compared for students online versus in person. By conducting these six *t* tests, conclusions can be drawn about the effectiveness of online courses versus in person courses across different demographic characteristics. The demographic characteristics (i.e. STEM major, gender, age, and race) were informed by previous literature.

Limitations

Although the research design and analysis will provide the statistical information to make determinations on the significance of offering introductory mathematics classes in comparison to in-person at a HBCU, there are limitations that apply to this study. One general limitation is that Johnson and Christenson (2016) believe that because there is no manipulation nor random assignment, evidence gathered in non-experimental research to support cause-and-effect relationships is significantly restricted and far weaker than evidence gathered in experimental research.

Additionally, another limitation relates to the research was conducted at one HBCU out of 102 that currently exist in the US. The impact of offering an online introductory mathematics courses in comparison in-person courses at a HBCU could be even more significant if known throughout the entire HBCU community. As a result of examining one HBCU the sample size is smaller, however, it is effective enough to determine how that particular HBCU could impact the global STEM workforce shortage. In addition to sample size related to the research site, conducting a descriptive comparative analysis on just one STEM related course is a limitation of the study.

CHAPTER FOUR - RESULTS

As previously described, this quantitative study was conducted for the purposes of examining the demographics and academic outcome differences between a web-based introductory math class and a classroom-based introductory math class at an HBCU over three academic years. As such, the previously stated research questions that guide this dissertation are:

1. What differences, if any, exist between an online introductory math class and a classroom-based introductory math class as it relates to grades, race, gender, age, and major?
2. What difference, if any, exists between STEM majors in an online introductory math class and classroom-based introductory math class?

Therefore, the results of this dissertation would determine what differences, if any, exist between an online introductory math class and a classroom-based introductory math class as it relates to grades, race, gender, age, and major. Additionally, the results also show if any differences exist between STEM majors in an online introductory math class and classroom-based introductory math class. Specifically, the hypotheses that were tested in this study are as follows:

RQ1: What differences, if any, exist between an online introductory math class and classroom-based introductory math class as it relates to grades, race, gender, age, and major?

$H1_0$: There are no statistical differences between mean grades for an online introductory math class and classroom-based introductory math class as it relates to race, gender, and age.

$H1_a$: There are statistical differences between mean grades for an online introductory math class and classroom-based introductory math class as it relates to race, gender, and age.

RQ2: What difference, if any, exists between STEM majors in an online introductory math class and classroom-based introductory math class?

$H2_0$: There are no statistical differences between mean grades for STEM majors in an online introductory math class and classroom-based introductory math class.

$H2_a$: There are statistical differences between mean grades for STEM majors in an online introductory math class and classroom-based introductory math class.

Chapter Four will start with a description of the data source from which the data were obtained. The sample's demographic features, including gender, race, and academic major will be discussed. Next, the findings of the statistical tests that were used to test the hypotheses will be presented. Finally, Chapter Four will conclude with a summary of the quantitative results and a preview of Chapter Five.

Data Source Description

The research site is a Historically Black College and University (HBCU) accredited by the Southern Association of Colleges and Schools Commission on Colleges. Data was collected from Public University's Student Information System which is the Ellucian Banner system. The data was drawn from the academic years of 2016-2017, 2017-2018, and 2018-2019. The data analyzed was drawn from students who were actively enrolled in all sections of College Algebra (MAT 115) and

Accelerated College Algebra (MAT 115A). Students who withdrew from either course were not included in the data collection process.

In addition to the demographic information, data were analyzed included students who participated in the courses in person or online as well as students who had STEM or non-STEM related majors. For the purposes of this study, non-STEM or STEM major included the majors referenced in Table 1.

Table 1

STEM and non-STEM Courses

STEM Majors	
Agriculture	Music Education
Africana Studies	Non Degree
Business Administration	Nursing
Criminal Justice	Physical Education
Elementary Education	Political Science
English	Psychology
Liberal Studies	Social Sciences
Mass Communication and Journalism	Social Work
Music	Undeclared
Non STEM Majors	
Biology	Chemistry
Computer Science	Information Technology
Mathematics	

Data Analysis Procedures

Upon receiving the data set, the file was downloaded from SPSS version 26. First, the data were inspected for missing values. Cases with missing values were excluded from analysis. Mahalanobis distance scores were used to determine statistical outliers at the significance level of $p < .001$. None of the cases were identified as statistical outliers. The Levene's F test was run to examine homogeneity of variance, which is an assumption of the independent samples *t*-test. The results showed comparable variance across groups as the significance level was greater than 0.05. Thus, this assumption of the independent samples *t*-test was met, and the test was conducted as planned. Furthermore, the dependent variables that were included in the independent samples *t*-tests had skewness and kurtosis values that fell within the ranges of normality.

