2021

THE IMPACT OF GRAPHING CALCULATORS ON THE MATHEMATICS ACHIEVEMENT OF BLACK FEMALES

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A dissertation submitted in partial fulfillment

of the requirements for the degree of

DOCTOR OF EDUCATION

to the faculty of the

DEPARTMENT OF ADMINISTRATIVE AND INSTRUCTIONAL LEADERSHIP

of

THE SCHOOL OF EDUCATION

at

ST. JOHN'S UNIVERSITY

New York

by

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Submitted Date November 30,2020 Approved Date January 29,2021

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ABSTRACT

THE IMPACT OF GRAPHING CALCULATORS ON THE MATHEMATICS ACHIEVEMENT OF BLACK FEMALES

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This study examines the effect of the usage of graphing calculators on Black Females mathematics achievement based on the 12th grade National Assessment of Educational Progress (NAEP). This non-experimental research study will analyze the 2015 NAEP publicly available data set, using the 12th-grade sample, examining their overall math achievement compared to graphing calculator usage, race, gender, and SES.

Four regressions will be used to analyze factors created from the 12th grade NAEP student surveys, with test results as the dependent variable. The regressions will use race, gender, and SES, and graphing calculator usage in the classroom as independent variables and the NAEP results as results of the regression analysis will be used to evaluate the predictive power of the model.

Previous studies on mathematics achievement have used only 4th and 8th-grade data. This investigation will contribute to the body of research by investigating the 12th

grade NAEP results. This study evaluates academic performance at the end of their K-12 academic experience which can serve as a baseline for evaluations of future years 12th grade mathematics achievement.

DEDICATION

I would like to dedicate this dissertation to my daughters Rachel and Marissa who are my biggest cheerleaders, my sister Annette who listened for hours on end as I talked about my topic, my best friend Gina who probably knows my topic as well as I do because her numerous readings of my literature review, my other sisters who uplifted and encouraged me, and my mother who told me to never let anyone tell me what I can and cannot do.

I want to thank Dr. Annunziato, Dr. Bernato, and Dr. Campbell for embracing my topic early on and providing me with support and guidance throughout this process. I want to thank my Amityville Memorial High School students. You always remind me of why I am in education, help me grow, and keep me smiling. I would also like to thank all my family and friends who were simply there for me.

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CHAPTER 1

Purpose of the Study

The purpose of this national study was to examine the results of the 12th grade NAEP in mathematics, which were obtained from NAEP's publicly available database, to determine if the usage of technology, specifically graphing calculators, will significantly impact the mathematics achievement of Black Females. Although the 4th and the 8th grade NAEP has been used in multiple studies, this study used the results of the 12th grade population, a grade level that has never been used to conduct a study.

The knowledge obtained in this study can help mathematics educators select technology tools proven to improve mathematics achievement. By increasing mathematics scores, schools will be able to generate more students who are capable of being successful in the challenging mathematics courses required to be successful in an engineering, engineering technology, and mathematics bachelor's degree programs. These programs have the most significant underrepresentation of Black Females.

Graphing calculators are currently allowed on both the ACT and SAT national testing programs. These tests are used largely by colleges and universities to determine if students can be successful at their institution of higher learning. By increasing mathematics achievement, usage of graphing calculators will in turn increase the pool of students capable of completing engineering, engineering technology, and mathematics bachelor's degree programs.

The researcher identified factors from the NAEP 2015 12th grade mathematics student variables. The factors consist of socioeconomic status (SES), race, gender, and

graphing calculator usage in the classroom. Not providing graphing calculators to students who do not have access to them is a great disservice to these students.

Limited or no access to graphing calculators will negatively impact our most marginalized groups the most because they are less likely to be able to afford them. This population is already greatly disadvantaged because they are more likely to attend schools with fewer resources. It is important to provide resources that will result in educational equity whenever possible. This study looks at the end results of the nations' K-12 mathematics achievement, to identity a resource that is proven to increase academic performance and make recommendations on how to best use this resource.

Significance of the Study

The United States has long been recognized as one of the most prominent world leaders. The rapid advancement of technology has allowed other countries to rise in their world Status relative to the United States. If the United States wants to maintain its position as a world leader in today's global economy, it is imperative that it uses all its population resources to remain innovative and creative in the realm of technology.

The STEM (Science, Technology, Engineering and Mathematics) professions are recognized as essential components of the efforts to keep the United States competitive edge. STEM careers require extensive mathematics knowledge and students in the United States consistently underperform in mathematics and science when compared with other industrialized nations. A solution to the underperformance needs to be found.

Since mathematics scores in the United States consistently fall well behind students in other industrialized nations, research is needed on how to improve mathematics achievement in schools with remarkably diverse settings and populations. Educators are obliged to recognize that there is not just one method that will meet the needs of all students. Educational instruction should be diversified in ways that meet the diverse needs of its learners.

Within STEM careers, engineering and mathematics professions are the most severely impacted by this shortage. URMs are the largest untapped resources available to the STEM professions. Within the URMs, the most untapped resource is the American Black woman. One way the United States can create more workers in the engineering and mathematics related professions is to develop programs designed to increase the presence of Black women in these professions.

Research Questions

1. Is there a significant relationship between gender and achievement on the 12th-grade NAEP mathematics assessments?

2. Is there a significant relationship between race and achievement on the 12th-grade NAEP mathematics assessments?

3. Is there a significant relationship between SES and achievement on the 12th-grade NAEP mathematics assessments?

4. Is there a significant relationship between graphing calculator usage and achievement on the 12th-grade NAEP mathematics assessments?

Definition of Terms

Gender: This classification refers to being male or female. This is typically used with reference to social and cultural differences rather than biological ones.

Marginalized: To be marginalized is to be treated as insignificant or peripheral.

Microaggressions: This term is used to define brief and commonplace daily verbal or behavioral indignities whether intentional or unintentional, that communicate hostile, derogatory of negative attitudes towards stigmatized or culturally marginalized groups

Race/Ethnicity: Race/ethnicity is defined by the Census. Bureau as a person's self-identification with one or more social groups. An individual can report as White, Black, or African American, Asian, American Indian, and Alaska Native, Native Hawaiian and Other Pacific Islander, or some other race. Survey respondents may report multiple races.

Underrepresented minorities (URMs): This term refers to the race classification of African Americans/Black, American Indians/Alaska Natives, Latinos, and others who have historically been considered a minority population in the United States.

CHAPTER 2

Theoretical framework

Black Feminist Thought

This study uses Patricia Hill Collin's Black feminist thought as its theoretical framework. Black feminist thought asserts that Black women experience a unique form of oppression resulting from the United States having cultural, racist, and sexist ideologies permeating its social structure. (Collins, 2015) Collins defines Black feminism as a social justice project that argues Black women experiences are unique, because there are domestic and global structures that routinely place Black women at the bottom of the social hierarchy (Collins, 2015).

This study used quantitative data to examine the impact of race, gender, and SES status on mathematics achievement. This study uses the Black feminist thought theory to examine how technology can help decrease inequities in mathematics and makes recommendations for increasing the presence of Black females in engineering, engineering technologies and mathematics professions.

With long years of slavery, the civil rights movement, and the women's suffragist movement, the United States has a long history of racism and sexism. Black feminist thought theory wants to "produce facts and theories about the Black female experience that will clarify a Black woman's standpoint for black women" (Collins, 1986, p. 16). Black feminist thought comes from the premise that although all females experience sexism, and all Black people experience racism. Because of the United States' history

with racism and sexism, Black females have a unique experience that is experienced by all Black women and it originates from the intersectionality of these females being both Black and female.

Although the United States, does not have an official class system, there is a general class system based on one's SES. Studies have been done to analyze the impact of these SES structures on various groups of women. Numerous stereotypes of Black women create an experience unique to them making them feel "other than". "Other than" can be described as an intense feeling of not belonging. The Black female knows that she is a woman but also knows that she is usually treated differently or less gently than the White woman because of the "Strong Black Woman" stereotype. This feeling of "other than" can also be felt with knowing that they also experience racism, their experiences are viewed as far less impactful than the almost constant racist attacks against the Black male. These feelings result in a less than optimal educational experience and can keep many Black females from even considering seeking careers in engineering and mathematics related professions. A positive impact shows that if an educational tool helped to improve the mathematics achievement of the nation's population, it will also provide improvement of the marginalized Black female.

Black feminism came out of general feminism when Black women realized that instead of embracing them in solidarity, many White feminists were also racist and did not want the women's movement to deal with the issue of race. Black feminism uses intersectionality as it covers the many pieces of oppression that are experienced by Black women due to race, gender, and class, This intersectionality provides an excellent lens

through which to view each variable in the study and how the results of the study impact the condition of Black women in Academia and the workforce (Collins, 1980).

According to Collins (2015), there are some assumptions within the definition of black feminism that require identification. The first assumption is that while Black feminist thought may be written by others, it is produced by Black women. The second assumption is that although every individual has experiences unique to them, there are some experiences common to all Black women. The third assumption is that although there are commonalities, every Black woman has their own unique experience. This study focuses on the commonalities of all Black American women.

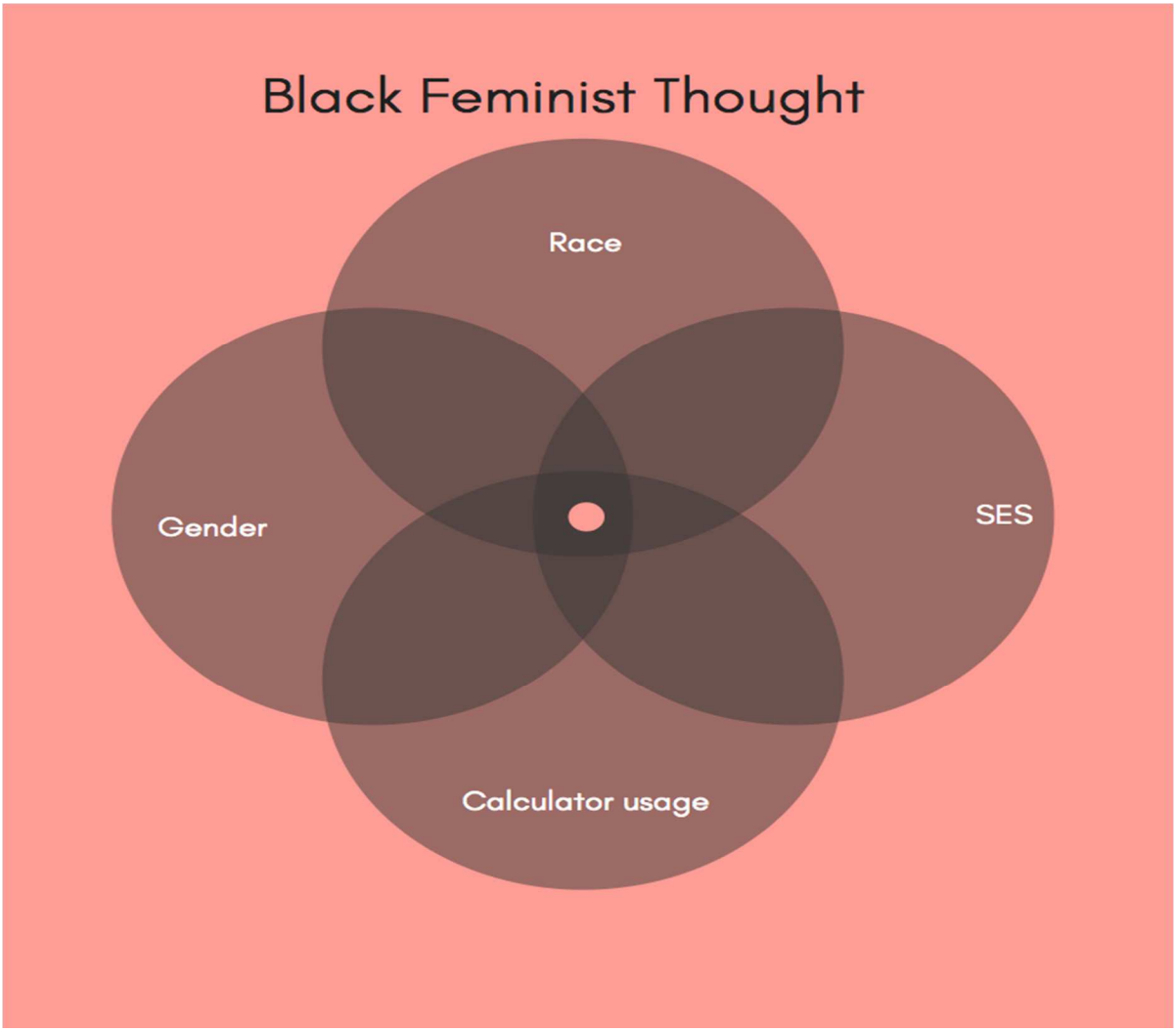
"United States culture, racist and sexist ideologies permeate the social structure to such a degree that they become hegemonic, namely, seen as natural, normal and inevitable" (Collins, 2002). Racism and sexism are so embedded in American culture that the ill effects of it are sure to negatively impact Black females more severely because they are members of more than one marginalized group. Black females receive their educational experience from those who have been exposed to the Black female stereotypes of mammies, jezebels, breeder women of slavery, smiling aunt Jemimah, and welfare mothers.

