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A Case Study the Effects of Student Engagement on Academic Achievement in African American Women: Comparing Undergraduate STEM Majors to Non-STEM Majors from a Historically Black College and University

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A CASE STUDY
THE EFFECTS OF STUDENT ENGAGEMENT ON ACADEMIC ACHIEVEMENT IN AFRICAN AMERICAN WOMEN:
Comparing Undergraduate STEM majors to NON-STEM majors from a Historically Black College and University

by

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ABSTRACT

THE EFFECTS OF STUDENT ENGAGEMENT ON ACADEMIC ACHIEVEMENT IN AFRICAN AMERICAN WOMEN:
Comparing Undergraduate STEM majors to NON-STEM majors from a Historically Black College and University

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The nation is at a critical juncture in history as it seeks to increase the number of students who enter the Science, Technology, Engineering, and Mathematics (STEM) workforce. The national push to have a properly trained STEM workforce was at the forefront of the past administration's top priority list. The higher education community has a unique opportunity to contribute to the creation of a sustainable U.S. STEM workforce. Although significant progress has been made in STEM fields, some argue that movement has been too slow in certain cases, as shown in degrees earned by women in engineering (National Academies of Sciences, Engineering, and Medicine, 2020; Armstrong and Jovanovic, 2015; Nassar-McMillan et al., 2011; NSF, 2002; NSF, 2017). Advancing towards degree attainment in STEM dwindles even further when race is considered. In efforts to include women, sustainable measures are needed, such as retention and academic/non-academic support throughout all levels of education, which serve as a roadmap to the inclusion of underrepresented minorities in STEM.

This study sought to investigate the relationship between student engagement and academic achievement of African American female, full-time undergraduate students in Science, Technology, Engineering, and Mathematics (STEM) majors to African American female, full-time undergraduate students in non-STEM majors who matriculate at Historically Black Colleges and Universities (HBCUs). The National Survey of Student Engagement and

Demographic Variables from institutional effectiveness were used for data collection tools. The researcher used descriptive statistics, ANOVA and ANCOVA statistical tests to conduct this study. The results indicated that the learning with peers student engagement indicator influence on academic achievement was significant within and between study groups. The remaining student engagement indicators (experiences with faulty, supportive campus environment, and academic challenge), which served as independent variables, were not significant.

This study contributes to emerging research related to student engagement and academic achievement of undergraduate African American females in STEM fields. As the nation strives to increase the number of STEM degrees, transformational best practices that support underrepresented minorities, are topics of investigation. Feedback from this population assesses factors that influence degree completion and provide recommendations to increase program retention at higher education institutions across the country.

This dissertation is dedicated to my sons, Bryson and Kendall, godson Larry, nephews and nieces, and the next generation of leaders in my family. You each inspire me to push past my limits and strive for greatness in a world of chaos. Always remember to believe in God who created you in His image. Luke 1:45 – "And blessed is she that believed: for there shall be a performance of the things told her by the Lord."

Zenora E. Gay

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CHAPTER I

INTRODUCTION

The nation is at a critical juncture in history as it seeks to increase the number of students who enter the Science, Technology, Engineering, and Mathematics (STEM) workforce. Over the last decade, the push to have a properly trained STEM workforce has been at the forefront of the nation's top priority list. During President Barak Obama's administration, the Council of Advisors on Science and Technology (PCAST, 2014) was created and detailed a list of recommendations to reach its goal of one million additional graduates with degrees in STEM. These recommendations included:

- Catalyze widespread adoption of empirically validated teaching practices.
- Advocate and provide support for replacing standard laboratory courses with discovery-based research courses.
- Launch a national experiment in postsecondary mathematics education to address the math preparation gap.
- Encourage partnerships among stakeholders to diversify pathways to STEM careers.
- Create a Presidential Council on STEM Education with leadership from the academic and business communities to provide strategic leadership for transformative and sustainable change in STEM undergraduate education (p.2).

The higher education community has a unique opportunity to contribute to creating a sustainable U.S. STEM workforce. Table 1 displays the intentions of freshmen to major in engineering by race and ethnicity. Underrepresented populations have the largest gap between intention to major in the degree versus program completion. Students who are classified in the White or Caucasian cohort have the smallest gap between major intentions versus degree completion. In addition to African American or Black students having a low degree attainment, their intention to major in engineering is the lowest amongst all classifications.

Table 1

Engineering: Freshmen intentions and degrees, by race and ethnicity (Percent)

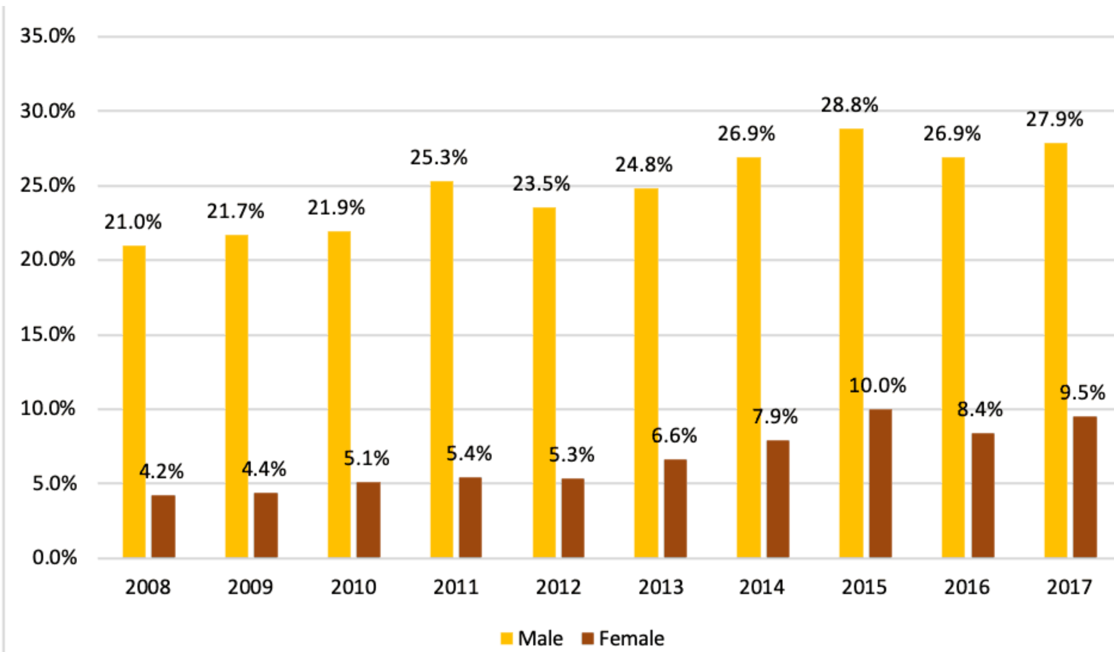
Characteristic	White or Caucasian	Asian American or Asian	African American or black	Hispanic or Latino
Intentions (2005)	8%	13.4%	6.9%	9.4%
Degrees (2011)	4.5%	7.8%	1.9%	3.9%

Note. Degrees do not reflect the same student cohort. Asian American or Asian includes Native Hawaiian or Pacific Islander. Adapted from National Science Board. (2014).

This number varies when considering program completion in STEM degrees. The Higher Education Research Institute (2010) states: “White and Asian students who started in STEM have four-year degree completion rates of 24.5% and 32.4% respectively. In comparison, Latino, Black, and Native American students had four-year STEM degree completion rates of 15.9%, 13.2%, and 14.0%, respectively” (p.2). This range increases when accessing degrees awarded by race in five years with 33% and 42% of degrees awarded to White and Asians students, as compared to 22.1%, 18.4%, and 18.8% awarded to Latino, Black, and Native American students. The data denotes that retaining students in their degree of choice is essential to building a strong STEM workforce. The data further suggests that “fewer than 40% of students who enter college intending to major in a STEM field complete a STEM degree. Merely increasing the retention of STEM majors from 40% to 50% would generate three-quarters of the targeted 1 million additional STEM degrees over the next decade" (NSTC, 2008). When introducing gender, the data shows a disproportionate gap of college female freshman who actually intend to major in S&E degrees compared to men. Figure 1 displays the gender disparities in students intending to major in STEM fields. Men have consistently outnumbered women since 2008.

Figure 1

Percent of College Freshmen Indicating Intent to 1Major in Engineering, Math, Statistics, or Computer Science Fields, 2008 – 2017



Note. Higher Education Research Institute, UCLA. The American Freshman: National Norms, fall 2017; National Science Board. 2016. Science and Engineering Indicators 2016. Arlington, VA: National Science Foundation (NSB-2016-1).

The number decreases significantly when considering African American women, which leaves room for transformational changes to include initiatives that support underrepresented populations to be implemented in higher education institutions. In this study, the researcher will survey underrepresented populations who matriculate at Historically Black Colleges and

Universities (HBCU) and retrieve enrollment data from participants who major in STEM programs. An HBCU is defined as a college or university that was originally founded to educate students of African American descent (Britannica, 2020). Feedback from this population helps assess factors that influence degree completion and helps provide recommendations to increase program retention.

Statement of the Problem

The purpose of this study was to examine if a relationship exists between student engagement and academic achievement by evaluating African American female, full-time undergraduates majoring in science, technology, engineering, and mathematics (STEM) in comparison to female, full-time non-STEM majors at a Historically Black College and University to classify the most effective tools to assist in degree completion and student retention among women pursing STEM disciplines.

Research Objectives

To guide this research study, the following questions were developed:

RQ_1: Does the influence of academic challenges on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_2: Does the influence of learning with peers on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_3: Does the influence of experiences with faculty on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ$_4$: Does the influence of a supportive campus environment on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

Background and Significance

Simpson (2014) presented evidence contributing to the retention and academic success of men majoring in STEM in their undergraduate careers. Upon comparison to men majoring in non-STEM majors, he found minimal difference between STEM and non-STEM majors in how the benchmarks of student engagement influenced retention. In this study, the researcher will further investigate the retention and academic achievement of females who major in STEM fields at the undergraduate level to determine the significance of benchmarks on student engagement by comparing STEM and non-STEM majors.

Retention has been at the forefront of strategic planning at institutions across the nation for a number of years including the re-evaluation of recruitment practices between the K-12 and higher education community. On the federal and state levels, funding has been designated to assist programs that support STEM initiatives through state and local agencies. However, this avenue has not necessarily solved the problem with STEM in America. Clark and Esters (2018) argues that:

> despite billions of dollars being invested on hundreds of programs that are created to increase the number of minorities who enter STEM fields, data from Change the Equation, indicates that today's STEM workforce is no more diverse than it was 15 years ago (p.1).

The process of retaining and recruiting underrepresented populations has already begun throughout institutions across the country by implementing various ways to help students persist in their degree programs. This includes understanding potential barriers in enrollment. Gasman and Nguyen (2014) provide strategies to help underrepresented populations in STEM obtain degrees, which include:

1) Providing atmospheres that encourage success by acknowledging student accomplishments
2) Offers an environment that provides constant academic, emotional, and professional support
3) Faculty identification of low performance students in STEM courses
4) Financial subsidies by providing a low-cost education
5) Peer mentoring/tutoring
6) Opportunities to participate in undergraduate research
7) Diversity amongst faculty to offer encouragement and support (p. 86).

Ong et al. (2011) advocate that understanding how underrepresented populations learn is a "key challenge for researchers, educators, and policy makers drawn to this effort has been the lack of a coherent knowledge base about this population" (p. 176). With all of the evidence provided, there is still room for future investigations to make the case for untapped populations in STEM. There is also the need for the STEM community to implement changes to help underrepresented populations become a major part in the STEM workforce and education system. Studies show that students defer from STEM majors due to the lack of faculty support. According to Jones (2007), the current mindset of professors, politicians, and industry leaders needs to change so they can eliminate or recognize some of the unintended biases that discourage underrepresented populations in STEM. He maintains that while U.S. population's minority groups are expanding in size and influence, STEM representation is still low. To address this concern, Jones (2013) provides four initiatives to help with retaining underrepresented populations in STEM, including:

(1) Student mentoring programs

(2) Undergraduate teaching assistant training

(3) Supplementary instruction summer workshop

(4) Freshmen independent study skill training (p. 34).

Underrepresented populations extends beyond men and women; Historically Black College and University's (HBCU) can be categorized as an untapped resource also. If the nation is to increase STEM participation, new methods of inclusion must be investigated and established. The following study provided evidence in support of obtaining talent from HBCUs: "between 2006 and 2010, ten HBCUs were included in the top 20 institutions that award science and engineering bachelor's degrees to Blacks" (as cited in Gasman & Nguyen, 2014; NSF 2011, p. 76).

The National Science Board (2014) recommends that improving science and engineering education at the undergraduate level can assist in increasing retention of students. Engineering degrees awarded to underrepresented populations have seen the smallest increase since 1990 compared to other racial populations (Yoder, 2011; Engineering Workforce Commission, 2012). Outlining strategies to address the STEM shortage and sustainability issue across the nation includes identifying factors that involve students and institutions being participatory, persistent, and committed to student success in underrepresented populations. A part of this commitment to education is self-efficacy. Self-efficacy, a term associated with Albert Bandura, aligns with persistence (Painter, 2012). Students' perceptions play an integral role in program completion. Students should have an active role in the learning process and have a level of satisfaction with the process of obtaining degrees (Gonzalez et al., 2014). Previous studies on persistence in education revealed several influences:

> Oscar Lenning stated a multitude of factors taken from previous studies that give a well-rounded picture of what influences student persistence. These include demographics (gender, ethnicity, social class, age), previously quantified academic achievements (test scores, grades, subject level achieved), goals and motivations, internal values (self-concept, maturity), institutional factors (size, prestige, services), and interactive factors (peer interactions, campus involvement, faculty interactions, familial and collegiate relationships) (Painter, 2012, p.3).

Acknowledging that underlying barriers exist is the first step in obtaining a unified and diverse STEM education community and workforce. This means support is needed from the federal government, local administrators, and industry. One example refers to President Obama's 2015 Budget, which invested $2.9 billion, an increase of 3.7 from 2014 to support STEM education (White House Office of Science and Technology Policy, 2014). This research sought to provide evidence of the importance of including underrepresented populations in the nation's quest to secure a stronger STEM future.

Allen (2008) suggests that programs designated towards first year experiences are successful and retention is a good predictor of students persisting through graduation. The significance of this study is to identify factors that can assist students in persisting towards obtaining a baccalaureate degree in STEM fields. This study will assess STEM and non-STEM female students after the first year of their undergraduate academic career. Empirical data serves as a resource to higher education communities, administrators, and STEM curriculum designers relevant to retention and enrollment strategies. Data retrieved from this study can also be used to provide strategies to the National Society of Black Engineers institution partners as they seek to graduate an additional 10,000 black engineers annually by 2025 (NSBE, 2018).