In addition, the assumptions of multiple regression were conducted and met. Specifically, there was no threat of multicollinearity as the correlations among the predictor variables was less than a correlation of 0.80. Furthermore, the residuals adhered to a normal distribution.

Descriptive Findings: Sample

The sample consisted of 2238 students enrolled in one of several sections of an introductory mathematics course from 2016-2019 academic years. Approximately 78% of the enrolled students (n= 1750) completed the online version of the course, whereas about 22% of enrolled students (n= 488) completed an in-person version of the course. In terms of student demographics, as shown in Table 2, the majority of enrolled students self-identified as female (59.5%), self-identified as a person of color (81.3%), had a non-STEM major (95.3%), and had passed their course with a grade of C or better (83.5%). The ages of the students ranged between 15 and 49 with an average age of about 19 years of age (M =18.62, SD= 2.33). Of the students who self-identified as a person of color, 45.2% self-identified as an African American or Black female, 27.9% as an African American or Black male, 3.9% as a Hispanic female, 3.3% as a Hispanic male, 0.8% as an Asian female and 0.2% as an Asian male.

Table 2

Demographic Characteristics of Sample

	F	**%**
Gender		
Male	902	40.5
Female	1326	59.5
Total	2228	100.0
Race		
Persons of Color	414	81.3
White	95	18.7
Total*	509	100.0
Academic Major		
Non-STEM	2132	95.3
STEM	106	4.7
Total	2238	100.0
Grades		
F	118	5.3
D	251	11.2
C	610	27.3
B	675	30.2
A	584	26.1
Total	2238	100.0

Note. Sample sizes for each variable vary as a function of the data available for participants. The race/ethnicity was unknown for 1729 students; thus, race/ethnicity data is available for 509 students.

Demographic Differences in Academic Performance

Independent sample *t*-test were used to assess whether students' performance, i.e. course grade, in the mathematics course differed as a function of gender, race, and academic major. As shown in Table 3, there were statistically significant differences in academic performance as a function of gender [t (2226) = -5.27, p <.001], race [t (507)

= -3.88, p <.001], and academic major [t (2236) = 5.28, p <.001]. Specifically, female students, White students, and students of Non-STEM majors outperformed their respective counterparts.

Correlation analysis shows a statistically negative, weak, and significant correlation between age and students' grades, r (2236) = -.08, p < .001. Specifically, younger ages were associated with better performance.

Table 3

Demographic Differences in Academic Performance

	M	***SD***	***t statistic***
Gender			
Male (n = 902)	3.45	1.16	-5.27***
Female (n = 1326)	3.71	1.12	
Race			
Persons of Color (n = 414)	3.03	1.33	-3.88***
White (n = 95)	3.62	1.33	
Academic Major			
Non-STEM (n = 2132)	3.63	1.12	5.28***
STEM (n = 106)	3.04	1.43	

Note. *p <.05, **p <.01, ***p <.001

Hypothesis I: Course Type Differences in Academic Performance

Independent sample t tests showed a statistically significant difference in academic performance, or course grade, as a function of course type [t (2236) = -12.66, p <.001]. Specifically, students who took the online course (n =1750, M = 3.76, SD= 1.02) outperformed their peers who took the in-person course (n =488, M = 3.05, SD= 1.36).

Multiple regression techniques were used to determine whether the course type difference holds up when students' demographic characteristics are statistically controlled for, which provides a more robust test of Hypothesis I. The analysis included data from 509 students. As shown in Table 4, the course difference is statistically significant when students' demographics are statistically controlled for, $\beta=0.16$, $t=3.38$, $p < .01$. Students' race was the only demographic variable that remained a statistically significant predictor of students' academic performance when the other variables were taken into account, $\beta=0.13$, $t=2.76$, $p < .05$. These findings provide statistical support for Hypothesis I.