"Black feminist thought's identity as a "critical" social theory lies in its commitment to justice, both for American Black women as a collectivity and for that of other similarly oppressed groups" (Collins, 2002). Viewed through the Black feminist thought lens will not only help increase educational equity for the Black female, but also for other marginalized groups. Increasing educational equity will result in increases in

mathematics academic gain which leads to a larger pool of applicants available to engineering, engineering technologies, and mathematics bachelor's degrees.

Black feminist thought recognizes that not all Black women have the same experiences. Due to the cultural experiences of life in America there are societal practices that relegates them to inferior housing, neighborhoods, schools, jobs, and public treatment (Collins, 2002).

Figure 2.1 Theoretical Framework: Black Feminist Thought



Review of Relevant Research

Introduction

The United States is lagging far behind other industrialized nations in mathematics. The 2018 Program for International Student Assessment (PISA) ranked the United States achievement in mathematics as 36 out of 79 amongst industrialized countries. PISA is a national study that is viewed as the standard by which the world analyzes its mathematics achievement. In a recent study conducted by the National Academy of Science, it was determined that one of the primary reasons the United States is losing its competitive edge is that there has not been enough investment into researching the causes of the lack of Americans entering STEM fields (Ehrenberg, 2010).

Mathematics background has been the greatest predictor of success of students who begin their undergraduate careers with majors in engineering and engineering technology professions. High school mathematics preparation is one of the largest factors in both attrition and retention of URMs in engineering. Pearson, Slaughter, and Tao (2015) state that because URMs typically attend school with the least resources and the most poorly qualified teachers, the URM and White achievement gaps in algebra and in advanced mathematics courses continue to persist. Having a strong mathematics foundation is a necessity for students to be successful in completed mathematics, engineering, and engineering technologies bachelor's degrees. Any holes in the mathematics foundation needs to be filled.

We are in a technologically driven world. Using technology that will be readily available to a student in the workforce would go a long way towards filling gaps by providing more time to go more in depth into their studies. Instead of using valuable instructional time on skills that should have been covered in previous coursework.

Past studies have shown that students who did not begin algebra until grade 9 were significantly less likely to complete a calculus course in high school and, in turn, less likely to complete an engineering baccalaureate (Pearson & Miller, 2012). Students are expected to have the knowledge gained from taking these rigorous courses. Because the Black female has a high likelihood of attending a high school that does not even offer some of these courses as an option, there are students who are already ahead academically because they had greater opportunities. Some schools have accelerated all students and have algebra taught in seventh grade. Students at these types of schools are also at an advantage. If the student has not attended a school that does not accelerate all students, they are again at a significant disadvantage.

According to Pearson, Slaughter, and Tao (2015), the pool from which the United States has traditionally drew its engineering talent has consisted of non-Hispanic White males. Over the past 20 years, this pool has decreased because of the decrease in the number of non-Hispanic White males in the United States and the decrease in entry to engineering and mathematics-related careers amongst this group. Madera (2016) believe that women may be discouraged from choosing engineering as a career because engineering has typically been viewed as a male field.

America is one of the most diverse countries in the world. However, lack of diversity is prevalent in the science, technology, engineering, and mathematics (STEM) professions. Ehrenburg (2010) contends graduates in STEM fields are the foundation of the United States' status as the world's foremost leader and innovator in technological growth. STEM professions are the most significant indicator of a country's status as a world leader. With modern technology changing rapidly, it is imperative that the United States do whatever necessary to have more diversity in STEM fields. By not tapping into individuals in all areas of its population, the United States is missing out on a large amount of potential talent.

The engineering workforce in America does not reflect the demographics of its population. Most eligible students do not have adequate knowledge about the benefits of a career in engineering. Academic institutions need to work diligently to remedy this situation. Corporate donors and private foundations should commit to the continued support these initiatives. It is necessary for all stakeholders to work together to increase the number of URMs who are academically ready to obtain these degrees.

The No Child Left Behind act was signed into law by former President George W. Bush in January of 2002. This act encouraged the usage of technology in the classroom. This law created the need for mathematics teachers to re-examine their educational practices to determine the best usage of technology to increase their student's mathematics achievement. Graphing Calculators are a cost-effective way to incorporate technology in the classroom and help increase mathematics achievement.

Recruitment and Admission

According to Pearson et al. (2015), successful recruitment practices require knowledge that not only are teachers, industry professionals, and post-secondary academic institutions essential for the successful engagement of African American students in STEM, explicitly engineering, but parents and primary caregivers are critical as well. Working together in recruitment endeavors can help the United States create an engineering workforce that mirrors its people.

Madera (2016) believes women may be discouraged from choosing to engineer because of the perception that engineering is a male field. Kayuth (2005) claims one reason for the lack of female and other underrepresented minorities in engineering is that these students show little interest in pursuing STEM related careers while in high school. Black female's low interest in engineering and engineering technologies professions creates the need for early recruitment programs.

Many of these students have low interest because they have not received exposure to the benefits of these careers. They may have no idea what people do in these careers, Increasing the number of rigorous mathematics courses taken in secondary school increased the likelihood of them being exposed to these career options, while providing them with the necessary skills the be successful in obtaining degrees in these fields.

Pearson, Slaughter, and Tao (2015) claim that with more universities competing for the small pool of students who were both prepared for and interested in engineering. College and university competition create difficulty for each institution to achieve its enrollment goals. In recent reports from the National Action Council for Minorities in

Engineering (NACME), the number of minority students pursuing STEM degrees and careers has leveled or declined. Inadequate mathematics preparation is one of the causes of this. Students lacking adequate mathematics foundation have a much higher probability of not meeting the minimum acceptance requirements.

Means et al. (2016) recommend better prepared K-12 STEM teachers and high school programs emphasizing college readiness as ways to increase students' chances of being accepted to and successfully completing engineering and engineering technology programs. Girgis (2015) maintains, that once these students have been accepted, many minority engineering students still struggle in college because of their weakness in problem-solving. Culturally, these skills may not be approached in the same way as they are presented on standardized exams. However, it was found that despite these challenges, Black male students are more likely to persist in STEM field majors if Black faculty members teach their STEM classes. But female students are less likely to continue when more of their STEM classes taught by female faculty

Valle, Jackson-Truitt, and Newsletter (2015) state that when engineering students experience the difficulty of the coursework and the poor quality of instruction, they either drop out or change their major to something less rigorous. Implementing programs specifically designed to counteract these causes of attrition should be conducted at all institutions of higher learning. Research should be done about the best way to meet the needs of the Black females to improve retention.

Dika et al. (2019) found being in an URM group means you will be faced with numerous stereotypes. These students are often viewed as having limited finances and no

family support which sometimes results in negativity from faculty. Microaggression experienced because of these stereotypes often make these students feel ostracized resulting in an unwillingness to seek help when needed. These institutions should provide sensitivity training to help faculty and others who directly interact with students. This training should be designed in such a was as to help the trainee learn how to identify known and unknown prejudices. They should also be trained to identify microaggressions, acts that the perpetrator may not even recognize there is even anything wrong with their words or actions.

Freshman transition to college life is tough enough under the best of circumstance. Add on the workload and pace of classes, not to mention the menu of extracurricular activities, in college you now have a recipe for disaster. Colleges and universities must develop strategies for retention of women, Blacks, and other URM students. Ehrenberg (2010) found that if you remove the element of differences in academic preparation, persistence rates by race and gender are generally the same. Ehrenberg (2010) also found that having taken AP classes in STEM fields in high school and having higher SAT scores results in greater persistence to graduation in STEM field majors. Students' performance in entry-level classes are significant predictors of their tenacity in STEM field majors and how well they do in these classes relative to their performance in non-STEM classes also matters.

Litzler and Samuelson (2013) show that Black students are more likely to persist in STEM field majors if Black faculty members teach their STEM field classes. They go on to say peer and faculty support, co-curricular activities and other personal interactions on campus affect these student's attrition and retention. These interactions include formal

and informal aspects of academic life such as faculty-student learning interactions both in and out of class, and respectively influence social and educational integration. ACT scores are accepted at colleges as being representative of high school academic preparation. And by evaluating these scores, one can use the ratings to explain about half of the Black-White persistence gap for minority STEM majors. Price concludes that by increasing the number of Black faculty teaching introductory STEM, courses, colleges would have more Blacks persisting to graduation with a STEM undergraduate degree.

Price (2010), remarks on average female students perform better in courses taught by a female instructor but experience no increase in performance in courses completed after the one shown by a female and it doesn't impact degree completion. Geisinger, Raman, and Raj (2013) contends students leave engineering for a variety of reasons. He states that students feel the programs are not modified to meet their individual needs. In addition, many of these students have low self-confidence and when confronted with subject material that they are having difficulty with they become discouraged. These students inevitably fall further behind which compounds the problem. This often results in students changing to non-STEM majors or even leaving the institution. Another source of contentions is that the traditional teaching methods of the engineering course material often create boredom leading to attrition. Race, gender, and social class issues also impact perseverance because of the systematic racism experienced by URMs.

Attrition and Retention

One of the primary issues facing universities that admit students into mathematics and engineering programs is student attrition. More attention focused on recruiting Black

female students is critical if colleges and universities are serious in their attempts to acquire and retain Black female students on the path to becoming engineers. But this cannot be the only factor. Academic institutions are obliged to focus on degree completion. On the authority of Geisinger, Rajaraman, and Raj (2013), the number of engineering students completing their degrees in engineering depends on two factors. The first being the enrollment rate and the second being the year to year retention rate.

Limited diversity creates an urgency that schools have effective retention programs. Tinto (2012) provides three principles of an effective retention program. The first is that the institution puts student welfare before other institutional goals. The second principle is being committed to the development of supportive social and educational communities which integrates all students as competent members. The third component is that these programs be committed to all not just some of their students. The purpose of colleges and universities is to educate and meet the needs of its student population. They should be designed in the best interest of the students. Colleges and Universities cannot operate without students. Not only is in their best interest, but it is also their duty to put students first.