Limitations

This study presented several limitations to participants and the subject matter of this study:

1. This study was limited to one institution with the classification of Historically Black Colleges and University (HBCU) in VA that offers STEM programs.
2. This study was limited to programs that fall in certain STEM departments in the STEM category. There are programs that classify engineering with another science, technology, physics, materials science, or mathematics programs in one department. For the purposes of this study, STEM programs with the distinction of the Accreditation Board for Engineering and Technology (ABET) will be utilized.
3. This study was limited to measuring academic success by retention, enrollment in sophomore through junior level curriculum, and graduating seniors. There are alternate methods in measuring academic success but for the purposes of this study, the definition is limited to retention in the second to fourth year students.
4. This study was limited to students categorized as underrepresented populations. For the purposes of this study, underrepresented populations are classified as women who are African American.
5. Research study participants were classified in STEM and non-STEM majors at a research-intensive institution in Virginia; therefore, study findings cannot be generalized.
6. This research used self-reported data from the National Survey of Student Engagement; responses were collected from 2016 – 2018.
7. This study was limited to measuring academic achievement by GPA.

Assumptions

There were several assumptions made in this study. These assumptions had to hold true for the study to reach its research objectives. The following assumptions were made:

1. The study participants were able to articulate the factors they perceive as being influential to their persistence and success in STEM programs.
2. It should be noted that participants might have chosen to negate to answer all questions of the survey, which may or may not skew assessment.

Procedures

One institution, which is designated as an HBCU, was selected to represent research-intensive institutions with STEM programs in Virginia that are recognized by the Accreditation Board for Engineering and Technology (ABET). The office of Institutional Research identified student enrollment data such as academic and demographic information. Academic achievement predictions were based on the second-year enrollment of new full-time freshmen in fall 2016 and fall 2018, respectively. The online survey served as the data collection method to identify persistence variables and enrollment data from institutions during the length of the commitment of this research study. Descriptive statistics analyzed data from study participants. Statistical analyses determined which variables were significantly correlated and impacted academic achievement and if differences between means, modes, and standard deviations of independent variables exist.

Definition of Terms

The following lists of terms were defined to eliminate any unintended misinterpretations of their meaning as intended for this study only:

***First Year Students* -** Students majoring in STEM programs who have completed their freshmen year requirements

ABET - Accreditation Board for Engineering and Technology

***Academic Success* -** "academic achievement, engagement in educationally purposeful activities, satisfaction, acquisition of desired knowledge, skills and competencies, persistence, attainment of educational outcomes, and post-college performance" (Alyahyan & Düştegör, 2020)

***Academic Achievement* –** Measured by end of the year GPA

Enrollment - A student is counted as having been enrolled in the fall or spring if they were enrolled for any length of time in a term that began throughout the calendar year

GPA - Grade Point Average

HBCU - Historically Black Colleges and Universities that are four-year institutions

***National Survey of Student Engagement (NSSE)* –** A data collection tool given to higher education institutions about student engagement (NSSE, 2020)

***Persistence* -** In this study, the term represents the propensity to remain a STEM major throughout undergraduate career matriculation

***Program Completion* -** Students who have satisfied all requirements to obtain the Bachelor of Science degree in STEM fields

***Retention* -** "The percentage of students who return to the same institution for their second year" (Snapshot Report, 2014)

***Senior* -** Students who are in their last year of study in STEM programs

Self-Efficacy - ***"***Beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, pg. 3)

STEM - Science, Technology, Engineering, and Mathematics was a term that originated from the National Science Foundation in the 1990s (Spellman, Jones, & Katsioloudis, 2014; Bybee, 2010).

Underrepresented Populations - For the purposes of this study, African American women matriculating at a Mid-Atlantic research-intensive institution are listed in this classification.

Overview of Chapters

To summarize, this study sought to identify African American female perceptions of engagement factors that influence academic achievement and enrollment in STEM programs to aid in increased retention and eventually persistence that will lead to the Bachelor of Science degree.

Chapter II provides a review of literature concentrated on retention, persistence, and student engagement to STEM degrees. A large portion of the literature explores influential factors that affect retention, academic achievement, persistence, and student engagement. This will be followed by Chapter III which focuses on the methodology and procedures used to extract data from study population that will help identify independent or correlations between persistence variables in retention in STEM programs.

Chapter IV presents the findings for the study, which led to Chapter V. Final recommendations were made based on study findings listed in Chapter IV. Conclusions and final recommendations were given to Historically Black Colleges and Universities that offer STEM programs to aid in possible infrastructure changes to assist with retaining students and institutional strategies to assist in academic achievement.

CHAPTER II

REVIEW OF LITERATURE

Persistence

There are various causes of influence that underrepresented populations encounter in persisting in their careers, education, and personal environments. For instance, defining one's identity plays a major role in determining one's goals and direction. Dunham (2016) describes student academic identity as "the appropriation of academic values and practices within a sense of self, reflecting the willingness and commitment to the practices of the academic community" (p.10). Painter (2012) reported factors taken from previous studies that provide an overview of other influences of student persistence. These include demographics (gender, ethnicity, social class, age), previously quantified academic achievements (test scores, grades, subject level achieved), goals and motivations, internal values (self-concept, maturity), institutional factors (size, prestige, services), and interactive factors (peer interactions, campus involvement, faculty interactions, familial and collegiate relationships) (Painter, 2012; Swail, 1995). In his early work, Vincent Tinto (1993), a respected scholar in the field of education for his work on student persistence and engagement, classifies two variables that coincide with students who do not complete degrees in their chosen fields as "intention" and "commitment" (p. 37). Hein et al. (2012) studied 300 students in science, math, and engineering; the goal was to investigate commitment to their major based on intention to stay in current major, attain their degree, and long-term commitment to being a scientist or engineer. Self-efficacy, a term associated with Albert Bandura, has been aligned with persistence (Painter, 2012). Iroegbu (2015) defines self-efficacy as follows:

> The belief, or confidence, that one can successfully execute a behavior required to produce an outcome such that the higher the level of self-efficacy, the more an individual

believes he or she can execute the behavior necessary to obtain a particular outcome (Bandura, 1977). One tends to avoid situations believed to exceed his or her abilities and get involved, without hesitation, in activities for which he or she feels capable (Bandura, 1977). A central idea posed in social cognitive theory is that success experiences raise self-efficacy but repeated failures lower self-efficacy (Bandura 1997, as cited in Iroegbu, 2015, p.1)

Another variable outlined by Bandura's historical work is motivation. According to Shin (2018), self-efficacy is one of predictors that indicate how students will be motivated and how they will learn (as cited in Zimmerman, 2000). He also indicates how the needs of students are coupled with their educational environment, which plays an important role in their motivation and behavior in that environment (Eccles et al., 1983, as cited in Shin, 2018).

Retention

Like persistence, retention amongst students at higher education institutions has been a staple in strategic planning initiatives across America in recent years. For example, the Provost's Student Retention Task Force (2019) illustrates that institutions have begun to take a more active role in retaining students during their freshmen year. It is noted that "Southern Utah University increased its first-year retention from 64% to 73% in only three years by implementing such a system" (p. 8). Opare (2012) attributes non-persistence or retention of STEM students to discrimination especially those in institutions dominated by men. The author states "in order to avoid social identity threats, many decide not to study STEM subjects or leave after they start" (Opare, 2012, pg. 45). In addition, Jones, Ruff, & Paretti (2013) examined factors affiliated with perceptions and identification, classified as stereotype threats in gender engineering achievement gaps. The results identified "engineering ability perception was the most significant predictor of achievement, and that engineering identification was the most significant predictor of persistence in engineering" (Jones, Ruff, & Paretti, 2013, p. 486). Previous research suggests "fewer than 40% of students who enter college intending to major in a STEM field complete a STEM degree. Merely increasing the retention of STEM majors from 40% to 50% would generate three-quarters of the targeted 1 million additional STEM degrees over the next decade" (NSTC, 2008, p.8). Implementing strategies to train teachers who have the ability to translate STEM concepts to students in a creative way is also a necessity. However, teachers cannot handle this task alone. In order to prepare students, the government is encouraged to partner with corporations, private industry, and foundations to create a streamlined approach to decreasing current gaps between the K-16 community learning standards compared to what is required in the workforce (NSTC, 2008).

Training Pipelines to Retention

Haag & Collofello (2008) identify academic advising and career counseling as two areas of urgent need that have not been adequately addressed for the nation's students. They suggest major advisors provide students with alternative avenues for success that will allow them to properly navigate college. Several states have begun the process of providing resources to train the STEM future workforce. For example, the state of Washington offers several initiatives for implementing STEM in the education community. Legislative action items have been created to provide a "pathway for future STEM school design" (Milliken & Adams, 2010, para.1). Funding has been secured at the state level to support STEM initiatives. Another recommendation is for the focus areas to be pushed through legislation so that ample funds are available to support STEM in elementary and secondary education. This is one example of outlining strategies to address the STEM shortage and sustainability issue across the nation. However, there are other underlying barriers that exist.

Potential STEM Retention Barriers

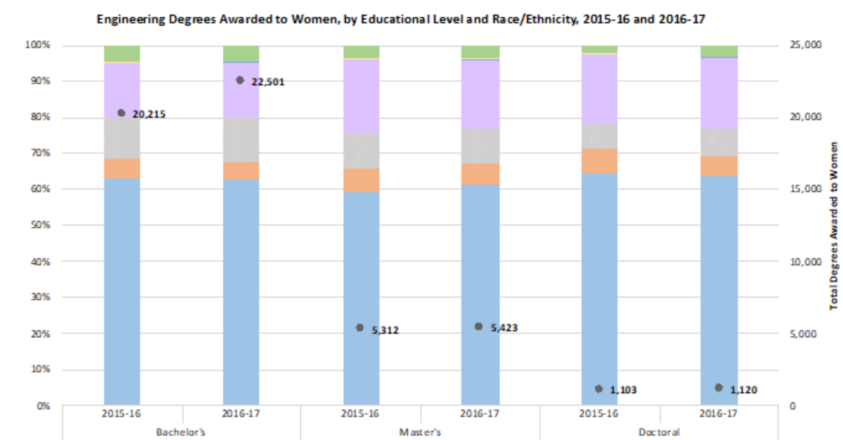
The list of nationally recognized minority groups in the United States include Asian American, Black or African American, Hispanic or Latino, Native Hawaiian and Other Pacific Islander, American Indian and Alaska Native (CDC, 2014). However, this list includes more than race; it also includes gender. According to the National Center for Science and Engineering Statistics (2017), about half of scientists and engineers (S&E) are Caucasian men. In addition, when considering other cultural demographics in S&E fields, men outnumber women. However, all demographics are needed to provide a sustainable STEM workforce (Riegle-Crumb & King, 2010), as explained below:

> disparities in STEM fields represent a troubling instance of stratification. Seen through the lens of national interest, the importance of diversity was recently underscored by reports from the National Academy of Sciences (2007a, 2007b), suggesting that, without the participation of individuals of all racial/ethnic backgrounds and genders, the increasing demand for workers in these fields will not be met, potentially compromising the position of the United States as a global leader (p.1).

Therefore, if it is not aptitude then what is the barrier? De Welde, et al. (2007) provide various reasons for the numerical shortfall of women in STEM. They include lack of female role models, perceived preferential treatment of men in the classroom, lack of encouragement in STEM, lack of high number of female faculty, gender biases in pay and status, and difficulty balancing work and home life. Underrepresented groups in STEM encompass more than race. Where does the disparity begin? As children, both boys and girls have an interest in science, however, it is suggested that the gender gap begins in middle school (Charlesworth & Banaji, 2019). Previous studies suggest that a gender gap exists although both boys and girls have an interest in science at an early age (Hilliard & Albrecht, 2020; Fryer & Levitt, 2009; National Center for Education Statistics, 1997; AAUW, 1992). However, over the last 20 years, STEM degrees obtained by women has increased (Reinking & Martin, 2018). Although an increase occurred, interest is lost at a higher rate than men. Reinking and Martin (2018) state "even when females perform as well or better than their male peers on STEM related tests or projects, and do not pursue advance courses, majors, and careers in STEM" (p.1). As children move through their academic careers, interest tends to dwindle. This trend also extends to industry; data reveal that women are outnumbered by male counterparts in science and engineering employment (73% vs. 27% overall) (NSF 2007a). Women in the U.S. are not alone; in a recent report, women are also underrepresented in STEM globally (Foster, 2019). It is suggested that low representation in STEM at every level (i.e., school to workforce) for women. Figure 2 denotes the engineering degrees by race, which outlines the disproportionate number of black females in engineering.

Figure 2

Engineering Degrees Awarded to Women, by Educational Level and Race/Ethnicity, 2015-16 and 2016-17



	Bachelor's 2015-16	Bachelor's 2016-17	Master's 2015-16	Master's 2016-17	Doctoral 2015-16	Doctoral 2016-17
Two or more races	4.5%	4.4%	3.5%	3.5%	2.2%	3.1%
American Indian / Alaska	0.3%	0.3%	0.4%	0.4%	0.3%	0.3%
Pacific Islander	0.2%	0.2%	0.1%	0.2%	0.0%	0.1%
Asian	15.2%	15.5%	20.6%	19.0%	19.3%	19.8%
Hispanic	11.3%	12.0%	9.9%	9.7%	7.1%	7.5%
Black	5.3%	5.0%	6.2%	5.7%	6.8%	5.6%
White	63.2%	62.7%	59.3%	61.4%	64.4%	63.6%
Total Degrees Awarded to Women	20,215	22,501	5,312	5,423	1,103	1,120

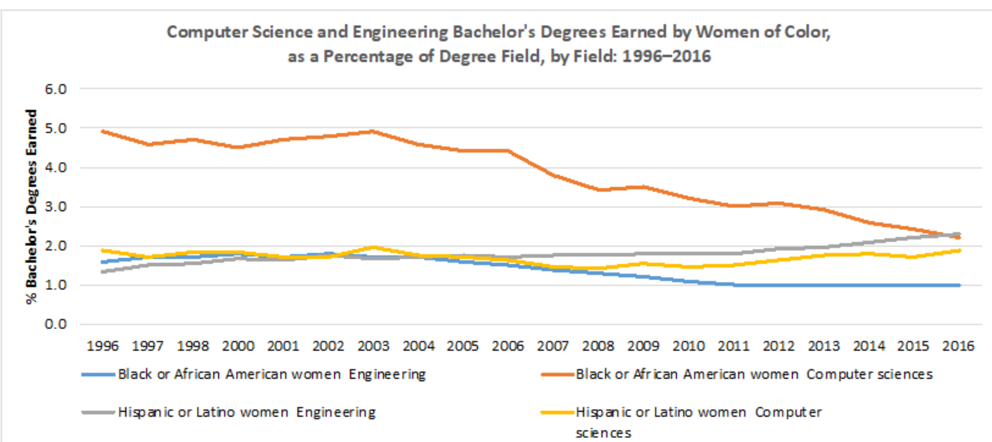
NOTE: Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, Digest of Education Statistics 2017.