Table 4

Multiple Regression Results for Hypothesis I

	B	***SE***	**β**	***t***	**95.0% Confidence Interval**	
					Lower Bound	Upper Bound
(Constant)	2.64	0.32		8.17	2.00	3.27
Course Type	0.60	0.18	0.16	3.38**	0.25	0.95
Gender	0.19	0.12	0.07	1.59	-0.05	0.43
Age	0.01	0.02	0.03	0.72	-0.02	0.04
Major	-0.01	0.15	0.00	-0.06	-0.31	0.29
White vs. POC	0.44	0.16	0.13	2.76*	0.13	0.75

Note. $n = 509$ *p <.05, **p <.01, ***p <.001

Hypothesis II: Course Type Differences in Academic Performance - STEM Majors

There were insufficient data to test Hypothesis II. A crosstabulation on major and course, demonstrated out of the 106 students who were STEM majors, only 2 of those students participated in the course online in comparison to 104 students who participated in the course in-person. As a result, the course type differences in academic performance among STEM majors cannot be determined.

Conclusion

In conclusion, the results revealed that the majority of the students enrolled in the introductory mathematics class took the class online. Furthermore, academic achievement, i.e. grade in the class, differed significantly by gender, race, and major. Other findings indicated that as it relates to course type and age, online students and younger students performed better. Race was also the only demographic component that continued to be a statistically significant predictor of academic success. Although there was not enough data to test the second hypothesis, the limited number of students taking online STEM courses is a finding in itself. A discussion and implication of findings will be presented in the following chapter, Chapter Five.

CHAPTER FIVE: DISCUSSION AND IMPLICATIONS

Introduction

The United States is producing fewer STEM graduates, and as a result, the country is losing its reputation as a global innovator. As the United States tries to produce and retain talented STEM workers, the worldwide dilemma continues. Because this is such an important issue and as a result of these concerns, the government has explored various ways to increase the number of STEM degrees and occupations. Nationwide programs have been established and made available to students from all backgrounds. In addition to the nationwide programs, literature has demonstrated three viable ways to combat this issue. The first viable option is utilizing and supporting HBCUs to assist in graduating a more diverse group of students with STEM degrees. Jett (2013) contends that, as a result of his and others' research, HBCUs are uniquely prepared to successfully give access to educational achievement, particularly as it relates to STEM-related degrees, because of their mission and objectives. Also, expanding STEM-related course options, such as mathematics, will also assist students in determining whether or not to pursue a STEM degree. Many students are also required to enroll in and pass college mathematics as part of their general prerequisites for degree completion as they begin their academic program (Douglas & Attewell, 2017). Additionally, increasing the modality options for students will assist by offering the flexibility of online STEM or math classes will appeal to a wide range of students who may not have previously attended the course in-person. As a result, the purpose of this research was to investigate the differences between web-based and classroom-based introductory mathematics courses at a historically black college or university (HBCU).

Summary of Study

As such, this dissertation examined the differences between an online and in-person mathematics classes at an HBCU. To examine the differences, the research questions that guided this study were:

3. What differences, if any, exist between an online introductory math class and a classroom-based introductory math class as it relates to grades, race, gender, age, and major?
4. What difference, if any, exists between STEM majors in an online introductory math class and classroom-based introductory math class?

To discover answers to the research questions, I conducted a non-experimental descriptive comparative study utilizing quantitative methods. The research site, which for the purpose of this study, I used the alias of Public University. This HBCU is accredited by the Southern Association of Colleges and Schools Commission on Colleges and in the 2019 fact book had an enrollment of 1,781. The data source were secondary data from Public University's Student Information System. The data were drawn from three academic years from 2016-2019 by the Institutional Research Department. The data analyzed were drawn from students who were actively enrolled in all sections of MAT 115 College Algebra and MAT 115A Accelerated College Algebra. The data from a total of 2238 students were assessed. The data analyzed were demographic in nature and included age, grades, gender, race, and major. In addition to published data and my research findings, it is important to note that as a 20-year African-American, female employee of Public University, I have research positionality into its uniqueness and organization culture. I have a collegial relationship with faculty and staff, and I have served as a supervisor, mentor and advisor to several students over the years. The desire to understand if any differences existed in performance in an introductory mathematics course between students from underrepresented groups and white students at a HBCU was a driver for my research.