Financial Support

Financial inequities also reduce the amount of URMs who complete engineering degrees. Geisinger, Rajaraman, and Raj (2013) claim the number one cause of attrition is insufficient financial resources. Financial issues may be the primary reason for attrition, but it is not the only one by far. Geisinger, Rajaraman , and Raj (2013) state the factors that contribute to attrition are " classroom and academic climate, grades and conceptual

understanding, self-efficacy and self-confidence, high school preparation, interest and career goals, race, and gender." Students cannot continue to attend an institution of higher learning if they are financially unable to. They may also have to work to meet their financial obligations which results in less time to focus on academics.

Dika, Pando, and Tempest (2016) found that membership in an underrepresented group was associated with a significantly higher perceived likelihood of financial barriers. The study found that both pre-college and college experiences and multiple forms of capital are significant in the persistence of Black and Latino students in engineering. According to the national academies, higher education institutions should create programs that provide underrepresented minority students in STEM with strong financial, academic, and social support. According to Geisinger, Rajaraman , and Raj (2013), minority freshman are roughly half as likely as a non-minority freshman to get an engineering degree, and minority sophomores are still two-thirds as likely to persist to an engineering degree as the majority. Toven- Lindsey et al., (2015) claim that only 40% of women and URMS in America's colleges and universities complete undergraduate STEM degrees within six years.

Intervention

Geisinger, Rajaraman, and Raj (2013) state significant proportion of engineering students leave because the engineering educational system has failed to show them that the engineering endeavor is profoundly human. It has been unable to make relevant the critical scientific, mathematical, and engineering principles needed for mastery of engineering, has failed to show that engineering is within reach of their abilities, has

failed to capture their imagination and fascination, and has failed to provide a welcoming atmosphere to them. Two additional factors related to attrition are low levels of parental education, lack of female peers,

The educational environment is also a major reason for attrition. Most engineering course are taught in the traditional classroom form. Students who have difficulty with subject material may feel isolated because of the individualistic nature of the engineering classroom environment. Many of these students often lack self-efficacy or self-confidence. Without the belief that they can be successful in these courses many students will give up. Course material may also fail to capture student interest Black female students encounter these obstacles as well as facing obstacles due to gender, race/ ethnicity, and SES.

In one study, Bowman (2015), data was used from the American Society for Engineering Education (ASEE) database to learn more about degree attainment in engineering for URM students. When Bowman (2015) investigated degree attainment for African American Females, based on engineering discipline, the results were mixed. In some engineering disciplines, degree attainment percentages increased and decreased in others. Despite the increases in some subjects, the overall trend indicated a large portion of decreases. Bowman felt that since there were several factors affecting degree completion in different disciplines each of these factors should be studied to find methods that could increase in degree attainment for all engineering disciplines. The results of Bowman's (2015) study show how relevant it is to obtain demographic data for engineering degrees by gender, race, discipline, and degree level to understand what affects engineering degree completion of underrepresented minorities

Litzler and Samuelson (2013) define a sense of belonging as a student's psychological sense of identification and affiliation with the campus community. Many minorities students feel that they do not belong. Although this sense of belonging is individualistic and based on a student's perception of their environment, there are external factors that contribute to or detract from a sense of possession. Students need to feel like they are wanted and respected in their academic background. Feeling less than or other takes its toll on their psyche. Under these circumstances, they cannot be expected to succeed.

Pearson, Slaughter and Tao (2015) state it is up to the college dean to be vigilant and extremely aggressive about recruiting women and minorities faculty. Faculty can also be a cause of attrition. If a student feels unwelcome or unsupported, they are more likely to transfer to a more welcoming department of more welcoming school altogether. The college dean is one of the school's leaders and must therefore set the standard to which the university and its employees be held.

Geisinger and Rajaraman (2013) believe many faculties feel it is their responsibility to weed out under-prepared or unmotivated students. Geisinger and Rajaraman (2013) go on to say that many students report that they have left engineering programs because of lack of encouragement and attention from faculty. To reduce attrition, all stakeholders should have the same goal of leading engineering students to successful degree completion.

Litzler and Samuelson (2013) claim that minority students often report that they feel like faculty have lower expectations for them than from other students, and they may

even receive lower grades as a result. Geisinger and Raman (2013) say that students also claim that another reason they leave engineering degree programs is the individualistic nature of the engineering classrooms and the engineering profession. These students report feeling a lack of engagement with their communities and other engineering students.

In 2005, the National Science Foundation (NSF) found that successful interventions should be institutionalized.

> Institutionalization means that responses to diversify an institution is not tangential or marginal but should be incorporated as an integral component of the standard operating procedures of that institution.

Ohland et al. (2015) state that with the increasing demand for a skilled and technically savvy workforce in the United States, addressing retention problems in the first two years of college is a promising and cost-effective strategy to address this need". Pearson, Slaughter, and Tao (2015) determined that programs that focus. on strengthening student's skills in science and mathematics can also help to develop their interest in engineering as a career. Litzler and Samuelson (2013) state that research suggests that peer and faculty support, as well as co-curricular involvement, play essential roles in creating supportive educational environments which can contribute to the retention of URM undergraduate engineering students.

Litzler, Samuelson, and Lorah (2014) found that African American and Hispanic men report higher levels of STEM confidence than White men. African American men say higher stem confidence than White men, but African American women report similar

levels to White men after accounting for student experienced and GPA. White women have lower STEM confidence than White men. They found that although some underrepresented groups have lower STEM confidence than White men, after controlling for personal, environmental, and behavioral factors this no longer applies to all groups. Litzler et al. (2014) state, understanding differences in student STEM confidence for different racial/ethnic and gender groups within engineering can help educators and policy-makers improve retention among underrepresented groups within engineering can help educators and policy-makers improve retention among underrepresented groups in the field.

Smith and Paretti (2015) sought to gain an understanding of the salient aspects of faculty mentoring relationships that support African American undergraduate females in engineering. Smith and Paretti (2015) found that although each mentoring relationship began in its way, most formed through an informal process in a requirement for successful mentoring relationships s. The results of this study show that faculty should not automatically assume that he/she is not a good match for African American females because of race/ethnicity or gender.

Valle et al. (2015) focus was on Black students and women who persist and succeed in learning environments that are demanding and perhaps hostile. Its goal was to understand the pathways, the personal strategies, and mechanisms that these students have developed and used to find and create a space for success. The author wanted to identify a systematic method that includes “personal attributes, policies, and resources make it possible for a minority student to persist and succeed in a highly competitive, research-focused, majority institution”.

The authors came to the following conclusions from this study. The students uniformly describe demanding professors, a punishing workload, and an environment where they always felt alone and different, until they managed to "find their tribe" They described not being thrilled with the professional engineering job market, despite graduating from one of the most respected institutions in the country, with a high GPA and a degree that is in huge demand."

The engineering workforce in the United States has two significant problems: they have been unable to produce enough domestic engineers, and it has failed to build a sufficiently diverse engineering workforce. Lack of progress in gaining more students into these fields is further evidence that guidance counselors require specialized training to provide potential engineering students with the necessary skills to be successful in an undergraduate program. The entirety of America are stakeholders in the maintenance of the state of America's mathematics educational goals. Everyone can do their part to further this endeavor.

Colleges cannot fix the problems facing the engineering workforce on its own. Pearson, Slaughter, and Tao (2015) believe to increase Black Female participation in engineering, there should be a comprehensive approach that includes changes in federal, state, and institutional policies, improvements in educational practice, and rigorous. research. According to Litzler et al. (2014), understanding differences in student STEM confidence for different racial/ethnic and gender groups within engineering can help educators and policy-makers improve retention among underrepresented groups within engineering can help educators and policy-makers improve retention among underrepresented groups in the field.

The Mathematics to Engineering Pipeline

High school mathematics preparation is one of the largest factors in both attrition and retention of URMs in engineering. Many students leave high school without having mastery of basic algebra concepts. According to Pearson, Slaughter, and Tao (2015), because URMs typically attend school with the least resources and the most poorly qualified teachers, the URM and White achievement gaps in algebra and in advanced mathematics courses continue to persist. Past studies have shown that students who did not begin algebra until grade 9 were significantly less likely to complete a calculus course in high school and, in turn, less likely to complete an engineering baccalaureate (Pearson & Miller 2012).

Many Black students attend high minority high poverty school districts. Students from lower income households are less likely to have access to resources like private tutors, expensive calculators, and other forms of technology. Black female students may also have other responsibilities such as a part time job or are required to care for younger siblings. Resulting in less study time, a factor that limits one's ability to do well in mathematics. Not having a tutor when faced with difficult concepts and an inability to attend extra help sessions at school because of other responsibilities also hinder these student's performance.

Historically, Black students are steered towards less challenging mathematics courses resulting in lower standardized test scores. Without challenging course loads and the necessary SAT or ACT scores, these students will not even be accepted to these mathematically challenging programs. High School is an extremely important time to

focus on mathematics. High School is the time when students decide what they want to major in and what they want to do with their lives. It is a time in their lives that they are very receptive to the educators and guidance counselors around them.

If Black female high school students do not take challenging mathematics courses in high school, they limit their chances of being accepted to school of engineering, engineering technology, and other mathematics rich programs. Many times, even when they are accepted, they may not be able to keep up with the rigor and difficulty of the mathematic courses needed to complete these degrees (Meece et al., 1990).

"Because courses are structured around topic areas, rather than along an underlying continuum of complexity, a greater number of mathematics courses does not necessarily imply participation in increasingly higher-order and more complex mathematics" (Meece et al., 1990). May and Chubin (2003) conducted a study to document the various factors that contribute to the success of minority students in engineering programs. The study sought to explore past and current paradigms that promote minority success in engineering and yield new models for advancing the participation of members of these populations at every phase of educational achievement. The authors concluded that student success directly correlates to pre-college preparation, recruitment programs, admissions policies, financial assistance, academic intervention programs, and graduate school preparation and admission.

According to American Association of State Colleges and Universities, beginning in grade school, American students are being outperformed in mathematics and science

by their counterparts in China, Japan, and Singapore. These trends continue into the high school years and college. Although Black females tend to perform better than the Black males academically, they still lag all other races/ ethnicities in mathematics ability. If these students are to increase their presence in these fields, studies need to be conducted to determine how to best do this.

High School Preparation and Pre-College Programs

Minorities, both male and female, are less likely to have taken advanced degree classes in high school, which puts them at a disadvantage for being accepted into these college programs. This results in less minority students going through these academic programs together. Having a larger share of minority student and some same-race teachers can positively impact retention.

Early exposure to STEM has been shown to have a significant impact on a student's desire to major in a STEM profession (Wilson et al., 2014). For females, from middle school to the first few years of college are the most critical times. The gender gap becomes larger and larger as the female's progress through school. According to Holmun et al. (2015), providing STEM coursework in high school and middle school is one of the most effective ways to ger more students involved in STEM, This type of coursework gives students an idea about what STEM is and what STEM courses may be like at the college level.

Taking algebra before the 9th grade can do much to reduce the academic shortfall In studies by Pearson et al. (2015), students who did not begin algebra until grade 9 are

less likely to be able to take a calculus course in high school. Deficiency in calculus skills significantly decreases the likelihood of obtaining these bachelor's degrees.

Low teacher expectations and underrepresentation of female teachers can adversely affect females desire to major in these college programs (Wilson et al., 2014). Females have been found to be more deeply affected by grades than males. STEM courses often result in lower performance which discourages many from remaining in these majors (Wiswall & Zaffa, 2011). Many Black females come from academically failing schools. These schools often lack course offerings such as computers, calculus, or advanced placement science classes. Academic preparation in advanced science and mathematics in high school is one of the most significant predictors of obtaining mathematics, engineering, and engineering technology degrees (Wiswall & Zaffa, 2011).