Retaining underrepresented women and minorities has been a challenge (Brown, n.d). For this reason, restructuring of current recruitment practices between the high school and college level are encouraged. The process has already begun throughout institutions across the country in which they are implementing various ways to attract and retain underrepresented populations. One way is by increasing recruitment efforts upon high school graduation. Research studies agree that recruitment and retention are areas of concern for minority women. Knight, et al. (2011) agree that this is a problem that must be recognized nationally. Gasman & Nguyen (2014) provide strategies currently implemented by HBCUs across the country to help underrepresented minorities in STEM obtain degrees in STEM. These strategies include: 1) providing atmospheres that encourage success by acknowledging student accomplishments; 2) offers an environment that provides constant academic, emotional, and professional support; 3) faculty identification of low performance students in STEM courses; 4) financial subsidies by providing a low-cost education; 5) peer mentoring/tutoring; 6) opportunities to participate in undergraduate research; and 7) diversity amongst faculty to offer encouragement and support.

Ong et al. (2011) wrote an article titled "Inside the Double Bind: A Synthesis of Empirical Research on Undergraduate and Graduate Women of Color in Science, Technology, Engineering, and Mathematics" funded through the National Science Foundation, where a culmination of works and data collection over the years provide insight of underrepresented minority group (women) experiences in STEM. They made many observations resulting from a misunderstanding of how this group learns: "thus far, however, a key challenge for researchers, educators, and policy makers drawn to this effort has been the lack of a coherent knowledge base about this population" (Ong, et al., 2011, p. 176). Despite all of the evidence provided, there is still room for future investigations that will continue to make the case for the untapped population in STEM. There is a need for the community to implement success and change failures to help the underrepresented population become a major part in the STEM workforce and education system. Studies show that students defer from STEM majors due to lack of faculty support. The current mindset of professors, politicians, and industry leaders needs to change so they can eliminate or recognize some of the unintended biases that discourage underrepresented populations in STEM. While there is no quick fix, identifying barriers to women and underrepresented populations in the United States is imperative when recruiting and retaining STEM students.

Finances, or a lack thereof, are another contributing factor for underrepresented populations. Finances are cited as an important indicator of early departure and low enrollment in minority students who matriculate in STEM (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011) Higher Education institutions that offer monetary support to underrepresented populations help to retain and attract students to STEM fields. This is essential for students enrolled at HBCUs as finances play an important role in their persistence. Norfolk State University (NSU) created a program entitled Science and Technology Academicians on the Road to Success (STARS) that assisted in the coordination of student financial aid and stipends for STEM research grants and student stipends. It also provides scholarships to juniors and/or seniors each year to increase enrollment in response to retaining underrepresented populations (NSU, 2017). Figure 3 magnifies the decrease in degrees earned by women of color over the past 20 years.

Figure 3



NOTE: Source: National Science Foundation, National Center for Science and Engineering Statistics. 2019. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019. Special Report NSF 19-304. Alexandria, VA.

Historically Black Colleges and Universities

Historically Black Colleges and Universities (HBCUs) have a rich history of educating African Americans and underrepresented populations over the past 100 years. The U.S. Department of Education (n.d.) provides the following definition for HBCUs:

> any historically black college or university that was established prior to 1964, whose principal mission was, and is, the education of black Americans, and that is accredited by a nationally recognized accrediting agency or association determined by the Secretary [of Education] to be a reliable authority as to the quality of training offered or is, according to such an agency or association, making reasonable progress toward accreditation (para.1).

The White House Initiative on Educational Excellence for African Americans (2016) provided evidence for the success of educating blacks by outlining that 21 of the top 50 institutions with science and engineering doctoral degrees are HBCUs. Throughout the years of HBCU existence, they have educated and graduated members of the African American community. Knight et al. (2012) reported that HBCUs graduate a number of African Americans who are able to compete in the following:

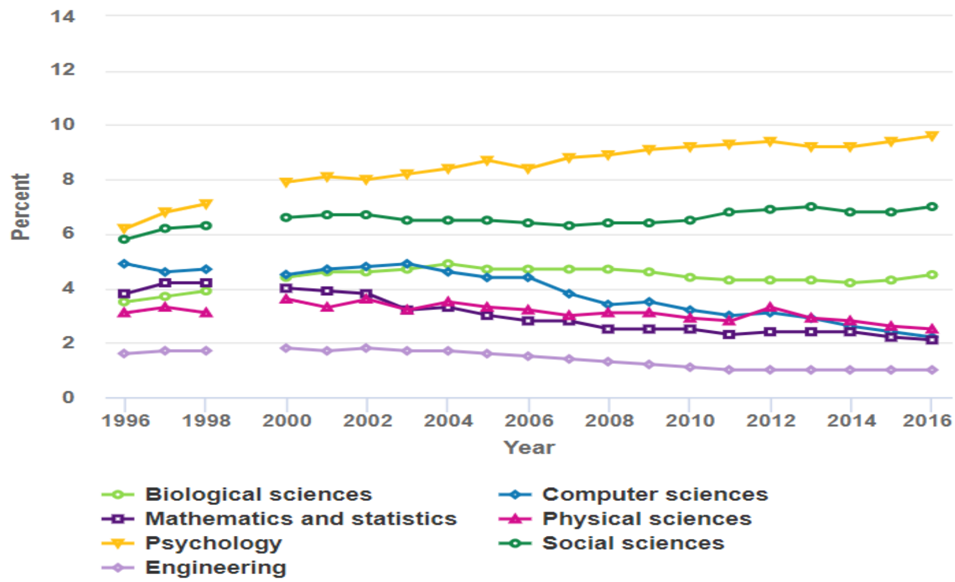
> corporate, research, academic, governmental, and military arenas. Specifically, over half of all African American professionals are graduates of HBCUs. Nine of the top ten colleges that graduate the most African Americans who go on to earn PhDs are from HBCUs. More than 50% of the nation’s African American public school teachers and 70% of African American dentists earned degrees at HBCUs (p. 224)

African American women have benefited from attending HBCUs; however, limited studies focus specifically on the interactions between black women and faculty relationships at HBCUs (Williams & Johnson, 2017). According to the National Center for Education Statistics

(2020), women have attended HBCUs at a higher rate than men. Enrollment increased "from 53 percent in fall 1976 to 62 percent in fall 2018" (para. 5). Not only do women attend HBCUs at a higher rate than men, several studies indicate almost seven out of ten HBCU graduates are women (Gasman, 2014; Gasman et al, 2010). Although the numbers are encouraging for women as a whole, the number varies when examining African American women who graduate with STEM degrees nationally. As shown below in Figure 4, there is a decline in African American women receiving science and engineering degrees over the last 20 years. This trend has the potential to reverse course by examining success of HBCU graduates. Rankins (2019) advocates that HBCUs can serve as an example to other institutions as they have experience in educating underrepresented populations specifically those "marginalized in other learning environments and it is critical that we look to these schools to learn how to best educate all STEM students" (p.1).

Figure 4

Science and engineering bachelor's degrees earned by black or African American women, as a percentage of degree field, by field: 1996–2016



Note: Data not available for 1999. Data are for U.S. citizens and permanent residents only (NCES, 2019).

STEM Funding

Over the years, large amounts of funding have been designated to assist programs that support STEM initiatives. However, various authors suggest that this avenue has not necessarily solved the problem with STEM in America. Part of the issue lies with the small number of students that complete elementary and secondary school with the appropriate knowledge to pursue further studies in STEM. Lips & McNeill (2009) denote prioritizing STEM education would benefit our economy in the years to come. They suggest:

> Improving learning in STEM education should remain a priority for American policymakers. For students, succeeding in K-12 STEM classes will open the door to future opportunities in higher education, and in the workforce. Also, ensuring that the

> next generation of American workers has adequate skills and training in critical areas is vital to America's national security and economic competitiveness. (Lips & McNeill, 2009, para.3)

A proposed method for U.S. policy makers is to create opportunities for local and state reform at the k-12 level. This can assist in fixing the STEM broken "pipeline" that currently exists. Policy makers are also encouraged to "support reforms that allow greater innovation to improve STEM education, including new school models, providing incentives for teacher excellence, and supporting other initiatives to promote learning in STEM fields" (Lips & Mcneill, 2009). Florida provides an example of these reforms working, where students have made dramatic progress on the annual National Assessment of Educational Progress, a reliable indicator of student learning. (Lips & Ladner, 2009).

The National Academy of Engineering and the Board of Science Education of the National Research Council Center for Education (2014) report "STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research" developed and distributed a plan for STEM education in the K-12 community that hoped to yield the greatest impact nationally. The report encourages an interdependent approach to teaching and learning STEM disciplines, increasing STEM literacy and interest in STEM fields, which may lead to STEM careers. In order to do this, there must also be an effective teacher workforce to foster hands-on learning and professional development opportunities to help keep teachers abreast of current STEM concepts. Three focal areas that will contribute to the integration or non-integration of STEM disciplines in the classroom are offered to include implementing standards, assessments, and providing opportunities for professional development for teachers.

Student Preparedness

Under-preparation in Academics

DeJong & Langenderfer (2012) found that the low persistence rate is partly due to so many engineering students being underprepared in math. Students unprepared to take calculus have extremely low persistence rates. In fact, until now, the progression of pre-calculus students are entirely undocumented in the engineering education literature (DeJong & Langenderfer, 2012). Data from the National Survey of Student Engagement shows that this similarity extends to engagement outcomes including course challenge, faculty interaction, satisfaction with institution, and overall satisfaction. Engineering differs from other majors most notably by a dearth of female students and a low rate of migration into the major. Noting the similarity of students of engineering and other majors with respect to persistence and engagement, I propose that engagement is a precursor to persistence (Ohland, et al., 2008).

Cognitive Factors

Byars-Winston, Estrada, & Howard (2008) provide three factors that are reflective of success in underrepresented populations: 1) contextual (perceive surrounding environments, campus climate, academic support, career barriers; 2) cognitive (self-efficacy can I do this and confidence); 3) cultural ethnic identity, belonging) (p.2). Haag & Collofello (2008) examined student cognitive attitudes associated with educational experiences in their new major contrasted to their engineering experiences. Thus, information gained could be a basis for decision making for future processes and proposed improvements (Haag & Collofello, 2008). French et.al (n.d) investigated the "extent theoretically-articulated" to cognitive, non-cognitive, and environmental variables predict engineering students' academic success and persistence. Results intended to provide support for the inclusion of specific factors in models designed to assist with the explanation of engineering student outcomes. They also found success in the use of seminars geared toward first year students' transition to college.

Academic Achievement

Chang et al. (2016) defines academic achievement according to scores on achievement tests or the grade point average (GPA) for each school year or semester. Sakiz et al. (2021) define academic achievement as a measure of individuals' level of knowledge and skills acquisition in higher education where institutional stakeholders have an interest. In this study, the researcher measures academic achievement through GPA. Previous research shows a link between academic achievement and student engagement. Selim & Yil (2014) suggest that there is a large amount of research focusing on student achievement and positive relationships from student engagement in the K-12 environment. However, higher education does not have the same research content on academic achievement and student engagement. Therefore, researchers have an opportunity to gain more data that reflects on how academic achievement and student engagement with the learning process may be improved from students' perspective. Sakız & Aftab (2019) outline academic achievement studies in higher education:

> Academic achievement, as measured by grade point average (GPA), is one of the performance outcomes of education and is associated with several personal and social outcomes, including higher self-concept (Guay et al., 2003; Sakız & Aftab, 2019), and social skills (Caemmerer & Keith, 2015). As this evidence illustrates, academic achievement is a good indicator of several key aspects during the course of life. For a few decades, university administrators and academics have sought ways to identify strong correlates of academic achievement that they can use in the education process. Around the world, university admission performance is the most common factor utilized for the

> prediction of academic success (Evans, 2000). However, while the traditional admission performance is still important, educators involved in higher education want to locate as many predictors of success as possible when planning and practicing at university. Therefore, academic achievement and associated learning outcomes in higher education are of significant interest to various stakeholders including students, researchers, teaching staff, tertiary education institutions, and funding authorities. (p. 2)

Mann (2021) suggests that over the years, college applications placed significant value in academic achievement (GPA) across the country. However, the pandemic caused institutions to seek additional ways to measure factors that contribute to prospective students' academic stories. Although alternative selection criteria were deployed, GPA still carries a significant weight but it does not solely tell students' stories. Student behaviors, experiences, and relationships can have an important role of their academic success as an undergraduate. Therefore, this research study aimed to identify influences on student engagement, such as campus environment, learning with peers, experiences with faculty, and academic challenges has on academic achievement.

Student Engagement

According to Kuh et al. (2008), student engagement symbolizes the time and energy students place on perceived institutional academic and social activities. Institutions across the country are committed to increasing retention by providing academic and social offering to attract and retain students who receive degrees from their institutions. Examples include offering peer led tutorial sessions that promote collaboration with undergraduates, research opportunities with faculty and student engagement and advising models where students can participate in their educational pursuits. Student engagement has a variety of definitions tailored to intuitional goals. For example, student engagement can be viewed as a construct that places motivation at its center. Great Schools Partnership (2016) defines student engagement as "the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education" (p. 1). In other words, if students are involved, motivated, and interested in their campus environment, they are more prone to persist in obtaining a degree in their perspective fields. Student engagement puts the ownership of learning and academic experiences on more than the institution. Martin & Torres (2016) concludes that three specific areas of student engagement exist to include behavioral, emotional, and cognitive engagement. These dimensions focus on students' levels of participation, how they react towards receiving both positive and negative feedback, and their personal commitment to learning. Previous studies have noted that engagement with one's institutional campus is necessary in order for an effective learning process to occur for matriculating students (Selim & Yil, 2014). These measures not only serve as a benefit to students but to the institutions to provide quality education for its stakeholders. Some student engagement benefits include satisfaction, social and academic achievements, and safety (Selim & Yil, 2014; Harris, 2008; Krause & Coates, 2008; Lewis, 2010; Li et al. 2010; Park, 2005; Wang & Eccles, 2012; Willems et al. 2009).

There is an enormous amount of literature regarding student achievement and student engagement that focuses on positive relationships throughout K-12; however higher education lacks the same depth of research on academic achievement and student engagement. This research provides the higher education community a deeper look at academic achievement and student engagement and provides institutional resources that put the voices of students at the center of their success. For the purposes of this research, student engagement will be classified through the students' perspective based on questions from the National Survey of Student Engagement.