The sample of 2238 students enrolled in one of several sections the College Algebra or Accelerated College Algebra from the 2016-2019 academic years. Out of the sample, the majority (78%) of the enrolled students completed the online version of the course, whereas the remaining enrolled students (22%) completed an in-person version of the course. The majority of enrolled students self-identified as female (59.5%), self-identified as a person of color (81.3%), as having a non-STEM major (95.3%), and based on performance, passed the course with a grade of C or better (83.5%). The average age of the enrolled students was approximately 19 years. Of the students who self-identified as a person of color, 45.2% self-identified as an African American or Black female, 27.9% as an African American or Black male, 3.9% as a Hispanic female, 3.3% as a Hispanic male, 0.8% as an Asian female and 0.2% as an Asian male.

The outcomes of this study explained the differences in performance in an introductory mathematics course between students from underrepresented groups and white students, as well as between men and women at a HBCU. Female students, White students, and students of Non-STEM majors outperformed their respective counterparts. Additional findings highlighted how students who enrolled in the mathematics course online outperformed students who enrolled in the course in-person. Finally, younger students had higher levels of performance than older students.

This chapter will review a summary of findings as they relate to answering if differences, exist between an online introductory math class and a classroom-based introductory math class as it pertains to grades, race, gender, age, and major as well as answering if any differences exist between STEM majors in an online introductory math class and classroom-based introductory math class. A conclusion based on the significance of the study will be given as well theoretical, practical, and future implications will be introduced. The chapter will review the strengths and weakness of the study. Finally, recommendations for future research will be presented.

Summary of Findings

The findings of this study attempted to assist in understanding the gaps between students of underrepresented populations and white students and between women and men as it relates to grades and introductory mathematics. Additionally, the findings intended to help highlight whether or not online courses can be a beneficial and efficient way to increase STEM graduates.

By attracting more students, especially in STEM, universities can expand online offerings and conserve academic standards and rigor while also reducing cost to the organization. Over 68% of institutions decided to offer online courses as a way to expand enrollment into their organization.

The results of the study indicated that when using independent sample *t* tests student performance in the introductory mathematics course significantly differed according to gender, race and academic major. This demographic difference in academic performance were specifically seen with female students, White students, and students of Non-STEM majors as they outperformed their respective counterparts.

When a correlation analysis was conducted, it showed a statistically negative, weak, and significant correlation between age and students’ grades. This correlation specifically showed younger ages were found to be connected with improved performance in this study.

In terms of race, gender, and age, research confirmed my hypothesis that there are statistical differences between mean grades for an online introductory math class and a classroom-based introductory math class. The results demonstrated a statistically significant difference in academic performance as a function of course, based on independent sample *t* test.

Multiple regression techniques were employed to determine if the course type difference remained when demographic variables of students were statistically adjusted for, resulting in a more robust test. When students' demographics were statistically adjusted for, the course difference between 509 students was statistically significant. Additionally, when all other variables were taken into account, students' race was the only demographic variable that remained a statistically significant predictor of academic performance. Based on these results, Hypothesis I is statistically supported by these facts.

Unfortunately, the second hypothesis of there are statistical differences between mean grades for STEM majors in an online introductory math class and classroom-based introductory math class could not be tested because there was insufficient data. A crosstabulation of major and course revealed that only 2 of the 106 STEM majors took the course online, compared to 104 students who took the course in person. As a result, disparities in academic achievement across STEM majors due to course type cannot be detected.

Demographic Differences in Academic Performance

Gender. The findings indicated that gender was a significant factor in academic performance in the introductory mathematics class. Gender being a significant factor with academic performance has been a significant finding in research for many years. The difference with this finding is that, students who identified as female, performed better in the course than their male counterparts. Higher levels of academic achievement in mathematics and other STEM related courses have primarily dominated by white males (Martin et al., 2010), this finding shows that progress is being made and this outcome is not a surprise. There is literature that support women outperforming men and demonstrating higher levels of achievement in mathematics classes in comparison to males based on classroom grades (Xu & Jaggars, 2013; Arslan et al., 2012).

There is an extensive amount of research that discusses how “stereotype threat”, “gender biases” and “wavering confidence” negatively impacts academic performance for women. Since majority of the women in my study participated in the class online, while these women may have experienced a form of stereotype threat, gender biases and issues with self-efficacy in their academic career or endeavors, the women in my study did not have to experience stereotype threat or gender biases that can often occur as the result of the classroom environment. The lack of these negative experiences is a factor in the high levels of performance for women (Bench et al., 2015).