Another thing that negatively impacts Black females' ability to succeed in mathematics at the collegiate level is lack of access to upper-level courses. Since high school preparation is the most excellent indicator of being able to complete an undergraduate degree that requires a significant amount of upper level mathematics courses. Pearson, Slaughter, and Tao (2015) claim most Black female students attend schools with the least amount of resources and the most poorly qualified teachers and are therefore are the least likely to complete undergraduate degrees in.

Pearson et al. (2015), show that low mathematics and science preparation at the high school and college levels has been the primary challenge in completing these degrees. Attrition during students' undergraduate years accounts for some of the disparities in STEM fields. If these students do not enroll in appropriate preparatory

courses while in high school, and if they are unaware of the career choices available to them, they will not be prepared to pursue these careers and are likely to choose an alternate career path.

High school preparation is the largest factor in both attrition and retention of URMs in engineering. Pearson, Slaughter, and Tao (2015) state that because URMs typically attend school with the least resources and the most poorly qualified teachers, the URM and White achievement gaps in algebra and advanced mathematics course taking continue to persist. Students who did not begin algebra until grade nine were significantly less likely to complete a calculus course in high school, and in turn, less likely to achieve the baccalaureate (Pearson & Miller, 2012). The NASCEM (2011), recommend K-12 STEM teachers get better teaching preparation, and high school programs should emphasize college readiness.

Girgis (2015) maintains many minority engineering students struggle in college because of their weakness in problem-solving. Low academic performance in mathematics is "generally due to the students' lack of conceptual understanding and difficulty in applying their mathematical knowledge while solving engineering problems".

Ehrenberg (2010) found that controls for academic preparation eliminate a substantial portion of the differences in persistence rates by race and gender. Ehrenberg also found that having taken AP classes in STEM fields in high school and having higher SAT scores enhance persistence to graduation in a STEM field. Students' performance in entry-level courses is a significant predictor of their tenacity in STEM field majors and

how well they do in these classes relative to their performance in non-STEM classes also matters. And Black students are more likely to persist in STEM field majors if Black faculty members teach their STEM field classes. But female students are less likely to continue in their STEM classes taught by female faculty.

Self-efficacy

In a study, Cheung and Slavin, (2011) conducted a meta-analysis that evaluated how student outcomes, motivation to learn and attitudes about learning is impacted when technology is used as a remediation tool. This meta-analysis used several studies on the impact of technology on mathematics achievement.

In this study, the data collection was done in three stages. During the first stage, the researchers searched a database using the term, mathematics. The first stage consisted of a database search and the selection of article criteria for inclusion. During the second stage, the articles that met the inclusion criteria were coded. The third and final stage consisted of identifying and analyzing effect sizes. Eighty-nine effect sizes, 24 articles with a total of 4,522 subjects were extracted for the between-groups data analysis and 23 independent effect sizes from 8 articles with a total of 655 subjects for the within-group analysis.

The results of this study found that incorporating technology during mathematics instruction, mathematics achievement, attitude, and motivation creates significant improvements in mathematics achievement. It also addresses attitude and motivation, two of the largest factors that influence mathematics achievement. This study substantiates

the belief that the proper use of technology in the classroom improves mathematics achievement as well as motivation and self-efficacy.

According to Rask (2010), researchers and policymakers have been investigating the educational pathway that leads high school graduates into STEM fields and have determined that there is plenty of room for improvement. The current educational system does not produce enough graduates in STEM fields and from this small pool of URMs, Black females are the least represented, especially in engineering and math.

In 1997 Reichert and Absher provide the following data about African Americans receiving bachelor's degrees in engineering; In 1993-94, only 4.3% of all engineering graduates earning bachelor's degrees were African American. 70.4% of these graduates received degrees from predominantly White Institutions (PWIs), and the last 29.6% received their degrees from historically Black colleges and universities (HBCU). In 2014, individuals self-identifying as Black was 13% of the population (Bowman, 2015). In this period, only 4.3% of all engineering and mathematics degrees earned went to Blacks.

The percentage of engineering degrees awarded to Black people in America is in steady decline. While there is a considerable increase in the total amount of bachelor's degrees in engineering and engineering being awarded to Black students, the number of Black female engineering and engineering technology majors is so low that nearly all studies about the Black female population mixes Black females together with all URM females (Valle et al., 2015).

Even at extremely competitive schools where you find the most prepared URM students, there is a vast difference in their degree completion rate as compared to the majority. “Data show that for students entering UCLA with a declared STEM major between 2004 and 2006, nearly 70% of non-URM students completed their STEM degree in 5 yr., while the degree-completion rate of URM students in STEM was only 39%" (Toven- Lindsey et al., 2015). Although a strong STEM presence is at currently at risk, The National Academy of Science, Engineering, and Medicine (NACSEM) projects America’s labor market will grow fastest in science and engineering. Ehrenburg (2010) asserts employers may not feel the need to have incentives like higher salaries to generate more interest in STEM fields and thereby increase the number of American citizens entering these fields.

One reason employer lack urgency regarding increasing URM graduation rates is that there are more than enough highly qualified foreigners living both in America and abroad to fill these jobs. Pearson, Slaughter, and Tao (2015) state that the United States. currently finds itself importing talent and exporting jobs. Workers in developing countries complete the same tasks at a much cheaper rate. Colleges and universities in the United States also failed to produce enough native-born, well-qualified scientist and engineers.

The NASCEM (2011), state that non- United States. citizens, particularly those from India and China, have accounted for almost all growth in STEM doctorates awarded. International students densely populate science and engineering disciplines. Alim (2013), says although there is some progress in engineering and mathematics degree completion rates of women and URM, the growth is minimal. America needs to

use its resources to create programs that can generate a growth in the amount United States citizens in careers in engineering and engineering technology

When employers hear there is a shortage of STEM workers and lack of diversity, they might not believe this to be true because it is not directly impacting their company or organization. These employers are in the business to make profits. It is not hard to understand why employers may not be concerned with the limited amount of URM graduates. Employers will need to see concrete evidence as to why it is essential to have more Americans in these professions. Pearson, Slaughter, and Tao (2015) claim that the United States doesn't hire foreigners and outsource business to third world countries just because of it less expensive, they also employ them because our colleges and universities are entirely merely not producing enough native-born, well-qualified STEM graduates.

Many undergraduate students are not attempting to major in engineering and engineering technology f because they do not see the advantages of dealing with the academic rigor required in these majors. These students find that they can make similar salaries and impact their world all in a less demanding field of study.

The underrepresentation of women in engineering is an even more significant problem facing America. One reason for the lack of women in engineering is in high school, and female students show little interest in pursuing STEM careers. Students who do not enroll in upper-level mathematics and science preparatory courses while in high school are underprepared to pursue a career in engineering or mathematics-related careers and are likely to choose an alternate career path.

It is imperative that our universities develop not only plans for recruiting URM), but also exam attrition and retention of these individuals. Women comprise more than 50% of earned bachelor's degrees but only 20% of those received in engineering. Mattis et al., (2010) feel women may be discouraged from choosing to EM due to the stereotype of engineering as a male field. Determining the attributes of Black women who complete EM bachelor's degree can help improve retention programs.

Relationship Between Prior Research and Present Study

Gender Differences

High achievement in mathematics can open the door to many careers for Black females. Hyde, Fennema, and Eamon (1990). Conducted a meta-analysis that showed males tend to do better on problems solving and females tend to do better in computation when solving mathematics problems. The study did not find any gender differences in the understanding of mathematical concepts.

Although males perform better on standardized assessments, females get better grades. (Kimball, 1989). If females get better grades than males in mathematics classes but have lower standardized achievement scores, there is some element that is preventing women to connect their classroom experiences to the standardized assessments

Cultural/Racial Differences

Black females experience the world differently at the intersection of race and gender, Black culture influences their mathematics attitudes. According to Ladson-Billings (2004), "Mathematics functions as a feared and revered subject in our culture.

We fear it because we believe that it is too hard, and we revere it because we believe that it signals advanced thinking reserved only for the intelligentsia." Many Black females do not have the confidence to believe they can be successful in math,

There is no cultural stigma in United States about not doing well in math. In fact, there is a general belief that some people can do math, and some cannot. Whereas Asian who have rationally outperformed all races and ethnicities in mathematics achievement are taught by their parents that their mathematics achievement level is a direct result of the effort they put in. (Stevenson, 1992). This leads students to give up on learning mathematics instead of persisting.

SES

In a meta-analytic review of SES research, Sirin (2005) determined that SES has a high impact on academic achievement. The researcher used publications from 1990-2000 and gathered from 74 independent samples, a total sample of 101,157 students, 6,871 schools, and 128 school districts was collected. Numerous. studies have been done showing the impact of SES on academic performance and achievement.

According to Ladson-Billings (1997), Black argues that despite the many changes in mathematics education, Black students still perform poorly. She states that experts found "that African American children's poor mathematics performance is the result of a discontinuity that exists between students' home language and the perceived "precision" of mathematics and mathematical language. Ladson-Billings (1997), continues on to say that other experts claim that Black students perform poorly in mathematics because they can not see the relevance in what they are learning and the material is incredibly different than what they experience in their person lives. Although expert opinions of the cause of

poor performance, all will agree that problems still exist, and other changes need to be made. This discussion attempts to accomplish this and suggests some direction for further research on the mathematics performance of African American students.

Numerous studies have been done showing the impact of SES on academic performance and achievement Because Black females are more likely to be poor and live in poorer neighborhoods, with high minority populations they are already at a deficit when it comes to academic achievement. Since a school is generally a smaller representation of the demographics of the neighborhood which it is within, as the amount of segregation in a school increases, student academic achievement decreases (Rumberger & Palardy, 2005).

In a meta-analytic review of SES research, Sirin (2005) determined that SES has an extremely high impact on academic achievement. The researcher used publications from 1990-2000 and gathered from 74 independent samples, a total sample of 101,157 students, 6,871 schools, and 128 school districts was collected. With such a high correlation between SES and mathematics achievement, in order for schools to increase math achievement of Black females, schools should examine student's societal influences, school mathematics curriculum, teacher attitudes, and the academic behavior of student who to well in mathematics (Reyes et al., 1998).

Technology Usage in the Mathematics Classroom

Ysseldyk and Bolt (2007) conducted a study examining the impact of technology-enhanced continuous. progress monitoring systems on mathematics achievement in elementary and middle school classrooms. Continuous. progress monitoring assesses the effectiveness of instruction to determine where modifications in instructional approaches are needed. These systems give teachers immediate feedback on what a student does and does not know to allow the teacher to let this data to drive their instruction. The researchers considered the different ways teachers incorporated the program in their classroom and compared teachers who did and did not utilize the program when generating their conclusions.

The sample was selected from principals who had shown interest in the program during the past eighteen months by asking for a quote but not purchasing the system. These principles were contacted and invited to apply. To be eligible to apply the elementary schools had to have at least three classes per grade level who were willing to use the system. Eight schools in seven school districts and seven states were selected to be a part of the study. Forty-one classrooms were treatment classrooms and 39 were the control group. Classrooms were randomly assigned to within-school experimental and control groups. Participating students were pre- and post-tested with two standardized, nationally normed tests of mathematics achievement.