National Survey of Student Engagement

The National Survey of Student Engagement (NSSE) is a self-reporting survey designed in 1999 to gather institutional data on undergraduate educational experiences (NSSE, 2020; NSSE, 2001). High order learning measures were used to capture engagement throughout the undergraduate experience (Eastern New Mexico University, 2016). In its infancy, the survey asked questions based on five benchmarks of student engagement to include influence of faculty, level of academic challenge, enriching educational experiences, active and collaborative learning, and supportive campus environment (NSSE, 2008). The survey was updated in 2013 to reflect indicator themes resulting in four benchmarks versus five. Quantitative reasoning, teaching practices and learning strategies, and interactions among various groups are all concepts investigated within the updated NSSE (Fosnacht & Gonyea, 2018). Additionally, the update provides the opportunity to improve the clarity and consistency of the survey's language and to improve the properties of the measures derived from the survey. The new indicators are (1) academic challenge (e.g., apply facts/theories to practical problems or new situations, review class notes after class, and connect learning to societal problems or issues), (2) learning with peers (e.g. explained course material, engaged with others on assignments, asked for assistance), (3) experiences with faculty (e.g. discussed career plans, academic performance, non-course topics with faculty), and (4) campus environment (e.g. quality of interactions with campus personnel and support services, and attendance of social and academic campus events) (National Survey of Student Engagement, 2020). Fosnacht & Gonyea (2018) summarize the way institutions across the country utilize NSSE to foster student engagement based on its benchmarks. They explain:

> NSSE collects information at hundreds of bachelor's-granting universities to estimate how students spend their time and how their educational experiences are shaped. Institutions use NSSE primarily in two ways. The first is to compare, or benchmark, their students' responses with those of students at other institutions. Such an approach provides the institution with diagnostic information about how their students are learning, and which aspects of the undergraduate experience have been effective and which are in need of improvement. The second way institutions use NSSE is to assess subgroups of their students to determine how student engagement varies within the institution and to uncover areas for institutional improvement for groups such as first-generation students (p. 62).

Academic Challenge

The academic challenge benchmark encompasses utilizing rigorous and challenging work with what and how students learn as its central focus (Turi, 2012; Kuh, 2009a). Simpson (2013) classifies the level of academic challenge as the "institutional promotion of high expectations and student demonstration of high academic standards and performance that encourages intellectual creativity and intentional participation in learning activities" (p. 24; see also Cole & Korkmaz, 2010; Jacob, 2002; Laird, Chen, & Ku, 2008). Several ways to measure academic challenge include the incorporation of critical thinking skills, institutional emphasis on academics both in and out of the classroom, and identification of student met required academic expectations. NSSE examines these measures by asking how often student respondents participated in "educational purposeful activities" (Judson College, n.d.). Turi (2012) supports the position of institutions creating expectations that formulate areas for high student achievement and academic performance. In addition to academics as a focal point of student engagement, new research has developed new instruments that incorporate measuring student motivation (Pineda et al., 2014; Seifert et al, 2010).

Understanding the various components of How People Learn (HPL) is essential in creating an effective student learning experience in a challenging academic environment (Bransford, J., Brown, A. L., Cocking, R. R., 2000). This idea requires the education community to become familiar with HPL in order for challenging academic climates that foster student learning in the classroom. Brown and Green (2011) define learning as a relatively permanent change in either behavior or in mental representations or associations brought about by experience (Ormrod, 2009). Students contend with various socioeconomic factors both in and outside of the classroom that affect their ability to rise to the rigorous academic challenge presented by STEM degrees (Oladipupo & Ehigbochie, 2017).

Learning with Peers

The next benchmark, learning with peers, fosters collaboration in all areas of one's academic career. Students use collaboration as a means to manage difficult coursework by discussing content with peers. Dubey (2019) supports peer collaboration and states: "for some students discussing or working through the course material at exam time is a strategy for dealing with exam stress and anxiety. Collaborative learning provides a boost to their self-confidence at exam time" (p. 29). In addition to managing course difficulty, Paranjape and Dharankar (2020) comment that peer learning also contributes to learning that is engaging, impactful, and creates higher order thinking. Vaughn & Cloutier (2016) suggest that learning is increased when students can apply classroom content in various settings by critically thinking and applying what was learned outside of the classroom (as cited in Chickering & Ehrmann, 1996). NSSE (2020) measures learning with peers by asking questions based on two components: collaborative learning and discussions with diverse others. Furthermore, it is suggested that diversity encompasses more than race, but economic backgrounds, religious beliefs, or political views other than owns personal views (NSSE, 2020).

Experiences with Faculty

First year students and their experiences with faculty are considered valuable relationships, as faculty have the ability to assist students in settling into the university academically and socially (Romsa, et al., 2017). Previous research outlines the necessity of interactions between faculty and students; it contributes to student retention and satisfaction, success, motivation, and academic achievement (Romsa, 2017; Anaya & Cole, 2001; Chickering & Reisser, 1993; Cokley, 2000; Endo & Harpel, 1982; Terenzini & Pascarella, 1980). Not only is interacting with faculty important but studies have shown that having a positive interaction increases the experiences of students through retention and academic performance (Wheatle, et al.; Kim, & Sax, 2009; Kuh & Hu, 2001; Lundberg & Schreiner, 2004; Sax, Bryant, & Harper, 2005). Creating a connection through exploring various ideologies, academic perspectives, or viewpoints from both faculty and student assist both cognitively and socially as the student matriculates through college (Pineda et al., 2014; Pascarella & Terenzini, 2005; Astin, 1993). NSSE (2012) measures experiences with faculty by the professional and academic interaction students and faculty/advisors have regarding academic and nonacademic content, research experiences, and timing of the feedback offered. Insight as to why experiences are relevant is listed below:

> Interactions with faculty can positively influence the cognitive growth, development, and persistence of college students. Through their formal and informal roles as teachers, advisors, and mentors, faculty members' model intellectual work, promote mastery of knowledge and skills, and help students make connections between their studies and their

> future plans. Student learning is heavily dependent on effective teaching. Organized instruction, clear explanations, illustrative examples, and effective feedback on student work all represent aspects of teaching effectiveness that promote student comprehension and learning (NSSE, 2021, para. 1).

In addition to the academic, cognitive, and social benefits of faculty student interactions, the HBCU community provides additional examples of experiences with faculty. For example, Spelman College created a program to provide avenues designed to reduce barriers faced by black women by using "deliberate interactions" between faculty and students and institutional practices that affect Black women persisting in STEM (Perna et al., 2009, p. 116). Underrepresented populations face various financial barriers in persisting towards graduation. Many students work to cover institutional and personal expenses. Programs designed to assist financially through scholarly activity (i.e. research experiences with faculty) assist in persisting towards degree attainment (DeLoatch & Mattix, 2013). Undergraduate research participation has historically better prepared all students for the challenges of graduate research (Hayward et al., 2016; see also Osborn and Karukstis, 2009; Laursen et al., 2010; Lopatto and Tobias, 2010; Linn et al., 2015) Undergraduate research provides students with intellectual challenges and experiences in the scientific methods of investigation, problem solving, state-of-the-art experimental procedures, and both independent work and teamwork. Continuing to emphasize undergraduate research experiences and faculty student interactions aides in the success of students by providing necessary experiences for graduate school.

Supportive Campus Environment.

Administrators of the higher education community aim to create supportive campus environments that foster student success leading to degree attainment (Thomas, 2019). Recent studies outline various ways to accomplish a supportive campus environment to include the formation of learning communities, on campus activities, academic and social advising, and peer tutoring, as they all have an impact on retaining students in STEM majors and on campus (NSU, 2017; Loveless-Morris & Reid, 2018; Hill & Woodward, 2013). For example, the School of Science and Technology at a local HBCU developed a vigorous platform to include K-12 preparation, recruiting initiatives, academic advising and mentoring, undergraduate faculty/student research opportunities, and curriculum development in efforts to increase the graduation rates of students who are categorized in underrepresented populations. All of the components outlined above aimed to contribute to providing a supportive campus environment. In addition, higher education communities have capitalized on using graduate and undergraduate students and made them an important part of the educational structure across the nation, ex. peer tutors, research and teaching assistants, and peer mentors (Spellman, 2013). NSSE (2021) measures the supportive campus environment benchmark by respondents' indications of the quality of their interactions with the campus community to include peers, faculty, administrators, and staff (NSSE, 2020). In addition, a supportive campus environment is intended to capture the institution's commitment to student learning and success based on institutional offerings from the survey respondents' perspectives. Reason (2013) denotes that when a student experiences a supportive campus environment coupled with institutional goals that align extracurricular and academic activities, student learning happens (see also Pascarella and Terenzini 2005; Terenzini and Reason 2012). Wright (2017) supports this claim by providing an example from Vincent Tinto's work on student retention. He states:

> Tinto proposed that university environments play a critical role in facilitating integration, especially for those students who are more likely to find themselves on the boundaries that define social integration (see also Attinasi, 1989; Tinto, 1993). He commented that a

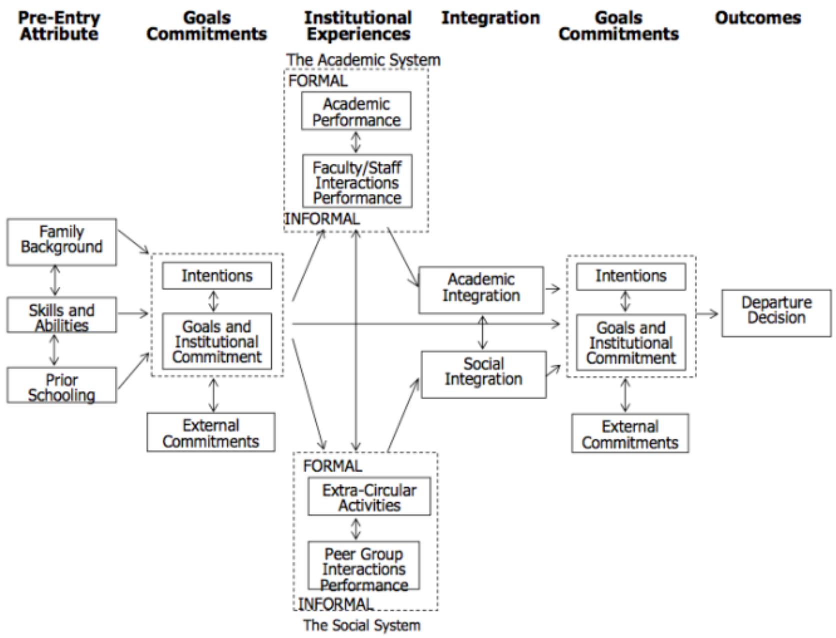
> university's capacity to reach out and make contact with its students is a defining characteristic of a healthy culture by empowering individuals to succeed through finding a societal niche or cultural subgroup on campus. This can be increasingly important for minority or other lesser represented populations in order for these students to avoid feeling alienated or outside of the mainstream practices occurring on campus (p. 44).

Student Departure Theory

As institutions seek various ways to be competitive, retention remains at the forefront of the higher education community; this is essentially important as institutions apply for grants and government resources. Vincent Tinto's (1993) Student Departure Theory serves as an indicator of depicting student engagement. Hill (2013) notes that "Tinto's (1987) model of departure was used to explain why 41% of those entering college departed the higher educational system without obtaining a degree. In this model, Tinto described of student departure as an interaction between the student and their institutional environment" (p. 21). The theory offers the following components as measures of matriculating or departing from college, as seen in Figure 5. They include: 1) pre-entry attribute, 2) goals commitments, 3) institutional experiences, 4) integration, 5) goals/commitments, and 6) outcomes. This study will focus on the 3rd phase of Tinto's Departure Theory, Institutional Experience.

Figure 5

Vincent Tinto's Conceptual Schema for Dropout from College



Note. A Conceptual Schema for Dropout from College, (Tinto 1993)

Creating a More Diverse STEM Workforce

The Office of the President (2018) points out that women make up less than 30% of those employed in STEM fields although they are half of the U.S. population. Stem representation of those classified in the underrepresented category is very low, only 11%. To address this concern, North Carolina A&T State University, in conjunction with a program entitled the Minority Science and Engineering Improvement Program (MSEIP), provides four initiatives to help with retaining underrepresented populations in STEM at their institution. They include: (1) student mentoring program; (2) undergraduate teaching assistant training; (3) supplementary instruction summer workshop; and (4) freshmen independent study skill training (Brown, n.d.). Because of the proposed activities, the freshmen retention rate improved in fall 2009. The untapped resource (underrepresented population) extends beyond merely women but includes the entire Historically Black College and University (HBCU) community.

Over the years, large amounts of funding have been designated to assist programs that support STEM initiatives. However, this avenue has not necessarily solved the problem with STEM in America. Lips & McNeill (2009) suggest that Improving learning in STEM education should remain a priority for American policymakers. For students, succeeding in K-12 STEM classes will open the door to future opportunities in higher education, and in the workforce. Also, ensuring that the next generation of American workers have adequate skills and training in critical areas is vital to America's national security and economic competitiveness. The suggested method for U.S. policy makers is to create opportunities for local and state reform at the k-12 level. Policy makers are also encouraged to support reforms that allow greater innovation to improve STEM education (p.1). Finding creative ways to keep students interested in STEM disciplines is a task designed not for the education community but the United States government as well. The National Science Foundation explains that “if the U.S. fails to increase the number of students mastering STEM content and preparing for STEM careers, the nation will fall farther and farther behind in the global economy - and that affects us all” (Community for Advancing Discovery Research in Education. (2011).

Summary

Chapter II presented a literature review of engagement factors that assist students succeed academically, retaining women in STEM, the barriers that exist, and efforts in place to address existing practices. Although significant progress has been made in STEM fields, progress in some cases has been too slow or stunted, as shown in degrees earned by women in engineering (National Academies of Sciences, Engineering, and Medicine, 2020; Armstrong and Jovanovic, 2015; Nassar-McMillan et al., 2011; NSF, 2002; NSF, 2017). This reference notes that "even though the percentage of women earning bachelor's degrees in engineering doubled from 2001 to 2010, their numbers in 2010 were still extremely low at 16 percent, and even slightly declined by 2015" (p. 9). Sustainable measures to include women through efforts such as retention, academic, and non-academic support, which serve as a roadmap to the inclusion of underrepresented minorities in STEM throughout all levels of education, are needed. As the nation strives to increase the number of additional STEM degrees, transformational best practices that support underrepresented minorities are topics of investigation.

Chapter III discusses the method and instruments used to discover factors that have contributed to the academic success of underrepresented populations from first to sophomore year in STEM disciplines. Also discussed in Chapter III is a description of the study population and sample, the method of selecting the sample, and the statistical tools selected for analyzing the data collected.