Race. When other characteristics were taken into consideration, my research verified previous studies showing a student’s race is a strong predictor of academic achievement in a STEM related course (Adams et al., 2017; Collins et al., 2020; National Science Board, 2017). The finding that whites had higher levels of performance than persons of color in the mathematics course is not a new result, however, the finding emphasized that even at a HBCU, academic performance by persons of color may still be negatively impacted by obstacles such as ‘chilly’ climate, instructional bias, negative stereotypes, self-doubt, alienation, isolation, and cultural insensitivity” (Collins, et al., 2020; Swali, Redd and Perna (as cited by Lloyd-Jones, 2011, p. 216) as well as lower academic readiness (Adams et al., 2017).

Additionally, African American or Black Students and students with lower academic readiness, perform at a lower rate than their peers when learning online. While these achievement gaps also occur with in-person classes, the negative impacts of lower academic achievement is amplified when participating in online courses, and as a result, African Americans or Blacks and Hispanics may have a lower achievement levels when learning online than their peers (Xu & Jaggars, 2013).

Intersection of Race and Gender. As highlighted in this discussion, gender and race were both significant findings as it relates to academic performance. Important to highlight with this finding is that white females performed better than their male counterparts (white and non-white) and women of color. This higher performance while not identified during this study, could be related to result of other studies where white females were found to benefit from advantages that are not available to African American or Black females or other women of color (Collins, et al., 2020). Also, as noted previously, even though the research site is a HBCU, challenges are greater and the expectancy for success varies for African American or Black and Hispanic females

(Rice & Alfred, 2014). African American or Black females often face dual marginalization by males overall and white females causing their academic struggles to be overlooked; the combination of all these factors often will have an adverse effect on performance (Collins et al., 2020).

Age. While the majority of the findings from my study confirmed previous research in the areas of race, gender, there were some aspects the findings that challenged prior studies. The association between age and student grades is statistically negative, weak, and significant, according to the correlation analysis. Younger ages in my study were linked to higher levels of achievement. Based on course enrollment, the participants in my research ranged in ages from 15 to 49 with an average age of 19 years of age. Younger students typically do not have the same pressures or social circumstances as older students who have family and job commitments (Cavanaugh & Jacquemin, 2015). Not having to face these challenges can influence positive levels of achievement (Sanchez-Gelabert et al., 2020).

Hypothesis I: Course Type Differences in Academic Performance

The findings demonstrated that majority of the students enrolled in the mathematics course online. This could be due in part to online learning growing in popularity and becoming a preferred form of learning when compared to in-person learning. (Allen et al., 2016; Ashby et al., 2011; Kentnor, 2015). Students are either taking courses either entirely online or enrolling in a mix of online and in-person courses (Allen & Seaman, 2002). Online learning is considered to be flexible and support students who may have family and job responsibilities. Online learning is also free from environmental and social dynamics that in-person courses may have. Additionally, in some instances, participating in online courses can be lower in cost (Dumbauld, 2020) as well as offer a quicker path to graduation (Magda et al., 2020). Additionally, there was a statistically significant difference in academic success between online and in-person course performance. My study revealed, students who took the online course achieved better than those who took the in-person courses. In addition to the flexibility, convenience of time and lower costs benefits of online learning as mentioned earlier, being able to learn at their own pace and the method of learning are also important factors that increase performance (Hiranrithikorn, 2019; Yeboah et. al, 2016).

Hypothesis II: Course Type Differences in Academic Performance with STEM Majors

Online Learning and STEM. The differences in academic achievement with STEM majors based on course delivery of online or in-person could not be determined based on the findings. Only a small number (2) of students who were STEM majors (104) enrolled in the introductory mathematics course online. While studies have determined that there is not a significant difference between the academic performances of students who participate in STEM courses online or in-person (Cavanaugh & Jacquemin, 2015; Jones & Long, 2013; Sitzman et al., 2006; Zhao et al., 2005), STEM majors still have preferences to taking the course in-person.