A linear regression and one-way analyses of variance were used to analyze the data. The study found that teachers who used the program had far greater achievement

results than those who did not. This study will be used to show the significant impact of technology usage in the classroom has on student achievement (Ysseldyk and Bolt, 2007)

CHAPTER 3

Methods and Procedures

Research Questions

1. Is there a significant relationship between gender and achievement on the 12th-grade NAEP mathematics assessments?

2. Is there a significant relationship between race and achievement on the 12th-grade NAEP mathematics assessments?

3. Is there a significant relationship between SES and achievement on the 12th-grade NAEP mathematics assessments?

4. Is there a significant relationship between classroom graphing calculator usage and achievement on the 12th-grade NAEP mathematics assessments?

Hypotheses

1.There is no relationship between gender and achievement on the 12th-grade NAEP mathematics assessments.

2. There is no relationship between race and achievement on the 12th grade NAEP mathematics assessments?

3. There is no relationship between SES and achievement on the 12th grade NAEP mathematics assessments.

4. There is no relationship between graphing calculator usage and achievement on the 12th grade NAEP mathematics assessments.

Research Design and Data Analysis

For this non-experimental study using data and variables from the 2015 NAEP, publicly available data set. This research follows the Black Feminist Thought framework. The researcher identified appropriate variables based on student surveys from the 2015 NAEP 12th grade data set. Four separate regressions were done using SES, graphing calculator usage in the classroom race and gender as dependent variables and 12th-grade NAEP mathematics assessment scale score as the independent variable. The results of the regression analyses were used to evaluate the predictive power of the model.

Sample and Population

The student sample comes from nationally representative samples of about 46,000 12th-graders who participated in the 2015 NAEP mathematics assessment. The initial list comes from the United States Department of Education's most current public education system database. The schools are then divided by type, location, and racial-ethnic composition. Students are then randomly selected from this list within the grade to be assessed. The samples consist of a sample of approximately 100 grade-eligible public schools within each jurisdiction. Approximately 60 students are selected from each school (McFarland, 2017).

Instruments

The NAEP is a congressionally mandated project of the NCES. NAEP, best known as the nation's report card, is the nation's largest national assessment of students in private and public schools. It provides national, state, and some district-level results. It also provides results based on demographic results. The National Assessment Governing Board, an independent, bipartisan organization made up of governors, state school superintendents, teachers, researchers, and representatives of the public, sets policy for NAEP. NCES administers the same NAEP assessment in every state" (McFarland, 2017).

The 12th-grade assessment determines how well-prepared 12th-grade students are for post-secondary education and training. The instruments are designed based on the framework for each content area. Each assessment instrument consists of two components. The instruments have subject-specific cognitive items and non-cognitive items by gathering data from students, teachers, and school administrators (McFarland, 2017). This study uses the nations' 12^{th} mathematics achievement results.

Procedures for Collecting Data

The publicly available data from The Nation's Report card, NAEP Main Data Explorer (NDE) NAEP 2015 12th grade mathematics achievement results were used in this study. Each step performed by the researcher is listed below in a sequential order. Each bullet represents a new screen on the online NDE:

- The Nation's Report card NAEP Main Data Explorer (NDE) was accessed online
- Selection of subject (mathematics), grade (12th) and jurisdiction (national) are entered into the data explorer.

- Acceptance of the conditions of usage to proceed to the usage of the NDE.
- Selection of subject (mathematics), Framework (2005 framework from 2015), Scale (composite) jurisdiction (National)
- Selection of category (major reporting group) and subcategory (student factors).
- Selection of Student response variables- gender, race/ ethnicity using 2011 guidelines (school-reported), national school lunch program eligibility (SES)
- On the same screen as the above selection, category (instructional content and practice), subcategory (Modes of instruction response), variable (usage of graphing calculators in mathematics).
- statistic (composite score.)
- Deselect all students
- Create report, show report data, run regression analysis, create column chart, and generate the output.

CHAPTER 4

Results

This chapter presents the findings of this study, this chapter also lists the research questions that guided the study. The research questions to be explored and their corresponding hypotheses. The findings for each research questions and hypotheses are within the text of the results for each question

The data analysis was conducted in 3 stages. In the first stage, a table was generated to find the average composite score for both the independent variable and the reference variable. In the second stage, a significance level test was run to determine the position of the null hypothesis. In the 3rd stage, a regression was done to identify the predictive model of each variable.

Research Question/Hypotheses 1

Research question 1 asked, is there a significant relationship between gender and achievement on the 12th-grade NAEP mathematics assessments? The first hypotheses challenged this question with a position of no for hypothesis 1, that is, there is no relationship between gender and achievement on the 12th-grade NAEP mathematics assessments. This research question sought to determine the relationship between gender and mathematics achievement of the United States 12th grade students.

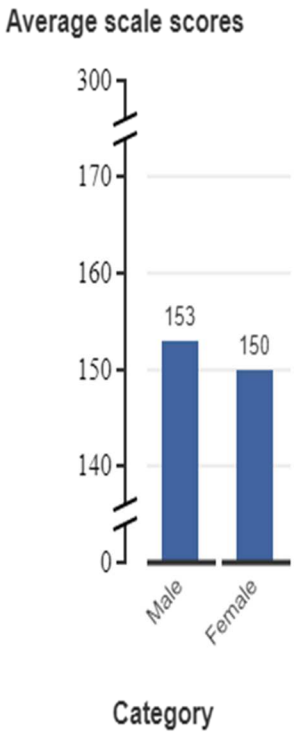
A simple linear regression was calculated to predict the12th grade mathematics achievement results based on gender. The study generated a significant regression equation of

(F (663561.72, 1230777.02) = 5.39, p <.001), with an R^2 of 0. The p<.001 shows a significant correlation which shows that the null hypothesis can be rejected. Tables 4.1- 4.4 show the results of the average scale score, the significance test, and the regression. Figure 4.1 presents a graph of the mean score. It shows the mean score for the male was 153 and the mean score for the female was 150, indicating a 3-point difference in their means.

Figure 4.1

Average Scale scores by Gender

Average scale scores for grade 12 mathematics, by Gender [GENDER] for jurisdiction: 2015
2015, National



NOTE: The NAEP Mathematics scale ranges from 0 to 300. Some apparent differences between estimates may not be statistically significant.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

Table 4.1
Average scale scores by Gender

Year	Jurisdiction	Gender	Average Scale Score
2015	National	Male	153
		Female	150

NOTE: Some apparent differences between estimates may not be statistically significant
SOURCE: United States Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

Table 4.2
Multiple Correlation and R squared by Gender

Multiple Correlation	0.04
R Squared	0

Table 4.3
ANOVA Test by Gender

	DF	Mean Square	F Ratio	P – Value
Model	1	663561.72	5.39	0
Error	3145.56	1230777.02		

Table 4.4
Regression Test by Gender,

	Std. Coeff.	S, E. of Std. Coeff	Reg, Coeff	S.E. Reg. Coeff	T	Prob	Sig
Intercept	0	0	152.8979	0.6674	229.0869	0	>
Female	-0.0413	0.0097	-2.8431	0.6688	-4,2513	0	<

NOTE: A 0-1 contrast coding has been used where the first subgroup of the (independent) variable is the reference group. Except for the reference group, each subgroup is contrasted
(code 1) in a separate dummy variable against all the other subgroups of the variable (code 0). For more details about contrast coding with multiple variables see the help documentation.
SOURCE: United States Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

Research Question/Hypotheses 2

Research question 2 asked, is there a significant relationship between race and achievement on the 12th-grade NAEP mathematics assessments? The second null hypotheses challenge this question with a position of no for hypotheses 2, that is, there is no relationship between race and achievement on the 12th grade NAEP mathematics assessments

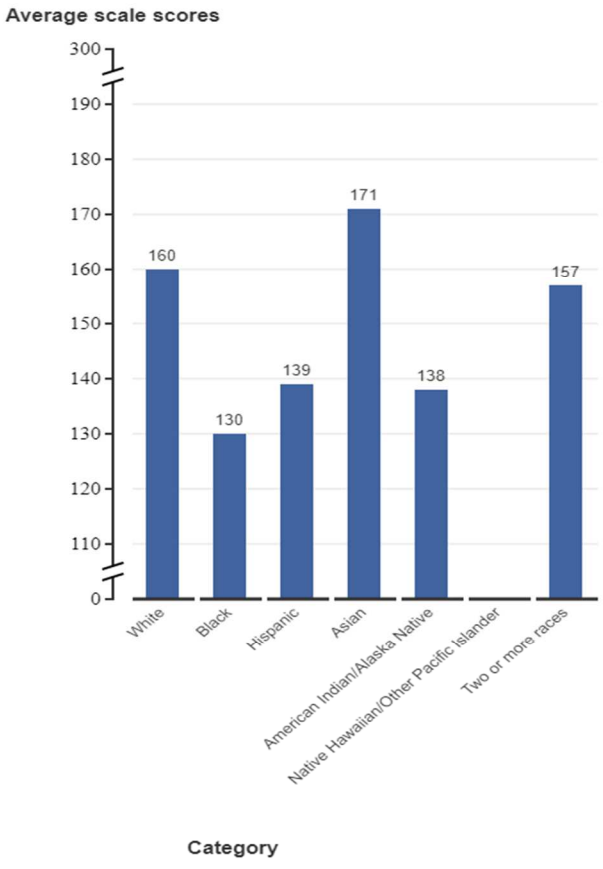
A simple linear regression was calculated to predict the12th grade mathematics achievement results based on race/ethnicity. In this regression, a significant regression equation was found Black ($F(91891355.45, 463190.79) = 198.39$, $p < .001$). $R^2 = .14$ A significant correlation was found with Black ($p < .001$) Hispanic ($p < .001$), American Indian/Alaska Native ($p < .001$). No significant relationship was shown with Asian ($p > .05$)

The obtained p values show that the null hypothesis can be rejected. Tables 4.5-4.6 shows the results of the average scale score, the significance test, and the regression. Figure 4.2 shows the average scale score for each group. The mean scores for race/ethnicity are White (160), Black (130), Hispanic (139), Asian (171), American Indian/ Alaska Native, two or more races (157). This shows Black people have the lowest mean score with a 30-point deficit when compared to the White male reference group.

Figure 4.2

Average Scale scores by Race/Ethnicity

Average scale scores for grade 12 mathematics, by Race/ethnicity using 2011 guidelines, school-reported [SRACE10] for jurisdiction: 2015
2015, National



‡ Reporting standards not met.
NOTE: Black includes African American, and Hispanic includes Latino. Race categories exclude Hispanic origin. The NAEP Mathematics scale ranges from 0 to 300. Some apparent differences between estimates may not be statistically significant.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

Table 4.5
Average Scale scores by Race/Ethnicity

Year	Jurisdiction	Race/Ethnicity using 2011 guidelines, school-reported	Average Scale Score
2015	National	White	160
		Black	130
		Hispanic	139
		Asian	171
		American Indian/ Alaska Native	138
		Native Hawaiian/Other Pacific Islander	‡
		Two or more	157

‡ Reporting standards not met.

NOTE: Black includes African American, and Hispanic includes Latino. Race categories exclude Hispanic origin. Some apparent differences between estimates may not be statistically significant.