CHAPTER III

METHODOLOGY

Introduction

This research study used a descriptive survey design to investigate the relationship between student engagement and academic achievement by comparing African American female, full-time undergraduate students in select science, technology, engineering, and math (STEM) majors to female, full-time undergraduate students in non-STEM majors at a Historically Black College and University. The intention of this study was to assist institutional stakeholders like administrators, faculty, staff, and students identify specific practices that help retention rates increase within the African American female STEM population at HBCUs. The preferred method will focus on the voices of the participants in hopes of increasing the number of women in STEM fields. A survey methodology was used to examine research study participants' engagement experiences. The researcher examined participant perception, evaluation, and experiences from females majoring in STEM and non-STEM majors in for this study. The chapter outlines study methodologies to include student population, research variables, statistical measures, procedures, and analyses.

Participants include African American female students majoring in STEM professions at a HBCU located in the Mid-Atlantic region of the United States. The participant selection of STEM and non-STEM fields is vital as they are aiming to persist through various curriculums while matriculating in college. The purpose of this study was to investigate the relationship between student engagement and academic achievement of African American female students by comparing fulltime majors in STEM to full-time students in non-STEM majors to aid in increasing program retention and continued enrollment in STEM fields. Data retrieved from this study can also provide strategies to the National Society of Black Engineers institutional partners as they seek to graduate an additional 10,000 black engineers annually by 2025.

Population and Sample

This study used existing survey data from a Historically Black College and University in the Mid-Atlantic Region of the U.S. that participated in the National Survey for Student Engagement (NSSE) during the 2016 - 2018 academic years. In order to protect confidentiality, this research refrained from reporting the institution's name. The survey participants were undergraduate African American female students enrolled in face-to-face Science, Technology, Engineering, and Mathematics (STEM) courses compared to non-STEM majors that fall within the same category. Students must have completed entry level math and science course required for first time freshman.

In 2016, total enrollment decreased due to the change in federal laws that affected student financial aid, in which 90% of students at this institution rely on. In this study, the researcher will opt to use full-time undergraduate female students during the 2016 - 2018 academic years. To provide a substantive number, academic years were combined. This study investigated benchmark indicators associated with the National Survey of Student Engagement (NSSE) engagement indicators and its influence on the retention of female, full-time undergraduate student STEM majors by comparing the responses of female full-time undergraduate student STEM majors to the responses of female full-time undergraduate student non-STEM majors. Simpson (2013) and Sullivan (2010) offer that academic success is synonymous to retaining students. Therefore, in this study academic success measures students retained from their freshman to sophomore year with a GPA of 2.0 or better as indicated by university standards

(NSU, 2018). Surveys were distributed online to all students who sought degrees listed in Table 2.

Table 2

Population B.S. Degree Category

Academic Concentration	# of majors included	Degree Title
School of Business	5	Business Entrepreneurship, Business Finance, Business Management, Business Management Information Systems, Business Marketing
School of Education	3	Early Childhood Education, Health, Education & Physical Science, Secondary Education
College of Liberal Arts	7	English & Foreign Languages, History, Mass Communications, Political Science, Psychology, Sociology, Visual & Performing Arts
College of Science, Engineering & Technology	7	Biology, Chemistry, Computer Science, Engineering, Mathematics, Physics, and Technology
School of Social Work	1	Social Work

Note. All majors that fall in degrees listed above are included.

Instrument Used

Participant data is derived from the National Survey of Student Engagement (NSSE), an annual survey that collects information from students matriculating at undergraduate institutions across the nation. A subsidiary report used to determine success through engagement by NSSE is the College Student Report, which includes the ten-student engagement indicates categorized into four themes, as listed in Table 3.

Table 3

Topical Themes that Represent Student Engagement Indicators and Items

Student Engagement Themes	Number of Statements
Academic Challenge	Higher-order learning, reflective & integrative learning, learning strategies, an quantitative reasoning
Learning with Peers	Collaborative learning and discussions with diverse others
Experiences with Faculty	Student-faculty interaction and effective teaching practices
Campus Environment	Quality of interactions and supportive environment

Note: Adapted from the National Survey of Student Engagement, 2012.

The NSSE states:

> Through its student survey, *The College Student Report*, NSSE annually collects information at hundreds of four-year colleges and universities about first-year and senior students' participation in programs and activities that institutions provide for their learning and personal development. The results provide an estimate of how undergraduates spend their time and what they gain from attending college (National Survey of Student Engagement, 2018, p. 1).

The College Student Report consists of 47 questions containing 85 statements grouped by student engagement indicator themes (see Appendix B). The instrument is sent to students classified as first-year freshman and seniors. For the purposes of this study, first year freshman retained as sophomore - seniors are used to measure student engagement. Responses are categorized by the Likert scale of very often, often, sometimes, and never. The first set of questions helped obtain data regarding higher-order learning and reflective, learning strategies, quantitative reasoning, and integrative learning. Students provided insight on analyzing or applying methods or theories to new situations and taking an inward look at conceptual knowledge personally and through others lens. The second group of questions relate to collaborative learning and diverse discussions with others. Here respondents identified how often students communicated and worked collaboratively with peers of different cultures, beliefs, and political views. The third set of questions sought to find inferences regarding student faculty relationships. Students categorized the effectiveness of formative assessments, academic performance, activities with faculty, and career plans with faculty. The last set of questions sought responses based on students and their campus environment experiences. For example, students were asked to indicate the quality of interactions with campus community (i.e., faculty, students, support staff, peer tutoring, extracurricular activities). Table 4 represents the questions relating to the student indicator themes.

Table 4

Topical Themes that Represent Student Engagement Indicators

Student Engagement Themes	Number of Statements
Academic Challenge	17
Learning with Peers	8
Experiences with Faculty	9
Campus Environment	13

Research Variables

Student engagement indicators developed by NSSE operated as the independent variables to determine their influence on retention. They include: (a) academic challenge, (b) learning with peers, (c) experience with faculty, and (d) and campus environment. The researcher measured academic success by retaining of students from their first to second year. It is classified as the dependent variable mediated by grade point average. The dependent variable assisted in proving evidence of any influences between females who achieve academic success in STEM and NON-STEM disciplines. As mentioned in Chapter II, retention is used in various level of government, funding agencies, and higher education communities to determine annual budgets, institutional efforts, and aid. Previous research provided significant data that declared almost 40% of first-year students will not persist to their sophomore year of college (Simpson 2013, Morrow & Ackermann, 2012; Tinto, 1993). This data, coupled with the low retention rate from first to second year academic success, is a suitable measure for retention (Simpson, 2013, Kim et al, 2010). GPA served as a mediator variable for this research; institutions are graded through various accreditation agencies and use academic performance to determine funding or academic support for programs. Therefore, academic achievement (GPA) is suitable for this research as it relates to retention. For the purpose of this study, academic success is reached if participants were retained from their first year to their sophomore year.

Reliability and Validity of NSSE Instrument

NSSE underwent a rigorous quantitative and qualitative “psychometric” testing resulted in the creation of the ten engagement indicators, which replaced the former five benchmarks (NSSE, 2018). Descriptive statistics, analyses, and various testing methods were employed to ensure measures performed as intended, to include:

> exploratory factor analysis, confirmatory factor analysis, known-groups validity, internal consistency reliability, generalizability theory, concurrent and predictive validity, cognitive interviews, focus groups, and item response theory (National Survey of Student Engagement, 2018, n.d.).

Reliability

According to Joppe (2000), reliability is defined as the extent to which results are consistent over time. In addition, if results from a study can be replicated utilizing a methodology that is comparable, the instrument or study is considered reliable (Golafshani, 2003; Joppe, 2000). The NSSE instrument tested both temporal stability and internal consistency to measure for reliability (National Survey of Student Engagement, 2014). In addition, Cronbach’s alphas and intercorrelations for NSSE scales were calculated as another verification tool of measuring how items relate to each other (National Survey of Student Engagement, 2010). Cronbach’s alphas for the NSSE Engagement Indicators (Table 5) ranged between .758 for the first-year Learning Strategies scale and .887. Since results show Cronbach’s alphas for subpopulations were above the .70 standard, results suggest NSSE scales high reliability and consistency (National Survey of Student Engagement, 2016).

Table 5

Required Cronbach's Alpha Level

Scale	First-Year α
Higher-Order Learning	.845
Reflective & Integrative Learning	.867
Quantitative Reasoning	.838
Learning Strategies	.758
Collaborative Learning	.823
Discussions with Diverse Others	.878
Student-Faculty Interaction	.826
Effective Teaching Practices	.839
Quality of Interactions	.848
Supportive Environment	.887

Note. Adapted from "Table 2 Scale Cronbach's Alpha by Class" by the National Survey of Student Engagement, 2016, p. 2.

Student Engagement Indicators was also tested by examining the temporal stability using Pearson's *r* as noted in Table 6. In 2014, NSSE tested temporal stability by conducting a correlation analysis on its institutions. Scores for engagement indicators were obtained from 190 institutions in academic years 2013 and 2014. In 2014, engagement indicator scores from 190 institutions, who participated in both the 2013 and 2014 NSSE survey administrations with at least 50 first-year or senior respondents, were analyzed. Pearson's r was used to identify correlations; all except first year Learning Strategies fall above .70, which shows stability over time (see Table 6). Litwin (2003) offers that correlations of at least .70 are reasonable indicators that responses are consistent from one point in time to another (National Survey of Student Engagement, 2014).

Table 6

Pearson's r Correlation of NSSE Characteristics of Student Engagement

Indicator	First-Year
Academic Challenge	
Higher-Order Learning	.76
Reflective & Integrative Learning	.78
Quantitative Reasoning	.77
Learning Strategies	.63
Learning with Peers	
Collaborative Learning	.85
Discussions with Diverse Others	.80
Experiences with Faculty	
Student-Faculty Interaction	.79
Effective Teaching Practices	.76
Campus Environment	
Quality of Interactions	.79
Supportive Environment	.72
Institutions (n)	175

Note. Adapted from "Table 1. 2013-2014 Engagement Indicator Correlations by Class" the by National Survey of Student Engagement, 2014, p. 2

Validity

Heale and Twycross (2015) define validity as the "extent to which a concept is accurately measured in a quantitative study" (p. 66). NSSE's former five benchmarks were tested by utilizing a research based and theoretical conceptual framework (Simpson, 2013) resulting in high validity throughout its initial years (Simpson, 2013, National Survey of Student Engagement, 2018). However, as benchmarks were reframed into the new ten engagement indicators and four themes, new formative strategies were employed to assist the higher education community best practices. National Survey of Student Engagement (2018) states that the "Engagement Indicators combined high face validity with a more coherent framework and specific measures for the improvement of teaching and learning; in addition, six items related to High-Impact Practices began to be reported separately" (National Survey of Engagement, 2018, n.d.). The following forms of validity tests encompass the scope of studies representative of the history of NSSE until the present: (a) response process validity, (b) content validity, (c) construct validity, and (d) concurrent validity.

Response process validity seeks to determine if participants comprehend questions as NSSE intends. Answers were derived using cognitive interviews and focus groups. Experts determined validity and scope of questions by measuring content validity. The conceptual framework initially began in 2003 with two variations in 2009 and 2013. Construct Validity used factor analyses to support the ten engagement indicators and themes. The National Survey of Student Engagement (2018) denotes "by examining EI factor structures through exploratory and confirmatory factor analysis, quantitative evidence can support claims that the engagement indicators actually measure what they intend to measure" (p. 1). To test concurrent validity, NSSE researchers used data from 2008, 2011, and 2014 to compare responses from participants' major against institutional data. Results from the various validity tests throughout the year resulted in the continued use of the instruments at higher education institutions across the country. National Survey of Student Engagement (2018) declares "in addition, their strong reliability and validity properties have proved useful for supplemental analyses by institutions and higher education researchers" (National Survey of Engagement, 2018).

Research Questions

To guide this research study, the following questions were developed:

RQ_1: Does the influence of academic challenges on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_2: Does the influence of learning with peers on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_3: Does the influence of experiences with faculty on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_4: Does the influence of a supportive campus environment on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

Methods of Data Gathering

This study was conducted at a large, public Historically Black College and University, mid-Atlantic university in Virginia that participated annually in the National Survey of Student Engagement (NSSE) during the 2016 – 2018 academic years. Academic years were combined as a measure to have a sufficient female sample set to provide recommendations to the higher education community. The Office of Institutional Effectiveness invited students to complete the NSSE College Student Report annually in the corresponding study baseline years. The researcher examined, coded, and cleaned the data for this study. The researcher collected the following data: gender, classification, academic status, major, and GPA from student participants. Data identifying participants was excluded to ensure privacy. The researcher drew from a sample of female respondents to the College Student Report during the baseline years for statistical analysis performance. The study utilized participants who self-report as females; not all other classifications will be included. The categories were divided into two groupings based on STEM on NON-STEM disciplines. The researcher used a one-way analysis of covariance (ANCOVA) when applicable to test the influence of retention as the mediator and a one-way analysis of variance (ANOVA) to perform statistical analyses. ANOVA was selected as it is a process of inspecting the difference amongst means of various groups of data for homogeneity and uses regression.

Statistical Analysis

To conduct statistical analysis on this study, the Statistical Package for the Social Sciences (SPSS) was chosen. Figure 6 outlines steps the researcher took to perform statistical analyses for this study. In efforts to diminish TYPE I and TYPE II errors from the instrument, data cleaning was necessary (Simpson, 2013; Field 2009). The researcher categorized data by major into STEM and non-STEM groups to identical initial differences. The ranges were determined by the following criteria: 1) low range = standard deviation – mean; 2) high range = standard deviation + mean; and 3) all remaining scores were assigned to the medium range. In order to examine differences between and within groups, the researcher created six categories that stemmed from the previous ranges and classified total mean score responses into STEM HIGH, STEM MEDIUM, STEM-LOW, NON-STEM HIGH, NON-STEM MEDIUM, and NON-STEM LOW. NSSE classifies its scale determination by using a Likert response scale of “very often,” “often,” “sometime,” and “never” to its College Student Card questionnaire see APPENDIX B). The questions were designed to gauge association with its student engagement indicator themes (i.e., learning with peers, experiences with faculty, supportive campus environment, and academic challenge), which allowed for further analysis.

Figure 6

Steps for Research Statistical Analysis

The researcher ran an ANOVA to determine if a relationship existed between both dependent and independent variables corresponding to the six categories listed above. Testing was performed against the independent and dependent variables to determine levels of significance. After this, the Tukey's post-hoc test was performed to determine differences amongst groups and control for Type I error (Simpson 2013, Field, 2009). The next phase of the analyses was to calculate the effect sizes (n^2), which examined relationship strength between retention and the student engagement indicators. According to Cohen (2015), effect sizes are categorized in distinct sizes that fall between small, medium, and large. Table 7 lists the breakdown.