Some students who major in STEM may have reservations with taking a STEM related course online. These students may believe that online education may not be suitable for their STEM major courses, especially mathematics. This could be due in part to STEM courses needing hands-on experimentation or other learning modalities which may be difficult to navigate online (Ferguson, 2020; Wladis et al., 2011). Additionally, STEM major coursework often requires collaboration, and this is found to be difficult in an online environment (Abramenka, 2012). For this reason, STEM students may find it easier to learn in the classroom (Karambelas, 2013).

Conclusion

To remain a global leader, the US must develop and recruit a talented STEM workforce. With US students in elementary and secondary schools performing at a lower rate in mathematics and science, US undergraduates selecting STEM majors at a lower rate than those of many competing countries, and as the US ratio of STEM to non-STEM bachelor's degrees is one of the lowest globally, this effort is a daunting challenge. The findings of promoting STEM graduates by supporting and focusing on the contribution of graduates from HBCUs and comparing the performance of introductory mathematic classes in an online and in-person format, assist in demonstrating academic solutions to assist with this global crisis.

This research answered the question of if any differences exist between an online introductory math class and classroom-based introductory math class as it relates to grades, race, gender, age, and major. The findings highlighted how gender, ethnicity, and academic major all had a substantial impact on academic success. The findings also revealed that online students and younger students scored better than in-person and older students. Race remained the sole demographic factor that was statistically significant in predicting academic performance. These findings demonstrated the importance of gender, race, faculty diversity and the effectiveness of online learning.

Implications

The implications of this research show how important HBCUs are in helping the United States meet the general problems of developing and sustaining a strong STEM workforce. Additionally, this study highlighted the how gender, race are equally important factors for the US to address the STEM workforce shortage. Through the findings of this study, it revealed the importance of eliminating one of the barriers to learning for students of color by having more diverse faculty. This study also highlighted how online learning is a viable teaching and learning method for mathematics.

Theoretical Implications

Faculty Diversity. Important to note for the achievement of African American or Black students is the number of faculty who represent their race. While this study was held at a HBCU and while HBCUs often have a more diverse workforce (Lundy-Wagner, 2015) and positive racial climate (Solorzano et al., 2000), majority of the faculty at Public University are not reported as being faculty of color. This could also be a factor in the finding that White students had higher achievement as compared to students of color. Students of color often report experiencing racial micro-aggressions (McCabe, 2009; Robinson et al., 2016; Solorzano, et al., 2000) as well as impostor syndrome, unwelcoming institutional climate, institutional and social barriers in their departments, racial/ethnic stereotyping, and a lack of role models or mentors. Additionally, a lack of STEM faculty of color all has negative effects on students of color and contributes to high numbers of them dropping out of college (McGee, 2016).

Gender and STEM. The findings of this study indicate that women are a significant factor in relation to STEM persistence. Likewise, to have a more diverse and globally innovative STEM workforce, targeting women and minorities in order to meet the STEM demands should be a goal (National Research Council, 2011). Women obtain over half of bachelor's degrees and of this number, a small percentage of these degrees are in STEM. The study demonstrated how female, white students and non-STEM majors performed better than their counterparts. This finding opens the door for discussion on how to increase non-white students, especially females, to pursue STEM degrees or careers. The gender and racial disparities in STEM graduation rates are significant and persistent (Lloyd-Jones, Jean-Marie, Frierson, & Tate, 2011). In the United States, although 40 % of whites graduate with a STEM degree, just 24 % of African Americans or Blacks will receive one (Lloyd-Jones et al., 2011). Despite the efforts to increase the number of African American or Black STEM graduates (Suran, 2021), African Americans or Blacks are still leaving STEM majors at a higher rate than whites. African American or Blacks are leaving at a rate of 40 % and whites are leaving at a rate of 29 % (Riegle-Crumb et al., 2019); data that is almost opposite of degree attainment for the groups.

Online Learning. The data from this research was gathered from academic years prior to the COVID-19 pandemic when in-person learning was primarily shifted to online platforms for not only P-12 but also for higher education. Various studies are being conducted on the effectiveness of online learning and student satisfaction, especially as it relates to the pandemic (Pham et al., 2021; Tartavulea et al., 2020). While this study found that determined that there was improved performance in the online mathematics class as compared to the in-person class, some research has shown no significant difference between online and in-person mathematics programs based on the literature on the effectiveness of online courses and mathematics (Jones & Long, 2013). This study highlighted how mathematics can be taught effectively online (Sanchez-Gelabert et al., 2020). The conclusion can be reached that students in both online and in-person courses will achieve equal mathematical understanding (Jones & Long, 2013).