SOURCE: United States Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment

Table 4.6
Multiple Correlation and R squared by Race/Ethnicity

Multiple Correlation	0.38
R squared	0.14

Table 4.7
ANOVA Test by Race/Ethnicity

	Degrees of Freedom	Mean Square	F Ratio	P-Value
Model	6	91891355.45	198.39	0
Error	7182.29	463190.79		

Table 4.8
Regression Test by Race/Ethnicity

Black	-0.3067	0.0132	-30.3061	1.1746	25.8018	0	<
Hispanic	-0.2571	0.0111	-21.5183	0.9302	23.1323	0	<
Asian	0.0735	0.0137	10.7895	1.9266	5.6002	0	>
Native Hawaiian/Other Pacific Islander	-0.0266	0.0084	-21.7209	6.6095	-3.2863	0	<
	Std. Coeff.	S, E. of Std. Coeff	Reg, Coeff	S.E. Reg. Coeff	T	Prob	Sig

NOTE: A 0-1 contrast coding has been used where the first subgroup of the (independent) variable is the reference group. Except for the reference group, each subgroup is contrasted (code 1) in a separate dummy variable against all the other subgroups of the variable (code 0). For more details about contrast coding with multiple variables see the help documentation. Black includes African American, and Hispanic includes Latino. Race categories exclude Hispanic origin.
SOURCE: United States Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

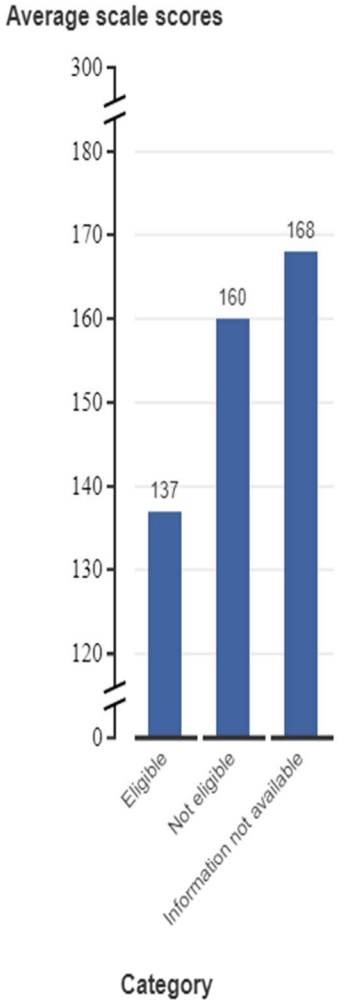
Research Question/Hypotheses 3

Research Question 3 asked, is there a significant relationship between SES and achievement on the 12th-grade NAEP mathematics assessments? The null hypotheses challenged the question with an answer of no for hypothesis 3, that is, there is no relationship between SES and achievement on the 12th grade NAEP mathematics assessments. This question sought to determine the relationship between SES and the mathematics achievement of the nation's 12^{th} grade students.

A simple linear regression was calculated to predict the 12th grade mathematics achievement results based on school lunch program eligibility which was used to measure SES. A significant regression equation was found (F (232169356.25, 1229640.04) = 188.81, p < .001), R^. 12.. The P value shows significant correlation between national school lunch program eligibility and the average score. P<.001 provides the needed evidence to support rejection of the null hypothesis. Tables 4.9- 4.11 show the results of the average scale score, the significance test, and the regression. Figure 4.3 presents a graph of the mean scores. It shows the mean score for the eligible was 137, the mean score for the ineligible was 160, and the mean score for unknown was 168 indicating a 23-point difference in the means of the eligible and ineligible and a 31 point difference between the eligible and those whose information was not available.

Figure 4.3
Average Scale scores by SES

Average scale scores for grade 12 mathematics, by National School Lunch Program eligibility, 3 categories [SLUNCH3] for jurisdiction: 2015
2015, National



NOTE: The NAEP Mathematics scale ranges from 0 to 300. Some apparent differences between estimates may not be statistically significant.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

Table 4.9
Average Scale scores, by SES

Year	Jurisdiction	National School lunch program; 3 Categories	Average Scale Score
2015	National	Eligible	137
		Not Eligible	160
		Information not available	168

NOTE: Some apparent differences between estimates may not be statistically significant.

SOURCE: United States Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment

Table 4.10
Multiple Correlation and R squared by SES

Multiple Correlation	0.35
R Squared	0.12

Table 4.11
ANOVA Test by SES

	DF	Mean Square	F Ratio	P-Value
Model	2	232169356.25	188.81	0
Error	2776.24	1229640.04		

Table 4.12
Regression Test by SES

	Std. Coeff.	S, E. of Std. Coeff	Reg, Coeff	S.E. Reg. Coeff	T	Prob
Intercept	0	0	137.2499	0.7205	190.4985	0
Not Eligible	0.3307	0.0141	22.7828	1.0878	20.9437	0
Information not available	0.2449	0.018	30.9672	1.9214	16.1171	0

NOTE: A 0-1 contrast coding has been used where the first subgroup of the (independent) variable is the reference group. Except for the reference group, each subgroup is contrasted (code 1) in a separate dummy variable against all the other subgroups of the variable (code 0). For more details about contrast coding with multiple variables see the help documentation.

SOURCE: United States Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

Research Question/Hypotheses 4

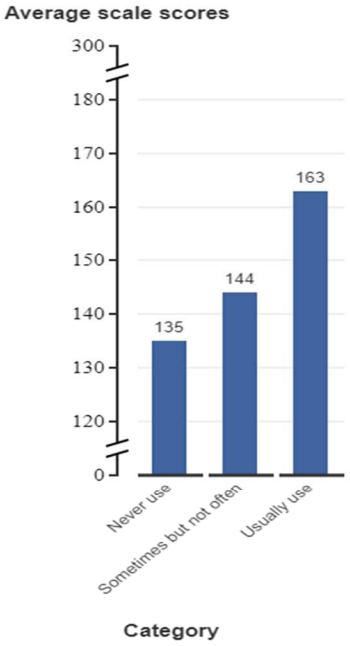
Research question 4 ask the question of, is there a significant relationship between classroom graphing calculator usage and achievement on the 12th-grade NAEP mathematics assessments? The 4th null hypothesis takes the position of no in response to the research question., that is, there is no relationship between graphing calculator usage and achievement on the 12th grade NAEP mathematics assessments

A simple linear regression was calculated to predict the12th grade mathematics achievement results based on graphing calculator usage. In this study, there was a significant regression equation found of (F (164684237.44877043.89,) =187.77, p < .001). R ^2 = .11. P<.0001 supports rejection of the null hypothesis. P<.001 provides the needed evidence to support rejection of the null hypothesis. Tables 4.13- 4.16 show the

results of the average scale scores, the significance test, and the regression. Figure 4.4 presents a graph of the mean scores. It shows the mean score for those who never use was 135, the mean score for those who use the graphing calculator sometime was 144, and the mean score for those who usually use a graphing calculator was 163 indicating an 9-point difference in the means of those who never use and sometimes use, and a difference of 28 points from those who never use and those who usually do.

Figure 4.4
Average Scale scores by Graphing Calculator Usage

Average scale scores for grade 12 mathematics, by Use graphing calculator in math class [M817601] for jurisdiction: 2015
2015, National



NOTE: The NAEP Mathematics scale ranges from 0 to 300. Some apparent differences between estimates may not be statistically significant.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

Table 4.13
Average Scale scores by Graphing Calculator Usage

Year	Jurisdiction	Use Graphing Calculator in mathematics class	Average Scale Score
2015	National	Never Use	135
		Sometimes not always	144
		Usually use	163

NOTE: Some apparent differences between estimates may not be statistically significant.

SOURCE: United States Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

Table 4.14
Multiple Correlation and R squared by Graphing Calculator Usage

Multiple Correlation	0.33
R Squared	0.11

Table 4.15
ANOVA by Graphing Calculator Usage

	Degrees of Freedom	Mean square	F Ratio	P Value
Model	2	164684237.44	187.77	0
Error	3068.71	877043.89		

Table 4.16
Regression Test by graphing calculator usage

	Std. Coeff.	S, E. of Std. Coeff	Reg, Coeff	S.E. Reg. Coeff	T	Prob	Sig
Intercept	0	0	135.3295	1.0915	123.9825	0	>
Sometimes but not often	0.1061	0.013	9.0156	1.1304	7.9753	0	>
Usually use	0.3905	0.0163	28.1193	1.3597	20.6804	0	>

NOTE: A 0-1 contrast coding has been used where the first subgroup of the (independent) variable is the reference group. Except for the reference group, each subgroup is contrasted (code 1) in a separate dummy variable against all the other subgroups of the variable (code 0). For more details about contrast coding with multiple variables see the help documentation. SOURCE: United States Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

CHAPTER 5

Interpretation of Results

The United States is in dire need of more engineers, engineering technologist, and other mathematics related professions. To meet this need, it is more important than ever that students be recruited from the pool of Black females as well as previously recruited populations. The Black female has been shown to the most underutilized human resource in these professions. Studies have shown that although the Black female is more likely to graduate from college than the Black male, they are far less likely than the White male who is the reference group by which the data of this study was referenced. This disparity needs to be decreased or eliminated.

Mathematics has been shown to be the largest milestone in completing these degrees. As mentioned earlier in this study, Black females tend to be in schools with the least amount of resources and the most poorly qualified teachers. To that end, this study sought to show that graphing calculators can help to increase Black females' presence in these professions by using graphing calculators to increase mathematics education equity. This study looks at its findings at the intersection of race, gender, and SES.

Research question one sought to determine if gender had any significant impact on mathematics achievement as indicated by the mean score on the 2015 NAEP for females. At the less than 1 % significance level, there is sufficient evidence to support the rejection of the null hypothesis and show sufficient evidence that there is a significant

relationship between gender and achievement on the 12th-grade NAEP mathematics assessments.

Statistical comparisons regarding Black females generally focus on the comparisons between Black females and Black males with Black females significantly outperforming Black males regarding both entrance to undergraduate school as well as their college graduation rates. What these studies fail to mention is that this is also the case for White, Asian, and Hispanic women. One cannot ignore the fact that Black females endure gender/patriarchy in addition to racism in academic institutions. This is especially true for a male dominated field like engineering and other STEM professions. Black females' experiences should be viewed in historical, social, economic, and cultural context as a Black female (Collins, 1986).

Research question two wanted to determine if race had a significant impact on mathematics achievement as indicated by the mean score on the 2015 NAEP based on race/ethnicity. Race was found to have a significant negative impact on all race/ ethnicity' mathematics achievement mean score except for Asians. Asians mean score was higher than all Race/ Ethnicities. Blacks had the largest gap with a 30-point deficit in the mean score when compared to the mean score of the reference group White males. At the less than 1 % significance level, there is sufficient evidence to support the rejection of the null hypothesis and show sufficient evidence that there is a significant relationship between race and achievement on the 12th-grade NAEP mathematics assessments.

The Asian ethnicity is the only ethnicity whose mathematics achievement is not impacted by race. In fact, this study shows that this population excels academically when compared with the White male by exceeding the White male's mean score on the NAEP exam by 11 points. The finding of this study did not allow for the rejection of the null hypothesis with the Asian Racial ethnic group when compared to the reference group of White Males.

The high negative correlation between having a race/ethnicity of Black and mathematics achievement is compounded for Black females because they are members of both groups examined in research questions 1 and 2. Black females are often viewed as the model minority because they seem to excel despite being faced by many obstacles. Black females frequently experience the "outsider within" (Collins, 2015), where they have been embraced due to their status as the model minority, but still have experiences related to their race.

This study shows that being female negatively impacts your performance on standardized mathematics exams and being Black negatively impacts mathematics achievement on standardized exams. It should be understood that although Black females are graduating and going to college in greater numbers than Black males, it does not negate the fact that they are subjected to the causes for the lower mathematics achievement scores in both the gender and race/ethnicity category. This significant negative impact on mathematics achievement directly impacts and limits the amount of opportunities for Black females in engineering, engineering technologies, and other mathematics-related professions.

Research question three addressed the impact of SES on mathematics achievement. The SES of different groups of people in America has created segregation among the country's population (Owens, 2017). This segregation is mirrored in school districts because most students attend schools in the neighborhoods, they live in. School districts in higher SES neighborhoods have access to more resources which results in higher academic performance.