Table 7

Difference Between Two Means*

Size of effect	*d*	% variance
Small	.2	1
Medium	.5	6
Large	.8	16

Note. Cohen's *d* is not influenced by the ratio of n_1 to n_2, but r_{pb} and eta-squared are.

The next step in the process used ANCOVA to identify outcomes for Retention, the mediator variable and covariant. The covariant is used independently against each student engagement indicator to determine its level of significance. However, before ANCOVA analysis could be conducted, the assumption of homogeneity-of-slopes was tested to verify ANCOVA could be conducted. Simpson (2013) signifies that the significance of a covariant and independent variable's relationship offers differences on the dependent variable in groups because of covariant. If the interaction is significant, Field (2009) states that the ANCOVA cannot be conducted. Therefore, conducting both ANOVA and ANCOVA analysis allowed for determination of whether the independent variables and outline if GPA influences retention, if so, to what degree. Lastly, comparisons between STEM and NON-STEM disciplines were analyzed both between and within STEM and non-STEM major groups. Results are presented in Chapter IV.

Summary

The study's purpose was to investigate the relationship between student engagement and academic achievement of African American female, full-time female students by comparing science, technology, engineering, and mathematics (STEM) disciplines to non-STEM disciplines African American females in efforts to provide evidence-based practices and recommendations to the higher education community to increase academic success and retention. NSSE's four student engagement indicator themes served as independent variables, including: (a) academic challenge, (b) learning with peers, (c) experience with faculty, and (d) and campus environment. The dependent variable used is academic achievement, retentions as covariant. Statistical analyses and procedures aforementioned are suitable means to discuss study research questions and perform analyses. This research aimed to find sustainable measures for the higher education community to employ to increase representation of African American women in STEM degree attainment. Chapter IV outlines the researcher’s findings for this study.

CHAPTER IV

RESEARCH FINDINGS

The purpose of this study is to examine whether a relationship exists between student engagement and academic achievement by evaluating African American female, full-time undergraduates majoring in science, technology, engineering, and mathematics (STEM) to female, full-time non-STEM majors at a Historically Black College and University to classify most effective tools to assist in degree completion and student retention among women pursing STEM disciplines. The outcome of the study was reported in this chapter.

This research was guided by the following research questions:

RQ_1: Does the influence of academic challenges on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_2: Does the influence of learning with peers on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_3: Does the influence of experiences with faculty on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_4: Does the influence of a supportive campus environment on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

This study contributes to emerging research related to retention, academic achievement, and academic success of undergraduate African American females in STEM fields. As the nation strives to increase the number of additional STEM degrees, transformational best practices that support underrepresented minorities are topics of investigation. Feedback from this population assesses factors that influence degree completion and provide recommendations to increase program retention at higher education institutions across the country. This chapter provided findings obtained from the population studied by NSSE, analysis of the survey questions, its benchmarks, and an overall summary.

Population

This study used existing survey data from a Historically Black College and University in the Mid-Atlantic Region of the U.S. that participated in the National Survey for Student Engagement (NSSE) during the 2016 - 2018 academic years. In order to protect confidentiality, this research refrained from reporting the institution's name. The survey participants were undergraduate African American female students enrolled in face-to-face Science, Technology, Engineering, and Mathematics (STEM) courses compared to non-STEM majors that fall within the same category. Students must have completed entry level math and science course required for first time freshman. The total number of respondents who met the study's criteria were 561. Academic years were combined as a measure to have a sufficient female sample set to provide recommendations to the higher education community. The Office of Institutional Effectiveness invited students to complete the NSSE College Student Report annually in the corresponding study baseline years. The researcher examined, coded, and cleaned the data for this study. The researcher drew a sample of female respondents to the College Student Report during the baseline years for statistical analysis performance. The study utilized participants who self-report as females; not all other classifications will be included. Both a one-way analysis of covariance (ANCOVA) and a one-way analysis of variance (ANOVA) will be used along with SPSS to perform statistical analyses. ANOVA is selected as it is a process of inspecting the difference amongst means of various groups of data for homogeneity. To allow for comparisons within and between subjects, data were categorized into STEM and Non-STEM groups. The researcher used SPSS to obtain the total score from each study's independent variables (NSSE benchmarks academic challenge, learning with peers, experiences with faculty, supportive campus environment). The researcher calculated the total score from respondents' answers to the NSSE College Student Report, which associated the experiences of students with each of the indicators (i.e., independent variables). Descriptive statistics from the total score were used to identify indicator (independent variables) standard deviation and means to develop low, medium, and high ranges within both Non-STEM and STEM groups. The ranges were determined as follows: low (subtract the standard deviation from mean), high (add both standard deviation and mean together), and medium consists of remaining values that fall between high and low ranges. Next, the researcher recoded these values into new variables that combined low, medium, and high ranges for each group. Determining where specific differences lie resulted from the participant data being assigned to the six groups created (Non-STEM Low, Non-STEM Medium, Non-STEM High, STEM Low, STEM Medium, and STEM High) based on each NSSE indicators total score. In this research, utilizing ANOVA allowed for comparisons. ANCOVA tested the influence of retention as the mediator variable. These statistical analyses offered a comparative look at how student engagement influenced academic achievement of African American female STEM and Non-STEM majors.

Results

RQ_1: Does the influence of academic challenges of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

The researcher conducted a one-way analysis of variance (ANOVA) to evaluate the influence student engagement indicators (i.e., academic challenge) have on African American women majoring in STEM and non-STEM fields academic achievement, and retention from their first to second year of college. Academic achievement (GPA) served as the dependent variable and retention, which indicated if study participant persisted to the sophomore year of college and the independent variable, academic challenge, was used in both major categories based on their responses using a Likert scale in the NSSE survey. The study results for RQ_1 were not significant, F (5, 548) = 2.02, p = .74. It, therefore, cannot be determined how academic challenge influenced differences in academic achievement between STEM and non-STEM groups. The researcher did not conduct post-hoc tests because results were not significant.

Next, the researcher performed an ANCOVA to determine if the significance for academic challenge remained the same after introducing retention as covariant. In order to proceed with an ANCOVA preliminary testing (homogeneity of slopes) had to occur. The results from the homogeneity of slopes of academic achievement and academic challenge are outlined in Table 8. Findings indicate that the interaction between GPA and academic challenge was significant F (6, 547) = 20.94, p = .000 indicating the differences on GPA varied as a result of the covariant. This result caused a violation of homogeneity of slopes assumption; therefore, ANCOVA could not be conducted.

Table 8

Academic Challenge Test of Between-Subject Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	32.328[a]	6	5.388	20.944	.000
Intercept	30.606	1	30.606	118.968	.000
AcademicChallenge * Retained	32.328	6	5.388	20.944	.000
Error	140.725	547	.257		
Total	4998.393	554			
Corrected Total	173.053	553			

Note. a. R Squared = .187 (Adjusted R Squared = .178)

RQ_2: Does the influence of learning with peers of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

The researcher conducted a one-way analysis of variance (ANOVA) to evaluate the influence student engagement indicators (i.e., learning with peers) has on African American women majoring in STEM and non-STEM fields academic achievement, and retention from their first to second year of college. Academic achievement (GPA) served as the dependent variable and retention, which indicated if the study participant persisted to the sophomore year of college and the independent variable, learning with peers, was used in both major categories based on their responses using a Likert scale in the NSSE survey. The study results for RQ_2 were significant, F (5, 551) = 2.806, p = .016 indicating learning with peers influenced differences between and within both STEM and Non-STEM groups. Descriptive statistics is displayed in Table 9. The results also indicated the strength of the dependent variable and learning with peers was weak as noted by r^2, where learning with peers representing 2% of the variance of GPA.

Table 9

Descriptive Statistics and Standard Deviation for Learning with Peers

Learning with Peers	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Non_STEM_Low	62	2.8187	.60720	.07711	2.6645	2.9729
Non_STEM_Medium	212	2.9722	.62573	.04298	2.8875	3.0569
Non_STEM_High	60	3.1173	.45249	.05842	3.0004	3.2342
STEM_Low	38	2.7522	.57264	.09289	2.5640	2.9404
STEM_Medium	146	2.9435	.45479	.03764	2.8691	3.0179
STEM_High	39	2.9657	.55220	.08842	2.7867	3.1447
Total	557	2.9477	.56142	.02379	2.9010	2.9945

The researcher also conducted Tukey's post-hoc test to identify all possible pairwise comparisons between the group's means because F was significant. Non-STEM results from Tukey's post-hoc test are outlined in Table 10.

Table 10

Non-STEM Tukey Post-Hoc Tests

(I) LearningPeers	(J) LearningPeers	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Non_STEM_Low	Non_STEM_Medium	-.15345	.08041	.398	-.3834	.0765
	Non_STEM_High	-.29852*	.10086	.038	-.5869	-.0101
	STEM_Low	.06653	.11474	.992	-.2616	.3947
	STEM_Medium	-.12472	.08442	.679	-.3661	.1167
	STEM_High	-.14700	.11382	.790	-.4725	.1785
Non_STEM_Medium	Non_STEM_Low	.15345	.08041	.398	-.0765	.3834
	Non_STEM_High	-.14508	.08144	.479	-.3780	.0878
	STEM_Low	.21998	.09811	.220	-.0606	.5005
	STEM_Medium	.02873	.05989	.997	-.1426	.2000
	STEM_High	.00645	.09703	1.000	-.2711	.2839
Non_STEM_High	Non_STEM_Low	.29852*	.10086	.038	.0101	.5869
	Non_STEM_Medium	.14508	.08144	.479	-.0878	.3780
	STEM_Low	.36506*	.11546	.020	.0349	.6952
	STEM_Medium	.17381	.08540	.324	-.0704	.4180
	STEM_High	.15152	.11455	.772	-.1761	.4791

*. The mean difference is significant at the 0.05 level.

The mean score for Tukey's post hoc test for the non-STEM LOW range (M = 2.81, SD = .61) was not significant when compared to non-STEM MED (M = 2.97, SD = .63), STEM LOW (M = 2.75, SD = .57), STEM MED (M = 2.94, SD = .45), and STEM HIGH (M = 2.96, SD = .56). However, the mean score for non-STEM low (M = 2.81, SD = .61) was found to be significant when compared to non-STEM HIGH (M = 3.11, SD = .45). Tukey test indicated the mean score for the non-STEM MED (M = 2.97, SD = .63) was not significant compared to non-STEM LOW (M = 2.81, SD = .61), non-STEM HIGH (M = 3.11, SD = .45), STEM LOW (M = 2.75, SD = .57), STEM MED (M = 2.94, SD = .45), and STEM HIGH (M = 2.96, SD = .56). Tukey test indicated the mean score for the non-STEM HIGH (M = 3.11, SD = .45) was not significant when compared to non-STEM MED (M = 2.97, SD = .63), STEM MED (M = 2.94, SD = .45), and STEM HIGH (M = 2.96, SD = .56). However, the mean score for non-STEM HIGH (M = 3.11, SD = .45) was found to be significant when compared to non-STEM LOW (M = 2.81, SD = .61) and STEM LOW (M = 2.75, SD = .57). Learning with peers influenced the academic achievement of non-STEM majors within the non-STEM group among the participants.

Table 11 outlines the STEM group range results from Tukey's post-hoc test. The mean score for Tukey's Post Hoc test for the non-STEM STEM LOW range (M = 2.75, SD = .57) was not significant compared to non-STEM LOW (M = 2.81, SD = .61), non-STEM MED (M = 2.97, SD = .63), STEM MED (M = 2.94, SD = .45), and STEM HIGH (M = 2.96, SD = .56). However, the mean score for STEM low (M = 2.81, SD = .61), was found to be significant when compared to non-STEM HIGH (M = 3.11, SD = .45). Tukey post-hoc test indicated STEM MED (M = 2.94, SD = .45) was not significant compared to non-STEM LOW (M = 2.81, SD = .61), non-STEM MED (M = 2.97, SD = .63), non-STEM HIGH (M = 3.11, SD = .45), STEM LOW (M = 2.75, SD = .57), and STEM HIGH (M = 2.96, SD = .56). Tukey post-hoc test indicated STEM HIGH (M = 2.96, SD = .56) was not significant compared to non-STEM LOW (M = 2.81, SD = .61), non-STEM MED (M = 2.97, SD = .63), non-STEM HIGH (M = 3.11, SD = .45), STEM LOW (M = 2.75, SD = .57), and STEM MED (M = 2.94, SD = .45). Learning with peers influenced the academic achievement of STEM majors between non-STEM Medium group among the participants.

Table 11

STEM Tukey Post-Hoc Tests

(I) LearningPeers	(J) LearningPeers	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
STEM_Low	Non_STEM_Low	-.06653	.11474	.992	-.3947	.2616
	Non_STEM_Medium	-.21998	.09811	.220	-.5005	.0606
	Non_STEM_High	-.36506*	.11546	.020	-.6952	-.0349
	STEM_Medium	-.19125	.10142	.412	-.4813	.0988
	STEM_High	-.21353	.12694	.544	-.5766	.1495
STEM_Medium	Non_STEM_Low	.12472	.08442	.679	-.1167	.3661
	Non_STEM_Medium	-.02873	.05989	.997	-.2000	.1426
	Non_STEM_High	-.17381	.08540	.324	-.4180	.0704
	STEM_Low	.19125	.10142	.412	-.0988	.4813
	STEM_High	-.02228	.10038	1.000	-.3094	.2648
STEM_High	Non_STEM_Low	.14700	.11382	.790	-.1785	.4725
	Non_STEM_Medium	-.00645	.09703	1.000	-.2839	.2711
	Non_STEM_High	-.15152	.11455	.772	-.4791	.1761
	STEM_Low	.21353	.12694	.544	-.1495	.5766
	STEM_Medium	.02228	.10038	1.000	-.2648	.3094

*. The mean difference is significant at the 0.05 level.

Next, the researcher performed an ANCOVA to determine if the significance for learning with peers remained the same after introducing retention as covariant. In order to proceed with an ANCOVA preliminary testing, homogeneity of slopes had to occur. The results from the homogeneity of slopes of academic achievement and learning with peers are outlined in Table 12. Findings indicate that the interaction between GPA and academic challenge was significant F (6, 550) = 20.74, p = .000 indicating the differences on GPA varied as a result of the covariant. This result caused a violation of homogeneity of slopes assumption; therefore, ANCOVA cannot be conducted.