Practical Implications

HBCU Relevance and Funding. Although the findings demonstrated how white females outperformed their counterparts, majority of the students attending Public University passed the course and contributed to academic persistence. Because of HBCUs' impact on the degree completion of African-Americans and other underrepresented populations, cooperating with and supporting them to build a diverse STEM workforce is a viable strategy. The federal government recognizes this and has programs to support HBCUs and assist them in graduating more STEM (National Academies of Science and Medicine, 2019; U.S. Government, 2018).

HBCUs are designed to create a supportive, nurturing, varied, and inclusive atmosphere for students (Jett, 2013). HBCUs' potential to increase the number of African Americans or Blacks in STEM is significant (Lundy-Wagner, 2015). For decades, HBCUs have played an important role in the education of African Americans or Blacks and other underrepresented populations (Jett, 2013; Williams & Davis, 2019). HBCUs' are just as important now than ever and their purpose continues of providing educational opportunities for all is still relevant. HBCUs are still graduating large percentages of African Americans or Blacks with advanced degrees and contributing economically to the global society (LeMelle, 2002).

Directly related to HBCU relevance is the funding of HBCUs. When compared to public non-HBCUs, public HBCUs rely more significantly on federal, state, and local assistance for funding while Private HBCUs are more dependent on tuition than private non-HBCUs. (Williams and Davis, 2019). Additionally, HBCUs have traditionally been underfunded by the states they reside in. So much so, in March of 2021 the governor of Maryland signed into legislation a $577 million bill to provide additional funding the HBCUs in their state over 10 years after the settlement of a 15 year lawsuit brought against the state for discriminating funding policies against the four HBCUs in their state (Seltzer, 2021). Through The American Rescue Plan (ARP) announced in July of 2021, President Joe Bide, is providing $1.6 billion to Historically Black Colleges and Universities (US Government, 2021), while this is type of funding is extraordinary, "it will take more than a onetime injection to Black colleges to make up for a legacy of racism" (Adams, 2021).

Future Implications

Gender and STEM. Encouraging African American or Black females to enter the STEM field starts at an early age (Collins, et al., 2019). While many obstacles have been overcome with female interested or pursuing STEM, there are many barriers that still exist (Robnett & Thoman, 2017). Fortunately organizations exist such as Black

Girls Do STEM, Black Girls Code and Meyeroff Scholars Program, to name a few, that are working to level the playing field and enhance the academic environment, as well as address common challenges that make it difficult for minority students to excel in STEM (Suran, 2021).

Faculty and Diversity. Having a diverse faculty population is not only beneficial to attracting and retaining a diverse population of students (Robinson et al., 2016) but also in attracting and retaining a diverse population of faculty. To address these challenges, institutions must demonstrate an authentic commitment to recruiting, hiring, and retaining faculty of color (Writer & Watson, 2019). Recruiting a diverse workforce needs to be a part of the organizations overall strategy (Dixie, 2021). This type of intentional recruiting must involve a faculty search committee that is carefully designed to include faculty of diversity and plans to re-evaluate hiring policies and procedures (Writer & Watson, 2019).

Strengths and Weaknesses

The study had several strengths, first the research methodology for the quantitative analysis allowed for a more in-depth understanding of how the study demonstrated three ways to promote STEM graduates (e.g. emphasis on HBCUs, exploration into introductory math classes, and utilizing the flexibility of online courses). The data analysis procedures were controlled and revealed that no statistical outliers were identified. Additionally the data analysis and determined that the independent sample *t*-test was met and the test was conducted as planned. Furthermore, the dependent variables fell within the ranges of normality.

While a non-experimental studies provide the strongest research method available for an educational environment, any non-experimental research has its own set of constraints. One disadvantage is that the study was undertaken at only one of the 102 HBCUs that exist in the United States. If known to the entire HBCU community, the impact of delivering an online introductory math course in compared to an in-person introductory math course at an HBCU might be much greater. The sample size is smaller as a result of only looking at one HBCU, yet it was sufficient to assess how that particular HBCU would impact the worldwide STEM workforce.