This study found that there is a significant negative correlation between SES and mathematics achievement as indicated by results on the 2015 12th grade NAEP mathematics assessment. At the less than 1 % significance level, there is sufficient evidence to support the rejection of the null hypothesis and show sufficient evidence that there is a significant relationship between SES and achievement on the 12th-grade NAEP mathematic assessments.

According to the NCTM (2015) it is essential that students are provided with technological tools to enhance their learning progress. Research question 4 sought to determine if graphing calculators could level the playing field and increase mathematics educational equity. The study found a significant positive correlation between graphing calculator usage and mathematics achievement. At the less than 1 % significance level, there is sufficient evidence to support the rejection of the null hypothesis and show sufficient evidence that there is a significant relationship between classroom graphing calculator usage and achievement on the 12th-grade NAEP mathematics assessments.

Relationship Between Results and Prior Research

United States culture, racist and sexist ideologies permeate the social structure to such a degree that they become hegemonic, namely seen as natural, normal, and inevitable" (Collins, 2015). The results of this study show that race, gender, and SES significantly impact mathematics achievement. The stereotypes of Black females often cause them to be viewed in a negative light which impacts the way they are taught and treated by those chartered to educate them.

Most mathematics teachers in the United States are White females. Many teachers only interaction with a Black female student is in the classroom and school building at large. Often White teachers learn about and gain their view of Black females based on what they see in media or hear from their co-workers (McGee, 2018). In the work environment, people are more likely to speak about their frustrations versus. their successes and their expressions of these frustrations can potentially negatively influence other educators who have no other frame of reference. These experiences often result in microaggressions at the expense of the Black female student. Students who feel discriminated against may have heightened anxiety because of feeling the need to defy any negative stereotypes (McGee, 2018).

The results of this study show that on average women score below men on the 12th grade NAEP mathematics assessment. Of all ethnic groups Black people had the lowest mean score on 12th grade NAEP mathematics assessment. Since Black females are a sub-segment of the assessment group identified as female and a member of the group with the lowest mean score of all races and ethnicities, one can conclude that Black

females would have the lowest mean score of both groups because they are both Black and female.

High-achieving Black females are often isolated and experience feelings of not belonging in mathematics in part because of societal stereotypes of being perceived as "less than" and incompetent. Racism and racist experiences also lead to these feelings (McGee, 2018). These feelings of inferiority are further cemented when these students are faced with the results of these achievement exams. Self-efficacy can help improve mathematics achievement because it gives students the confidence that they can do well in mathematics even if they do not understand the content right away. Increasing their confidence in mathematics during high school can lead to their persistence to degree completion when faced with the rigorous mathematics required in these courses. Strong self-efficacy can give them the confidence to seek assistance when needed because they have the confidence that they do in fact succeed in this course work with proper assistance. By working to increase their self-efficacy in high school, their mathematics achievement can be higher and therefore open doors to being admitted to these programs.

According to the United States Department of Education "African-American students still lack access to the educational resources that offer a fair shot at success." Less than one-third of public high schools serving predominantly African American students offer calculus. Schools with low SES are more likely to do academic tracking, a method of homogeneous student grouping according to ability. And since Black females have a higher probability of attending schools in neighborhoods with low SES, where

they are more likely to do academic tracking, Black females find themselves with yet another obstacle to overcome (McFarland, 2017).

Students who were placed in a lower academic track may not have taken algebra until high school and those who are placed in a slower educational track may not even have the opportunity to take upper level mathematics courses. This in turn prevents these students from having the chance or opportunity to take calculus in high school, placing them in being further behind than their White male counterparts. (Joseph et al., 2017) Once a student is tracked, they will generally be unable to change tracks unless they double up on one of their mathematic courses. Courses on the lower track are also frequently less rigorous. and not designed to prepare students for work in advanced mathematics (Joseph et al., 2017).

Mathematics is an academic subject that builds on mathematics learned in all previous. mathematics courses unlike other academic subjects. For example, a student does not have to remember information learned in the United States history to succeed in world history. However, in mathematics, it is highly unlikely that a student who has not taken algebra 1 will do well in algebra 2. High schools can help by providing the Black female academic population with additional educational resources such as tutoring and academic intervention services. These resources should be selected based on their records of improving the mathematics achievement.

Pre-college programs can help to lessen the impact of lower mathematics achievement by filling in mathematical learning gaps experienced by the Black female that may be the result of situations out of the student's control. A pre-college programs

could provide colleges and universities with opportunities to accept Black females who may not meet the school's admissions requirements but show tremendous. academic promise. These pre-college programs can potentially reduce many academic deficits.

The United States education system is designed to optimize the educational experience of White middle-class male students. Students who are not White males are expected to adjust to those norms if they are to be successful. Although all Black females in the United States have different life experiences, the history of slavery in America and slavery's after effects of slavery have caused some lived experiences that are unique to, and experienced by, all American Black females. These experiences have been found to generate significant negative impact on their academic achievement. Studies show mathematics achievement as the most significantly impacted.

Recruitment and Admission

Lower mathematics scores on academic achievement exams result in fewer college choices for students. Colleges should develop recruitment practices that look at more than standardized test results which can help reduce educational disparities. Colleges and universities should be providing mentors to these students to help provide the needed support. Black females have a higher likelihood of being poor and academically underprepared. Colleges need to actively recruit Black females based on more wholistic criteria.

Studies show that Black women often feel isolated and alienated on college campuses, especially predominantly White college campuses (Winkle-Wagner, 2014).

Mentors are needed to help provide essential support for these females who have a higher likelihood of being poor and academically disadvantaged. Without mentors' Black females who are accepted into these majors have a higher likelihood of withdrawing than both Black and White male counterparts as well as their White female contemporaries.

Black females often enter mathematics and other STEM classes where they are both the only Black person and only female. Guidance counselors and academic advisors can help by providing these students with examples and access to women who have done what it is they want to do. These actions can lessen their feelings of isolation.

Often male students and male instructors have had extraordinarily little and sometimes no previous interactions with Black females. Because of conditioning, professors and male students often treat female students differently than other male students. The impact is doubled when the element of race is added. The feelings of separation between men and woman are intensified in environments where women and men are treated differently (Heyman et al., 2002). Colleges and universities can work to reduce the awkwardness that often comes when interacting with a human population that is different from your own or the one you are used to interacting with by providing sensitivity training to staff and students.

Engineering and engineering technology careers are sometimes perceived as missing the human connection of being of service. Many Black females often need to feel that their careers are making a difference in their world. Colleges and universities need to train recruiters to show the positive impact these fields make in the world.

Stereotypes also affect the experiences of Black females. One new stereotype that is impacting the treatment of Black females is that of the model minority, a stereotype that has typically been associated with East and South Asian immigrants. According to the American Psychological Association, collectively, the model minority stereotype refers to the idea that Asian Americans are relatively problem free, hardworking, and perseverant, and it constitutes a powerful typecast for Asian Americans today. Black women are now being viewed as the model minority as they continue to make up ground and have made tremendous. gains in their academic experience. These stereotypes can cause further feeling of insecurity when Black females are unable to perform as well academically as their Asian female counterparts.

Co-curriculum programs are another means of reducing the feelings of isolation experienced by Black females in the mathematics classroom and other parts of educational institutions. Co-curricular programs are extensions of the formal learning space and generally occur outside of school and sometimes are operated by outside organizations (Shehata, 2015). One way of doing this is to provide internship opportunities with engineering companies that allowing students to complete activities that mirror what is being done within the classroom. Connecting what is learned in the classroom with its real-world counterpart will enhance learning for Black females

Racial Stereotypes

The racial stereotypes of the Black woman frequently create a hostile environment for Black women with them experiencing microaggressions on a regular basis. The narrative of the strong Black woman often results in the belief that Black girls do not need additional support because they are viewed as being extremely resourceful and able to excel despite facing numerous. obstacles. In addition to this misconception, Black female high school students are not yet women but are often viewed as more mature than their White, Latino, and Asian. counterparts. Educators often have different expectations for them. This narrative often results in the Black female student receiving less attention and help from their teachers. Teachers often have lower academic expectations of Black female students as well.

When slavery ended, Black women frequently found work as nannies and house keepers in wealthier White households. The White children grew to care for these Black women and the White households typically believed they had accepted these women as equals all while maintaining their racist beliefs. These women were loved but still viewed as inferior. In undergraduate settings these views continue to persist. Black women are expected to major in fields that lead to employment as caretakers like teachers and nurses. Most STEM professions are still viewed as the domain of the White male. These stereotypes of the Black women put them on the outskirts of these fields.

On top of these stereotypes, most Black households are led by single women where there is often no money to provide extra tutors. Family support is also extremely important to academic success and many single parents work long hours and have no time to provide this support. Some students are responsible for taking care of younger siblings resulting in reduced time for studies. All these factors contribute to their lower mathematics achievement.

The results of this study show significantly improved scores of students who used graphing calculators in the classroom. Schools in wealthier districts have an advantage because their parents can purchase calculators that can perform a significant amount of calculations. Students who do not have them will have to do these calculations by hand. Usage of these calculators allows students to have more time to complete more challenging problems because they do not have to spend needless time on performing operations that an approved calculator can perform for them.

According to the Associated Mathematics Teacher Education, teacher education programs should provide the opportunity for teachers to gain the knowledge and experience necessary to incorporate the technology in the context of teaching and learning mathematics. Teachers need to receive high quality professional development in how to maximize the usage of these calculators throughout their lessons. Colleges and teacher training programs should create a generation of teachers who know the most effective way of using this technology.

"Effective retention programs are committed to the development of supportive social and educational communities in which all students are integrated as competent members" (Tinto, 2012). Throughout their lives Black females suffer from racism, microaggressions, stereotypes, feelings of alienation and isolation, lack of teacher support, and lack of content relative to Black life. The mathematics classroom is a good starting place for applying the strategies discussed in this study.

Limitations of the Study

The participants of this study are people who self-identify within the designated race/ ethnicity and genders. Some non-sampling errors may occur due to human error. There are countless non-sampling errors that can occur. One example of a non-sampling error that may occur is mathematics examples or formulas that may have been left uncovered. Another example is that the assessment may have been given prior to lunch and students may be hungry. Yet another is that teachers may also not have actively participated in technology professional development. All non-sampling errors cannot be identified but their existence could affect student performance on the assessments.

Discussion

Little is known about the experiences of the Black female in the mathematics classroom. Whether conscious or not educators often view Black females as less academically capable. Mathematics teachers can make a tremendous difference in the success of these students in the mathematics classroom. One of the first steps would be acknowledging these preconceptions and taking steps to reduce their bias. Professional

development in sensitivity training could go a long way to decreasing these conscious and unconscious beliefs.

Numerous factors are not considered when trying to help the Black female succeed in the mathematics classroom. Many of these students are embarrassed to seek help because they think they are the only one who does not understand or feed into the stereotype of Black females not really having the ability to be successful in mathematics. Some students may not even know how to study for mathematics. To this end educators can show students how to study for mathematics using teaching strategies such as the flipped classroom model where students watch the lesson at home via a prerecorded video and do their homework in the classroom where they can get feedback from their teachers and classmates .

Educational administrators should provide quality professional development opportunities that provide mathematics educators with the necessary knowledge to helps the Black female's sense of belonging and self -efficacy and how their racial bias may affect their interactions with Black female students. Although most public high schools use state mandated curriculum, administrators should provide teachers with training on how to create lessons that are diverse and relevant to diverse cultures. Training on to create a classroom environment where the seek out and foster positive student teacher relationship

Parents play a tremendous role in increasing the presence of Black females in engineering and mathematics professions. They should serve as role models and support and encourage their Black female daughters to pursue careers in engineering and mathematics. They should seek out mathematics teachers and engineers to serve as

mentors. They should motivate their daughters to pursue these careers and provide exposure to STEM programs.