Table 12

Learning with Peers Test of Between-Subject Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	32.328[a]	6	5.388	20.735	.000
Intercept	37.131	1	37.131	142.891	.000
LearningPeers * Retained	32.328	6	5.388	20.735	.000
Error	142.919	550	.260		
Total	5015.137	557			
Corrected Total	175.246	556			

a. R Squared = .184 (Adjusted R Squared = .176)

RQ_3: Does the influence of experiences with faculty on the retention of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

The researcher conducted a one-way analysis of variance (ANOVA) to evaluate the influence student engagement indicators (i.e., experiences with faculty) had on African American women majoring in STEM and non-STEM fields academic achievement, and their retention from their first to second year of college. Academic achievement (GPA) served as the dependent variable, and retention, which indicated if study participant persisted to the sophomore year of college and the independent variable, experiences with faculty, was used in both major categories based on their responses using a Likert scale in the NSSE survey. The study results for RQ_3 were not significant, F (5, 551) = 2.67, p = .21. It, therefore, cannot be determined how experiences with faculty influenced differences in academic achievement between STEM and non-STEM groups. The researcher did not conduct post-hoc tests because results were not significant.

Next, the researcher performed an ANCOVA to determine if the significance for experiences with faculty remained the same after introducing retention as a covariant. In order to proceed with an ANCOVA preliminary testing, homogeneity of slopes had to occur. The results from the homogeneity of slopes of academic achievement and academic challenge are outlined in Table 13. The findings indicate that the interaction between GPA and experiences with faculty was significant $F(6, 550) = 20.41$, $p = .000$ indicating the differences on GPA varied as a result of the covariant. This result caused a violation of homogeneity of slopes assumption; therefore, ANCOVA cannot be conducted.

Table 13

Experiences with Faculty of Between-Subject Effects

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	31.907[a]	6	5.318	20.405	.000
Intercept	37.131	1	37.131	142.472	.000
ExperienceFaculty * Retained	31.907	6	5.318	20.405	.000
Error	143.340	550	.261		
Total	5015.137	557			
Corrected Total	175.246	556			

a. R Squared = .182 (Adjusted R Squared = .173)

RQ_4: Does the influence of supportive campus environment of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

The researcher conducted a one-way analysis of variance (ANOVA) to evaluate the influence student engagement indicators (i.e., supportive campus environment) has on African American women majoring in STEM and non-STEM fields academic achievement and their retention from their first to second year of college. Academic achievement (GPA) served as the dependent variable and retention, which indicated if the study participant persisted to the sophomore year of college and the independent variable, supportive campus environment, was used in both major categories based on their responses using a Likert scale in the NSSE survey. The study results for RQ_4 were not significant, F (5, 501) = 1.84, p = .10. It, therefore, cannot be determined how a supportive campus environment influenced differences in academic achievement between STEM and non-STEM groups. The researcher did not conduct post-hoc tests because results were not significant.

Next, the researcher performed an ANCOVA to determine if the significance for a supportive campus environment remained the same after introducing retention as a covariant. In order to proceed with an ANCOVA preliminary testing, homogeneity of slopes had to occur. The results from the homogeneity of slopes of academic achievement and supportive campus environment are outlined in Table 14. The findings indicate that the interaction between GPA and supportive campus environment were significant F (6, 506) = 17.84, p = .000 indicating the differences on GPA varied as a result of the covariant. This result caused a violation of homogeneity of slopes assumption; therefore, ANCOVA cannot be conducted.

Table 14

Supportive Campus Environment Test of Between-Subject Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	27.929[a]	6	4.655	17.837	.000
Intercept	31.388	1	31.388	120.275	.000
SEcampus * Retained	27.929	6	4.655	17.837	.000
Error	130.483	500	.261		
Total	4559.901	507			
Corrected Total	158.412	506			

a. R Squared = .176 (Adjusted R Squared = .166)

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

In efforts to include women, providing sustainable measures, such as retention and academic/non-academic support, to serve as a roadmap to the inclusion of underrepresented minorities in STEM throughout all levels of education are needed. This research study examined the relationship of student engagement and academic achievement with retention as a mediator variable. This was done by evaluating African American female, full-time undergraduates majoring in science, technology, engineering, and mathematics (STEM) to female, full-time non-STEM majors at a Historically Black College and University to classify the most effective tools to assist in degree completion and student retention among women pursing STEM disciplines. The study's research questions were based on the National Survey of Student Engagement's indicators (i.e., academic challenge, learning with peers, experiences with faculty, and supportive campus environment) and used as independent variables with academic achievement as the dependent variable and retention as the mediator variable. The research study's purpose and summary, data collection, statistical analyses, conclusions, and findings are included in this chapter. In addition, based on the research findings and conclusions, recommendations for implementation of findings to the higher education community and future research ideas are detailed. This study was guided by the following research questions:

RQ_1: Does the influence of academic challenges on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_2: Does the influence of learning with peers on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_3: Does the influence of experiences with faculty on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

RQ_4: Does the influence of a supportive campus environment on academic achievement of African American female, full-time undergraduate students differ between STEM majors and non-STEM majors?

Summary

This study was conducted at a large, public Historically Black College and University in Virginia that participated annually in the National Survey of Student Engagement (NSSE) during the 2016 – 2018 academic years. NSSE is an annual survey that collects information from students matriculating at undergraduate institutions across the nation. The College Student Report is a subsidiary report used to determine success through engagement by the NSSE, which includes the ten-student engagement indicators categorized into four themes. Academic years were combined as a measure to have a sufficient female sample set to provide recommendations to the higher education community. The Office of Institutional Effectiveness invited students to complete the NSSE College Student Report annually in the corresponding study baseline years. The researcher examined, coded, and cleaned the data for this study. The researcher collected the following data: gender, classification, academic status, major, and GPA from student participants. The researcher drew from a sample of female respondents to the College Student Report during the baseline years for statistical analysis performance. The study utilized participants who self-report as females; not all other classifications will be included. The categories were divided into two groupings based on STEM on NON-STEM disciplines. The researcher used SPSS to run statistical analyses on of the four research questions. A one-way analysis of variance (ANOVA) was used to determine if significant differences within and amongst study group means were detected. ANCOVA was used as the mediator variable to test retention's influence if assumptions were not violated. Significance was tested at .05 alpha level. The results from this research showed significant differences between both STEM and Non-STEM groups on the learning with peer's indicator. However, the remaining three indicators: academic challenge, supportive campus environment, and experiences with faculty indicated no differences between STEM and non-STEM groups. The relationship between learning with peers and academic achievement was weak, with learning with peers accounting for 20% of the variance of the dependent variable. The researcher conducted Tukey post-hoc test to control for type I error. The findings indicated there were differences between and within group means of the six aforementioned groups.

Conclusions

The National Survey of Student Engagement has become an invaluable resource made available to higher education communities seeking to explore and improve student engagement at various levels during their institutional experience. Results from participating schools continue to inform administrators, faculty, and state legislatures an avenue to create strategic goals and objectives, institutional changes, and funding aimed at supporting student success initiatives. The next section discusses the four student engagement indicators results.

Academic Challenges

The results of this research study suggest that academic challenges indicated no significant difference in interactions detected within or between Non-STEM and STEM groups with academic achievement as its influence or retention as its covariant.

In an academic setting, removing biases (i.e., under-preparation, gender, cultural) that exist can shape how a student succeeds in their class. A few of the components required to measure academic challenge include memorization of course materials that directly apply existing theories and or facts and apply them (NSSE, 2020). This study could not indicate if specific emphasis was placed of helping students increase their study skills or assess their preparation for college coursework. Many programs target first year courses to assist in the elimination of under preparation in math and science courses; curriculum teams could have a coordinated effort to examine the successful practices in higher course and discard those that have not. The emphasis will always be on student engagement and student-faculty interaction. Departments will be encouraged to reexamine curricula and to incorporate research and research results into the courses. This can assist in students being able to transfer knowledge and apply difficult course concepts into practice. However, this study implies employing a wide range of instructional methods and tools will assist students in making connections between course material and real-world scenarios, such as how to study, independent and team engagement, multimedia resources and online tutorial services, office hours to assist with confidence building. Preparation work before students encounter major STEM courses can help remove any preparation barriers and encourage confidence in students being able to perform academically. Particularly for African American women in STEM, barriers still exist, such as feeling of inadequacies, competence, and lack of mentors in field (Ong, 2011). Redesigning courses around real-world scenarios and providing strategies where students can learn how to apply facts, theories, or methods to practical problems or new situations is beneficial. Faculty have a unique opportunity to assist students in specific techniques on how to evaluate point of view, decision making, and problem solving and how to form new ideas from previous knowledge. Simpson (2013) echoes the sentiment of previous studies that advocate for students to be involved in their academic pursuits, which increases their retention as an undergraduate (Astin, 1993; Pascarella & Terenzini, 1995; Tinto, 1993). Ownership in one's academic endeavors specifically in the classroom allows women to feel empowered to succeed in STEM fields, which have been dominated by white men for years and gain confidence in solving academic challenges at the undergraduate level before entering their fields. The academic challenge indicator sets high expectations and places ownership on students to perform (Pike, 2018).

Learning with Peers

The results of this research study suggest that learning with peers indicates a significant difference in interactions within and between Non-STEM and STEM groups with academic achievement as its influence or retention as its covariant. Pairwise comparisons of the means using Tukey HSD revealed found that the mean value of learning with peers was significantly different within the Non_STEM low and Non_STEM High group ($p = 0.038$, 95% C.I. = [-01, -0.58]). Results also indicated that there was a significant difference between Non-STEM_High and STEM low groups where $p = 0.02$, 95% C.I. = .69, .03. There were no other significant differences found between the other conditions ($p>0.05$). This study's findings provide evidence that African American women found opportunities within the campus environment to connect with peers academically. Results also determined that opportunities for peer collaboration and engagement exist, but additional work could be done to promote shared learning amongst women and their peers. Previous research has shown that when trying to understand concepts that are difficult, student knowledge increases when students learn with their peers (Brett, 2021). In addition, working in small group settings fosters in depth collaboration and communication both in and out of the classroom. Schudde (2019) notes that student persistence improved after freshmen participated in peer study groups. These findings are in contrast with Simpson (2013), whose results indicated that men lacked developmental problem-solving skills and struggled with connecting with peers and faculty.

In a previous study, Dasgupta et al. (2015) provided evidence showing the impact of learning with peers in small groups has on female persistence. They indicate the hesitancy to work in groups when members consist mostly of men. It is argued that working with peers who identify as female lowers the feeling of inadequacy women face in STEM fields where men have dominated for years. Although findings indicated that the learning with peer's engagement indicator is significant on academic achievement within and between groups, additional methods should be employed to create sustainable campus-wide effort to continue to increase peer learning collaboration. These include discipline specific learning communities, tutorial centers that focus on math and science courses, and design course projects that encourage team collaboration and exam preparations.

Experiences with Faculty

The study results related to experiences with faculty indicated no significant difference in interactions were detected within or between Non-STEM and STEM groups with academic achievement as its influence or retention as it's covariant. Previous research outlines the necessity of interactions between faculty and students; it contributes to student retention and satisfaction, success, motivation, and academic achievement (Romsa, 2017; Anaya & Cole, 2001; Chickering & Reisser, 1993; Cokley, 2000; Endo & Harpel, 1982; Terenzini & Pascarella, 1980). Findings from this study support that interacting with faculty on an academic level helps student with overall academic success. This requires an institutional commitment to ensure each student has the opportunity to participate in faculty led shadow mentoring, research experiences, career experiences as a strategic goal. This promotes the institution's commitment to their students and expresses shared responsibility of the students' academic career. Not only is interacting with faculty important but studies have shown that having a positive interaction increases the experiences of students through retention and academic performance (Wheatle, et al.; Kim, & Sax, 2009; Kuh & Hu, 2001; Lundberg & Schreiner, 2004; Sax, Bryant, & Harper, 2005). The findings from this study could not determine if experiences with their students were limited to the classroom environment or was extended to research or non-academic experiences to foster a positive interaction with students. Previous research shows that a connection through exploring various ideologies, academic perspectives, or viewpoints from both faculty and student assist both cognitively and socially as the student matriculates through college (Pineda et al., 2014; Pascarella & Terenzini, 2005; Astin, 1993). Research experiences and shadow mentoring show a real connectivity to students' major, faculty, and experts in field. Faculty have a unique opportunity to help build confidence and remove biases that exist. Findings from this study could not identify if participants benefited from having a female professor for these research experiences or if it was beneficial to have shadow mentoring opportunities with women in professional fields. Women have become a dominant force in STEM fields; however, men have outnumbered women since 2008 consistently (National Norms, 2017; National Science Board, 2016; Science and Engineering Indicators 2016). This number decreases significantly when considering African American women (National Norms, 2017; National Science Board, 2016;

Science and Engineering Indicators, 2016). Women make-up less than 30% of those employed in STEM fields; underrepresented category representation falls to 11% (Office of the President, 2018). Minorities will comprise half of the U.S. population by 2050 (Jackson, 2013). Faculty have a unique opportunity to engage with students academically and professionally. They also have a networking capacity that can provide confidence, exposure, and accountability to students entering their specific fields.

Supportive Campus Environment

The influence of a supportive campus environment was not significant between or within STEM and non-STEM groups with academic achievement as its influence or retention as it's covariant. Student engagement encompasses how students characterize their relationships with the campus community (i.e., Faculty/staff, peers, advisors, student-centered services). If these relationships are positive, they promote student learning and success (NSSE, 2020). The learning with peer's engagement indicator supports previous research that suggests undergraduates who experience positive campus relationships seek ways to find assistance and are able to learn from all they are connected to on campus. These findings indicate that additional work is needed through institutional programs that display a coordinated campus-wide effort for students to engage with all aspects of campus experience. NSSE (2020) defines supportive campus environments as including support that addresses cognitive, social, and physical student domains, which will foster higher levels of student performance and satisfaction. Institutions should aim to create an environment that continually strengthens engagement with the campus community and academic achievement to prepare students to obtain degrees in STEM and the highly technological workplace of the 21st century.

The major finding of this research study highlights that when African American women engage with their peers, the influence on academic achievement is significant. The statistical significance of the results confirms the independent variable learning with peers impacted academic achievement in between and within study groups. This study contributes to the growing call to find ways to retain not only students in higher education but cultural and gender specific related studies to increase degree attainment in STEM fields. Institution administrators, faculty/staff, students, and state legislators as a collective body have more work to do to draw connections between African American women and their engagement with all aspects of their college experience to promote academic achievement in their pursuit of attaining undergraduate degrees in STEM.

In conclusion, this study has multiple strengths and adds to the body of research that seeks to understand student engagement and academic achievement. Learning with peers may be associated with changes in academic achievement from the beginning of higher education toward its end. Therefore, identifying students at the beginning of their undergraduate pursuits and having programmatic methods in place for their engagement may facilitate the development of academic skills on campus and in their chosen career paths.