Additional sample size restrictions centered on how when race and ethnicity were included in the study, the analysis and statistical power were dramatically lowered since a larger number of participants elected not to identify their race. Furthermore, the data could not be evaluated in terms of STEM students taking an online mathematics course.

Recommendations for Future Research

Due to the importance of the US creating ad sustaining a global stem workforce, future research should gain a further understanding of the preferences for online or in-person learning from degree seeking students enrolled in STEM courses or majors. While I conducted a quantitative study, in order to capture their emotional and behavioral preferences, that particular research should be qualitative. Additional research as it relates to STEM majors should be conducted to determine how their attendance and performance in online ad in-person courses directly relates to their persistence to graduation with a STEM degree, switched to a different major or dropped out of the university. According to research, a student's attendance in class is one element in academic performance (Nieuwoudt, 2020). It is thought that if a student attends class on a regular basis, they would attain greater academic success (Nieuwoudt, 2020). With online learning, however, a student is not required to attend class. Asynchronous, synchronous, and a combination of the two learning modes are prevalent strategies employed in online learning, according to authors in their studies (Nieuwoudt, 2020).

Chen and Soldner discovered in 2013 that by the spring semester of 2009, 48% of students who were pursuing bachelor's degrees in a STEM major between 2003 and 2009 had dropped out. According to the research, 20% of students changed their major to something other than STEM, and 20% of students dropped out of college or university without completing their degree.

While I researched academic performance, or grades, of an introductory mathematics class based on grades, future research should also examine how students who attend an HBCU persist in mathematics self-rate themselves as it relates to their perceived performance or comfort level with mathematics. Mathematics anxiety is intimately linked to a person's attitude toward mathematics (Dowker et al., 2016). However, having a negative attitude toward mathematics does not imply that a person suffers from mathematics anxiety (Dowker et al., 2016). Furthermore, Dowker et al., 2016) found that when a person judges oneself poorly, they are more likely to experience mathematics anxiety. Dowker et al. (2016) noted how self-rating is related to self-efficacy as part of the self-rating discussion. When discussing the relationship between self-efficacy and mathematical anxiety, The distinction between self-rating and self-efficacy, according to Dower et al. (2016), is that self-rating is primarily focused with actual achievement, whereas self-efficacy is related with an individual's confidence in their ability to achieve in mathematics.

Additionally, while grades are a measure of performance, future research should review whether they are the most reliable indicator of actual student learning or academic achievement. Researcher have discussed and proposed solutions to this dilemma for years, however, the reliance on grading as a basis for measuring learning remains an unchanged practice (Jones, 2005).

Lastly, online learning is growing and became the main mode of learning during the COVID-19 pandemic. The Ashby et al. (2011) and Kentnor (2015) research indicated that online learning has exploded in popularity and has shown to be the most efficient type of remote learning; to the point that many students who previously favored in-person classes are now choosing to learn online. While many students preferred online learning when there was an option between online and in-person, future research should review if student still have a high preference for online learning after experiencing that mode of learning during the pandemic.

The finding attempted to answer the differences if any, between STEM majors in an online introductory math class and classroom-based introductory math class but due to the low enrollment of STEM majors in the online portion of this class, this question was unable to be determined. This finding was itself was significant as it demonstrates how STEM majors may be hesitant to take a STEM-related course online. These students may think that an online education isn't appropriate for their STEM major subjects, particularly mathematics.

Given these findings, the bottom line is that HBCUs are a viable solution to solving the STEM problem within the US. Supporting these great institutions of higher education will not only improve the global innovative STEM workforce issue but also provide a pathway to create a diverse and inclusive workforce and community.

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APPENDICES

[Appendix A: Institutional Research Request Form]

Appendix A: Institutional Research Request Form

Office of Institutional Research Information Request Form

Please allow 3-5 working days for IR to complete your request. Failure to fill out all the fields below may delay the process to complete your data request. If this is an urgent request, please notify an IR team member as soon as you submit the form.

Name *

First

Last

I am a: *

Title

Address *

Address Line 1

Address Line 2

City

State

Zip Code

Phone *

Email *

Date needed *

Inquiring

Please specify the nature of your request: *

If option not listed, please fill in the nature of your request.

Please specify the term(s) or academic year(s) of the data you're requesting: *

(example: Fall 2017, Fall 2018, and Fall 2019)

Please specify the details of the information that you are requesting: *

Please specify the purpose of your request: *