When looking at financial factors, stipends and work study need to be included. Financial assistance often doesn't take into consideration that although tuition, room and board may be covered by financial aid these students may not have the means of transportation to get to the school or to get home over school breaks when the schools are closed. They may not have money to do things like laundry or buy toiletries. Incidentals that may not even be considered.

Usage of graphing calculators was shown to have a significant positive impact on mathematics achievement. It is imperative to get these calculators into classrooms across the nation. To successfully incorporate these calculators into classrooms, mathematics teachers require significant, high quality professional development on how to maximize instruction and learning while using this technology tool. Each student would need to be provided with a calculator that can be used in the classroom and at home. By freeing up time spent on basic calculations, graphing calculators can provide opportunities for mathematics teachers to go more in depth with material which will result in a deeper understanding of the subject matter which will result in higher mathematics achievement.

Recommendations for Future Practice

The researcher recommends that all schools incorporate the graphing calculator into all secondary mathematics classrooms. The cost of graphing calculators is significant enough that homes with a low SES would have great difficulty purchasing a graphing calculator. Households with a high SES would have a higher likelihood of providing their

child access to a graphing calculator for both home and school usage. Students in lower SES households are already at a disadvantage due to limited resources. Students in homes with low SES may not be able to stay after school for extra tutoring or other academic enrichment because they are more likely to have after school jobs or be responsible for the care of younger siblings. The graphing calculator can help to reduce these educational disparities.

Having access to the graphing calculator can give students more confidence by providing a tool to verify homework solutions. Some graphing calculators can perform algebraic manipulations. Although this application will be disabled during standardized exams, it can be used during the school year for students to practice and increase these skills. The calculator can enhance the student's confidence because they are able to compare their solution with the solution on the calculator.

The researcher recommends supervisors of mathematics instruction provide quality training and professional development to their teachers on the usage of the graphing calculator in the mathematics classroom. Placing the calculator into classrooms without professionally training classroom teachers in their usage will not optimize the learning opportunities that the graphing calculator can provide.

Quality professional development will help classroom teachers become proficient in the usage of the calculators. It will also provide training for best practices in the usage of these calculators. Classroom teachers need to be provided with additional time for this training or the preparation time needed to learn how to effectively use the calculators may not be available. Teachers need to be well versed in what the calculators can do as well as

when to use certain features with specific topics. Only with proper training will classroom teachers be able to maximize the learning experience with these calculators.

The researcher recommends that teachers attend quality professional development and research best practices for usage of the graphing calculator in such a way as to increase mathematics achievement. Classroom teachers are generally allowed to select the professional development they believe will most enhance their professional growth. This study has shown that the usage of graphing calculators significantly increases mathematics achievement. The usage of these calculators is in the best interest of the students. Mathematics classroom teachers need to know where their pedagogical knowledge intersects with the technological knowledge needed to effectively use the graphing calculator in their classrooms.

The researcher recommends district leaders allot funds towards the usage of technology in the classroom. This study shows that on average scores were significant improved when students used graphing calculators. These funds should be provided for both professional development opportunities as well as for the purchase of the graphing calculators. The calculators could then be signed out in the same fashion as textbooks. If school districts do not have the funds on hand to provide the calculators, grant proposals should be written in efforts to gain the funds.

Recommendations for Future Research

The researcher conducted the study comparing the results of women, ethnicities, and calculator usage and how the results could impact the Black female. One prospective area of future research could be to conduct a study that combines the race and gender of

the Black female as one variable. A study that focuses on the Black female as the independent variable can add additional support and more knowledge about how to increase the mathematics academic performance of this population

The researcher also recommends, as another potential area of research, conducting the same study using the NAEP restricted data. The restricted data allows researchers an opportunity to use other variables that can assess, SES and technology usage. It can also allow researchers to compare the Black female to females of other ethnicities.

This study does not intend to imply that technology can be a replacement for mathematics learning. Instead it wishes to provide a proven technology that can help further student's understanding of mathematical concepts. Mathematics teachers will need to know how and when to use this technology to enhance mathematics learning.

Conclusion

Although there are experiences of sexism that all women face, because of the history of slavery and racism in America, there are specific experiences that are unique to the Black female. Most studies on women are primarily from the perspective of White women. Most studies on the Black race focus on the Black male. Black females are members of both marginalized groups and have their own unique experiences because of their identity in the intersection of both groups. Black women have been the most under studied group and can provide and excellent source of undeveloped mathematics talent which can increase their chances of successfully completing degrees in mathematics and engineering.

Usage of the graphing calculator was shown to increase the nations' 12th grade mathematics achievement on average an increased score of 11 points for using the graphing calculator sometimes and on average an increase of 28 points for the nations' 12th grade students. This technology can be used to increase equability for the most marginalized population.

REFERENCES

Besterfield-Sacre, M., Atman, C. J., & Shuman, L. J. (1997). Characteristics of Freshman Engineering Students: Models for Determining Student Attrition in Engineering. *Journal of Engineering Education*, *86*(2), 139–149.

Bowman, K. Engineering Degree Trends for African American Women and Men. *2015 ASEE Annual Conference and Exposition Proceedings.*

Cheung, A. C., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta- analysis. *Educational Research Review, 9*,88-113.

Collins, P. H. (2015). *Black feminist thought: knowledge, consciousness, and the politics of empowerment*. Routledge, Taylor & Francis Group.

Dika, S., Hunt, B., Pando, M., Tempest, B.Q., & Allen, M. (2019). Self-Efficacy of Engineering Transfer Students: Links to Faculty Interaction and Other Forms of Capital. *International journal of engineering science and technology, 1*, 1-9.

Ehrenberg, R. G. (2010). Analyzing the factors that influence persistence rates in STEM field, majors: Introduction to the symposium. *Economics of Education Review*, *29*(6), 888–891.

Geisinger, Brandi N. and Raman, D. Raj, "Why They Leave: Understanding Student Attrition from Engineering Majors" (2013). *Agricultural and Biosystems Engineering Publications*. 607.

Girgis, M. A Scaffolding Case Study for Teaching Engineering Problem Solving to Underrepresented Minorities. *2015 ASEE Annual Conference and Exposition Proceedings* Hyde meta-analysis. Psychol Bull. 1990 Mar;107(2):139-55.

Joseph, N. M., Hailu, M., & Boston, D. (2017). Black Women's and Girls' Persistence in the P–20 Mathematics Pipeline: Two Decades of Children, Youth, and Adult Education Research. *Review of Research in Education*, *41*(1), 203–227.

Kuyath, S. (2005). Applying the Theory of Planned Behavior: Recruiting Underrepresented Minorities to Engineering and Engineering Technology. *2005 Annual Conference Proceedings*.

Ladson-Billings, G. (1997). It Doesn't Add up: African American Students' Mathematics Achievement. *Journal for Research in Mathematics Education*, *28*(6), 697.

Litzler, E., Samuelson, C. C., & Lorah, J. A. (2014). Breaking it down: Engineering student STEM confidence at the intersection of race/ethnicity and gender. *Research in Higher Education, 55*(8), 810–832.

Madara, D.S., & Namango, S. (2016). Perceptions of Female High School Students on Engineering. *Journal of Education and Practice, 7*, 63-82.

Mattis, M. C. Upstream and Downstream in the Engineering Pipeline: What's Blocking US Women from Pursuing Engineering Careers? *Women and Minorities in Science, Technology, Engineering and Mathematics*.

May, G. S., & Chubin, D. E. (2003). A Retrospective on Undergraduate Engineering Success for Underrepresented Minority Students. *Journal of Engineering Education*, *92*(1), 27–39.

Means, B., Wang, H., Young, V., Peters, V. L., & Lynch, S. J. (2016). STEM□focused high schools as a strategy for enhancing readiness for postsecondary STEM programs. *Journal of Research*

McFarland. (2017). The condition of education 2017. Retrieved February 22, 2021, from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2017144

McGee, E. (2018). "Black Genius, Asian Fail": The Detriment of Stereotype Lift and Stereotype Threat in High-Achieving Asian and Black STEM Students. *AERA Open,* October-December 2018, Vol. 4, No. 4, pp. 1–16.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology*, *82*(1), 60–70.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine 2011. *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads.* Washington, DC: The National Academies Press

Ohland, M. W., Brawner, C. E., Camacho, M. M., Layton, R. A., Long, R. A., Lord, S. M., &Wasburn, M. H. (2011). Race, Gender, and Measures of Success in Engineering Education. *Journal of Engineering Education*, *100*(2), 225–252.

Owens, A. (2017). Income Segregation between School Districts and Inequality in Students 'Achievement. *Sociology of Education*, *91*(1), 1–27.

Pearson, W., & Miller, J. D. (2012). Pathways to an Engineering Career. *Peabody Journal of Education*, *87*(1), 46–61.

Prather, C., Fuller, T. R., Jeffries, W. L., 4th, Marshall, K. J., Howell, A. V., Belyue Umole, A., & King, W. (2018). Racism, African American Women, and Their Sexual and Reproductive Health: A Review of Historical and Contemporary

Evidence and Implications for Health Equity. *Health equity*, *2*(1), 249–259.

Price, J. (2010). The effect of instructor race and gender on student persistence in STEM fields. *Economics of Education Review*, *29*(6), 901–910.

Reichert, M., & Absher, M. (1997). Taking Another Look at Educating African American Engineers: The Importance of Undergraduate Retention. *Journal of Engineering Education*, *86*(3), 241–253.

Reyes, L., & George M. A. Stanic. (1988). Race, Sex, Socioeconomic Status, and Mathematics. *Journal for Research in Mathematics Education, 19*(1), 26-43.

Rumberger, R. W, & Palardy, G. J. (2002). The Impact of Student Composition on Academic Achievement in Southern High Schools. *UCLA: The Civil Rights Project / Proyecto Derechos Civiles*.

Shehata, M. H. (2015). Co-Curricular Activities and their Role in Supporting Experiential Learning. *Proceedings of the Canadian Engineering Education Association (CEEA)*.

Sirin, S. R. (2005). Socioeconomic Status and Academic Achievement: A Meta-Analytic Review of Research. *Review of Educational Research, 75*(3), 417-453.

Slaughter, J. B., Tao, Y., & Pearson, W. (2015). *Changing the face of engineering the African American experience*. Johns Hopkins University Press.

Tinto, V. (2012). Enhancing student success: Taking the classroom success seriously. *The International Journal of the First Year in Higher Education*, *3*(1).

Toven-Lindsey, B., Levis-Fitzgerald, M., Barber, P. H., & Hasson, T. (2015). Increasing persistence in undergraduate science majors: a model for institutional support of underrepresented students. *CBE life sciences education*, *14*(2), ar12.

Valle, C., Jackson-Truitt, T., & Newstetter, W. How Students Choose Their Engineering Major: Effects of Gender and Race or Ethnicity. *2015 ASEE Annual Conference and Exposition Proceedings*

Wilson, T. D., Reinhard, D. A., Westgate, E. C., Gilbert, D. T., Ellerbeck, N., Hahn, C., Shaked, A. (2014). Just think: The challenges of the disengaged mind. *Science*, *345*(6192), 75–77

Wiswall, M., & Zafar, B. (2011). Determinants of College Major Choice: Identification Using an Information Experiment. *SSRN Electronic Journal*.

Ysseldyke, J., & Bolt, D. M. (2007). Effect of Technology-Enhanced Continuous Progress Monitoring on Math Achievement. *School Psychology Review, 36*(3), 453-467.

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