Best Practices for Administrators, State Agencies

Women have increased in visibility in the Science, Technology, Engineering, and Mathematics (STEM) fields recently. Underrepresented STEM populations, although small, are gaining traction in career fields associated with math, science, and engineering. Creating programs that develop specific STEM skillsets, peak curiosity, retain African American women from an early age, and provide avenues where students can learn together has proven to increase confidence, academic achievement, and increase STEM field attrition. This research provided insight to how students perceived their engagement with various levels of their campus experience influenced their academic achievement. To further identify best practices for institutions to consider, a short questionaire was given to administrative faculty to provide information on retention strategies currently in practice for the freshmen population at their institution. The following question was asked:

> What are best practices used at your institution to retain freshmen into the sophomore year? Faculty administrators listed a number of programs that targeted STEM populations below:

1. **Prestigious Mathematics and Applied Sciences Program** created to reduce the shortage of minority scientists by producing highly trained graduates capable of earning M.D.'s and Ph.D.'s. The key features are a four-week summer bridge program (pre-freshman), four-year academic scholarship; specialized curricula in biology, chemistry, computer science, engineering, applied mathematics, and physics; internships and/or research experiences; oral and poster competitions, career counseling; and seminars. Scholars participate in internships and/or research programs at the nation's premier government and corporate laboratories and prestigious universities. One of the primary objectives is to increase recruitment and enhance retention of students majoring in STEM courses at this HBCU. Accordingly, this program has taken a proactive approach to retaining students that includes Peer-Tutoring, Shadow Mentoring, and Collaborative Learning. The goal of these three new academically based programs and activities is to increase the graduation rate to 100%. Research suggests that providing structured academic support is more effective in meeting the academic needs of students.

2. **Peer Tutoring Program** provides one-on-one or peer group tutoring to assist other scholars who need extra help in STEM courses. Students are required to meet for two-hour tutoring sessions weekly, which are led by a team of volunteer upperclassmen proficient in the subject.
3. **Collaborative Learning Group** (**Evening Study/Tutorial)** is an intervention that organizes participants into study groups based on a common technical course. The groups meet for one to two-hour collaborative learning session weekly. The tutors are upper-class scholarship recipients who have achieved proficiency in the technical course in which they tutor. Students openly exchange problem solving ideas and methods. The idea is to create a forum where students in need of academic help are at ease in openly asking questions, and to promote and environment conducive to camaraderie and study.
4. **Shadow Mentoring Program** was created as a means to assist first year scholars in making a smooth transition to college life specifically as a STEM major. The purpose of the program is to help first year students manage their academic schedule, to provide proactive mentor support and to monitor the student's academic progress. A major meeting takes place with freshmen students just before the last day to drop a class to offer counseling.
5. **Summer Bridge Program** is designed to increase the success rate of all entering freshmen in all STEM fields, this Summer Bridge Program provides academic preparation and college acclimation to incoming freshmen enrolled within the College of Science, Engineering, and Technology. This is a four-week in-house academic enrichment program is required for all students who received STEM scholarships and available to any incoming STEM freshmen. Participants were administered the mathematics placement exam as a pre-

test and have been assigned to groups and math courses based on their performance. The program is designed to orientate students to the University and the rigors of studying in the areas of science and mathematics disciplines.

6. **Intrusive Academic Advising** is an initiative that involves academic advising of STEM discipline freshmen and sophomores by assigned departmental faculty to serve as Departmental Academic Counselors (DACs). These departmental faculty are also the same faculty who teaches the entering freshmen in their gateway courses within their departments. This allows the students to network and build relationships with their faculty members, not only as their advisor, but also as their professor and possibly faculty mentor. This advising model allowed for a smooth transition for students to build relationships with faculty in their academic disciplines and feel a since of community early on in their academic departments.
7. **Undergraduate Research and Summer Internship Program** provides students intellectual challenges and experiences in the scientific method of investigation, problem solving, state-of-the-art experimental procedures, and independent as well as teamwork. It has also been noted that students who participated in undergraduate research were more likely to choose to attend graduate school and research careers. An institutional effort was created that all undergraduate students in STEM have research experiences which are tracked, both on and off campus.
8. **University Progress Reports** allow the students and faculty to keep track of how well students are doing. It gives students the opportunity to make any adjustments in their study habits, identify any improvements needed concerning their time management, note taking skills, study skills, and begin using the university’s academic resources available

to them such as tutoring, mentoring, and the writing center. It may also help start a communication dialogue between the faculty and students about both parties' performances at that time. The goal of the 5^{th} and 10^{th} week progress report will hopefully provide students an opportunity to improve their grades before the final grade is submitted. For faculty, the progress reports can help them gauge how well students in their classes are learning, retaining information taught, and meeting their academic expectations.

These best practices can be mirrored at other Historically Black Colleges and Universities (HBCUs), seeking to improve student retention, academic success, and engagement opportunities for undergraduates. Faculty respondents mentioned that potential STEM majors are welcomed by a nurturing environment that provides resources to underrepresented minority students which include but not limited to tutoring, mentoring, undergraduate research, and internships via partnerships with national laboratories, other colleges and universities, and government agencies. HBCUs also provide funding via scholarships and/or last minute dollars to cover the expenses of low-income families who may not have enough funds to fully support their student's STEM education. As a result of these resources, HBCUs help increase their graduates work potential in the workforces, but more importantly moving forward to obtain his graduate and/or professional degrees in the STEM fields (faculty respondent, 2021).

Considerations for Higher Education Administrators, Faculty, & Advisors

Words cannot express the void that exists from the passing of my mentor, professor, encourager, advisor, and STEM inspiration, Dr. Sandra J. DeLoatch. She founded the department of Computer Science (CS), served in various administrative positions such as dean, provost, and interim president during her professional career at an HBCU. She administered millions in grants and external research projects for STEM initiatives. Her tutelage and training were the driving force behind me obtaining a B.S. in Computer Science. As a child, I was not exposed to African American women in STEM; her example served as a roadmap for my future career. Not only was she an inspiration academically but professionally. She delegated tasks that involved engagement with faculty, developing K-12 outreach STEM programs, and participating in scientific research initiatives, all to build confidence as a woman in STEM. She pushed me beyond my limits, taught me about ethics and integrity, how to be an effective leader, and respect towards all. I am now inspired to create opportunities for prospective STEM majors through scientific research, outreach activities, and cultivating technical presentation and leadership skills to assist in creating a well-rounded STEM professional. Dr. DeLoatch used her platform not only to inspire thousands of collegiate students, faculty, and staff but she was also committed to community endeavors. This type of intentional faculty/student engagement fostered confidence in working with others, learning with peers, academic challenges, and supportive campus environment. In my experience, having the right engagement with just one of the study's research independent variables provided positive engagement in the other three areas throughout matriculating through college. Having positive student engagement experiences with the campus, faculty, peers, and academically can make the difference in one leaving college with a degree or without one in STEM.

Future Research

This research offers extensive possibilities for future related studies. This study used one institution to collect data; future studies could solicit the use of HBCUs in the mid-Atlantic region and beyond that participate in the National Survey of Student Engagement at their institutions. Researchers should perform a meta-analysis to identify overall engagement trends from a larger student population. Another area for further studies is to replicate this research utilizing the same baseline years but to extend the study population to exclude gender or race specifications, thus allowing for a more extensive view on student engagement. While this research used undergraduates as its population, faculty engagement feedback will allow researchers to gain perspectives on student engagement through the lens of faculty. The NSSE collects data from faculty using the Faculty Survey of Student Engagement. In addition to using faculty data, another study can assess gender specific FSSE experiences or a comparative study against NSSE student participants. Ongoing research should inform future examination of student success programs to include mentoring, advising, and tutorial centers to assess satisfaction and how higher education can restructure to increase retention and provide a quality education for students using non-academic support institutional areas. This can also be compared to the supportive campus environment indicator to identify best practices for the higher education community. Several areas for future research on targeted demographics could add to the findings in this study. Another quantitative study that would further this study's findings would be the utilization of a larger and more diverse population, potentially comparing the perspectives of women and men, or undergraduates and faculty/administrators. A broader demographic of participants might provide additional views on academic achievement and retention of women in STEM pursing undergraduate degrees.

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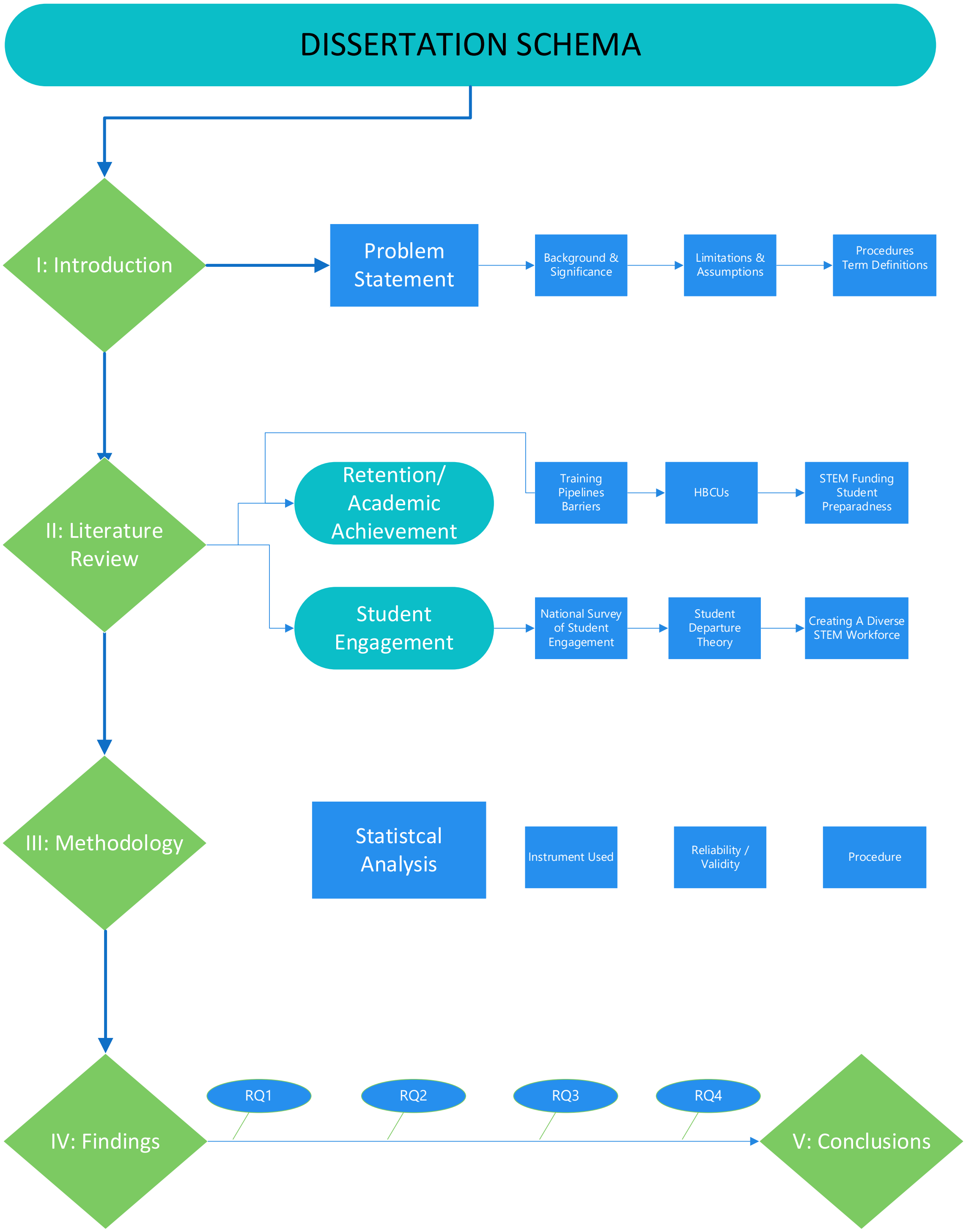
APPENDIX

Appendix A



Appendix B

NATIONAL SURVEY OF STUDENT ENGAGEMENT
2013-2020 COLLEGE STUDENT REPORT

This is a facsimile of the U.S. English version of the online NSSE instrument as it appears to the student. A paper-formatted facsimile of the survey which includes item numbering is available on the NSSE Web site: ***nsse.iub.edu/html/survey_instruments.cfm***

During the current school year, about how often have you done the following?

Asked questions or contributed to course discussions in other ways

Very often | Often | Sometimes | Never

Prepared two or more drafts of a paper or assignment before turning it in

Very often | Often | Sometimes | Never

Come to class without completing readings or assignments

Very often | Often | Sometimes | Never

Attended an art exhibit, play, or other arts performance (dance, music, etc.)

Very often | Often | Sometimes | Never

Asked another student to help you understand course material

Very often | Often | Sometimes | Never

Explained course material to one or more students

Very often | Often | Sometimes | Never

Prepared for exams by discussing or working through course material with other students

Very often | Often | Sometimes | Never

Worked with other students on course projects or assignments

Very often | Often | Sometimes | Never

Given a course presentation

Very often | Often | Sometimes | Never

Screen 1 of 3

VITA

Zenora E. Gay
Norfolk State University

EDUCATION

Doctorate of Philosophy in Education, May 2022
Old Dominion University, Norfolk, VA

Master of Science in Computer Science, 2014
Norfolk State University, Norfolk, VA

Bachelor of Science in Computer Science, 2001
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PUBLICATIONS

Spellman, Z. E. (2016). [Review of the book Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads by National Academy of Sciences, National Academy of Engineering, & Institute of Medicine]. Journal of Technology Education, 28(1), 71-76

Z. Spellman, M. Keeve, & S. DeLoatch, "Pathways to the STARS…A Summer Bridge Program to Retain Students." *HUIC Hawaii University International Conferences, Online Proceedings, June 2015.*

RESEARCH EXPERIENCE

- "Securing a Stronger STEM Future with Underrepresented Populations: A Narrative Approach of Persistence in African American Women in STEM"
- "The Impact of a STEM focused Industry partnership with HBCU's in Hampton Roads on Enrollment of Women in the STEM Workforce"
- "Impact of the STARS Undergraduate Research Program at NSU"
- "A Business Impact Analysis and Risk Assessment on the School of Business at Norfolk State University"

GRANTS

Co-Awarded $25,000 grant through the Department of Defense, Air Force Office of Scientific Research and Thurgood Marshall College Fund entitled: "Beyond the STARS: Extended Research Experience for Undergraduates in STEAM" (June, 2013)

Co-Awarded $180,000 grant through Workforce Development Opportunity Inc. entitled: Norfolk State University Out-of-School (OSY) Youth Program. (March, 2013)